



**Performance Report for Cooperative Agreement No: NA11SEC4810002  
for the Period from March 1, 2013 to August. 31, 2013**

**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 23 new students, and provided direct financial support to 79 students (18 Ph.D., 17 M.S., 44 B.S.) who received training in NOAA core science disciplines during this reporting period. In addition, 63 undergraduate and graduate students, who did not receive direct support from the Center, benefited from center programs and infrastructure. Sixteen (16) students graduated (6 BS, 8 MS, 2 Ph.D.) from the Center during this reporting period, and twenty-three (23) students interned at NOAA labs/facilities 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 where thirty-three (33) presentations were made by center students.

In order to maintain a pipeline of students into the marine sciences, the Center conducted several activities for grades K-12 which impacted 895 students, including the Coast Camp for Youth at Savannah State University (#=105 students), CREST-CISCEP SEEL program at UMES (#=7 students), and other programs initiated in spring 2013 for middle- and high school students from counties on the eastern shore of Maryland that reached more than 600 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. Thirty (30) NOAA scientific and administrative personnel were engaged in LMRCS education and outreach, scientific research and administrative functions.

NOAA LMRCS Research Cruise was held in June/July 2013 and ten (10) students participated, 9 of which came from LMRCS (UMES, DSU, IMET, HU) and ECSC-FAMU (1) institutions.

The LMRCS continued its Seminar Series by featuring presentations by two NOAA scientists and a seminar by Bradley Stevens. These seminars were made available to students and scientists at the Center and its partner institutions using Adobe Connect.

In support of Goal 3, thirteen (13) collaborative projects were funded by the LMRCS for 2012-2013 and 12 new projects were selected for funding in 2013-2014. 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 Research. For example, “The role of seascape characteristics of submerged aquatic vegetation as fisheries

habitat" (Project #6) explored the relationship between habitat characteristics and fisheries production (NMFS Objective 1.11), showing that fragmented seagrass habitats produce greater abundance of pink shrimp, and larger size in grey snappers and bluestriped grunts. Project #11 "Development of *in-situ* assessment and observation methods for black sea bass, *Centropristis striata*", tested new methods for fish stock assessment (NMFS Objectives 1.1-1.3) and modeled the relationship between trap CPUE and fish abundance, which will allow managers to interpret CPUE and landings data with greater accuracy. Project #7 "Evaluating the effects of prey quality on tissue lipids, taurine and growth in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) with a controlled feeding study" studied the importance of essential fatty acids contributed by zooplankton in the diet of wild salmon, and whether a plant-based alternative feed (taurine) provides equivalent nutrition. Aquatic animal health was explored by Project #9 "Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture", which determined whether certain strains of bacteria could be widely applied as probiotics in oyster aquaculture, potentially improving aquaculture yields (NMFS Objective 4.5), but found that similarities to human pathogens made them unsuitable for general use. This year we sponsored two projects in Fisheries Socio-Economics including Project #3 "Socioeconomic Factors Affecting Entry-stay-exit Behavior of the Blue Crab Fishers in the Chesapeake Bay" which explored decision-making strategies by commercial fishers (NMFS Objective 1.17), and found that both personal history and economic indicators were important determinants of fishing activity. 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*".

In the current reporting period, LMRCSC students and faculty made 45 presentations (oral and poster) at scientific meetings (33 of which were made by students), and published 21 articles in refereed journals and books, 11 of which were authored or co-authored by students or graduates of LMRCSC. 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 ~\$2.45 million 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.

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 U.S. competitiveness in the global economy. The tables below summarize some of the LMRCSC accomplishments during this reporting period.

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

- Number of students from underrepresented communities who were trained (**# = 109; 19 Ph.D., 17 M.S., 73 B.S.**) and graduated (**# = 13; 1 Ph.D., 6 M.S., 6 B.S.**) in NOAA-mission sciences in the past six months
- Number of students who were trained (**# = 156; 20 Ph.D., 26 M.S., 110 B.S.**) and graduated (**# = 16; 2 Ph.D., 8 M.S./PSM, 6 B.S.**) in NOAA-mission sciences in the past six months;
- Number of students who completed experiential opportunities at NOAA facilities/research vessels (**# = 17**);
- Number of EPP funded students who were hired by NOAA (**# = 2**), NOAA contractors (**# = 0**) and other environmental, natural resource, and science agencies at the Federal, State (**# = 0**), local and tribal levels, in academia (**# = 2**) and the private sector;
- Number of NOAA science and administrative personnel engaged in CSC Education and Outreach, Scientific Research, and Administrative functions (**# = 30**)
- Number of collaborative research projects undertaken between NOAA and MSI partners in support of NOAA operations (**# = 13**);
- Number of students (**# = 0**) and faculty (**# = 27**) 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 (# = 21);
- Funds leveraged with NOAA EPP funds (including student support) (Amount = ~\$2.45 million ); and,
- Number of outreach participants engaged in NOAA mission relevant learning opportunities (895).

### Summary of LMRCSC Performance Measures of Success (Education and Outreach Programs) for 2012 - 2013

	Proposed in the Implementation Plan 12 months	Accomplished (Jul. 1, 2012 – Feb. 28, 2013) 6 months	Accomplished (Mar. 1, 2013 – Aug. 31, 2013) 6 months	Accomplished (Jul. 1, 2012 – Aug. 31, 2013) 12 months
Activities/Programs	2012 – 2013	2012 - 2013	2012 - 2013	2012 - 2013
# K-12 Students participating in NOAA related science activities	1,000	Between 200 and 300	895	1,000 – 1,195
# of students trained in NOAA related Sciences	84	64	156	220
# B.S. Students who graduate in NOAA core Sciences	24	7	6	13
# M.S. Students who graduate in NOAA core Sciences	9	6	8	14
# Ph.D. Students graduating in NOAA core Sciences	4	2	2	4
# of internships at NOAA/other labs.	33	15	23	38
# of Courses to be offered via Virtual Campus or online	5	6	6	12
Amount of leveraged funds (\$) for education and outreach	500K	600K	895K	1,495K
# of student presentations at conferences	80	31	33	64
# of NOAA/LMRCSC Fisheries Cruises	1	0	1	1
# of student co-authored publications	15	4	11	15
# of individuals impacted by outreach activities	>1,000	Between 200 and 300	895	1,000 – 1,195

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

	Proposed in the Implementation Plan 12 months	Accomplished (Jul. 1, 2012 – Feb. 28, 2013) 6 months	Accomplished (Mar. 1, 2013 – Aug. 31, 2013) 6 months	Accomplished (Jul. 1, 2012 – Aug. 31, 2013) 12 months
Activities	2012 - 2013	2012 - 2013	2012 - 2013	2012 - 2013
1. Science Meeting date	March	No Science meeting was held this period	March 26, 2013	
2. # of TAB Proposals funded	10 to 16	12	12	12
4. # of proposals funded (leveraged funding)	10	13	31	31
5. # of scientific presentations at conferences	120 (80*)	59(31*)	45(33*)	104(64*)
6. # of theses & dissertations produced	10	7	10	17
7. # of peer-reviewed publications	15*-30	10(4*)	21(11*)	31(15*)
8. Amount of leveraged funds (\$)	\$3 million	~\$1.2 million	~\$2.45 million	~\$3.65 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 page 10.

**2. Status of Benchmarks due during the performance period:** Taking together the present and immediate past semiannual report for the year 2012 – 2013, the Center met or exceeded most of the benchmarks (e.g. number of students trained in NOAA related sciences, number of M.S. and Ph.D. students graduated, and number of theses and dissertations produced) in the 2012 – 2013 Implementation Plan, but apparently fell short of a few (e.g. number of B.S students graduated in NOAA related sciences, and number of presentations made by students). The performance measures are summarized on page 6 above.

3. **Status of Special Award Conditions (if applicable) Due During the Performance Period:** The following special award conditions have been met and the documents were submitted to NOAA EPP as required:
  - (a) LMR CSC 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, from page 22.
5. **Identification of All Collaborative Research Activities Undertaken During the Award Period:**

This is provided below under TAB funded projects, from page 22.
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 Committee Meetings, and conference calls by CSC Directors. The annual Science Meeting was held on March 26, 2013. The meeting was held at the OSU Hatfield Marine Science Center in Newport, OR, and was attended remotely via Adobe Connect by some scientists and TAB participants at partner institutions. The meeting included reports on the current TAB projects.
7. **Status of Recruitment (including students, staff and post-doctorates):** Twenty-three (23) students were recruited into the LMR CSC (please see Table 1). At SSU, a new outreach coordinator was hired, and interviews for a new post-doctoral research associate are underway. At UMES, interviews are underway to hire a post-doctoral research associate.
8. **Status of Faculty/NOAA Staff Exchanges:** None occurred during this reporting period.
9. **Status of Budget to Date (Expended and Remaining Funds):** Of the \$2,550,000 awarded to the LMR CSC in 2012-2013, \$1,795,584.50 has been spent whereas \$754,415.50 is remaining.

**10. Progress on LMR CSC Student Development Plan (SDP) Implementation:** The LMR CSC SDP focuses on three broad, but interrelated, areas that are known to influence educational success, namely academic/educational development, professional/career development, and social/personal development, facilitated using the Individual Student Development Plan (ISDP).

HU has developed a SDP that requires each student to conduct research during the academic year, to attend seminars, and workshops on effective science communication to peers and the public, and to participate in an outreach activity. Hampton University students, both LMR CSC and non-LMR CSC scholars, participate in all of the enhancement plans described below either through classes or the requirements for graduation from the Marine and Environmental Science department.

**Enhance Academic/Educational Development of students.** This will help to prepare the students to acquire knowledge and technical skills to develop NOAA mission-related portfolios, particularly in marine and fisheries sciences.

- a) **Offer rigorous courses in marine and fisheries science that include those considered essential for training fisheries scientists using the Centers virtual campus facility:** Among the courses that have been developed and offered online by the LMR CSC are Survey Sampling; Marine Population Dynamics; Introduction to Fish Population Dynamics and Stock Assessment; Ethics in Business, Fisheries Management, and Resource Economics; Multivariate Statistics, Risk and Decision Analysis; and Bayesian Statistics.
- b) **Provide students with research experiences on Center campuses:** All LMR CSC students are expected to engage in research work at their home institutions during the academic year under the guidance of a faculty mentor, and/or during the summer in form of internships. Thirteen (13) LMR CSC students interned at NOAA labs or in the labs of partner institutions during this reporting period, in addition to 10 students who received training during the 2013 summer NOAA LMR CSC research cruise aboard *RV Gordon Gunter*. Furthermore, center institutions (e.g. UMES, SSU, IMET, OSU) have summer research programs in marine and fisheries sciences that they use to train students recruited from various institutions. In summer 2013, 13 students gained research experience at UMES as part of the REU program funded by NSF, and partially by LMR CSC.
- c) **Organize seminars for faculty and students:** The LMR CSC has established a center-wide seminar series that is attended by center scientists and students. Presentations at these monthly seminars have been by scientists from the center and other institutions. Graduate students, particularly those supported by NSF CREST-CISCEP Center, leveraged with LMR CSC funds, have also given presentations of their research work to faculty and students. The Science Meeting, which included presentations of progress on TAB funded projects took the place of the seminar for March 2013. A seminar was given by Dr. Eugene Williams of Salisbury University on the "effects of climate change



on Arctic charr". Seminars are not held during the summer since students are occupied with field work. However, symposia were held at UMES and IMET at the end of summer REU internships in August 2013 during which undergraduate and high school students presented their research results to faculty, students and some of their parents who were in attendance.

#### **Enhance Professional/Career Development of students.**

- a) **Train students to develop skills to teach, to co-mentor, to give and to receive feedback:** In fall 2011 the LMRCSC paid an external consultant with expertise in Education who conducted a two day LMRCSC Teaching Assistant (TA) workshop attended by about 30 students that included center-supported and non-center supported students. The TA workshop idea has been adopted by the UMES School of Graduate Studies; the next workshop will be organized for all graduate students in October 2013.
- b) **Create opportunities for students to teach, co-learn and mentor other students:** LMRCSC graduate students, particularly at UMES, are encouraged to teach at least one semester long lab session before they complete their degrees. Undergraduate students are required to attend tutorial sessions to serve as tutors to other students and/or to receive tutoring from other students. The LMRCSC **has multiple levels of mentoring** such that during the summer and academic year high school and undergraduate students working in LMRCSC faculty research labs are co-mentored by graduate students, and high school students receive mentoring from undergraduate students. At UMES, for example, undergraduate and graduate students participated in the training and mentoring of summer 2013 interns in the REU, SEEL, and CSC Geosciences programs.
- c) **Enhance student's skills in writing grant proposals and completing application forms for scholarships and fellowships:** All graduate students in the LMRCSC write research proposals that are submitted to, and approved by the advisory committee before they can complete their degrees. Graduate students at the center are also required to take a Scientific Communications course or its equivalent that includes developing and writing a grant proposal. With the assistance of LMRCSC faculty and staff, LMRCSC students were encouraged to apply to various scholarships and fellowships during this reporting period including NOAA Sea Grant Knauss Fellowship (e.g. Emily Tewes, M.S., UMES).
- d) **Enable students to identify career opportunities and to develop interviewing and networking skills:** No center-wide Professional Development Workshop or LMRCSC Weekend was organized during this reporting period. However, through the recently developed "Network of NOAA Cooperative Science Centers for training high school students in geosciences", the LMRCSC collaborated with NCAS, ECSC and CREST and distributed materials to high school science teachers and gave presentations to high school juniors and seniors on geoscience career and educational opportunities at the centers. These activities drew several applications from high school students from which 16 students were selected, and subsequently participated in the 6 week summer 2013 Geosciences Bridge Program. Besides training in geosciences, participants received information on potential career options, particularly in NOAA related disciplines, learned about NOAA and how to look for and submit applications for internships. Likewise, exposures to career options in marine and fisheries science and opportunities for networking are integral components of the summer REU programs at LMRCSC institutions.
- e) **Create opportunities for students to develop collaborative leadership skills and to have leadership experiences:** LMRCSC students are included as co-moderators of sessions and as judges of posters and oral presentations during the annual university wide symposia at UMES, planned by the Graduate School collaboratively with the LMRCSC faculty. LMRCSC faculty and students were involved in the planning of the UMES research symposium that was held on April 16, 2013. Some LMRCSC graduate students took part in moderating the REU symposium that was held on August 8, 2013 at the Paul S. Sarbanes Coastal Ecology Center. Additionally, participation of center students in mentoring summer interns in the REU and CREST-CISCEP SEEL programs enabled them to gain some leadership skills.
- f) **Create opportunities for students to enhance their written and oral communication skills especially as it relates to translating discipline-based concepts, methods and practices in ways that experts from other fields will find understandable:** Several activities and programs have been held at the LMRCSC institutions to enhance students' oral and written communication skills, including LMRCSC sponsored seminars, symposia, conferences, and workshops. Written communication is enhanced through preparation of scientific reports as part of research experiences of undergraduates, and writing of proposals. Students wrote research abstracts and made oral and poster presentations at scientific meetings. LMRCSC graduate students are also required to prepare and submit a manuscript to a journal before completing their degree programs.

- g) **Create opportunities for students to learn budget management:** Budget developments and critiques are components of the Scientific Communications course that graduate students are required to take before completing their degrees. This course is taught at UMES in the fall.
- h) **Create opportunities for students to participate in NOAA's mission and LMRCS C research-related seminars:** LMRCS C students participated in LMRCS C's seminar series, which is made available online via Adobe Connect. Opportunities to participate in NOAA sponsored seminars are communicated to students as they become available.
- i) **Encourage students to participate in summer internships at NOAA labs and labs at LMRCS C partner institutions:** Thirteen (13) LMRCS C undergraduate and graduate students participated in summer internships or research activities at NOAA labs, non-LMRCS C institutions, and/or at LMRCS C institutions, including UMCES-IMET, OSU, UM-RSMAS and UMES during this reporting period. In addition, 8 LMRCS C students gained field research experience in summer 2013 aboard NOAA's vessel *RV Gordon Gunter*.
- j) **Encourage students to make oral and/or poster presentations at professional meetings:** Thirty-three (33) presentations were made by LMRCS C students at professional meetings during this reporting period.

**Enhance Social/Personal Development of students** – The development of social and personal skills is essential for academic and career success of students.

- a) **Provide opportunities for students to develop skills related to conflict and stress management:** Professional Development Workshop with modules on conflict management and strategies to reduce stress was not offered during this reporting period.
- b) **Guide students to develop professional profile on an established professional social networking site to document NOAA mission-relevant STEM career progress:** Students were encouraged to create accounts on linkedin.com.
- c) **Create opportunities for students to net-work:** Social interactions and development of LMRCS C students occurred during this reporting period through various means, including the LMRCS C Facebook page and the Graduate Student Association at UMES. Graduate and undergraduate students participated in the 4<sup>th</sup> Annual Regional Research Symposium held at UMES on April, 16, 2013 that was co-sponsored by the LMRCS C. A visit from University of Maryland Sea Grant UMCES REU students during summer 2013, and participation in the summer research cruise with students from other universities provided further networking opportunities for LMRCS C students. Furthermore, educationally enriching field trips (e.g. visits to NASA Space Center, Wallops Island and Smithsonian Natural History Museum in Washington D.C.) organized for students in the summer REU, CREST-CISCEP SEEL and CSC geoscience programs in summer 2013 provided opportunities for students to network.

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

For the period of **March 1, 2013 to Aug. 31, 2013**, 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:** Recruitment has been facilitated through increased outreach of LMRCS C using the following modalities: 1) LMRCS C web site and Facebook page, and Center institution web sites 2) LMRCS C

brochures, 3) Participation in meetings of American Fisheries Society (AFS), Association of Society of Limnology and Oceanography (ASLO), and other organizations which provide wide exposure, 4) Visits to universities/colleges and personal contact, 5) Internships at Center partner institutions and through instruction of pertinent courses by LMRCSO faculty.

- Summer programs including the CREST CISCEP Student Enrichment And Experiential Learning (SEEL), Geosciences program created by a consortium of NOAA Cooperative Science Centers, and intern programs like the Research Experience for Undergraduates funded by NSF expose students to the LMRCSO and the educational and research opportunities it offers.
- During this reporting period, Nivette Perez (B.S., University of Puerto Rico), who took part in the REU program at UMES in summer 2012, gained admission into DSU M.S. degree program, and Keya Jackson (B.S., HU), who participated in the UMES REU program in 2010, enrolled in the M.S. degree program at SSU. Four students (Dwight Collins, Avery Wilson, Wynton Goodman, and Jason Scott) who took part in the joint CSC geoscience bridge program in summer 2013 enrolled at UMES and joined the LMRCSO.
- Andrea K. Johnson (UMES) discussed the LMRCSO programs with students at the NOAA EPP Undergraduate Scholarship Program symposium in Silver Spring, MD in August 2013.
- SSU hosts open campus days during the summer for students who plan to apply to the university.

**IMET Internships:** The UMCES IMET hosted 7 undergraduate interns in summer 2013, including two students from HU (Shadaesha Green and Jonathan Garing). These students conducted guided research on LMRCSO projects alongside Center researchers in IMET's state-of-the-art aquaculture and biotechnology facilities. Although many interns are drawn from Center institutions, the program is open to students nationwide, providing the opportunity to recruit future graduate students.

The LMRCSO supported 79 students using NOAA funding and funds leveraged from other agencies through the efforts of Center researchers. Thirty-five (35) of the students were graduate students, including 18 Ph.Ds. Twenty-three (23) of the students were recruited during this reporting period (Table 1).

**Table 1. Students recruited into LMRCSO from March 1, 2013 to Aug. 31, 2013**

First Name	Last Name	Academic Institution	Degree Program	Expected Graduation Date
Nivette	Perez-Perez	DSU	M.S.	Spring 2016
Aneese	Williams	HU	M.S.	Spring 2015
Paul	Arkwright	SSU	M.S.	Spring 2015
Keya	Jackson	SSU	M.S.	Spring 2015
**Coral	Thompson	SSU	M.S.	Spring 2015
*Darius	Sanford	SSU	B.S.	Spring 2017
Laura	Almodovar-Acevedo	UMES	M.S.	Spring 2015
Wilmellie	Cruz-Marrero	UMES	M.S.	Spring 2015
Justin	Wilson	UMES	M.S.	Spring 2015
Juan	Alvarez	UMES	M.S.	Spring 2015
Detbra	Rosales	UMES	M.S.	Spring 2015
David	Marsan	UMCES	Ph.D.	Spring 2020
Kahil	Simmonds	UMCES	M.S.	Spring 2015
Jared	Jones	UMES	B.S.	Spring 2015
Dwight***	Collins	UMES	B.S.	Spring 2017
Avery***	Wilson	UMES	B.S.	Spring 2017
Wynton***	Goodman	UMES	B.S.	Spring 2017
Jason***	Scott	UMES	B.S.	Spring 2017
Remy	Jones	UMES	B.S.	Spring 2014
Eric	Lane	UMES	B.S.	Spring 2015
Even	Reeves	UMES	B.S.	Spring 2016

Assante	Thomas	UMES	B.A.	Spring 2015
Susan	Yeboah	UMES	B.S.	Spring 2016

*\*Supported on work study \*\*Supported as a Title VII fellow \*\*\*Participated in the summer 2013 CSC geoscience program funded by NOAA LMRCS and NSF*

## 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 LMRCS also engages in instructional and student support practices that have been shown to increase retention rates. LMRCS 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 March 1 to August 31, 2013 are listed in Table 2. Those who graduated during this reporting period are presented in Table 3. Among the students who graduated are 2 Ph.D., 8 M.S., and 4 B.S. students.

All faculty at SSU now use Grades First, a web-based software program that allows professors to report how students are doing in classes to a campus-wide system. In this way students who are having academic or non-academic challenges are identified in real time and assistance can be made available to them. All students are monitored in Grades First by their instructors during the week and by their academic advisors each semester. Dr. Chris Hintz (SSU) uses a NASA-funded SENSR program to provide early engagement to students on low risk research to help them develop their interests and build their skills early. He also hosts all the summer interns at his home for the summer Marine Sciences cookout. Dr. Tara Cox (SSU) coordinates the EDGE orientation/cookout at the beginning of the fall semester.

**Table 2. Students who received direct support during the funding period (March 1, 2013 to Aug. 31, 2013).**

First Name	Last Name	Academic Institution	Degree	Type	Amount (\$)
Lauren	Malinis	California State Univ. Monterey Bay/UMES Summer Intern	B.S.	Stipend, housing, travel	12,285.30
Omorose	Aighewi	College of Charleston/UMES Summer Intern	B.S.	Stipend	2,635.00
Kevin	Coles	DSU	B.S.	Stipend	5,789.88
Hillary	Dean	DSU	M.S.	Stipend/Tuition/Travel	14,494.87
Cory	Janiak	DSU	M.S.	Stipend/Tuition/Travel	5,752.90
Andrew	Kluge	DSU	B.S.	Stipend	2,043.20
Nivette	Perez-Perez	DSU	M.S.	Tuition	5,520.00
Brian	Reckenbeil	DSU	M.S.	Stipend	2,794.00
Andrea	Stoneman	DSU	M.S.	Stipend/Tuition/Travel	9,610.88
Aicha	Toure	DSU	B.S.	Stipend/Travel	4,739.28
Benjamin	Alston	HU	B.S.	Salary	1,280.00
Brittany	Carmon	HU	B.S.	Stipend	3,500.00
Dwayne	Dorsey	HU	M.S.	Stipend	4,800.00
Jonathan	Garing	HU/MET	B.S.	Stipend	6,750.00
Camille	Gaynus	HU	B.S.	Stipend	3,500.00
Shadaesha	Green	HU	B.S.	Stipend	3,500.00
Symone	Gyles	HU	B.S.	Stipend	3,000.00
Shani	Johnson	HU	Post-bac	Salary	5,324.00
Joalene	Mason	HU	B.S.	Salary	1,300.00
Joshua	Miller	HU	B.S.	Stipend	7,250.00
Tiara	Moore	HU	M.S.	Tuition and stipend	11,085.00
Ashlee	Ward	HU	B.S.	Salary	1,300.00
Aneese	Williams	HU	B.S.	Stipend	450.00

Chante	Davis	OSU	Ph.D.	Stipend/Tuition/Travel	10,000.00
LaTreese	Denson	OSU	M.S.	Stipend/Tuition/Travel	10,000.00
Marisa	Litz	OSU	Ph.D.	Stipend/Tuition/Travel	18,000.00
Matt	Ramirez	OSU	M.S.	Stipend/Tuition/Travel	14,000.00
Smit	Vasquez Caballero	OSU	Ph.D.	Stipend/Tuition/Travel	17,000.00
Paul	Arkwright	SSU	M.S.	Fellowship	9,188.00
James	Briscoe	SSU	B.S.	Stipend	4,000.00
Robert	Dumas	SSU	BS	stipend	4,000.00
Noelle	Hawthorne	SSU	MS	Stipend	4,999.99
Tisheena	Howard	SSU	BS	stipend	4,000.00
Shaneese	Mackey	SSU	BS	stipend	4,000.00
Tiffany	Ward	SSU	MS	Stipend	4,999.99
Jan	Vicente	UMCES	Ph.D.		0.00
Laura	Almodovar- Acevedo	UMES	M.S.	Stipend	3,441.68
Micheline	Brice	UMES	Ph.D.	Stipend	563.98
Wilmellie	Cruz-Marrero	UMES	M.S.	Stipend	3,985.68
Dan	Cullen	UMES	Ph.D.	Stipend, travel	10,238.38
Eric	Evans	UMES	Ph.D.	Travel	432.00
Wynton	Goodman	UMES	B.S.	Stipend, housing, tuition	7,041.46
Jared	Jones	UMES	B.S.	Stipend	2,362.28
Remy	Jones	UMES	B.S.	Stipend, housing	13,137.86
Nikkia	King	UMES	B.S.	Stipend	4,368.40
Eric	Lane	UMES	B.S.	Stipend, housing, travel	5,879.36
Hector	Malagon	UMES	M.S.	Stipend	7,594.62
Even	Reeves	UMES	B.S.	Stipend, travel, housing	11,067.78
Jhamyllia	Rice	UMES	Ph.D.	Stipend, travel	6,345.78
Candace	Rodgers	UMES	M.S.	Stipend	5,900.10
Jason	Scott	UMES	B.S.	Stipend, housing, tuition	5,973.46
Emily	Tewes	UMES	M.S.	Stipend	7,594.62
Assante	Thomas	UMES	B.S.	Stipend, housing, travel	6,016.86
Avery	Wilson	UMES	B.S.	Stipend, housing, tuition	6,697.96
Susan	Yeboah	UMES/IMET	B.S.	Stipend	3,608.00
Amanda	Alvarez	Univ. of Tampa/UMES Summer Intern	B.S.	Stipend, housing, travel	12,935.30
Karlissa	Calwood	University of Miami	Ph.D.	Partial Fellowship	1,653.05
Dwight	Ebanks	University of Miami	Ph.D.	Partial Fellowship, travel	14,280.00
Thomas	Granger	University of Miami	B.S.	Hourly student	600.00
Dominique	Lazarre	University of Miami	Ph.D.	Partial Fellowship	7,140.00
Rolando	Santos	University of Miami	Ph.D.	Partial Fellowship	7,140.00
Xaymara	Serrano	University of Miami	Ph.D.	Partial Fellowship	0.00
Erica	Dasi	University of Maryland Baltimore County	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	12,044.59
Jeanette	Davis	UMCES-IMET	Ph.D.	Salary, Fringe, Supplies, BAS Lab, Travel	11,811.71

Kathleen	Gillespie	UMCES-IMET	Ph.D.	Salary, Fringe, Supplies, BAS Lab, Travel	24,483.13
Ammar	Hanif	UMCES-IMET	Ph.D.	Salary, Fringe, Supplies, BAS Lab, Travel	17,371.22
Aaron	Watson	UMCES-IMET	Ph.D.	Salary, Fringe, Supplies, BAS Lab, Travel	7,658.88
Ulices	Dominguez	University of Maryland Baltimore County	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	6,466.05
Folasade	Ekulona	University of Baltimore	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	4,736.30
Charlene	Hernandez Camacho	Universidad Metropolitana	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	8,295.94
David	Marssn	University of Maryland College Park	Ph.D.	Salary, Fringe, Supplies, BAS Lab, Travel	4,591.02
Jonathan	Peake	University of Miami	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	4,851.59
Alexis	Peterson	Cheyney University of Pennsylvania	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	6,431.58
Caroline	Schkeeper	The Richard Stockton College of New Jersey	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	6,431.58
Jasmine	Smalls	Cheyney University of Pennsylvania	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	6,431.58
Elizabeth	Tkaczynski	Rider University	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	34.47
David	Billups	Univ. of North Carolina at Wilmington	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	2,465.76
Oluwatobi	Paul	Univ. of Maryland Baltimore County	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	8,344.43
Kahil	Simmonds	Univ. of Maryland Baltimore County	M.S.	Salary, Fringe, Supplies, BAS Lab, Travel	5,442.06
Erica	Iguacho	Univ. of Maryland Baltimore County	B.S.	Salary, Fringe, Supplies, BAS Lab, Travel	474.89
<b>Total</b>					<b>\$517,257.68</b>

**Table 3. Students who graduated from March 1, 2013 to Aug. 31, 2013.**

First Name	Last Name	Academic Institution	Degree	Date	Post-Graduation Information
Katelyn	Fleming	DSU	M.S.	May 2013	NOAA/DE Seagrant Fellowship
Cory	Janiak	DSU	M.S.	May 2013	unknown
Brian	Reckenbeil	DSU	M.S.	August 2013	Research Technician DSU
Shani	Johnson	HU	M.S.	May 2013	Applying for medical school
Tiara	Moore	HU	M.S.	May 2013	PhD program at ODU
Aneese	Williams	HU	B.S.	May 2013	Graduate student at U. of Miami
Noelle	Hawthorne	SSU	M.S.	May 2013	Working as a tech in Hoskins' lab
James Edward	McCullars	SSU	B.S.	May 2013	Working in marine-related position
Courtney	Depass	UMES	B.S.	May 2013	Looking for a position
Belita	Nguluwe	UMES	M.S.	May 2013	Looking for a position
Alexander	Nyarko	UMES	B.S.	May 2013	Pharm D program
Candace	Rodgers	UMES	M.S.	May 2013	Looking for a position
Xaymara	Serrano	University of Miami	Ph.D.	August 2013	NRC Post-Doc at NOAA AOML
Aaron	Watson	UMCES-IMET	Ph.D.	August 2013	unknown

Retention and degree completion rates are higher in academic programs that engage students in collaborative research with faculty members. Projects funded by LMRCSC 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 LMRCSC campuses, or at NOAA labs. Table 4 shows students who worked at NOAA labs or LMRCSC partner institution labs. Students who took part in the LMRCSC summer research cruise are presented in Table 5.

**Table 4. Students who worked at NOAA labs or LMRCSC partner institution labs (March 1, 2013 to Aug. 31, 2013)**

First Name	Last Name	Institution	Degree	Facility	Time Period	Activity or Title of Research Project
Derrick	Alcott	UMES	PSM	NOAA J.J. Howard Marine Sciences Lab, Sandy Hook, NJ	June to Sep. 2013	Meta-analysis of ocean acidification experiments on early life-stage of marine fishes
Laura	Almondovar-Acevedo	UMES	M.S.	NOAA Oxford Lab, MD	June to Aug. 2013	Augmenting the Black Sea Bass, <i>Centropristis striata</i> , Stock
Aicha	Toure	DSU	B.S.	NOAA Oxford Lab, MD	July to Aug. 2013	Menhaden Diet Project
Brittany	Carmon	HU	B.S.	NOAA Pascagoula, Harvesting Systems Lab	June to Sep. 2013	Assessing Gear Interactions with Protected Species
Jonathan	Garing	HU	B.S.	UMCES-IMET	June to Aug. 2013	IMET internship on submerged aquatic vegetation
Camille	Gaynus	HU	B.S.	UCLA/NOAA EPP	June to Sep. 2013	Coral Reef research
Shadaesha	Green	HU	BS	UMCES-IMET	June to Sep. 2013	Red Crab research with Sook Chung
Symone	Gyles	HU	B.S.	NOAA HQ	June to Sep. 2013	Analysis of killer whale ( <i>Orcinus orca</i> ) and Pacific white-sided dolphin ( <i>Lagenorhynchus obliquidens</i> ) occurrence and distribution patterns near Monterey Bay, CA using multiple data sets
Joshua	Miller	HU	B.S.	UM-RSMAS		Role of seascape characteristics of submerged aquatic vegetation
Eric	Parks	SSU	B.S.	OSU	May to Sep. 2013	Solid analysis of biogenic materials
Susan	Kelly	UMES	PSM	NOAA Cooperative Oxford Lab., MD	June to Sep. 2013	Forecasting Chesapeake Bay striped bass recruitment via environmental modeling
Jaime	Belanger	UMES	PSM	Mid Atlantic Fisheries Management Council, Dover, DE	June to Sep. 2013	Preliminary assessment of Mid-Atlantic Fishery Management Council impacts through time considering trends in council managed fisheries.
Susanna	Yeboah	UMES	B.S.	UMCES-IMET	June to Aug. 2013	Diversity of bacterial isolates from marine invertebrates

**Table 5. Students who participated in the summer 2013 LMRCS Research Cruise.**

First Name	Last Name	Degree	Institution	Vessel	Date
Evan	Lindsay	PSM	UMES	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Derrick	Alcott	PSM	UMES	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Efeturi	Oghenekaro	Ph.D.	UMES	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Jaime	Belanger	PSM	UMES	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Omorose	Aighewi	B.S.	College of Charleston, SC; UMES Intern	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Aicha	Toure	B.S.	DSU	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Shadaesha	Green	M.S.	HU	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Imam	Syhada	Ph.D.	Univ. of Rhode Island	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Kahil	Simmonds	B.S.	UMCES-IMET Intern	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013
Latrisha	Allen	M.S.	FAMU	NOAA R/V Gordon Gunter	Jun 28 – July 9, 2013

Sixty-three (63) undergraduate and graduate students, who did not receive direct support from the LMRCS, benefited from the programs offered by the Center and/or infrastructure established by the LMRCS during this reporting period. Names of the students 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 LMRCS**

First Name	Last Name	Classification/Institution
Kris	Roeske	M.S. Graduate Student, DSU
Matthew	Dill	B.S. student, HU
Krista	Kraskura	B.S. student, HU
Justin	Shaifer	B.S. student, HU
Oroboghene*	Adia	B.S. student, UMES
Habibul*	Bakht	Ph.D. student, UMES
Addis*	Bedane	B.S. student, UMES
William*	Boley	B.S. student, UMES
Courtnee*	DePass	B.S. student, UMES
Chiamaka*	Ebigbo	B.S. student, UMES
Bernadette*	Ezeabikwa	Ph.D. student, UMES
Kihoto*	Gitonga	B.S. student, UMES
Dev*	Gurung	Ph.D. student, UMES
Samir*	Karim	B.S. student, UMES
Mahalet*	Nega	B.S. student, UMES
Iheoma*	Ngoka	B.S. student, UMES
Ijeoma*	Ngoka	B.S. student, UMES
Kingsley*	Nkeng	B.S. student, UMES
Abena*	Okyere Acheampo	B.S. student, UMES
Oghale*	Otiede	B.S. student, UMES
Chelsea*	Richardson	B.S. student, UMES
Kennard*	Roy	B.S. student, UMES
Abey*	Zeleke	B.S. student, UMES
Muneerah	Abdusshahid	B.S., Geoscience, UMES
Saadman	Chowdhury	B.S., Geoscience, UMES
Dwight	Collins- Nixon	B.S., Geoscience, UMES



Anthony	Cooper	B.S., Geoscience, UMES
Ashlyn	Ford	B.S., Geoscience, UMES
Wyntin	Goodman	B.S., Geoscience, UMES
Harley	Gribben	B.S., Geoscience, UMES
Basir	Johnson	B.S., Geoscience, UMES
Caleb	Jones	B.S., Geoscience, UMES
Lucy	Lin	B.S., Geoscience, UMES
Sara	Louie	B.S., Geoscience, UMES
Jason	Scott	B.S., Geoscience, UMES
Kelley	Smith	B.S., Geoscience, UMES
Alexis	Sturm	B.S., Geoscience, UMES
Zane	Toyon	B.S., Geoscience, UMES
Avery	Wilson	B.S., Geoscience, UMES
Kristen*	Lycett	M.S. student, UMES
Dana*	McNair	M.S. student, UMES
Detbra*	Rosales	M.S. student, UMES
Heather*	Wolfer	M.S. student, UMES
Ejiro*	Mayor	Ph.D. student, UMES
Efeturi*	Oghenekaro	Ph.D. student, UMES
Ozuem*	Oseji	Ph.D. student, UMES
Baruch*	Volkis	Ph.D. student, UMES
Derrick**	Alcott	PSM student, UMES
Jaime **	Belanger	PSM student, UMES
Susan**	Kelly	PSM student, UMES
Limary**	Rivera-Santana	PSM student, UMES
Krizia	Chambers	REU Intern, UMES
Daniel	Hernandez	REU Intern, UMES
Matthew	Maxwell	REU Intern, UMES
Erik	Mobley	REU Intern, UMES
Tonisha	Patton	REU Intern, UMES
Patricia	Perez	REU Intern, UMES
Adrian	Plummer	REU Intern, UMES
Ronald	Tardiff	REU Intern, UMES
Alexandra	Thompson	REU Intern, UMES
Coral	Thompson	B.S. student, SSU
Loughlin***	Onyeokoro	B.S. student, SSU
Sanya****	Compton	M.S. student, SSU

\*Supported with NSF CREST funds leveraged from the LMRCSC

\*\*Supported with NSF PSM funds leveraged from the LMRCSC

\*\*\*Supported with Georgia Conservancy funds leveraged from the LMRCSC

\*\*\*\*Supported with NSF REU funds leveraged from the LMRCSC

**Examples of How Students Benefitted from the LMRCSC:** Research advisors of some of the students are also LMRCSC supported faculty. LMRCSC supported faculty are involved in teaching and advising PSM students. Some of the students also use instrumentation and supplies as well as facilities provided by the LMRCSC, or participate in workshops organized by the LMRCSC.

**Career Development Assistance:** It is critical for students to understand that editing and proofreading are critical aspects of the writing process and that even professional scientists have their work reviewed by supervisors, colleagues and co-authors prior to submission. Students are, therefore, expected to submit all applications for scholarships and fellowships, cover letters, and CVs for review by at least one faculty or staff member. Three LMRCS C students were assisted to identify and apply for scholarships and fellowships during this reporting period. In addition, LMRCS C faculty and staff reviewed application materials for several graduating students applying for professional positions. Students were encouraged to participate in training and mentorship of summer interns working in their labs (Table 7). Faculty provided instruction and feedback to help students develop mentorship skills.

**Table 7. Examples of UMES LMRCS C Graduate Students Who Participated in Mentoring Activities During Summer 2013 Undergraduate and High School Internships**

First Name	Last Name	Intern Mentored	Project Title
Kristin	Lycett	Adrian Plummer (Undergraduate); Danielle Brittingham (High School Student)	Cloning Potential Candidates for Genes that Code for Protein Kinase C in <i>Perkinsus marinus</i>
Heather	Wolfer	Patricia Perez (Undergraduate); Cristin Archer (High School Student)	Immune System Response to Hypoxia of Atlantic Croaker In Chesapeake Bay, MD
Dan	Cullen	Ronald Tardiff, Amanda Alvarez (Undergraduates)	Size related variation in black sea bass diet Sex ratios of Black sea bass, <i>Centropristis striata</i> , in the northern Atlantic Ocean
Tedra	Booker	Matt Maxwell, Even Reeves (Undergraduates); Andre Collins (High School Student)	Determination of Vitellogenin in White Perch as a biomarker of exposure to estrogenic compounds Estrogenic effluents effect on sex ratios in White Perch
Alexander	Nyarko	Erik Mobley (Undergraduate)	Analysis of Heavy Metals in Maryland Coastal Bays (MCB) With Chelex 100 Resin
Eric	Evans	August Fuller (High School Student)	Determination of Sex Ratios of Bay Anchovy in the Maryland Coastal Bays
Rehab	El Fadul	Joseph Ephrem (High School Student)	Determination of Contaminants of Emerging Concerns (CECs) in Maryland Coastal Bays
Evan	Lindsay	Abraham Kim (High School Student)	Biological Characteristics of Black Sea Bass

**Build strong peer networks through student collaboration:** The Center has a Facebook web page, where potential students and those interested in the LMRCS C participate in discussions on a range of topics, including research projects, employment opportunities, and postdoctoral fellowships. The 4<sup>th</sup> Annual Regional Research Symposium held at UMES on April, 16, 2013 provided students an opportunity to network with students from UMES and other institutions.

**Continually assess student performance and progress toward degree completion**

**LMRCS C Exit Evaluation:** Two exit evaluations were submitted during this reporting period.

**LMRCS C Cruise Evaluation:** Five evaluations of the July 2013 research cruise were submitted during this reporting period.

**Evaluation Forms for interns and mentors:** No evaluation forms were submitted 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 LMRCS C graduates to enter the scientific and environmental management workforce. Participation in LMRCS C 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 were 63 in number. Additionally, the infrastructure that the LMRCS C 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. The Center leveraged ~\$2.45 million from external sources during this reporting period.

Monitoring the career paths of LMRCS C students is critical in determining the extent to which the Center is meeting NOAA’s workforce development goals. The LMRCS C 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 LMRCSO has contributed significantly to the research and teaching infrastructure at the partner institutions.

**New videoconference facility:** Due to the high volume of usage of the existing IVN system at UMES, we are currently exploring options for funding the purchase of a second system.

**Monitoring student progress:** LMRCSO 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 LMRCSO program overall, which graduating students are requested to submit, and for specific recurring activities such as the LMRCSO research cruise.

**Post-Graduate Tracking:** Efforts are on-going to provide up-to-date graduate tracking information.

**Scholarship:** Emily Tewes (M.S., UMES) has been awarded NOAA Sea Grant Knauss Fellowship for 2014.

#### **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.

Students attended various scientific meetings, for example: the SEAMAMMS, SEERS, and Benthic Ecology meetings.

**Engagement with NOAA:** All LMRCSO 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 graduate program.

Eight (8) LMRCSO students worked at NOAA labs under the guidance of NOAA scientists, and 8 additional students took part in summer 2013 research cruise aboard NOAA vessel.

Three students from Hampton University are receiving NOAA EPP scholarships

The LMRCSO at SSU continues to contribute oral histories to the NOAA Voices From the Fisheries program.

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

**Activities and Accomplishments:** Several scientists from LMRCSO institutions participate in collaborative TAB projects funded 2012-2013 and the joint CSC projects. For example, OSU faculty members, Jessica Miller, Selina Heppell, Gil Sylvia, and Rebecca Vega-Thurber, are all leading or participating in TAB-funded research projects that involve scientists and students at HU, UMES, UM-RSMAS, SSU as well as NOAA's Northwest, Southeast, and Southwest Fisheries Science Centers. Jessica Miller is also collaborating with Center partners on the Center-wide project "Trophic ecology of forage fishes: linking primary productivity to fisheries production". This joint research project involves five Center partners as well as ECSC, NOAA collaborators, and provides excellent training opportunities for both undergraduate and graduate students.

David Die (RSMAS) and Elizabeth Babcock (RSMAS) provide support to the Professional Science Master's degree program in quantitative fisheries and resource economics at UMES by teaching Marine Population Dynamics and Bayesian Statistics to the students who are enrolled in the program as well as to students enrolled in the MEES program at UMES, and DSU students in the Fish and Wildlife program.

#### **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:** Through the LMRCSO collaboration, students have access to a broader range of curricular and research experiences. They have opportunities to take courses and engage in research with faculty at other LMRCSO partner institutions, and with NOAA scientists who serve as adjunct faculty, thesis or dissertation committee members, and professional mentors.

CSC Directors had several conference calls during the reporting period during which potential collaborative research and educational programs were discussed and developed. To ensure that students and faculty are informed about current research within LMRCSO, 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:** Extensive collaboration between LMRCSC faculty and NOAA scientists ensures that curriculum development is informed by the current challenges and emergent needs in the marine and fisheries sciences. This level of collaboration extends to having NOAA scientists teach courses with LMRCSC faculty, and serve on dissertation committees. Internship experiences at NOAA laboratories and field research aboard NOAA vessels also ensure that students participate in a curriculum that is highly aligned with the needs of NOAA-NMFS.

Each January or February since 2007, LMRCSC has offered 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 has been conducted in collaboration with the NOAA Northeast Fisheries Science Center. This year a summer cruise was conducted in July 2013 aboard the *R/V Gordon Gunter*. Examples of NOAA scientists collaborating with scientists and students at the LMRCSC are presented in Appendix I.



Participants in the 2013 Summer Cruise

## 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 to include not only courses offered through videoconferencing, but also in an online format. Three courses were offered to center students during spring 2013 using the virtual campus facility: Introduction to Fish Population Dynamics and Stock Assessment, Marine Population Dynamics, and Multivariate Statistics (Table 8). Dr. David Die (RSMAS) teaches the Marine Population Dynamics course. Four students from UMES and five from DSU were enrolled in the course in addition to four RSMAS students.

At Hampton University, Tiara Moore’s committee meetings were held using the virtual campus to engage Howard Townsend from the NOAA Chesapeake Bay Office. At OSU, weekly Miller lab meetings and journal discussion groups were made available via polycom to students in both Newport and Corvallis (~50 miles apart), providing students with more options for participating in professional development. Furthermore, Center MS student LaTreeese Denson, who currently takes courses on the main campus and lives in Corvallis, frequently meets with her advisor, Dr. David Sampson via Skype.

OSU hosted the March 2013 Annual LMRCSC Science Meeting and offered remote participation options for interested partners, including the University of Miami, UMES, IMET, and Hampton University which made it possible for scientist at the Center who received TAB funding to provide updates of their research results from a remote site.

**University of Maryland Interactive Video Network (IVN) courses:** Several University System of Maryland MEES courses were offered in Spring 2013 semester to LMRCSC students and others at UMES.

**Table 8. Courses Offered Online at the LMRCSC during Spring Semester 2013 as Part of the PSM Degree Program**

Course number	Course Title	Instructor	Students (online)
MEES 642	Intro. Fish Pop. Dynamics & Stock Assessment	Chigbu & Alade	Derrick Alcott (PSM, UMES) Susan Kelly (PSM, UMES) Limary Rivera Santana (PSM, UMES) Jaime Belanger (PSM, UMES) Michele Traver (PSM, UMES) Hector Malagon (M.S., UMES/LMRCSC)
MEES 688	Marine Pop. Dynamics	David Die (RSMAS)	Derrick Alcott (PSM, UMES) Susan Kelly (PSM, UMES) Limary Rivera Santana (PSM, UMES) Jaime Belanger (PSM, UMES) Hector Malagon (M.S., UMES/LMRCSC) James Kilfoil (DSU) Amy Comer (DSU) Hillary Dean (DSU) Symone Johnson (DSU)

MEES 644	Multivariate Statistics	Malik Malik	Derek Alcott (PSM, UMES) Susan Kelly (PSM, UMES) Limary Rivera-Santana (PSM, UMES) Jaime Belanger (PSM, UMES) Hector Malagon (MEES, UMES) Ozeum Oseji (MEES, UMES) Anthony Pokoo-Aikins (UMES)
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**Seminars:** The LMRCS SC Seminar Series continued in this reporting period. Dr. Eugene Williams (Salisbury University) gave a seminar on April 5, 2013 entitled “Climate Change and the Icelandic Arctic Charr: Biochemical and Metabolic Responses”. The presentations were made available at LMRCS SC partners via the Virtual Campus.

**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 LMRCS SC 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. Thirteen (13) students worked at NOAA labs, Center institutions or other agencies in summer 2013 (Table 4).

The placement statistics of SSU Marine Science Department graduates demonstrate our ability to meet the needs of the ocean sciences professional community. We continue to evolve our offerings to meet market needs. SSU offers an Associate degree in Aquarium Science in addition to B.S. and M.S. degrees in Marine Sciences. The B.S. curriculum has been revised to offer students additional higher level electives in courses such as Oceanic Change and Climate Change. The M.S. program offers several courses through the GK-12 program that teach graduate fellows how to teach and then places them in classrooms for 10 hours weekly.

LMRCS SC students (e.g. Tiffany Ward, a master’s graduate fellow) at SSU participate in research on monitoring of oyster reef restoration sites. This work started as a collaborative project with NOAA’s Restoration Center. This year, every undergraduate LMRCS SC intern at SSU went out to conduct monitoring with Tiffany. The EDGE program supports a research cruise twice per year and most undergraduates go on that 2 day cruise at least once each year.

**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. LMRCS SC research undergoes a rigorous scientific review process. Each year, LMRCS SC 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 LMRCS SC research is of high quality and aligned with NOAA-NMFS research priorities. Each year, LMRCS SC 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:**

12 projects were funded in 2012-2013 and are currently being completed (Table 9).

12 projects were selected for funding for 2013-2014.

**Table 9. Projects Funded by the LMRCS SC for 2012 - 2013**

PI	Title	Amount
Andrew Baker (RSMAS)	Do elevated nutrients increase the susceptibility of essential reef fish habitat to climate change stressors? A field experiment in the Florida Keys using novel genetic tools	\$27,869

2. Dwight Ebanks (RSMAS)	Influence of Aqueous hypercapnia on cobia, <i>Rachycentron canadum</i> , pre-fertilization and larval stages of development	\$43,445
3. Tao Gong (UMES)	Socioeconomic factors affecting entry-stay-exit behavior of the blue crab fishers in the Chesapeake Bay	\$46,088
4. Selina Heppell (OSU)	Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles	\$38,367
5. Andrea Johnson (UMES)	Organic Contaminants in monkfish, <i>Lophius americanus</i>	\$28,174
6. Diego Lirman (RSMAS)	The role of seascape characteristics of submerged aquatic vegetation as fisheries habitat	\$50,593
7. Jessica Miller (OSU)	Evaluating the effects of prey quality on tissue lipids, taurine and growth in juvenile Chinook salmon ( <i>Onchorynchus tshawytscha</i> ) with a controlled feeding study	\$54,596
8. Joseph Pitula (UMES)	Dinoflagellate Community Structure within a Maryland Coastal Bay Ecosystem	\$32,885
9. Eric Schott (IMET)	Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture	\$34,753
10. Bradley Stevens (UMES)	Augmenting the Black Sea Bass, <i>Centropristis striata</i> , Stock Assessment: Assessing the importance of fixed and fluid estuarine habitats	\$38,186
11. Bradley Stevens (UMES)	Development of <i>in-situ</i> assessment and observation methods for black sea bass, <i>Centropristis striata</i> , Year 3	\$43,044
12. Gill Sylvia (OSU)	Modeling Spatial-Temporal Fishing Effort of the West Coast Salmon Fishery	\$41,451

## TAB Project Summary

**1. Project Title:** Do elevated nutrients increase the susceptibility of essential reef fish habitat to climate change stressors? A field experiment in the Florida Keys using novel genetic tools

**Project Summary:** The long-term future of reef ecosystems, and the organisms that inhabit them, depends on the continued persistence of reef corals as essential habitat builders. Principal threats facing coral reefs worldwide include the effects of climate change (in particular, coral 'bleaching' as a result of heat stress) and nutrient pollution. These stressors are usually thought of as acting independently, but using a novel molecular technique we have recently discovered an interaction between partners in the coral-algal symbiosis that suggests that nutrient pollution can directly increase the severity of coral bleaching. We propose to leverage an existing field-based nutrient and herbivory experiment in the Florida Keys to test this hypothesis. The lab at OSU will take samples of corals exposed to a variety of nutrient and herbivory treatments (and controls) from this field experiment, extract the DNA, and send the samples to the lab at UM. UM will then analyze these samples and test whether elevated nutrients increases the S:H ratio in these corals. Thermal tolerance experiments at UM will then test whether elevated S:H ratios caused by high nutrients makes corals more susceptible to bleaching. The results of this collaboration are important because if management action to reduce nutrients directly increases coral resistance to bleaching this would have immediate applicability to preserving essential fish habitat in the face of climate change.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Andrew Baker, University of Miami (UM)

**NOAA Collaborator(s):** Margaret Miller

**LMRCSC Collaborator(s):** Rebecca Vega Thurber, Oregon State University (OSU)

**LMRCSC Research Student(s):** Ms. Kim Galvez (Undergraduate student, UM); Ms. Stephanie Rosales (PhD student, OSU)

**2. Project Title:** Influence of predicted aqueous hypercapnia on cobia, *Rachycentron canadum*, pre-fertilization and larval stages of development

**Project Summary:** Increased atmospheric CO<sub>2</sub> has decreased oceanic pH by 0.1 (pre-industrial through 2005) with a continued projected decrease to 0.35 by 2100 (IPCC 2007). Studies of the effects of hypercapnia on marine teleosts are sparse but warranted due to anticipated changes. The goal of this research is to assess the impact of projected increases in

CO<sub>2</sub> on the recruitment of the widely distributed and aquacultured cobia *Rachycentron canadum* by determining physiological impacts in gametes under reproductively relevant conditions. Sperm respiratory rates, motility, and the impact on egg and yolk-sac larval development will be accessed. Findings will provide the basis for further physiological and reproductive studies and aid in forecasting the response in fish stocks to global climate change. Experiments were concluded earlier this year. The trip to the Institute of Marine and Environmental Technology (IMET) to work in the Jagus Lab as part of the TAB collaboration was conducted in summer 2013. The results are still being analyzed and will be incorporated when submitted for publication. Thesis defense date has been scheduled for October 10<sup>th</sup>, 2013

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Dwight Ebanks, University of Miami, RSMAS

**NOAA Collaborator(s):**

**LMRCSC Collaborator(s):** Dan Benetti and Nelson Ehrhardt, UM-RSMAS; Rose Jagus, UMCES-IMET.

**LMRCSC Research Student(s):** Dwight Ebanks, University of Miami, RSMAS (PhD)

**3. Project Title:** Socioeconomic Factors Affecting Entry-stay-exit Behavior of the Blue Crab Fishers in the Chesapeake Bay

**Project Summary:** The purpose of the Phase I part of the study was to identify the socioeconomic factors that affect the entry-stay-exit behavior of the blue crab fishermen in Maryland by conducting semi-structured interviews and performing qualitative analysis using consensual qualitative research (CQR) methods. The final sample included 15 blue crab fishermen from 10 Maryland coastal counties and four other respondents representing industry at-large, crab processors, restaurant industry, and fishermen's associations. Interviews lasted 15 to 30 minutes and were digitally recorded. Transcriptions were made of the interviews for the purpose of data analysis. The analysis of the interviews yielded five domains: 1) fishermen's entry experiences; 2) factors affecting fishermen's entry-stay-exit behaviors; 3) measures for improving fishermen's economic likelihood; 4) policies for future management of the blue crab fishery; and 5) barriers to enter the fishery for young people. After the domains were established, each member of the research team individually coded the core ideas within domains for each interview. Then the research team discussed the core ideas to create a consensus version of the individual transcripts. Next a cross-analysis was conducted where the core ideas were organized into categories within each domain. For example, the first domain of fishermen's entry experiences indicates that fishermen's entry was affected by their family history and summer job experiences. The second domain of factors affecting fishermen's participation in the blue crab fishery includes personal interest, market conditions (market price of crabs, fuel cost, gear cost, etc.), blue crab abundance, and abundance of other species.

**Thematic Area Addressed:** Resource Economics

**Lead Scientist(s):** Tao Gong, UMES; Stephan L. Tubene, UMES

**NOAA Collaborator(s):** David Tomberlin, NOAA

**LMRCSC Collaborator(s):** Gil Sylvia, Oregon State University

**LMRCSC Research Student(s):** Jared Jones (undergraduate student), UMES

**4. Project Title:** Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles

**Project Summary:** The majority of laboratory analyses were completed during this reporting period. In April and May, Matthew Ramirez traveled to NC and CA to meet with NOAA collaborators Larisa Avens and Jeffrey Seminoff in order to gain necessary laboratory training, coordinate research, and select bone samples ( $n = 75$ ). In May, Matthew Ramirez (OSU) collaborated with Tara Cox (SSU) on a second LMRCSC proposal. In early June, Matthew Ramirez participated in Iso-Camp, a two-week intensive course in the use of stable isotopes in ecological studies. Laboratory analyses for this study commenced at OSU in mid-June upon the arrival of undergraduate intern Eric Parks. Matthew Ramirez and Eric Parks worked in tandem to complete collection and packaging of sea turtle bone dust for stable isotope analysis using a computer-guided micromill and ultra-microbalance. Samples are currently under analysis for stable carbon and nitrogen isotopes at OSU. Model development and refinement will commence upon completion of isotope analyses. Over the summer, Matthew Ramirez and Eric Parks also conducted two pilot projects to enhance the existing study. The first project consisted of running paired analyses to characterize the relationship between carbon isotope ratios of bulk bone and isolated collagen. The second project served as an independent study for undergraduate Eric Parks and investigated the use of laser ablation-inductively coupled plasma mass spectrometry to characterize the elemental composition of sea turtle bone. This was the first application of this technique to the study of sea turtles and may provide for rapid assessment of sea turtle diet and habitat use.

**Thematic Area Addressed:** Quantitative fisheries & Essential Fish Habitat

**Lead Scientist(s):** Selina Heppell, Oregon State University

**NOAA Collaborator(s):** Larisa Avens, NOAA SEFSC; Jeffrey Seminoff, NOAA SWFSC

**LMRCSC Collaborator(s):** Tara Cox, Savannah State University

**LMRCSC Research Student(s):** Matthew Ramirez (M.S. student, OSU); Eric Parks (Undergraduate) SSU

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

**Project Summary:** 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 contain contaminants such as trace metals, polychlorinated biphenyls (PCBs) and dioxins. Though a commercially important fish, very little information is available on contaminant concentrations in monkfish tissue from the U.S. Thus, 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 variations in concentrations of contaminants and lipids, and 5) Examine the utility of selected contaminants as tracers in the delineation of *L. americanus* habitats. Monkfish samples ( $n=8$ ) were collected during the NOAA LMRCS research cruise aboard the *R/V Gordon Gunter* in July, 2013 from Mud Hole, Fingers and Norfolk Canyon. For each fish, total length (TL), body weight, and the weights of muscle, liver, and gonads were measured. Samples of muscle, liver, and gonads were collected, wrapped in aluminum foil, and frozen at  $-20^{\circ}\text{C}$  for organic contaminant analyses. Samples are being held for further processing in Dr. Deshpande's Lab. Plans are underway to analyze 34 PCB congeners, 24 organochlorine pesticides, and 27 flame retardant PBDE congeners in monkfish liver, muscle and gonads.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Andrea Johnson, UMES; Ashok Deshpande, NOAA/NMFS

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

**LMRCSC Collaborator(s):** NA

**LMRCSC Research Student(s):** TBN

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

**Project Summary:** We evaluated the structure of nektonic communities found on continuous and fragmented seagrass seascapes to understand how the spatial configuration of seagrass patches influences associated fauna. The relationship between the habitat and associated fauna is of key relevance to the management of Biscayne Bay where the spatial patterns of nearshore habitats are directly affected by the projects of the Comprehensive Everglades Restoration Plan (CERP). The seascape was mapped using satellite images, and the fish and invertebrate community was sampled at night using seine nets. Predation effects in the different habitat types and niche breadth of *Lagodon rhomboides* (Pinfish) in response to structure of SAV seascapes were also quantified. Fragmented habitats had higher abundance of pink shrimp *Penaeus duorarum* and the code goby *Gobiosoma robustum*, and continuous habitats had higher abundance of the sardine *Herengula sp.* and the pinfish *Lagodon rhomboides*. Larger individuals of grey snappers and bluestriped grunts were found in fragmented compared to continuous habitats. At the community level, percent dominance was significantly higher in continuous habitats, but diversity and taxonomic distinctness were significantly higher in fragmented habitats. The niche space occupied by pinfish was larger in fragmented habitats and a higher predation of shrimp was recorded within fragmented habitats and at the edges of SAV meadows (i.e., close to the mangrove fringe). These results help conceptualize the potential future effects of water management practices on the spatial composition and configuration of nearshore SAV communities where changes in the delivery of freshwater could induce shifts in the abundance, assemblage composition, predation patterns, and distribution of fish and invertebrate species.

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

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

**NOAA Collaborator(s):** Joe Serafy, Ph.D. (RSMAS, NOAA Southeast Fisheries Science Center); Simon Pittman, Ph.D. (NOAA Center for Coastal Monitoring and Assessment)

**LMRCSC Collaborator(s):** Andriy Horodysky, Hampton University

**LMRCSC Research Student(s):** Rolando O. Santos, Ph.D. Student (University of Miami – RSMAS), Josh Miller (HU), James McCullars (SSU)



**7. Project Title:** Evaluating the effects of prey quality on tissue lipids, taurine, and growth in juvenile Chinook salmon (*Onchorhynchus tshawytscha*) with a controlled feeding study

**Project Summary:** This project is examining the effects of prey quality on growth, condition, and fatty acid composition in juvenile salmon from the Upper Columbia summer/fall Chinook salmon (*Onchorhynchus tshawytscha*) stock group. Juvenile salmon (n=518) were acquired from Priest Rapids Hatchery, Washington in May 2013 and acclimated to saltwater over a period of 5 weeks, at which point the length and weight of each fish were measured. To track individual growth throughout the experiment, 97 individuals were tagged. For 6 weeks, fish were fed a low-fat diet (1% lipid), and then switched to one of three formulated diets with varying quantities of fatty acids (all with ~5% lipid content). The diets have ratios of the essential fatty acids docosahexaenoic acid (22:6w3; DHA) to eicosapentaenoic acid (20:5w3; EPA) equal to 0.56 (krill diet), 0.94 (krill and anchovy diet), and 1.47 (anchovy diet). We also determined the concentration of taurine in several species of common salmon prey (i.e. juvenile fish and invertebrates). Salmon are being collected every 2 weeks to determine the rate at which dietary fatty acids become incorporated into fish tissue, and lengths and weights measured every 4 weeks. The experiment will conclude after fish have been on the experimental diets for 12 weeks. This study will inform NOAA field collections of salmonids originating from the Columbia River Basin and provide enhanced research on juvenile salmon growth and lipid uptake rate to help understand how changing environmental conditions may affect biological components of ecosystems (NMFS Objectives 1.15, 1.16).

**Thematic Area Addressed:** Quantitative Fisheries

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

**NOAA Collaborator(s):** Robert Emmett, NOAA Fisheries, NWFSC

**LMRCSC Collaborator(s):** Allen Place, UMCES-IMET

**LMRCSC Research Student(s):** Marisa N. C. Litz (Ph.D. Student, OSU); Jessica Porquez (M.S. Student, OSU); Aaron Watson, (Ph.D. Student, University of Maryland)

**8. Project Title:** Dinoflagellate Community Structure Within a Maryland Coastal Bay Ecosystem

**Project Summary:** Since April of 2010, our laboratory has performed monthly environmental sampling of sites within the Maryland Coastal Bays, collecting both sediment samples and water samples enriched for various plankton species. Our goal was to discover whether we could observe *Hematodinium* sp. in environmental sites. Ultimately we seek to correlate biotic and abiotic parameters to the presence of *Hematodinium*. Our principal findings are that: a) *Hematodinium* has a bimodal distribution in its environmental manifestation, with a spring peak and late summer peak; b) A distinct population of *Hematodinium* has arisen in the MCB; c) Only one clade of the parasite (Clade A) exists in the MCB, contrary to a hypothesis based upon previous observations; and d) *Karlodinium venificum* was observed in June 2012 in Newport Bay.

**Thematic Area Addressed:** Essential Fish Habitats

**Lead Scientist(s):** Joseph Pitula, UMES

**NOAA Collaborator(s):**

**LMRCSC Collaborator(s):** Feng Chen, IMET

**LMRCSC Research Student(s):** Kristen Lycett (MS Student, UMES)

**9. Project Title:** Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture.

**Project Summary:** Experiments examining the processes by which an oyster larvae probiotic bacterium, strain OY15, inhibits growth and biofilm formation of the bacterial pathogen, strain B183, demonstrated that OY15 produced a factor(s) that destabilized B183 biofilms, suggesting a potential mechanism for OY15 probiosis. OY15 was also found to interfere with growth and biofilm maintenance of fish pathogens DNO1 (*Vibrio harveyi*) and *Vibrio damsela* as well as a human pathogen, *Vibrio parahaemolyticus*, but did not affect *Pseudomonas stutzeri* or marine *Bacillus* sp. FE-1. The biofilm inhibiting activity was not sensitive to treatment at 80°C, signifying that it is likely non-proteinaceous in nature, and may be similar to a carbohydrate-based factor produced by another *Vibrio* spp. that displays similar properties. Previous sequence analyses of strain OY15 revealed that this bacterium was most similar to members of the pathogenic *V. parahaemolyticus* family, and, therefore, would not be suitable for industry use as a probiotic. Multi-locus sequence tag analysis using DNA oligonucleotide primer sets that targeted *V. parahaemolyticus* *recA*, *vmp*, *dnaE*, *gyrB*, *pntA*, *pyrC*, *dtdS*, *tnaA*, *tdh* and *tth* genes by polymerase chain reaction amplification showed that only the *gyrB* gene could be amplified from OY15; the DNA sequence of the OY15 *gyrB* amplicon was found to be more similar to *V. alginolyticus* than *V. parahaemolyticus*. This information provided evidence that was used to receive funding from NOAA to sequence the entire OY15 genome, a project that is on-going.

**Thematic Area Addressed:** Aquaculture

**Lead Scientist(s):** Eric Schott, UMCES-IMET; Harold Schreier, UMBC-IMET  
**NOAA Collaborator(s):** Gary Wikfors and Diane Kapareiko, Northeast Fisheries Science Center, Milford, CT  
**LMRCSC Collaborator(s):** Dennis McIntosh, Delaware State University  
**LMRCSC Research Student(s):** Oluwatobi Paul (B.S., Intern at IMET), David Billups (B.S., Intern at IMET).

**10. Project Title:** Augmenting the Black Sea Bass, *Centropristis striata*, Stock Assessment: Assessing the importance of fixed and fluid estuarine habitats

**Project Summary:** A graduate student (Laura Almodovar) was recruited but could not begin work until June, 2013. During summer 2013, Ms. Almodovar worked with a NOAA fisheries modeler (Howard Townsend) to develop a habitat suitability model (HSM) including a growth rate potential model with structural benthic habitat (bottom type/oyster reef available). The HSM model will be linked either to the interpolated temperature/salinity (T/S) data from the Chesapeake Bay and Tidal Tributary Interpolator (CBTTI) or estimated values of T and S from the Chesapeake Bay Operational Forecasting System (CBOFS) model. A literature review was initiated to assess the optimal temperature, salinity and dissolved oxygen requirements for maximal growth of Black Sea Bass (BSB). One field trip was conducted to sample for the occurrence, distribution, abundance, and population structure of juvenile black sea bass and other demersal species on structured habitats using fish traps. We had planned to measure and preserve BSB so that otoliths could be collected and examined for daily growth rings to determine if there are differences in growth rates among different habitats. This aspect will be supervised by Dr. Miller; the student will travel to the OSU Hatfield Marine Center in Newport, OR, for training in her laboratory for two weeks, and will then complete the work at UMES. Unfortunately no BSB were captured during the first trip. Further field sampling trips are planned for early fall of 2013.

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

**Lead Scientist(s):** Bradley G. Stevens, UMES; Howard Townsend, NOAA Cooperative Oxford Laboratory  
**NOAA Collaborators:** Steve Giordano and David Bruce, NOAA Chesapeake Bay Office – Cooperative Oxford Lab  
**LMRCSC Collaborator(s):** Jessica Miller, OSU  
**LMRCSC Research Student(s):** Laura Almodovar (M.S. Student, UMES)

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

**Project Summary:** Black sea bass (BSB, *Centropristis striata*) support an important commercial and recreational fishery in the Mid Atlantic Bight. There is no acceptable index of abundance for BSB because NOAA trawl surveys are not effective in sampling BSB habitats. We are developing quantitative methods for assessing abundance of black sea bass using in-situ video technology. In Yr 1 and Yr 2 we used underwater video cameras to estimate fish abundance, established that baited and unbaited trap CPUE are similar, and compared fish counts against hook-and-line CPUE. In Yr 3, we compared trap CPUE to soak time, with independent video counts for a background standard, and tested an adaptive sampling design for estimating the abundance of BSB using video techniques. This project will become the PhD Thesis for Dan Cullen at UMES, and has supported related research by 4 minority undergraduate students.

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

**Lead Scientist(s):** Bradley G. Stevens (UMES)  
**NOAA Collaborator(s):** Vincent Guida, NEFSC, Sandy Hook Laboratory  
**LMRCSC Collaborator(s):** Elizabeth Babcock, University of Miami, RSMAS.  
**LMRCSC Research Student(s):** Dan Cullen (PhD Student, UMES); Nikkia King (undergraduate student, UMES).

**12. Project Title:** Modeling Spatial-Temporal Fishing Effort of the West Coast Salmon Fishery

**Project Summary:** To date, we have accomplished the first series of tasks on the initial project timeline; an extended literature review, data collection, and model selection and we are in the process of organizing our second collaboration meeting in Newport, OR in October 2013. Additionally, we are currently working on obtaining additional data sets from the Pacific States Fishery Commission to complement our West Coast Salmon Genetic Stock Identification Collaboration (WCGSI) data set obtained earlier this year. The combined dataset will create a unique fine spatial-temporal data set to be used in our quantitative analysis. At this point, we are unable to provide concrete results given the fact that no data analysis has been performed so far.

**Thematic Area Addressed:** Economics and Social Science

**Lead Scientist(s):** Gil Sylvia, Oregon State University

**NOAA Collaborator(s):** Peter Lawson, NOAA/NMFS; Dan Holland, NOAA/NMFS

**LMRCSC Collaborator(s):** Tao Gong, UMES

**LMRCSC Research Student(s):** Smit Vasquez Caballero (Ph.D. Student, OSU)

### **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.**

We are making excellent progress on the collaborative project within the Center on the trophic ecology of forage fishes. This joint research project involves five Center partners as well as two other CSCs, NOAA collaborators, and provides excellent training opportunities for both undergraduate and graduate students. Graduate student Marisa Litz (OSU) has received training and lab experience in lipid extraction, the use of the thin-layer chromatography with flame ionization detection, derivatization of raw lipid extracts into fatty acid methyl esters (FAME) using  $\text{BF}_3$  in methanol, and detailed fatty acid analysis using gas chromatography. Marisa is also participating in related TAB-funded research to quantify muscle tissue turnover rates for lipids and fatty acids in juvenile salmon, which consume northern anchovy during their early marine residence. Jessica Porquez, a Center-funded undergraduate, assisted with this lab project during summer 2013 and is beginning a MS program in OSU's College of Earth, Ocean, and Atmospheric Sciences this fall.

Dr. Thomas Hurst, NOAA AFSC scientist, participates in weekly Miller Lab meetings. This frequent and consistent exposure to a NOAA scientist provides a diverse learning experience for our graduate and undergraduate students and the students clearly enjoy this opportunity. Mr. Smit Vasquez-Caballeros (graduate student, OSU) and Dr. Gil Sylvia (OSU) continue to work with NOAA fisheries scientist Dr. Peter Lawson and NOAA economist Dr. Dan Holland on their project, "Modeling spatial-temporal fishing effort of the West Coast salmon fishery". This project combines genetic stock information and digital traceability systems to develop a spatial-temporal bio-economic model of effort distribution of West Coast salmon. The researchers aim to provide fishery managers with a characterization of fishermen behavior (allocation of effort in time and space) that can be used to design optimal finer spatial-temporal management tools for reducing by-catch of weak salmon stocks and avoiding long term closures of the salmon fishery.

Mr. Matt Ramirez (graduate student, OSU) is developing his MS thesis research in close collaboration with scientists at both NOAA's SEFSC and SWFSC. Matt traveled to both NOAA Science Centers for training and coordination with regional scientists. In May, Matthew Ramirez (OSU) collaborated with Tara Cox (SSU) on a second LMRCSC proposal. In early June, Matthew Ramirez participated in Iso-Camp, a two-week intensive course on the use of stable isotopes in ecological studies (Stable Isotopes in Biogeochemistry and Ecology in Salt Lake City, Utah).

### **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 LMRCSC Research Committee
- LMRCSC Science meeting was held in March 2013
- Several collaborative research projects between scientists at LMRCSC 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 \$2.45 million (Appendices II and III)
- Dr. David Die (RSMAS) continued his research with leveraged funding from NOAA and ISSF. Dominique Lazarre (RSMAS Ph.D. student) used \$8,000 she obtained from the Manson Foundation for her research on lionfish.
- Dominique was also awarded fellowship during 2013/2014 of the UM/NSF Science Made Sensible program that will now fund her salary for a year.

***Provide supportive networks and mentoring for early-career faculty, including faculty from underrepresented groups:*** LMRCSC provides a strong intellectual community for scholars in the marine and fisheries sciences. Faculty connections across institutions are important not only for research collaboration, but also for career support and mentoring. Among the early-career faculty who received funding from the LMRCSC for 2012 - 2013 to conduct research are: Eric Schott (UMCES-IMET), Joseph Pitula (UMES), Andrij Horodysky (HU), Andrea Johnson (UMES), and Stacy Smith (DSU).

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

LMRCSC institutions, for example HU, provide opportunities for faculty enhancement through workshops on grant writing, pedagogical newsletters, and budget management.

**NOAA LMRCSC Scientific and Educational cruise aboard the NOAA R/V Gordon Gunter in 2013:** For the 7<sup>th</sup> consecutive year, the LMRCSC co-sponsored a marine research cruise aboard a NOAA Research Vessel. Previous cruises were conducted in winter (January or February) aboard *RV Delaware II* which has been decommissioned. This was the first year in which the cruise was conducted during summer, aboard one of the larger NOAA vessels.

Students on the cruise were 10 in number and came from UMES, HU, DSU, the University of Rhode Island, and Florida Agricultural and Mechanical University. After assembling at UMES on June 28, they drove to Norfolk, VA to board the NOAA R/V Gordon Gunter, a 225 ft research vessel out of Louisiana. Immediately after leaving port, the ship experienced mechanical problems, requiring its return to Norfolk, where it waited 5 days for repair. Despite the delay, the students kept up their spirits, explored the local area, and were elated when the ship finally left port on July 4.

Aboard ship, students were assigned to work either the “day” shift (noon to midnight) or the “night” shift (midnight to noon). Research activities were organized and supervised by Dr. Bradley Stevens of UMES and Dr. Rich Langton of the NOAA Sandy Hook (NJ) laboratory. This year’s research efforts were focused on the population biology and reproduction of deep sea red crabs and monkfish, both of which are important seafood resources.

Several times each day, the ship towed a large bottom trawl across the sea floor, bringing up a plethora of crabs, sea stars, fish, and other organisms. Some of the trawls were conducted as deep as 2500 feet, or about half a mile. Many of the fish captured from these depths have rarely been seen or studied by scientists. Some of the students found the process of sorting and identifying them to be the most enjoyable part of the cruise.

After recording all the data, students worked in teams to dissect and collect specimens from crabs and fish. Tissues were sampled for determination of reproductive stage, genetic analysis, presence of contaminants, and age or growth. At least one graduate student and several undergraduates will use these specimens for their thesis or internship research projects. According to UMES graduate student Evan Lindsay, “*The cruise provided hands-on experience that could benefit one’s future work as a marine or fishery scientist, for example. Personally, I am seeking a job that includes field work aboard research and/or fishery vessels. Participating on the NOAA-LMRCSC cruise provided both practical and resume-building experience for my career.*” Although half of the planned sampling was omitted due to the delay, a significant amount of biological samples were collected that will provide new information about deep sea crabs and monkfish. According to Dr. Stevens, “*The last two years, we studied red crabs during winter. This was the first time I’ve looked at them during summer, and we learned a significant amount already. Once we get all the samples processed, we’ll know much more about their reproductive cycle. This information is critical to support sustainable management of this resource.*”

## **SCHOLARLY PRODUCTIVITY**

In the current reporting period, LMRCSC students and faculty made 45 presentations at scientific meetings, and published 21 articles in refereed journals (Appendix IV).

**Grantsmanship:** A total of \$2.45 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, \$253,459 came from NOAA, whereas \$2,195,856 was obtained from other agencies. The funds provided by these agencies were used to support faculty and students and develop/enhance infrastructure.

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

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

**Student Recruitment into Marine Science Programs:** Seventy-nine (79) students (Tables 1-4) participated in academic programs, training, workshops, conferences, or seminars during this reporting period.

**Faculty Recruitment into Marine Science Programs:** Dr. Shari Wiley, an Applied Mathematician hired in fall 2011 by HU in the Department of Mathematics, has established collaboration with Howard Townsend at NOAA Chesapeake Bay Office, and has continued to work with LMRCSC faculty, particularly at HU.

**2. What are the new education programs (degree certificate programs, etc.)?** A consortium of NOAA Cooperative Science Centers offered in 2013 a six week summer program for 16 high school seniors interested in pursuing degrees in the Geosciences. Students received training in marine 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 also enrolled in a college-level math class and freshman seminar designed to introduce them to college life. CSC faculty who participated in teaching the students were Remata S. Reddy (Jackson State University-NCAS), Tarendra Lakhankar (CUNY CREST), Chuck Jagoe (FAMU-ECSC) and several scientists from UMES (P. Chigbu, A. Ishaque, N. Chen, M. Xia, S. Parveen, U. Ojiabo, D. Seaton, A. Potter).

**3. Students receiving direct and indirect support from the LMRCSC.** Seventy-nine (79) students received direct support, and 63 students, at a minimum, 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.

UMES hosted 365 K-12 students at the UMES campus or the Paul S. Sarbanes Coastal Ecology Center (PSSCEC) for hands-on activities to learn about the Maryland Coastal Bays environment.

UMES LMRCSC Master's Student Emily Tewes, Ph.D. student Dan Cullen and Dr. Bradley Stevens hosted two public meetings at PSSCEC reaching out to regional fishermen and stakeholders for further research collaborations. The event was attended by 200 people.

Dr. Gibson at Hampton University conducted three outreach events for middle and high school students at Hampton University. All groups had the opportunity to collect plankton samples and analyze them in the laboratory.

**SSU Coast Camp for Youth:** Over 100 children (n=121) were trained in Coast Camp from June 24 to July 19. Some students have participated all 5 years the program has been run. While this cannot be connected to each class, knowing these numbers by class could give some qualitative information on how much of class performance can be attributed to new and first time learners. The mean pre- and post-test scores have been compared by camp year, gender and race. The camp scores show a statistically significant improvement from the pre-test to the post-test although the scores have decreased in several years. The camp has always been >95% Black and more than half male. The scores and racial patterns match the national trends seen in the performance of black males in public schools and may explain the drop in scores. It also suggests that students' level of preparedness is decreasing each year, but that the camp is increasing student performance.

**CREST CISCEP Student Enrichment and Experiential Learning (SEEL):** This program is funded by NSF and was leveraged with LMRCSC funds. LMRCSC faculty hosted and mentored 7 high school students from Worcester, Wicomico and Somerset county public schools in Maryland, as well as other locations for 7 weeks during summer of 2013. Students conducted research along-side their mentors, LMRCSC graduate students and REU undergraduates. They produced posters and Power Point presentations of their results, which were presented at a symposium held at UMES on August 2, 2013.

**Teacher Development Workshop:** This is another component of the CREST CISCEP program funded by NSF and leveraged with LMRCSC funds. UMES offered a workshop for K-12 science teachers in July, 2013, 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. Eight teachers who participated in the program 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. We have continued to hold conference calls with the teachers to determine the impact of their training on instructions to students.

**Research Experiences for Undergraduates in Marine and Estuarine Sciences:** The LMRCSC is a site of an REU program funded by NSF, and with additional support from the LMRCSC. In summer 2013 thirteen (13) interns (8 supported with NSF funds; 5 with LMRCSC funds) participated in various activities such as research, seminars, workshops, and field trips. The program ended on August 9 with symposium at the PSSCEC during which the students gave oral and poster presentations of their research work. The critical mass of scientists with expertise in NOAA related sciences recruited and

supported by the NOAA LMRCS has made it possible to establish in 2010 at UMES this REU site. Some students (e.g. Nivette Perez, MS student at DSU) have enrolled in graduate programs at LMRCS institutions after participating in the internship program.

**Website:** The LMRCS web site ([www.umes.edu/lmrsc](http://www.umes.edu/lmrsc)) is currently being updated. The site highlights linkage with NOAA and Center accomplishments and makes them more accessible to the user. The site includes biographical information for faculty and graduate students at each Center partner. Each of the LMRCS partner institutions also has its own website that is directly linked to the LMRCS main web page. At SSU, the website [www.ssufisheries.com](http://www.ssufisheries.com) is being revamped by the new Outreach Coordinator. It now includes an outreach calendar and online signup for student volunteers.

**Facebook:** LMRCS Technical Monitor Jeanine Cody created an LMRCS 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. Three hundred forty-four (344) individuals, including many students, have signed up as 'fans' of the site.

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



*2013 Geoscience Interns with Dr. T. Lakhankar (CREST-CUNY)*

- This summer, 16 recent high school graduates were hosted at UMES through a joint effort of the Cooperative Science Centers. They were provided instructions in marine geology, physical oceanography, atmospheric science, marine biology, marine chemistry/biogeochemistry, and remote sensing/GIS through hands-on laboratory activities, field exercises, and lectures in order to help them prepare for undergraduate programs in the geosciences.
- Eleven new M.S. students were recruited to the center during this reporting period: Nivette Perez-Perez (DSU), Aneese Williams (HU), Paul Arkwright (SSU), Keya Jackson (SSU), Coral Thompson (SSU), Laura Almodovar-Acedo (UMES), Wilmellie Cruz-Marrero (UMES), Justin Wilson (UMES), Juan Alvarez (UMES), Detbra Rosales (UMES), and Kahil Simmonds (UMCES). One Ph.D. student was recruited to the center during this reporting period: David Marsan (UMCES)
- Two students (Xaymara Serrano, RSMAS; Aaron Watson, UMCES-IMET) completed their Ph.D. degrees during this reporting period. Xaymara Serrano received a two-year NRC postdoctoral fellowship to work at NOAA AOML
- Ammar Hanif, who received his M.S. in spring 2013, received NOAA Sea Grant funding to partially support his Ph.D. work at IMET.
- Emily Tewes (M.S. student at UMES) has been selected for NOAA Sea Grant Knauss Fellowship to begin in 2014.
- Tiara Moore (M.S., HU) was awarded Hall-Banner Scholarship and accepted to Old Dominion University to work on her Ph.D.

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

- The LMRCS educational, research and outreach activities have resulted in several contributions during this reporting period. 156 students from B.S. to doctoral levels were trained in NOAA core sciences. 16 students graduated (2 Ph.D., 8 M.S., 6 B.S). Twelve (12) projects funded through the TAB for 2012-2013 are being completed, and 12 new projects have been selected for funding for 2013-2014; \$2.45 million in external funding is supporting Center-related activities.
- The Center's doctoral graduate, Larry Alade, a NMFS employee, taught Introduction to Fish Population Dynamics and Stock Assessment with P. Chigbu this spring 2013.
- HU students are currently funded by NOAA internship and scholarship programs.

**2. How many students participated in Center projects or activities?** 156 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 IV. 895 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:**

- Xaymara Serrano received a NRC postdoctoral fellowship to work at NOAA AOML
- Ammar Hanif, who received his M.S. in spring 2013, received NOAA Sea Grant funds to partially support his Ph.D. work at IMET.
- Emily Tewes (M.S. student at UMES) has been selected for NOAA Sea Grant Knauss Fellowship to begin in 2014.
- Tiara Moore (M.S., HU) was awarded Hall-Banner Scholarship and accepted to Old Dominion University to work on her Ph.D.



Xaymara Serrano

At SSU external funding supported over 87 undergraduate and 22 graduate participants in oceanographic research aboard the University National Oceanographic Laboratory System (UNOLS) research vessel (*R/V Savannah*) in 2012-13. Such experiences have led to invitations for 3 of our undergraduates (2 MSCI and 1 ENVS) and faculty member (Hintz) to serve aboard the *R/V Melville* sailing off of California on a research cruise lead by scientists from the Skidaway Institute of Oceanography and the University of Chicago. Additionally, another undergraduate SSU student participated in a NOAA National Marine Fisheries Service cruise in May 2013.

#### **Students who Received Employment as a Result of their Work at the Center:**

- Matthew Dill (HU) and Krista Kraskura (HU) obtained summer employment at the Virginia Tech Seafood and Agricultural Research Center.
- Xaymara Serrano a Ph.D. graduate from the LMRCSC obtained an NRC post-doctoral fellowship at NOAA AOML.
- Noelle Hawthorne was hired as a technician at SSU as a direct result of the expertise in tagging that she developed as an LMRCSC fellow conducting research at Gray's Reef.
- Adam Tulu, a 2012 LMRCSC graduate secured employment as an Environmental Protection Specialist USDA/ Biotechnology Regulatory Service.
- Rebecca Ann Hazelkom, who graduated in 2013 with a Master's Degree from SSU was hired as a technician at the Mote Marine Laboratory.

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

- Tiara Moore (M.S., HU) received the Hall Bonner Scholarship funding at Old Dominion University.
- Dominique Lazarre (Ph.D. student, RSMAS) received a fellowship from the Science Made Sensible program that will now fund her salary for a year.
- Katelyn Fleming (M.S., DSU) received a NOAA Seagrant Fellowship.
- Ammar Hanif, a Ph.D student at UMCES IMET, received a Maryland Seagrant fellowship for a project entitled "Diet and feeding of menhaden using barcoding identification based on cox1 sequences to enable the linking of primary productivity to fisheries."
- Jan Vicente, a Ph.D. student at UMCES IMET received the Nancy Foster Scholarship to support his work on ocean acidification and sponges.
- Emily Tewes, an M.S. student at UMES received a Knauss Marine Policy Fellowship.

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

Seven students conducted research at NOAA labs (Table 4).

**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. A minimum number of sixty-three (63) 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 (\$2.45 million) that has enabled the Center institutions to recruit and support more students than they would otherwise be able to support.

LMRCSC activities and infrastructure have created a model upon which other outreach and training programs have been built. Other marine science outreach programs at SSU feed into the Coast Camp. SSU Coast Camp has become the testing ground for K-12 modules. Hampton University reports that students who received training through LMRCSC are more involved with outreach, maintaining and improving their GPAs, traveling and presenting their work at conferences,

receiving international and NOAA scholarships, securing NOAA internships, and are being accepted to graduate programs. Faculty have been able to apply for other base funding for research fellowships because of the prior funding provided by the LMRCSC. Finally, travel and research funding from the LMRCSC that allowed students to travel to NOAA labs helped publicize the quality of LMRCSC faculty and students, thereby improving our collaborative and recruitment success.

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

**6. In what specific NOAA science, service or stewardship activities (e.g. NOAA research cruises; weather forecast modeling, etc.) were students involved?** Students participated in the research cruise that occurred in July 2013 as well as in the many outreach activities described above.

**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.
- LMRCSC 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.

#### **University-wide-**

- SSU: At SSU, the Marine Science Program has been upgraded to a department. This is due, in large part, to the success of students who pursue research within the LMRCSC. The LMRCSC was the original source of funding for the M.S. program. All research fellowships in the program were patterned after those offered in the LMRCSC with the exception of the GK-12 program.
- Also at SSU, The LMRCSC has the largest, oldest, most formalized K-12 educational outreach program on campus because of EPP funding. The Coast Camp is now the model for other camps on campus. More broadly, there is also no other 30 day science camp in the county, and certainly none that are free. All science camps confer with the Coast Camp before planning, and rely on the LMRCSC to provide guidance on registering to be a free lunch site, and coordinating programming in the STEM complex. The LMRCSC helped facilitate a new camp for 6<sup>th</sup> graders that was hosted by the College of Sciences and Technology in July 2013, and registered as the City of Savannah 2013 free lunch site at SSU for this summer for the MSCI camp. Comments that have been received during oral presentations on the camp at ASLO reflect that no other camp appears to serve this level of ocean literacy instruction to a cohort of predominantly African American male students between the ages of 7 and 18. The committed outreach Coordinator makes this happen in a way that would not be possible if the program relied on seasonal or graduate student effort alone.

#### **Local Community & Region-**

- HU: LMRCSC students have been participating in various outreach activities for the general public in the Hampton Roads and Tidewater area.
- SSU: Research within the LMRCSC supports local needs through the diversity of work that is performed. Dr. Tara Cox is the only person locally authorized to perform necropsies on stranded marine mammals and has performed several in 2013. Dr. Sue Ebanks has been working with community members along the Ogeechee River to understand a large fish kill believed to be caused by a local carper manufacturer. Dr. Hoskins has documented African American fishing families and practices in 3 communities, preserving a heritage asset and adding fishery socioeconomics to the research available for students at SSU. Dr. Hoskins continues to chair the Chatham County Resource Protection Commission, the regional body tasked with identifying, evaluating, and acquiring green space for the county. A recent news article summarizing their work can be found at: <http://savannahnow.com/news/2013-09-01/splost-eyed-land-conservation>. To date, all of the property acquired except one has contained freshwater wetlands or saltmarsh, essential fish habitat.

#### **National-**

- LMRCSC students have traveled nationally to conduct research and to present the results of that research to national labs and conferences.
- Value-added national statistics for the SSU Marine Sciences Department and the LMRCSC:
  - 19% of Bachelor's degree graduates entered Master's or Doctoral degrees
  - 30% of Master's degree graduates entered Doctoral programs



- 33% of Master's degrees in marine/ocean sciences earned by African Americans in the U.S. from 2004-2007 were earned at SSU
- 10% of African American Master's and Doctoral students in marine/ ocean sciences in 2007 were either enrolled in the Master's program at SSU or were former SSU students enrolled in Doctoral programs elsewhere
- 20% of master's graduates went on to Ph.D. programs in past three years (NSF/NIH survey spring 2011)
- 47% of master's graduates found jobs in research-oriented careers in past three years (NSF/NIH survey spring 2011)
- The LMRCS's support of the outreach coordinator helps the LMRCS host the GA-SC regional competition of the National Ocean Sciences Bowl, something that the Project Director and other faculty would not be able to do otherwise.

**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 LMR CSC Scientists and Students

NOAA Scientists	NOAA Lab	Role at the LMR CSC
Andi Stephens*	NOAA NWFSC	Committee member for LaTreese Denson, M.S. student, OSU
Anne Richards*	NEFSC, Woods Hole Lab	Research collaborator with Andrea Johnson (UMES), Al Place (IMET), and serves on graduate student committees of Dan Cullen (MS, UMES 2010) and Belita Nguluwe (M.S., 2013, UMES)
Ashok* Deshpande	J.J. Howard Marine Sciences Lab	Research collaborator with Eric May (UMES) and graduate student committee member of William Gardner (Ph.D., UMES 2012).
Ayeisha Brinson*	NOAA NEFSC Woods Hole Lab, MA	Participated in teaching Intro. to Environmental and Resource Economics course at UMES; serves on the LMR CSC TAB
Ambrose Jearld*	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participated in teaching the Fish Stock Assessment course at UMES; serves on the CREST-CISCEP External Advisory Committee
Beth Phelan*	NOAA NEFSC, Sandy Hook Lab	Collaborated with Brad Stevens (UMES); Served on committee of Courtney McGeachy (M.S., 2013, UMES)
Bob Wood*	NOAA NCCOS Cooperative Oxford Lab, MD	Serves as a member of Employer Advisory Board of the Professional Science Master's degree Program that was leveraged with the LMR CSC; Collaborates with Eric Schott (IMET) and Sook Chung (IMET); mentors PSM intern
Bruce Vogt	NOAA Chesapeake Bay Office, MD	Served as mentor of Andrew Turner (PSM 2012, UMES) during summer 2011 internship at NOAA
Chris Chambers*	NOAA NEFSC, Sandy Hook Lab	Collaborated with Ali Ishaque (UMES), Rose Jagus (IMET); Served on committee of Adam Tulu (Ph.D., 2012, UMES); mentors PSM intern
Craig Brown*	SEFSC, NMFS	Research collaborator with David Die (RSMAS) and Elizabeth Babcock (RSMAS)
David Tomberlin	NOAA Headquarters, Silver Spring, MD	UMES Adjunct Faculty. Participates in teaching Intro. to Environmental and Resource Economics course
Dan Holland*	NOAA NWFSC	Committee member of Smit Vasquez Caballero (Ph.D. Student, OSU); collaborates with Gill Sylvia (OSU) on modeling salmon fishing effort
Doug Wilson	NOAA NEFSC Chesapeake Bay Office, MD	Serves as a member of External Advisory Committee of LMR CSC
Dvora Hart*	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participated in teaching the Fish Stock Assessment course at UMES; Served on thesis committee of Tunde Adebola (M.S. 2012, UMES)
Elizabeth Brooks	NOAA NEFSC Woods Hole Lab, MA	Served as mentor of Jessica Blaylock (PSM 2013, UMES) during summer 2011 internship at NOAA
Ed Farley	NOAA AFSC	Serves on graduate committee of Shari Mullen (UMES graduate student)
Frank Morado	NOAA NWFSC, Seattle, WA	Collaborates with Joseph Pitula (UMES), Eric Schott (IMET) and Feng Chen (IMET)
Gary Wikfors*	NOAA NEFSC Milford Lab	Collaborates with Eric Schott (IMET); Al Place (IMET), Schreier (IMET); Gulnihal Ozbay (DSU); Serves on Graduate Student committees
Gary Shepherd*	NOAA NEFSC Woods Hole Lab, MA	Works with Brad Stevens (UMES) and Dan Cullen (Ph.D. student, UMES)
Gretchen* Messick	NOAA NCCOS Cooperative Oxford Lab, MD	Collaborates with Eric Schott (IMET), and Chung (IMET)
Howard* Townsend	NOAA Chesapeake Bay office	Served or currently serves on graduate committees of many students; for example: Laura Almondovar (M.S. student, UMES), Eric Evans (Ph.D. student, UMES), Brian Reckenbeil (M.S. student, DSU), and Tiara Moore (M.S., HU 2013), and research collaborator with Shari Wiley (HU), and Brad Stevens (UMES); adjunct faculty, UMES; Served as mentor of Andrew Turner (PSM 2012, UMES) during summer 2011 internship at NOAA
Jamal Moss	NOAA AFSC	Serves on graduate committee of Shari Mullen (UMES graduate student); Shari conducts her research at AFSC.
Jeffery Seminoff*	NOAA SWFEC	Collaborating with Selina Heppell (OSU) and Mat Ramirez (graduate student, OSU) on forage strategies and habitat use by loggerhead sea turtles

Jim Nance	NOAA SEFSC Galveston, TX	Member, External Advisory Committee of the LMRCS
John Ewart	NOAA/Delaware Sea Grant	Served on graduate student committee at DSU
John Jacobs*	NOAA NCCOS Cooperative Oxford Lab, MD	UMES Adjunct Faculty. Collaborates with Eric May (UMES), Served on thesis committees of Lonnie Gonsalves (Ph.D., 2012, UMES) and Candace Rodgers (M.S. 2013, UMES)
Joe Serafy*	NOAA SEFSC	Collaborates with Diego Lirman (RSMAS) and Rolando Santos (Graduate student, RSMAS)
Kate Andrews	NOAA NEFSC Beaufort, NC	Served as mentor of Jeff Kipp (PSM 2012, UMES) during summer 2011 internship at NOAA
Kevin Chu	NOAA Southwest Regional Office	Member Employer Advisory Board of the Professional Science Master's degree Program that was leveraged with the LMRCS.
Larisa Avens*	NOAA SEFSC	Collaborating with Selina Heppell (OSU) and Mat Ramirez (graduate student, OSU) on forage strategies and habitat use by loggerhead sea turtles
Larry Alade*	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participates in teaching the Fish Stock Assessment course at UMES
Larry Jacobson*	NEFSC, Woods Hole	Collaborates with Brad Stevens (UMES) on red crab research
Lonnie* Gonsalves	NOAA/MDDNR Cooperative Laboratory, Oxford, MD	Serves on graduate student committee of Hillary Dean (M.S. student, SU); worked with undergraduate Aicha Toure (DSU) on menhaden project
Marc Turano*	NOAA/North Carolina Sea Grant	Served on graduate student committee of Cory Janiak (M.S. 2013, DSU)
Matt Loretta*	SEFSC, NMFS	Ph.D. student committee member at RSMAS
Matthew Poach*	NOAA NEFSC, Sandy Hook, NJ	Serves on graduate student committee of Andrea Stoneman (M.S. student, DSU)
Pete Lawson*	NOAA NWFSC	Committee member of Smit Vasquez Caballero (Ph.D. student, OSU); collaborates with Gill Sylvia (OSU) on modeling salmon fishing effort
Mark Brady	NOAA Northeast Regional Office, Gloucester, MA	Served as mentor of Leonardo Matthews (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Margaret Miller*	NOAA SEFSC, Miami, FL	Collaborates with Daniel Benetti (RSMAS) and RSMAS graduate student (Dwight Ebanks)
Mike Fogarty	NOAA NEFSC Woods Hole Lab, MA	Participated in teaching the Fish Stock Assessment course at UMES. Member of LMRCS External Advisory Committee
Rich Langton*	NEFSC Sandy Hook Lab	Served as chief scientist during the LMRCS summer 2013 Research Cruise
Richard Brill*	NEFSC	Research collaborator with Andrea Johnson (UMES), Andrij Horodysky (HU), and graduate student committee member of Heather Wolfer (M.S. student, UMES)
Richard McBride*	NEFSC, Woods Hole Lab	Research collaborator with Andrea Johnson (UMES) and graduate student committee member
Stephen Brown	NMFS HQ, Silver Spring	NOAA Project coordinator for externally funded project (CIE)
Thomas Hurst*	NOAA AFSC	Collaborates with Jessica Miller (OSU)
Vince Guida*	NEFSC Sandy Hook Lab	Committee member for Dan Cullen (Ph.D. student, UMES) and Emily Tewes (M.S. student, UMES)
William Michaels	NMFS HQ, Silver Spring	NOAA Project coordinator for externally funded project (CIE)
Tom Minello*	Galveston Laboratory, SEFSC	Serves on graduate student committees at SSU; hosts interns from SSU
Kristy Wallmo*	OST-Silver Spring	Adjunct faculty at UMES; Serves as Technical Monitor of the LMRCS; LMRCS Technical Monitor; Participates in teaching Intro. to Environmental and Resource Economics course
Greg McFall*	NMS- Gray's Reef National Marine Sanctuary	Serves on student committees; trains students from SSU
Sarah* Fangman	NMS- Gray's Reef National Marine Sanctuary	Serves on student committees; trains students from SSU
Ron Goldberg*	NEFSC, Milford Laboratory	Collaborates with Dr. Schott
Barry Berejikian*	Northwest Fisheries Science	Collaborates with Drs. Zohar and Place

	Center	
Walt Dickoff	Northwest Fisheries Science Center	Collaborates with Drs. Zohar and Place
Penny Swanson	Northwest Fisheries Science Center	Collaborates with Drs. Zohar and Place
James Morris	NOS Center for Coastal Fisheries and Habitat Research	Collaborates with Dr. Place
Francis van* Dolah	NOS Hollings Marine Laboratory	Collaborates with Drs. Jagus and Place
Susan White	NCCOS, Hollings Laboratory	Collaborates with Drs. Jagus and Place

\*NOAA scientists who worked with LMRCSC scientists and/or students during the current reporting period

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

Author	Funding Agency	Title of Project	Start/End Date	Amount	Current 6 month period
Gibson, PI Horodysky, Co-PI	NOAA-Seagrant	Sustainable Fisheries and Aquaculture Outreach, Education and Training for Under-Represented Groups and Aquaculture Producers	6/1/2013 - 1/31/2015	\$76,763	\$0.0
David Die	NTVI/NOAA	Development of survey inventory, fishery-independent survey	9/1/2013 - 8/31/2014	\$159,500	\$0.0
David Die	NOAA	Ecological Indicators for Water Management & Ecosystem Restoration of South Florida Estuaries	8/1/2012 - 9/30/2015	\$142,850	\$23,702
David Die	NTVI/NOAA	Centre for independent experts	9/22/2007 – 9/30/2013	\$460,925	\$23,756
B.G. Stevens (UMES), R. Lipcius (VIMS)	NOAA Bycatch Reduction Program	Determination of the impacts of trap fishing on Mid-Atlantic benthic habitats, with emphasis on structure-forming invertebrates	2/1/14 -1/31/15	\$103,235	0
A.K. Johnson (UMES)	NOAA NMFS	Influence of temperature and lunar cycle on the distribution and catch rates of monkfish, <i>Lophius americanus</i>	5/1/13 - 4/30/14	\$105,840	\$52,920
M. Xia (UMES)	NOAA, MD Seagrant	The effect of climate change to the coastal bay dynamics	2/1/13 - 2/1/2014	\$9,000	\$4,500
Jagus, R.	NOAA/MD Seagrant	Diet and feeding of menhaden using barcoding identification based on cox1 sequences to enable the linking of primary productivity to fisheries (for graduate student support)	05/28/13-05/27/15	\$77,277	\$19,319
Place, A.R.	NOAA	PCM HAB: Mitigating <i>Microcystis</i> in the Chesapeake (MMIC).	09/01/10-08/31/13	\$585,802	\$97,634
Schott, E.	NOAA/MD Seagrant	Monitoring for outbreaks of a fatal blue crab virus in waters with shedding systems.	02/01/12-01/31/14	\$126,511	\$31,628
<b>Total</b>					<b>\$253,459.00</b>

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

Author	Funding Agency	Title of Project	Start/End Date	Amount	Current 6 month period
Andrij Horodysky, Deidre Gibson, Benjamin Cuker	NSF HBCU-UP TIP	Education Partnership in Climate Change and Sustainability (EPICCS)	Nov 1, 2011 – Oct. 31, 2014	\$164,800	\$55,000
Benjamin Cuker	NSF OCE	American Society of Limnology and Oceanography Multicultural Program	July 1, 2013 to June 30, 2018	900,000	\$90,000
Ozby, 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
Jiang, Li, Lee, Chen, Ozby, 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
Ozby (DSU)	USDA-NIFA	Mid-Atlantic Drinking Water Program: Drinking Water and Human Health	9/1/12 - 8/31/13	\$20,000	\$10,000
D. Lazarre	Munson Foundation	Lionfish impacts on the Florida Lobster fishery	8/1/2012 - 8/31/2013	\$8,000	\$4,800
D. Die	ISSF	Evaluation of management strategies for tropical tuna fisheries	7/25/2011 - 10/31/2013	\$167,869	\$22,027
B. G. Stevens (UMES)	Maryland Department of Natural Resources	Assessment of epibenthic megafaunal communities in the Maryland nearshore region	8/1/13 - 6/30/14	\$100,000	\$50,000
Curran, C.(SSU)	US Dept of Edu	The HBCU 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. 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 & E.B. May (UMES)	NSF	University of Maryland Eastern Shore REU in Marine and Estuarine Science	6/1/12 – 5/31/15	\$262,000	\$43,667
P. Chigbu (UMES), A. Ishaque, (UMES) R. Khambilvardi (CREST)	NSF	A Network of CSCs and High Schools for Training Students in Geosciences	9/1/12 – 8/31/15	\$500,000	\$83,333
E. May, A. Allen (UMES)	USDA Capacity Building 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 Building 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.,	NSF (HRD-	Targeted Infusion Project: Educational	9/1/11 – 8/31/14	\$300,000	\$50,000.00

Horodysky, A., Cuker, B.	HBCU-UP)	Partnership in Climate Change and Sustainability (EPICCS)			
Dionne Hoskins	Ocean Leadership	National Ocean Sciences Bowl Regional Competition Site	2013 – 2014	\$5,000	\$2,500.00
Chung, J.S.	NSF	Functional Roles of a Novel Crustacean Female Sex Hormone in Sex Differentiation and Developing Secondary Sex Features of Crustaceans	01/03/12 - 01/02/16	\$635,507	\$79,438.00
Jagus, R.	NIH/NSF	Translation regulation of gene expression in toxic dinoflagellates.	01/09/12 - 01/31/18	\$1,953,810	\$162,817.00
Schott, E.	CRRC	Understanding chronic impacts of dispersants and dispersed oil on molting	12/15/12 -12/14/13	\$177,778	\$88,889.00
<b>Total</b>					<b>\$2,195,856</b>

#### Appendix IV: Presentations and Publications

##### Oral Presentations (\*Students)

- Alvarez\*, A., Cullen\*, D.W., Johnson, A.K., and Stevens, B.G. (2013) Reproductive biology of black sea bass (*Centropristis striata* L.) in Maryland. Research Experience for Undergraduates (REU) Symposium, UMES Paul Sarbanes Coastal Ecology Laboratory, 9 August, 2013.
- Hanif, H.\*, Secor, D., Jagus, R., Place, A. (2013) Diet and Feeding of Menhaden Using Barcoding Identification Based on COX1 Sequences. Morgan State University 13<sup>th</sup> Annual Research Symposium, Baltimore, MD, May, 2013.
- Cullen, D.W.\*, and Stevens, B. G. (2013) Comparing Baited and Unbaited Video to Assess Black Sea Bass (*Centropristis striata* L.) Abundance. UMES Research Colloquium, April 2013.
- Cullen, D.W.\*, and Stevens, B.G. (2013) Comparing Baited and Unbaited Video to Assess Black Sea Bass (*Centropristis striata* L.) Abundance. LMRCS Marine Fisheries Workshop, UMES Paul Sarbanes Coastal Ecology Laboratory, 15 May, 2013.
- Denson, L.S.\*, Sampson D. B. (2013) Can We Use Environmental Data to Inform a Spatial Stock Assessment? Developing a Simulation Experiment. Oral presentation at the 28<sup>th</sup> Annual Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) National Conference in Sacramento, CA.
- Gong, T. and Jones, J.\* (2013) Socioeconomic factors affecting entry-stay-exit behavior of the blue crab fishermen in Maryland. Maryland Department of Natural Resources, Annapolis, MD. June 3, 2013.
- Hawthorne N.C.\* and Ogburn, M.B. (2013) Separating behavior from environmental interference: Controls in a marine acoustic telemetry study. Benthic Ecology meetings, Savannah, GA Mar 21-23, 2013.
- Janiak, C.\*, McIntosh, D. (2013) Putting theory into practice: aquaculture as a STEM tool in the classroom. Association of Research Directors 17<sup>th</sup> Biennial Research Symposium, Jacksonville, FL April 6-10, 2013. First Place Oral Presentation, Aquatic Sciences Division
- Lycett, K.\*, Pitula, J.S. (2013) Bioinformatics and parasite ecology: What do we really know. Eastern Fish Health Workshop, Gettysburg, PA. April 29-May 3, 2013.
- Maylone, M., Palmer, F., and Pride, C. (2013) Changes in sediment properties of the Savannah River estuary corresponding with precipitation in the Savannah River drainage basin, 2012 Spring SEERS, Charleston, SC April 17-19, 2013
- Miller, J.A. Tracking Marine Biota on Japanese Tsunami Debris: The Initial Stages of the Invasion Process. (2013) Pacific Ocean Education Team (POET.) Webinar Series [posted on YouTube at <http://www.youtube.com/watch?v=HV13J-ltteQ>].
- Miller, J.A., Teel, D., Peterson, W. T., and Baptista, A. (2013) Assessing the relative importance of local and regional processes on the survival of Snake River spring/summer Chinook salmon. Oral presentation at the North Pacific Anadromous Fish Commission 3<sup>rd</sup> International Workshop on Migration and Survival Mechanisms of Juvenile Salmon and Steelhead in Ocean Ecosystems, Honolulu, Hawaii.
- Pitula, J.S. (2013) Bioinformatics and Protista: what do we really know. UMCES-IMET Seminar Series, Baltimore, MD. March 2013.
- Pitula, J.S. (2013) *Hematodinium* in the context of other dinoflagellate populations in the Maryland Coastal Bays. National Park Service North Atlantic Coast Cooperative Ecosystems Studies Unit Annual Meeting. Narragansett, RI. June 2013.
- Rodgers, C.\*, Parveen, S., Chigbu, P., Ishaque, A., Jacobs, J., Rhodes, M., Harter-Dennis, J. (2013) Assessments of the levels of *Vibrio parahaemolyticus* and trace metals in blue drabs (*Callinectes sapidus*), water and sediments of Maryland Coastal Bays. UMES 2013) Regional Research Symposium, April 16, 2013.

- Santos, R.\* and D. Lirman. (2013) Response of nektonic community assemblages to spatial patterns of seagrass habitats in nearshore seascapes. Benthic Ecology Meeting March 2013 Savannah Georgia.
- Stevens, B.G. (2013) *In-situ* Assessment of black sea bass (*Centropristis striata* L.) Abundance and Behavior. LMRCS Science Meeting, 3/26/2013, Hatfield Marine Science Center, Newport OR.
- Stevens, B.G. (2013) Using underwater video for assessing abundance and behavior of black sea bass and seafloor habitats. One NOAA Science Seminars: NOAA HQ, Silver Spring MD, 09/26/2012.
- Stevens, B.G. (2013) Distribution and sexual maturity of deep-sea red crabs *Chaceon quinquegens* in the Mid-Atlantic Bight. American Fisheries Society, St. Paul, MN, 8/22/12.
- Stoneman, A. T.\* and Smith, S.L. (2013) The Design and Operation of an Ocean Acidification System to Measure Larval Red Porgy (*Pagrus pagrus*) Otolith Growth. 2013. British Ecological Society's 11<sup>th</sup> International Congress of Ecology, London, UK, 18-23 August.
- Stoneman, A. T.\*, Smith, S.L., and Ozbay, G. (2013) The Effects of Ocean Acidification on the Occurrence of Otolith Deformities in the mummichog (*Fundulus heteroclitus*). Association of Research Directors 17<sup>th</sup> Biennial Research Symposium, Jacksonville, FL April 6-10, 2013.
- Tardiff, R. \*, Cullen, D.W.\*, and Stevens, B.G. (2013) Feeding habits of black sea bass (*Centropristis striata* L.) in Maryland. Research Experience for Undergraduates (REU) Symposium, UMES Paul Sarbanes Coastal Ecology Laboratory, 9 August, 2013.
- Tewes, E.\*, and Stevens, B.G. (2013) Assessment of Marine Renewable Energy Installation Siting: Effects on Epibenthic Communities. LMRCS Marine Fisheries Workshop, UMES Paul Sarbanes Coastal Ecology Laboratory, 15 May, 2013.
- Walters, T.M.\*, Frazier, L., Frischer M., Paffenhofer, G. (2013) Molecular profiling of zooplankton diet using PNA-PCR and denaturing high performance liquid chromatography (PNA-PCR-DHPLC) Spring SEERS, Charleston, SC April 17-19, 2013
- Ward, T.,\* Hoskins D.L., Ogburn M. (2013) The evaluation of natural and restored intertidal oyster reefs in coastal Georgia. Benthic Ecology meetings, Savannah, GA Mar 21-23, 2013.
- Wolfer, H.M.\* and Johnson, A. K. (2013). Physiological and immune system effects of sublethal hypoxia on Atlantic croaker, *Micropogonias undulatus*, in Chesapeake Bay. UMES 2013 Regional Research Symposium, Princess Anne, MD April 16, 2013.
- Xia M., and Jiang, L.; Schaeffer, B.A. The Impact of Wind Forcing and River Discharge to A Gulf Estuary Hypoxia. ASLO 2013 Aquatic Sciences Meeting. New Orleans, Feb16-23, 2013
- Xia, M., and Jiang, L. (2013) The Impact of River Discharge to A Gulf Estuary Hypoxia. Gordon Research Conference: Coastal Ocean Circulation, University of New England, Biddeford, ME, June 9-14, 2013.
- Xia, M., Jiang, L., Schaeffer B.A. (2013) The effect of wind to a Gulf estuary hypoxia variation, IMBER (Integrated Marine Biogeochemistry and Ecosystem Research) III, GOA, India. Jan 28-31, 2013

#### Poster Presentations (\*Students).

- Brinton B.A.\*, LaBarre J., and Curran M.C. (2013) The parasitic effects of *Probopyrus pandalicola* on the behavior of *Palaemonetes pugio* and the predation preferences of *Fundulus heteroclitus* Spring SEERS, Charleston, SC April 17-19, 2013
- Cotton C. and Curran M.C. (2013) Residency and movement patterns of three species of elasmobranchs in Georgia during the off season, Spring SEERS, Charleston, SC April 17-19, 2013
- Dean, H.A.\*, Smith, S.L. and Ozbay, G. (2013) A Stable Isotopic and Fatty Acid Food Web Comparison of Atlantic Menhaden and Gulf Menhaden. Association of Research Directors 17<sup>th</sup> Biennial Research Symposium, Jacksonville, FL April 6-10, 2013.
- Denson, L. S.\*, Sampson D. B. (2013) Spatial Stock Assessment Assumptions and Environmental Data Capabilities Within Stock Synthesis. Poster presented at the World Conference on Stock Assessment Methods, Boston, MA.
- Gut J.\* Reichmuth, J., Curran, M.C. (2013) Variation in fish assemblages between estuarine and coastal sites near the mouth of the Savannah River, Georgia Spring SEERS, Charleston, SC April 17-19, 2013
- Howard, T.\* and Cox, T. Tursiops Truncatus Strandings in Georgia, Florida, and South Carolina from 2008 to 2012. Savannah State University 3rd Annual Research Conference and RIMI Symposium, Savannah GA. April 9, 2013
- Lindsay, E.K.\*, McBride, R. and Johnson, A.K. (2013) Exploring fecundity-somatic relationships in the American goosefish, *Lophius americanus*. UMES School of Graduate Studies 4<sup>th</sup> Annual Regional Research Symposium, April 16, 2013
- Murry, B.\* and Pride C. (2013) Seasonal and annual variations of surface diatom distribution in the Savannah River Estuary. Savannah State University 3rd Annual Research Conference and RIMI Symposium, Savannah GA. April 9, 2013
- Murry, B.C.\* and Pride, C. (2013) Seasonal and annual variations of surface diatom distribution in the Savannah River estuary, Spring SEERS, Charleston, SC April 17-19, 2013
- Parks, E.\* and M. B. Ogburn, Roberts, P.M., Kramer, M.A. and Hines A.H. (2013) Abundance and Distribution of Blue Crab, *Callinectes Sapidus*, Juveniles in Upper Chesapeake Bay, Savannah State University 3rd Annual Research Conference and RIMI Symposium, Savannah GA. April 9, 2013
- Parks, E.\* and M. Ogburn. (2013) Near Shore Surveys of Juvenile Blue Crabs, *Callinectes Sapidus*, in the Chesapeake Bay, Savannah State University 3rd Annual Research Conference and RIMI Symposium, Savannah GA. April 9, 2013

- Smith C.\* (2013) An assessment of microbial extracellular polymeric substances (EPS) in coastal Georgia sediments. Benthic Ecology meetings, Savannah, GA Mar 21-23, 2013.
- Smith, C.\* and Hoskins, D. (2013) Microbial Extracellular Polymeric Substances (EPS) Savannah State University 3rd Annual Research Conference and RIMI Symposium, Savannah GA. April 9, 2013
- Stoneman, A.T.\*, and Smith, S.L. (2013) The Effects of Ocean Acidification on Otolith Deformities in the mummichog (*Fundulus heteroclitus*). Ecological Society of America Mid-Atlantic Chapter, 13<sup>th</sup> Annual Meeting, Dover DE, April 13-4. First Place Poster Presentation
- Tewes, E.\*, and Stevens, B.G. (2013) Assessment of Marine Renewable Energy Installation Siting: Effects on Epibenthic Communities (Poster). UMES Research Colloquium, April 2013.
- Ward, T.\* and Hoskins, D. (2013) Spatial Analysis of Physical Parameters of Oyster Reefs In Coastal Georgia

## **Publications (\*Students)**

### **Published**

- Braccini, J.M., Troynikov V.S., Courtney A.J., Die D.J., Prosser A. and Montgomery S.S. (2013) Stochastic growth of the eastern king prawn (*Melicertus plebejus* Hess, 1865) harvested off eastern Australia. *Crustaceana* 86: 651-660.
- Burke, B.J., Peterson, W.T., Beckman, B.R., Morgan, C.A., Daly, E.A., and Litz, M.N.C\*. (2013) Multivariate models of adult Pacific salmon returns. *PLoS ONE* 8(1): e54134.
- Chigbu, P. and Parveen, S. (2014). Bacteriological Analysis of Water. In *L.M.L. Nollet and L.S.P. De Gelder* (editors). Handbook of Water Analysis. Third Edition. CRC Press, Boca Raton, New York.
- Egiebor, E., Tulu, A., Abou-Zeid, N., Aighewi, I. T., Ishaque, A. (2013) The kinetic signature of toxicity of four heavy metals and their mixtures of MCF7 breast cancer cell line. *International Journal of Environmental Research and Public Health* 10: 4507-4518.
- Hanif, A.W.\*, Dyson, W.D.\*, Bowers, H.A., Pitula, J.S., Messick, G.A., Jagus, R., Schott, E.J. (2013) Variation in spatial and temporal incidence of the crustacean pathogen *Hematodinium perezii* in environmental samples from Atlantic Coastal Bays. *BMC Aquat Biosyst.* 9:11. doi: 10.1186/2046-9063-9-11.
- Litz, M.N.C.\*, Emmett, R.L., Bentley, P.J., and Claiborne, A.M. (2013) Biotic and abiotic factors influencing forage fish and pelagic nekton community in the Columbia River plume (USA) throughout the upwelling season 1999-2009. *ICES Journal of Marine Science*, doi:10.1093/icesjms/fst082.
- McComb, D.M., Kajiura, S.M., Horodysky, A.Z., and Frank, T.M. (2013) Comparative Visual Function in Predatory Fishes from the Indian River Lagoon. *Physiological and Biochemical Zoology*: 86: 285-297
- Miller, A.S.\*, Cadrin, S. X. , and Stevens, B.G. (2013) Effects of shell disease on egg quality of the American lobster. *Journal of Crustacean Biology*, 33(4): 461-469.
- Miller, J. A., Teel, D. J., Baptista, A., and Morgan, C. A. (2013) Disentangling bottom-up and top-down effects on survival during early ocean residence in a population of Chinook salmon (*Oncorhynchus tshawytscha*). *Canadian Journal of Fisheries & Aquatic Sciences*. 70:617-629.
- Peemoeller, B-J.\*, and Stevens, B. G. (2013) Age, Size, and Sexual Maturity of Channeled Whelk (*Busycotypus canaliculatus*) in Buzzards, Bay, MA. *Fishery Bulletin*, 111: 265-278.
- Saul, S.E.\*, Walter III, J., Die D.J., Naar, D.F., and Donahue, B.T. (2013) Modeling the Spatial Distribution of Commercially Important Reef Fish on the West Florida Shelf. *Fisheries Research* 143: 12-20.
- Stevens, B. G. (2012) Feeding rate of juvenile red king crabs, *Paralithodes camtschaticus*, in the laboratory: Effects of temperature, size, molting, and feeding frequency. *Polar Biology* 35:1791-1799. DOI 10.1007/s00300-012-1221-4.
- Stevens, B. G. (2012) Growth of juvenile red king crabs, *Paralithodes camtschaticus*, through sequential molts in the laboratory. *Journal of Crustacean Biology* 32(2):215-222. DOI: 10.1163/ 193724011X615460
- Vicente, J.\*, Stewart, A., Song, B., Hill, R.T., and Wright, J.L. (2013) Biodiversity of actinomycetes associated with Caribbean sponges and their potential for natural product discovery. *Mar. Biotechnology*, 15:413-24.
- Watson, A. M.\*, Barrows, F.T., and Place, A.R. (2013) Taurine supplemented plant protein based diets with alternative lipid sources for juvenile gilthead sea bream. *Journal of Fisheries and Aquaculture*, 4:59-66.
- Watson, A.M.\*, Barrows, F.T., and Place, A.R. (2013) Taurine supplementation of plant derived protein and n-3 fatty acids are critical for optimal growth and development of cobia, *Rachycentron canadum*. *Lipids*, 2013, 48:899-913.

### **In Press or Accepted**

- A.J. Adams, A.Z. Horodysky, R.S. McBride, K. Guindon, J. Shenker, T.C. MacDonald, H.D. Harwell, R.Ward, & K. Carpenter. (2013) Global conservation status and research needs for tarpons (Megalopidae), ladyfishes (Elopidae), and bonefishes (Albulidae). *Fish and Fisheries*. In press.
- Davis, J.\*, Hill, R.T. (2013) Characterization of the bacterial community of the chemically defended Hawaiian sacoglossan *Elysia rufescens*. *Applied and Environmental Microbiology* (in press)



- Die D.J. and Shivlani M. (2013). Some key issues to get right in peer reviews of stock assessments: lessons from the US Center of Independent Experts. ICCAT. In press.
- Kocovsky, PM., Stoneman, A.T.\*, and Kraus, R.T. (2013) Ecology and population status of Trout-perch (*Percopsis omiscomaycus*) in western Lake Erie. Journal of Great Lakes Research. In Press
- Smith, W. D. and Miller, J. A. (2013) Elemental markers in elasmobranchs: effects of environmental history and growth on vertebral chemistry. PlosONE. In press.

#### Appendix V. Acronym and LMRCS Links

Link to the LMRCS Performance Reports - <http://www.umes.edu/LMRCS/Default.aspx?id=16024>

Link to LMRCS Leveraged CREST-CISCEP - <http://www.umes.edu/crest/Default.aspx?id=31676>

Link to the LMRCS Leveraged PSM Program - <http://www.umes.edu/psm/Default.aspx?id=30892>

#### Appendix VI. 2012 – 2013 TAB Project Reports

**1. Project Title:** Do elevated nutrients increase the susceptibility of essential reef fish habitat to climate change stressors? A field experiment in the Florida Keys using novel genetic tools

**Project Description:** Our goal is to apply a newly developed DNA assay (developed by the Baker lab to identify and quantify *Symbiodinium* in reef corals) to a large collection of field-collected mucus samples (collected by the Vega Thurber lab for the purposes of identifying microbial communities). This includes over 3,000 samples from 3 resident coral species (first experiment) and over 100 samples (to date) from 2 transplanted species (second experiment). Using these samples we will: (1) Quantify changes in the types of algal symbionts found in coral colonies exposed to elevated nutrients and/or reduced herbivory, and compare them to controls; (2) Quantify changes in the total number of symbionts found in coral colonies exposed to elevated nutrients and/or reduced herbivory, and compare them to controls; and (3) Expose subsamples of both experimental and control colonies to thermal stress in the laboratory, and use chlorophyll fluorometry, photography, and DNA assays to compare the thermotolerance of each group. This will help us assess whether elevated nutrients increases the susceptibility of reef corals to bleaching by increasing the density of symbionts in coral tissue.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Andrew Baker, University of Miami (UM)

**NOAA Collaborator(s):** Margaret Miller, NMFS, Southeast Fisheries Science Center

**LMRCS Collaborator(s):** Rebecca Vega Thurber, Oregon State University (OSU)

**LMRCS Research Student(s):** Ms. Kim Galvez, UM (Undergraduate student); Ms. Stephanie Rosales, OSU (PhD student)

**Start Date:** 1 September 2012    **End Date:** 31 August 2013

**Project Results:** Our project had a late start due to delays in receiving funds to begin the proposed work. However, all field work in the Florida Keys is now complete, and in the last 6 months DNA has been extracted from all samples by OSU Ph.D. student Stephanie Rosales. Different DNA extraction methodologies have been trialed to determine which protocol works best for analyses of S:H cell ratio in these corals. With a reliable DNA extraction protocol now in place, OSU has sent UM a subset of ~100 DNA (low volume) aliquots for analysis. These are currently being processed by UM Ph.D. student Rivah Winter and minority undergraduate student Kim Galvez. OSU will send the rest of the samples to UM as soon as these samples have been analyzed. In addition, we have run a parallel short-term nutrient enrichment experiment in the laboratory at UM to complement Vega-Thurber's long-term field experiment. We enriched corals with elevated nutrients for 3 months prior to exposure to heat stress (32°C). We also included fragments of the nutrient-enriched corals from the Vega-Thurber field experiment to test their thermotolerance. These data (which include genetic assays of *Symbiodinium* type/abundance, and assessments of thermotolerance using chlorophyll fluorometry) are currently being analyzed.

Year 2 funding will allow us to complete the analyses of the field samples, analyze the results from the nutrient experiment, and run an additional experiment that will help us establish critical nutrient thresholds which result in measurable declines in thermotolerance.

#### **How will results be incorporated into NOAA Fisheries operations?**

This project will allow us to assess whether nutrient pollution increases the vulnerability of reef corals to thermal stress. Because reef corals are the principal builders of Essential Fish Habitat for many species of commercially and recreationally important species, this work is relevant to NOAA's mission to *examine the effect of natural disturbance and/or climate change on habitat quality, quantity, and availability*. *Climate Adaptation and Mitigation* is one of NOAA's four Long Term

Goals, and *Increasing the resilience of ecosystems by reducing their vulnerability in the short-term* is part of NOAA's Vision for the Future, as described in NOAA's Next Generation Strategic Plan. NOAA collaborator Miller will help incorporate our findings into NOAA Fisheries activities, and we are also working with our local Sea Grant extension office to communicate these themes to a variety of user groups in the South Florida area.

**How will results be incorporated into LMRCS research and curriculum?**

For many years, elevated nutrients on Florida's reefs (and elsewhere) have been implicated in reef decline, but when faced with the long-term threat of climate change, meaningful improvements to water quality have been hard to implement or support. If reducing nutrients can be shown to directly reduce bleaching risk and severity of bleaching, then management action to improve water quality would be a meaningful way to directly mitigate the impacts of climate change. Establishing links between local human actions and an ability to build resilience to climate change would be a very powerful way of motivating action to improve water quality. We anticipate that these themes would be suitable elements for subsequent LMRCS research activities and could also be incorporated into curricular activities.

**2. Project Title:** Influence of predicted aqueous hypercapnia on cobia, *Rachycentron canadum*, pre-fertilization and larval stages of development

**Project Description:** Increased atmospheric CO<sub>2</sub> has decreased oceanic pH by 0.1 (pre-industrial through 2005) with a continued projected decrease to 0.35 by 2100 (IPCC 2007). Studies of the effects of hypercapnia on marine teleosts are sparse but warranted due to anticipated changes. The goal of this research is to assess the impact of projected increases in CO<sub>2</sub> on the recruitment of the widely distributed and aquacultured cobia *Rachycentron canadum* by determining physiological impacts in gametes under reproductively relevant conditions. Sperm respiratory rates, motility, and the impact on egg and yolk-sac larval development will be assessed. Findings will provide the basis for further physiological and reproductive studies and aid in forecasting the response of fish stocks to global climate change. Experiments were concluded earlier this year following the approval of my committee. The trip to the Institute of Marine and Environmental Technology (IMET) to work in the Jagus Lab as part of the TAB collaboration was conducted this summer. The results are still being analyzed and will be incorporated when submitted for publication. Currently, I am working on writing the final chapter of my dissertation. A defense date has been scheduled for October 10<sup>th</sup>.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Dwight Ebanks, University of Miami, RSMAS

**NOAA Collaborator(s):**

**LMRCS Collaborator(s):** Dan Benetti and Nelson Ehrhardt, UM-RSMAS; Rose Jagus, UMCES-IMET.

**LMRCS Research Student(s):** Dwight Ebanks, University of Miami, RSMAS

**Start Date:** 1 September 2012      **End Date:** 31 August 2013 (Y2: 31 August 2014)

**3. Project Title:** Socioeconomic Factors Affecting Entry-stay-exit Behavior of the Blue Crab Fishers in the Chesapeake Bay

**Project Description:** The purpose of this project is to examine the effects of socioeconomic factors on the entry-stay-exit decision of the blue crab fishermen in Maryland. Phase I of the study is to collect qualitative data, which include 10-20 interviews with fishermen to gain insight on the socioeconomic factors that affect their participation in blue crab fishery in Maryland. The majority of the interviews were completed by Jared Jones, an undergraduate student at UMES. The Phase II of the study will incorporate the Phase I results into a random utility model and conduct an econometric analysis using harvest as well as cost data. The findings in this study will be important in understanding the socioeconomic factors that affect the entry-exit behavior of watermen in blue crab fishery, which will be helpful in implementing the conservation initiatives in fishery resources and improving the economic livelihood and resilience of fishing community.

**Thematic Area Addressed:** Resource Economics

**Lead Scientist(s):** Tao Gong, UMES; Stephan L. Tubene, UMES

**NOAA Collaborator(s):** David Tomberlin, NOAA

**LMRCS Collaborator(s):** Gil Sylvia, Oregon State University

**LMRCS Research Student(s):** Jared Jones (undergraduate student), UMES

**Start Date:** 1 Oct 2012      **End Date:** 31 Sep. 2013

**Project Results:** The purpose of Phase I part of the study was to identify the socioeconomic factors that affect the entry-stay-exit behavior of the blue crab fishermen in Maryland by conducting semi-structured interviews and performing qualitative analysis using consensual qualitative research (CQR) methods. The final sample included 15 blue crab fishermen from 10 Maryland coastal counties and four other respondents representing industry at-large, crab processors, restaurant industry, and fishermen's associations. Interviews lasted 15 to 30 minutes and were digitally recorded. Transcriptions were

made of the interviews for the purpose of data analysis. The analysis of the interviews yielded five domains: 1) fishermen's entry experiences; 2) factors affecting fishermen's entry-stay-exit behaviors; 3) measures for improving fishermen's economic likelihood; 4) policies for future management of the blue crab fishery; and 5) barriers to enter the fishery for young people. After the domains were established, each member of the research team individually coded the core ideas within domains for each interview. Then the research team discussed the core ideas to create a consensus version of the individual transcripts. Next a cross-analysis was conducted where the core ideas were organized into categories within each domain. For example, the first domain of fishermen's entry experiences indicates that fishermen's entry was affected by their family history and summer job experiences. The second domain of factors affecting fishermen's participation in the blue crab fishery includes personal interest, market conditions (market price of crabs, fuel cost, gear cost, etc.), blue crab abundance, and abundance of other species.

**How will results be incorporated into NOAA Fisheries operations?**

The results will be incorporated into NOAA fisheries operations in implementing the conservation initiatives in fishery resources and making regulations in managing fishery resources.

**How will results be incorporated into LMRCS research and curriculum?**

The project results will be incorporated into LMRCS research related to marine fisheries management and fisheries socioeconomics. More specifically, the socioeconomic factors that were found to be significant in affecting the entry-stay-exit behavior of the blue crab fishermen in Maryland will be incorporated into studying fishermen's participation behavior in other federally managed fisheries. The results will also be incorporated into the curriculum such as Introduction to Environmental and Resource Economics in explaining economic issues that arise with wild fisheries and the economic implications of different ways of managing wild fisheries.

**4. Project Title:** Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles

**Project Description:** Understanding variation in life history parameters is essential for assessment models. Loggerhead sea turtle assessments suffer from a lack of information on variability in vital rates and habitat use, which inhibits our ability to fit current stage-structured models to length distribution data. We will examine variation in juvenile growth and residence time in pelagic and nearshore habitats using skeletochronology and stable isotope analysis of growth layers sampled from the humerus bones of stranded loggerheads. The effects of variability in life stage length and age at maturity on population dynamics will then be investigated with a stochastic stage-structured model fit to length distribution data obtained from monitoring programs in the SE US.

**Thematic Area Addressed:** Quantitative fisheries & Essential Fish Habitat

**Lead Scientist(s):** Selina Heppell, Oregon State University (OSU)

**NOAA Collaborator(s):** Larisa Avens, NOAA SEFSC; Jeffrey Seminoff, NOAA SWFSC:

**LMRCS Collaborator(s):** Tara Cox, Savannah State University (SSU)

**LMRCS Research Student(s):** Matthew Ramirez, Oregon State University (MS); Eric Parks, Savannah State University (undergrad)

**Start Date:** 1 Sept 2012 **End Date:** August 31 2013

**Project Results:** Analysis of growth data shows that juvenile loggerhead sea turtles exhibit considerable inter- and intra-specific variation in growth at all sizes, possibly due to changes in foraging pattern. Due to equipment failure, only 1/3 of our samples have been analyzed to date. Remaining samples will be analyzed for isotopes by the end of September. Visual inspection of preliminary isotope data suggests that a shift in foraging pattern ( $\delta^{15}\text{N}$ ) is associated with an initial increase in growth, which has been reported previously in loggerhead sea turtles (Snover 2002). However, there does not appear to be a clear relationship between rate of growth and isotope signature. Complete analyses will be conducted once all isotope data is available.

Pilot project #1 – Collagen extractions resulted in yields of 6.5-20.5% (mean = 14%), which are typical for bone samples. Paired collagen and bulk bone samples will be analyzed for carbon ( $\delta^{13}\text{C}$ ) in the coming weeks.

Pilot project #2 – Of the twenty elements measured via laser ablation-ICP-MS, 9 are present in sea turtle bones sufficient ratios to Ca to measure (B, Ba, Cr, Cu, Mg, Mn, Se, Sr, Zn). Of these, Mg, Sr, and Zn are the most abundant. Ba, Sr, and Zn show the greatest variability, possibly due to interannual variation in foraging pattern, growth, and/or habitat use. Further analyses are being conducted to investigate these results.

**How will results be incorporated into NOAA Fisheries operations?**

Results from this study will provide one of the first detailed accounts of intraspecific variation in habitat usage throughout the juvenile life stage and its potential effects on growth and residence time in the loggerhead sea turtle, a protected marine

species. The parameters will then be used to improve existing loggerhead population models for stock assessment and studying the impacts of fisheries bycatch on this species. Sea turtles are long-lived, late-maturing animals that cannot be effectively monitored with nest counts alone, according to a recent report by the National Research Council. Thus, information gained through this study on the cryptic juvenile life-stage will be valuable to future application of a variety of quantitative tools. Assessment models for sea turtle species are generally data-poor, so this study has direct relevance to NMFS management efforts.

**How will results be incorporated into LMRCSC research and curriculum?**

This study will lay the groundwork for future study of alternate foraging strategies and differential habitat use in juvenile loggerhead sea turtles and may be applied to study the population dynamics of other sea turtle species as well as unrelated marine species being studied by individuals in the LMRCSC. Additionally, this study will exemplify the utility of stranded marine organisms in the improvement of life history parameter estimation. Because this study relies heavily on assistance (and samples) from NMFS cooperators at SWFSC and SEFSC, it is an excellent example of a multi-institutional project for LMRCSC.

**5. 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 United States. 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. Thus, 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 variations 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):** Andrea Johnson; Ashok Deshpande

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

**LMRCSC Collaborator(s):**

**LMRCSC Research Student(s):** TBA

**Start Date:** January 1, 2013

**End Date:** December 31, 2013

**Project Results:** Monkfish samples ( $n=8$ ) were collected during the NOAA LMRCSC research cruise aboard the *R/V Gordon Gunter* in July, 2013 from Mud Hole, Fingers and Norfolk Canyon. For each fish, 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. Samples are being held for further processing in Dr. Deshpande's Lab at the J.J. Howard Marine Sciences Laboratory in Sandy Hook. We plan to analyze 34 PCB congeners, 24 organochlorine pesticides, and 27 flame retardant PBDE congeners in monkfish liver, muscle and gonads. So far, lipid concentrations have been determined for 21 samples of muscle, liver and gonads. We are in the process of recruiting a graduate student to replace Ms. Bediako who is no longer working on the project. In the interim, Dr. Deshpande's lab plans to finish processing the six samples started by Ms. Bediako for PCB congeners, organochlorine pesticides and PBDE.

**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 a graduate student in the LMRCSC program. Results will be presented at the annual meeting of the American Fisheries Society and at national/regional science conferences.

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

**Project Description:** We evaluated the structure of nektonic communities found on continuous and fragmented seagrass seascapes to understand how the spatial configuration of seagrass patches influences associated fauna. The relationship

between the habitat and associated fauna is of key relevance to the management of Biscayne Bay where the spatial patterns of nearshore habitats are directly affected by the projects of the Comprehensive Everglades Restoration Plan (CERP). The seascape was mapped using satellite images, and the fish and invertebrate community was sampled at night using seine nets. We also quantified predation effects in the different habitat types and the niche breadth of *Lagodon rhomboides* (Pinfish) in response to structure of SAV seascapes. Fragmented habitats had higher abundance of pink shrimp *Farfantepenaeus duorarum* and the code goby *Gobiosoma robustum*, and continuous habitats had higher abundance of the sardine *Herengula sp.* and the pinfish *Lagodon rhomboides*. Larger individuals of grey snappers and bluestriped grunts were found in fragmented compared to continuous habitats. At the community level, percent dominance was significantly higher in continuous habitats, but diversity and taxonomic distinctness were significantly higher in fragmented habitats. The niche space occupied by pinfish was larger in fragmented habitats and a higher predation of shrimp was recorded within fragmented habitats and at the edges of SAV meadows (i.e., close to the mangrove fringe). These results help conceptualize the potential future effects of water management practices on the spatial composition and configuration of nearshore SAV communities where changes in the delivery of fresh water could induce shifts in the abundance, assemblage composition, predation patterns, and distribution of fish and invertebrate species.

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

**Lead Scientist(s):** Diego Lirman (University of Miami – RSMAS)

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

**LMRCSC Collaborator(s):** Andrij Horodysky (Hampton University)

**LMRCSC Research Student(s):** Rolando O. Santos, University of Miami – RSMAS (MS), Josh Miller, Hampton University (undergraduate); James McCullars, Savannah State University (undergraduate)

**Start Date:** 05/01/2012

**End Date:** 08/31/2013

**Project Results:** Habitat maps produced using remote sensing techniques applied to satellite images were used to develop a sampling scheme for the fish and macro-invertebrate communities of nearshore habitats of western Biscayne Bay. Sites were identified as either continuous or fragmented SAV seascapes where the nektonic community was sampled using seine nets at night to understand how the spatial configuration of seagrass patches influences associated fauna. Percent dominance was significantly higher in continuous habitats, but diversity and taxonomic distinctness were significantly higher in fragmented habitats. These results establish direct relationships between seagrass seascape patterns and abundance and biomass of associated fauna and help conceptualize the potential future effects of water management practices on the spatial composition and configuration of SAV communities and associated nektonic organisms.

We quantified diet variability and niche breadth of *Lagodon rhomboides* (pinfish) in response to structure of SAV seascapes by comparing gut contents and  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  in muscle tissues of individuals collected from continuous and fragmented SAV habitats. Individuals within continuous habitats were more enriched in  $\delta^{13}\text{C}$  but more depleted in  $\delta^{15}\text{N}$  relative to isotopic signatures from individuals from fragmented habitats. The niche space occupied by pinfish was larger in fragmented habitats as depicted by the  $\delta^{13}\text{C}$ - $\delta^{15}\text{N}$  space. The results demonstrate the critical importance of seascape structure on our understanding of trophic dynamics of key ecological species in nearshore SAV communities.

Predation effects were assessed using baited remote underwater video (BRUV) surveys and tethering experiments with pink shrimp (*Farfantepenaeus duorarum*). Preliminary results indicate a higher predation of shrimp within fragmented habitats and at the edges of SAV meadows (i.e., close to the mangrove fringe).

We provided internships to two undergraduate students, Josh Miller (HU – Junior) and James McCullars (SSU – class of 2013) who developed independent projects. Mr. Miller will present his findings on predation effects at HU and at the ASLO Multicultural Program in 2014.

#### **How will results be incorporated into NOAA Fisheries operations?**

The products of the proposed research will benefit NOAA Fisheries operations by: (1) providing information on the role of vegetated benthos as essential fisheries 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; (3) providing habitat indicators that relate directly to the abundance and distribution of fish and prey resources; (4) offering new sampling methodologies (e.g., 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 LMRCSC research and curriculum?**

The results of this research project will support the mission of the LMRCSC by providing fisheries research opportunities to students from underrepresented communities. For example, data obtained in this project will be used by students to learn

spatial analyses and statistical techniques and provide a better understanding on how different habitat characteristics influence fish populations at the ecosystem level.

**7. Project Title:** Evaluating the effects of prey quality on tissue lipids, taurine and growth in juvenile Chinook salmon (*Onchorynchus tshawytscha*) with a controlled feeding study

**Project Description:**

Growth, body condition, and fatty acids of juvenile salmon fed different formulated diets varying in the proportion of taurine and fatty acids will be measured over a period of three months to test the hypothesis that lipid composition influences growth, and possibly survival during a critical life history stage.

**Thematic Area Addressed:** Quantitative Fisheries

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

**NOAA Collaborator(s):** Robert Emmett, Fish Ecology Division, NOAA Fisheries

**LMRCSC Collaborator(s):** Allen Place, University of Maryland

**LMRCSC Research Student(s):** Marisa N. C. Litz, Oregon State University (PhD); Jessica Porquez, Oregon State University (MS); Aaron Watson, University of Maryland (PhD)

**Start Date:** 1 October 2012

**End Date:** 31 August 2013

**Project Results:** A potential consequence of climate change in coastal oceans is a change in the abundance or composition of prey available to emigrating juvenile salmon. To quantify the effect of prey quality on juvenile salmon growth, condition and potentially survival, we are conducting a controlled feeding experiment to measure differences in growth of juveniles consuming diets with different amounts of fatty acids. The fish came from a hatchery on the upper Columbia River in Washington and were transported to the Oregon State University (OSU) fish laboratory at the Hatfield Marine Science Center in Newport, Oregon according to OSU Institutional Animal Care and Use Committee (Animal Care and Use Proposal 4430), Oregon Department of Fish and Wildlife Fish Transport Permit 13-0182, and Washington Department of Fish and Wildlife Department Fish Transport Permit 6102-04-13. Over 5 weeks, the fish were gradually introduced to saltwater while being fed a commercial marine finfish diet (Otohime™ Extruded Pellet – 1.7 mm) containing a minimum 14% lipid. Upon smolting, all fish were weighed and measured, and 97 fish (20%) were tagged to track individual growth throughout the experiment.

Juvenile salmon transitioning from freshwater to saltwater typically experience ontogenetic shifts in their diet from mostly invertebrate prey to mostly juvenile marine fish prey. To simulate this transition, all fish were fed a low-fat (1% lipid) invertebrate diet based on krill for 6 weeks, and then switched to one of three experimental diets (all with 5% lipid) based on krill (Diet 1), krill and anchovy (Diet 2), or anchovy (Diet 3). Fish were distributed among 9 circular 500 L flow-through tanks containing ambient seawater pumped from the adjacent Yaquina Bay at high tide (mean temperature = 13.6° C and mean salinity = 32.6). Each tank contains approximately 40 fish. An additional tank is being maintained where fish are fed nothing but the Otohime™ diet throughout the experiment. Lengths and weights of all fish are measured every 4 weeks, and sampling of salmon tissues occurs every 2 weeks for determination of tissue lipid content and fatty acid composition.

The experimental diets were specially formulated to contain contrasting levels of the essential fatty acids docosahexaenoic acid (22:6w3; DHA) and eicosapentaenoic acid (20:5w3; EPA). The primary sources of DHA and EPA in coastal marine foodwebs are either small-celled, lipid-poor dinoflagellates (DHA) or large-celled lipid-rich diatoms (EPA). The ratio of DHA to EPA can be used as a quantitative indicator of dinoflagellate to diatom abundance, and because DHA is conserved in marine foodwebs, marine fishes typically contain higher amounts of DHA in their lipids than invertebrates. The ratios of DHA to EPA in our experimental diets equaled to 0.56 (krill diet), 0.94 (krill and anchovy diet), and 1.47 (anchovy diet). Table 1 shows the percent of each fatty acid in all our experimental diets. Based on greater condition observed in fish displaying greater piscivory in the field, we expected that fish fed the anchovy diet (Diet 1) would grow faster and be in better condition than fish fed the krill diet (Diet 1) or krill and anchovy diet (Diet 2). The concentration of taurine (an essential amino acid) in common juvenile salmon prey collected from the field, including krill and anchovy, is shown in Table 2.

To determine if there were any tank effects at the start of the experiment, we compared the size of fish using analysis of variance (ANOVA) followed by Tukey's multiple comparison tests, adjusting the level of significance to 0.005 based on the number of comparisons being made (n=10). There were no significant differences in fish fork length (mean FL = 95.7 mm) between tanks (p = 0.53), but the fish in tank 5 were significantly heavier than other fish in tanks 1-10. However, after 4 weeks on the washout diet, there were no longer any significant differences between tanks either in fish FL (mean = 103 mm; p = 0.02) or weight (mean weight = 12.2 g; p = 0.21). We began the experimental diets on week 6. After 2 weeks on the experimental diets there were no within treatment differences indicating there were no tank effects, but there were differences in FL among treatments (p = 0.002; level of significance = 0.0125). After 2 weeks on the treatment diets, fish

eating Diet 2 (krill and anchovy) were significantly longer (mean FL = 112 mm) than fish eating Diet 1 (krill) or Diet 3 (anchovy; both with mean FL = 110 mm). In addition, the fish eating commercial Otohime™ were longer than fish eating Diet 1 (anchovy). Overall, fish appear to be growing on average at a rate of 0.27 mm d<sup>-1</sup> or 0.09 g d<sup>-1</sup>. Differences in size will continue to be monitored for the remaining 10 weeks of the experiment. In addition, we plan to monitor the rate at which dietary fatty acids are incorporated into juvenile Chinook salmon tissue to compliment fatty acid monitoring efforts of juvenile Chinook salmon in the field.

**Table 1.** Percent fatty acid composition of each of the juvenile Chinook salmon (*Onchorynchus tshawytscha*) treatment diets. Fatty acids are presented using International Union for Pure and Applied Chemistry (IUPAC) nomenclature for organic chemical compounds. Otohime™ is a commercial marine finfish diet which was used while fish transitioned from freshwater to saltwater. All fish were on the krill washout diet for 6 weeks prior to starting the experiment. The experimental diet treatments will last 12 weeks.

Fatty Acid	Otohime™ Diet	Krill Washout Diet	Experimental Diet 1 (Krill)	Experimental Diet 2 (Krill/Anchovy)	Experimental Diet 3 (Anchovy)
14:0	6.52	7.47	2.90	3.12	3.65
14:1	0.08	0.10	0.04	0.04	0.05
i15:0	0.19	0.22	0.09	0.09	0.11
ai15:0	0.06	0.07	0.03	0.03	0.03
15:0	0.46	0.51	0.25	0.25	0.28
i16:0	0.11	0.11	0.05	0.05	0.06
ai16:0	0.05	0.07	0.01	0.00	0.00
19:4w2	0.03	0.00	0.02	0.02	0.04
16:0	18.77	21.29	9.68	10.22	12.11
16:1w11	0.06	0.16	0.02	0.01	0.01
16:1w9	0.03	0.00	0.00	0.01	0.01
16:1w7	5.85	6.24	2.95	3.73	4.63
16:1w5	0.25	0.41	0.12	0.11	0.12
i17:0	0.42	0.31	0.23	0.24	0.26
ai17:0	0.11	0.19	0.10	0.08	0.09
16:2w4	1.43	1.37	0.86	0.87	0.92
17:0	0.36	0.35	0.25	0.29	0.35
16:3w4	0.73	0.74	0.49	0.58	0.65
17:1	0.07	0.00	0.05	0.03	0.05
16:4w3	0.10	0.07	0.04	0.04	0.06
16:4w1	0.83	0.84	0.49	0.79	0.88
18:0	3.13	3.16	2.18	3.00	4.06
18:1w9	13.97	14.26	8.62	8.37	9.57
18:1w7	4.14	5.07	2.73	2.71	3.08
18:1w6	0.26	0.27	0.13	0.14	0.16
18:1w5	0.07	0.00	0.08	0.06	0.04
18:2w6	2.61	1.35	0.00	0.00	0.00
18:2w4	0.19	0.10	0.15	0.30	0.30
18:3w6	0.22	0.22	0.00	0.32	0.37
18:3w4	0.08	0.00	0.00	0.00	0.07
18:3w3	0.87	1.03	0.91	0.70	0.60
18:4w3	1.95	2.57	1.17	1.92	1.63
18:4w1	0.12	0.00	0.11	0.18	0.14
20:0	0.22	0.35	0.17	0.43	0.54
20:1w11	1.73	1.52	0.50	1.47	1.95
20:1w9	1.71	0.80	0.58	0.00	0.00
20:1w7	0.31	0.32	0.10	0.23	0.29
20:2a	0.00	0.00	0.07	0.00	0.00
20:3w6	0.06	0.00	0.10	0.14	0.15
21:00	0.00	0.00	0.00	0.00	0.08
20:4w6	0.79	0.83	1.15	2.00	0.88
20:3w3	0.08	0.00	0.00	0.07	0.00
20:4w3	0.56	0.00	1.56	1.07	0.82
20:5w3	12.24	14.46	37.96	26.74	18.61
22:0	0.06	0.00	0.00	0.00	0.00
22:1w11(13)	2.50	0.00	0.00	0.00	0.00
22:1w9	0.64	0.00	0.00	0.00	0.17
22:1w7	0.12	0.00	0.00	0.00	0.00
21:5w3	0.49	0.00	0.00	0.44	0.33
22:5w6	0.28	0.00	0.41	1.22	1.52
22:5w3	1.41	1.16	1.14	2.33	2.26
24:0	0.05	0.00	0.00	0.00	0.00
22:6w3	12.04	12.01	21.35	25.05	27.34
24:1	0.59	0.00	0.16	0.51	0.66

**Table 2.** Mean ( $\pm$  SD) taurine concentration (mg 100 g<sup>-1</sup>) measured from common juvenile Chinook salmon (*Onchorynchus tshawytscha*) prey items. Values are based on measurements from 10-40 individuals.

Common Name	Scientific Name	Dry Weight Taurine (mg 100 g <sup>-1</sup> )
Krill	Euphausiidae	950.0 $\pm$ 48.1
Dungeness crab (megalopae)	<i>Cancer magister</i>	1428.3 $\pm$ 175.8
Market squid	<i>Doryteuthis opalescens</i>	5724.3 $\pm$ 306.6
Smelt (unid juv)	Osmeridae	120.7 $\pm$ 6.1
Northern anchovy (juv)	<i>Engraulis mordax</i>	721.1 $\pm$ 23.3
Rockfish (unid larvae)	<i>Sebastes</i> spp.	702.4 $\pm$ 47.6
Rockfish (unid juv)	<i>Sebastes</i> spp.	1204.2 $\pm$ 69.6
Copepods	Copepoda	338.1 $\pm$ 180.3

### How will results be incorporated into NOAA Fisheries operations?

NOAA Fisheries scientists working within the Estuarine and Ocean Ecology Program of the Northwest Fisheries Science Center study key linkages between physical processes, such as upwelling or local habitat conditions, and the growth and survival of fish and invertebrates in the coastal Pacific ocean and estuaries. A major objective of this work is to understand how variation in the nearshore environment influences growth and survival of juvenile Pacific salmon. Our study will improve the understanding of the factors that control growth and production of Chinook salmon, which is needed to successfully manage these populations and can contribute to forecast models (see <http://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/g-forecast.cfm>).

### How will results be incorporated into LMRCSC research and curriculum?

This project is providing professional development, employment opportunities, and laboratory experience in fisheries science for both graduate (Litz) and undergraduate (Porquez) students. Students are acquiring skills on animal husbandry, lipid extraction and derivitization (OSU) and learning how to analyze taurine from lyophilized tissue extracts using liquid chromatography-mass spectrometry (IMET). Through this project, we are supporting the mission of the National Oceanic and Atmospheric Administration (NOAA) research priorities of the NOAA Fisheries Service and the goals of NOAA's Educational Partnership Program by providing research and training opportunities for students so that they are prepared for careers in fisheries.

### 8. Project title: Dinoflagellate Community Structure Within a Maryland Coastal Bay Ecosystem

**Project Description:** Since April of 2010, our laboratory has performed monthly environmental sampling of sites within the Maryland Coastal Bays, collecting both sediment samples and water samples enriched for various plankton species. Our goal was to discover whether we could observe *Hematodinium* sp. in environmental sites. Ultimately we seek to correlate biotic and abiotic parameters to the presence of *Hematodinium*. Our principal findings are that: a) *Hematodinium* has a bimodal distribution in its environmental manifestation, with a spring peak and late summer peak; b) A distinct population of *Hematodinium* has arisen in the MCB; c) Only one clade of the parasite (Clade A) exists in the MCB, contrary to a hypothesis based upon previous observations; and d) *Karlodinium venificum* was observed in June 2012 in Newport Bay.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Joseph Pitula, UMES

**NOAA Collaborator(s):**

**LMRCSC Collaborator(s):** Feng Chen, IMET

**LMRCSC Research Student(s):** Kristen Lycett (MS)

**Start Date:** November 1, 2012      **End Date:** September 1, 2013

**Project Results:** The specific aims of this project were:

1. To identify dinoflagellate communities within the Maryland Coastal Bays through analysis of clone libraries and DGGE assays.
2. To determine the sub-species composition of environmental reservoirs of *Hematodinium* sp. using PCR-based techniques.

For aim #1 we performed ongoing analysis of *Hematodinium* populations, showing that there is a bi-modal distribution in the MCB with an early peak in April/March, followed by a sustained peak beginning in July and lasting until October. Our analysis for 2013 is currently incomplete, as we still need to complete our September – October analysis. Nevertheless, our results are similar, with May and June showing little presence, as compared to April. Interestingly, we also sampled one month earlier in 2013, and were able to confirm positives in March. This observation represents the earliest known detection in the water column. In addition, we attempted to identify other dinoflagellate populations within our samples. A search



using *Dinophysis*-specific primers did not reveal the presence of this genus. However, we did discover the presence of *Karlodinium venificum* in Newport Bay samples from June 2012. This finding was of particular interest to us, due to the fact that this is a bloom-forming and toxin-producing species. We will continue to monitor for its presence in future work.

For aim #2, it became apparent that there is only one sub-species of *Hematodinium* in the MCB. Based upon our publication results, we had hypothesized the potential presence of alternative clades in the ecosystem. However, our attempts to differentiate between a potential Clade A and Clade B-type parasite were not successful. It is likely that only Clade A is present in this ecosystem. We did generate a new primer set to analyze sub-species population structure. Interestingly, the 5.8S rRNA displayed a single nucleotide polymorphism that has not been reported (either in the literature or in GenBank sequence deposits) from eastern coast isolates. Therefore, there exists the possibility that a distinct population has arisen in the MCB. These results will need to be confirmed using alternate genetic markers.

**How will results be incorporated into NOAA Fisheries operations? How will results be incorporated into LMRCS research and curriculum?**

This work has served as a foundational study upon which a Maryland Sea Grant Pre-proposal was submitted (*Dinophysis* in the Maryland Coastal Bays; Pitula and Chung). We will also be submitting an NSF Grant in the Ecology and Evolution of Infectious Diseases Cluster. In addition, Dr. Pitula is the instructor for the UMES graduate course in Environmental Microbiology, where this data and the organisms involved, will be discussed.

**9. Project Title:** Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture

**Project Description:** Addition of probiotic bacteria to aquaculture system water or feed has proven effective at decreasing pathogen-induced mortality of fish and shellfish. The mechanisms by which host protection is achieved are being studied extensively, as the implications of probiosis to the aquaculture industry are substantial. In the present study we focused on examining the interaction of a bacterial probiotic strain, OY15, and an oyster larvae pathogenic bacterium, B183, with an emphasis on: (a) characterizing an activity produced by OY15 that interferes with the biofilm forming activity of B183, and; (b) examining the genetic composition of OY15 using molecular tools to determine its origin and pathogenicity risks. In addition, experiments were done to evaluate the host specificity of OY15 and determine whether it could provide probiotic benefits for other aquaculture species including finfish.

**Thematic Area Addressed:** Aquaculture

**Lead Scientist(s):** Eric Schott, UMCES-IMET; Harold Schreier, UMBC-IMET

**NOAA Collaborator(s):** Gary Wikfors and Diane Kapareiko, Northeast Fisheries Science Center, Milford, CT

**LMRCSC Collaborator(s):** Dennis McIntosh, Delaware State University

**LMRCSC Research Student(s):** Oluwatobi Paul and David Billups

**Start Date:** 1 Jan 2013

**End Date:** 31 December 2013

**Project Results:** In the previous six-month funding period we continued to examine the mechanisms used by an oyster probiotic *Vibrio* sp., OY15, in protecting its larval host, *Crassostrea virginica*, from a pathogenic *Vibrio* sp., B183. Experiments conducted by Mr. Billups, examining the processes by which OY15 inhibits B183 activity, demonstrated that OY15 produced a factor(s) that destabilized B183 biofilm over time, suggesting a potential mechanism for OY15 probiosis. In addition to B183, this activity was also found to interfere with biofilm maintenance of fish pathogens DNO1 (*Vibrio harveyi*) and *Vibrio damsela* as well as a human pathogen, *Vibrio parahemolyticus*, but did not affect biofilm maintenance of *Pseudomonas stutzeri* or marine *Bacillus* sp. FE-1, suggesting that the activity was selective against *Vibrio* spp. This was an important finding since both *P. stutzeri* and *Bacillus* spp. are representative of nitrifying and denitrifying bacteria found within biofilms of aquaculture biofiltration units and any effects of OY15 on these would be detrimental to system water quality. Preliminary studies by Ms. Paul focused on the nature of the activity, and indicated that it was resistant to treatment at 80°C, suggesting that it is likely not proteinaceous and may be similar to a carbohydrate-based factor produced by another *Vibrio* spp. that displays similar properties. The ability of OY15 to interfere with the growth of DNO1, *V. damsela* and *V. parahemolyticus* was also demonstrated using a filter disc assay that we optimized, which found that the probiotic was just as effective in inhibiting these *Vibrio* strains as it was B183.

Sequence analysis of the 16S rRNA and *toxR* genes from OY15 suggested that this bacterium was most similar to members of the *Vibrio parahemolyticus* family, which are often pathogenic hemolytic bacteria and, therefore, would not be suitable for industry use as a probiotic. To address the nature of OY15 further, multi-locus sequence tag analysis was done (Ms. Paul) using DNA oligonucleotide primer sets that targeted *V. parahemolyticus* *recA*, *vmp*, *dnaE*, *gyrB*, *pntA*, *pyrC*, *dtbS*, *tnaA*, *tdh* and *tlh* genes by polymerase chain reaction amplification. While all primer sets resulted in a product using *V.*

*parahemolyticus* DNA, only the *gyrB* gene could be amplified from OY15, with no products obtained for any of the other genes. The sequence of the OY15 *gyrB* amplicon was found to be more similar to *V. alginolyticus* than *V. parahemolyticus*. The absence of strong homology to a pathogenic *V. parahemolyticus* was promising and these results allowed us to obtain additional funding from NOAA Milford Lab partners to sequence the OY15 genome, which has been accomplished and is presently being analyzed.

The ability of OY15 to inhibit growth of a variety of *Vibrio* pathogens suggests that it may have a probiotic activity for aquaculture species other than oyster and an experiment is presently being done to assess its ability to protect *Mummichog* larvae from disease (done by our partners at Delaware State University).

Both students presented their research at the 2013 IMET Summer Research Day, August 3, 2013. Ms. Paul, "Molecular investigation of the probiotic oyster larvae bacterium OY15" and Mr. Billups, "Analysis of bacterial isolates from *Fundulus heteroclitus* for probiotic candidacy".

**How will results be incorporated into NOAA Fisheries operations?**

The ability for OY15 to interfere with growth and settling of various *Vibrio* spp. has stimulated studies into the use of this bacterium as a probiotic for other aquaculture species.

**How will results be incorporated into LMRCS research and curriculum?**

Continued characterization of the OY15 biofilm inhibiting activity is a focus of future studies as well as our analysis of the OY15 genome sequence.

**10. Project Title:** Augmenting the Black Sea Bass, *Centropristis striata*, Stock Assessment: Assessing the importance of fixed and fluid estuarine habitats

**Project Description:** Black sea bass (BSB, *Centropristis striata*) live offshore during winter, but juvenile fish migrate to reef and hard bottom habitats in estuarine areas in the summer. BSB are a data poor fishery largely due to difficulties in trawl sampling, and a long-term decrease in landings is observed. We hypothesize that the decline in BSB is associated with the decline in oyster reefs in the Chesapeake as juveniles are dependent on estuarine reef and hard-bottom habitat. The decline may also be mitigated by variability in precipitation and resulting changes in salinity in the estuary. The goals of the study will be to develop a habitat suitability model to determine preferred habitats of BSB in the Chesapeake Bay. We will test the model with sampling at fixed areas of preferred habitats as well as adaptive sampling in areas where salinity may vary widely and occasionally be outside the preferred range. This proposal addresses two of the LMRCS research themes including "Quantitative Fisheries" and "Essential Fish Habitat", as well as several NOAA Strategic Objectives including "improving stock assessments" (1.1), and delineating essential fish habitat (1.11).

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

**Lead Scientist(s):** Bradley G. Stevens, UMES; Howard Townsend, NOAA Cooperative Oxford Laboratory

**NOAA Collaborators:** Steve Giordano and David Bruce, NOAA Chesapeake Bay Office – Cooperative Oxford Lab

**LMRCS Collaborator(s):** Jessica Miller, OSU

**LMRCS Research Student(s):** Laura Almodovar, UMES (MS)

**Start date:** September, 2012

**End date:** August 31, 2013

**Project Results:** A graduate student (Laura Almodovar) was recruited but could not begin work until June, 2013. During summer 2013, Ms. Almodovar worked with a NOAA fisheries modeler (Howard Townsend) to develop a habitat suitability model (HSM) including a growth rate potential model with structural benthic habitat (bottom type/oyster reef available). The HSM model will be linked either to the interpolated temperature/salinity data from the Chesapeake Bay and Tidal Tributary Interpolator (CBTTI) or estimated values of T and S from the Chesapeake Bay Operational Forecasting System (CBOFS) model. A literature review was initiated to assess the optimal temperature, salinity and dissolved oxygen requirements for maximal growth of BSB. One field trip was conducted to sample for the occurrence, distribution, abundance, and population structure of juvenile black sea bass and other demersal species on structured habitats using fish traps. We had planned to measure and preserve BSB so that otoliths could be collected and examined for daily growth rings to determine if there are differences in growth rates among different habitats. This aspect will be supervised by Dr. Miller; the student will travel to the OSU Hatfield Marine Center in Newport, OR, for training in her laboratory for two weeks, and will then complete the work at UMES. Unfortunately no BSB were captured during the first trip. Further field sampling trips are planned for early fall of 2013.

**How will results be incorporated into NOAA Fisheries operations?**

We expect that the data gathered will help to improve the stock assessment for BSB by incorporating habitat indices for recruitment, and allowing improved monitoring/surveys for BSB (and other reef associated species) that are transferable to other parts of the Mid-Atlantic Bight. In addition, it will improve the assessment of NOAA Habitat Restoration activities and

ecosystem-services criteria (i.e., fisheries) for oyster habitat restoration site selection. This work can help NOAA Restoration Center decide where to focus oyster restoration efforts such that the restored reefs might increase fisheries production.

**How will results be incorporated into LMRCS research and curriculum?**

This project improves cooperation between UMES and the NOAA Chesapeake Bay Program as well as the Oxford Cooperative Fishery Research Laboratory.

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

**Project Description:** Black sea bass (BSB, *Centropristis striata*) support an important commercial and recreational fishery in the Mid Atlantic Bight. There is no acceptable index of abundance for BSB because NOAA trawl surveys are not effective in sampling BSB habitats. We are developing quantitative methods for assessing abundance of black sea bass using in-situ video technology. In Y1 and Y2 we used underwater video cameras to estimate fish abundance, established that baited and unbaited trap CPUE are similar, and compared fish counts against hook-and-line CPUE. In Y3, we compared trap CPUE to soak time, with independent video counts for a background standard, and tested an adaptive sampling design for estimating the abundance of BSB using video techniques. This project will become the PhD Thesis for Dan Cullen at UMES, and has supported related research by 4 minority undergraduate students.

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

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

**NOAA Collaborator(s):** Vincent Guida, NEFSC, Sandy Hook Laboratory

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

**LMRCS Research Student(s):** Dan Cullen (PhD Student) University of Maryland Eastern Shore; Nikkia King, undergraduate student.

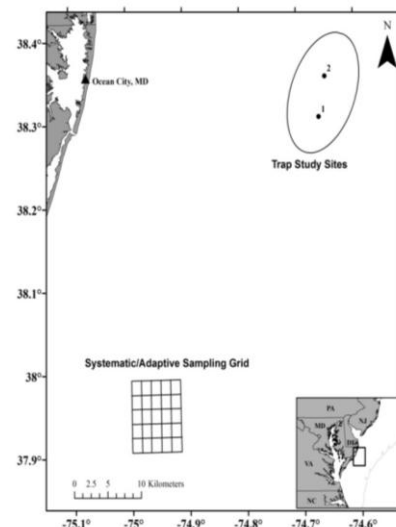
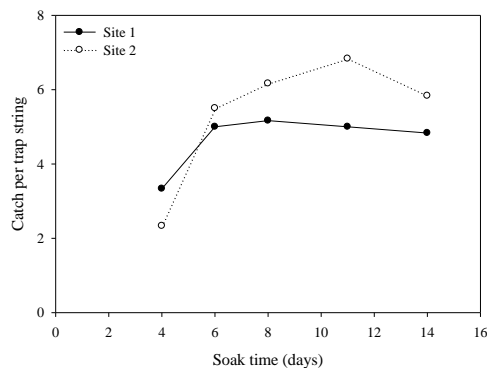
**Start Date:** 1 Sept 2012

**End Date:** 31 August 2013

**Project Results:** Trap study – The influence of soak time on catches of black sea bass (BSB) traps was studied on 6 days over a two week period in June at two locations with structured habitat 30 km off Ocean City, MD (Figure 1). A grid of 30 unbaited commercial BSB traps was deployed in strings of three. Two randomly chosen strings of 3 traps were recovered on each sampling date, after soak times of 4, 6, 8, 11, or 14 days. Underwater video was also used to collect independent density estimates for comparison. On each sampling day, an aluminum camera frame (~91 x 61 x 91 cm) with a Canon FS-30 camcorder in an underwater housing and 3 GoPro® HD Hero cameras was deployed adjacent to traps to get a pre-haul video density estimate. Two 30 minute camera frame deployments were made at a sampling site per day prior to hauling, producing a total of 48 hrs of video (4 cameras x 2 hrs/day x 6 days) over the sampling period. Habitats observed at both locations included a mixture of sandy bottom with mud, shell, gravel, and rocks with corals, and differed little between sites. Videos are currently being analyzed to estimate relative abundance using the MeanCount metric or the average number of fish counted in 60 frames per 30 minutes of video. CPUE of BSB increased to a maximum on days 8 and 11 at sites 1 and 2, respectively, after which it declined (Fig. 2). These data will be compared to video counts to determine if they fit theoretical models of soak time.

Adaptive sampling – From 24 June to 6 August, we evaluated the use of systematic adaptive sampling for surveying and estimating population abundance of BSB using underwater video. Sampling was conducted within a pre-defined 25 nmi<sup>2</sup> gridded area (Fig. 1) consisting of 25 primary blocks that were subdivided into secondary units. Initially, a total of 50 systematic samples were conducted with two units sampled per block. Thirty minute video samples were collected using the camera frame described above. Videos were brought back to the lab and viewed over 1-2 days to establish a minimum criterion value for BSB (count of fish).

Figure 1. 2013 Sampling sites. Fig 2. Catch per trap string for soak times ranging from 4 to 14 days.



Further sampling was conducted to the north, south,

east, and west of the systematic sampling units where 1 or more BSB were observed. The process was repeated iteratively until no fish were observed. This method allowed us to concentrate our sampling efforts in areas where BSB were most abundant. Twenty five hours of video were collected during the initial 50 systematic samples. Two of those samples (#15 and #43) included live bottom habitats where 1 or more BSB were observed while the rest consisted of mud, sand, and shell. An additional 10 adaptive samples were conducted in neighboring units surrounding #15 and 46 around #43. Videos are currently being analyzed to obtain counts of fish for each of the adaptive samples which will be used to estimate abundance and population totals using adaptive sampling estimators.

In addition, we hosted two undergraduate students as part of the NSF-funded Research Experiences for Undergraduates (REU) program. One of these conducted a study on food habits of BSB, and the other conducted a study on reproductive biology of BSB.

**How will results be incorporated into NOAA Fisheries operations?**

Video techniques are the best assessment methods for reef fish, and are being used by NOAA around the US. We expect that some variation of our system will become a standard method for NOAA to use for BSB assessment in the future.

**How will results be incorporated into LMRCS research and curriculum?**

The data and techniques have been incorporated into a class taught by Dr. Stevens "Survey Sampling". LMRCS assets were leveraged to support additional research by two minority REU students on our chartered vessel in 2013 (Ron Tardiff, and Amanda Alvarez). Undergraduate student Nikkia King conducted an independent study of BSB behavior (BIO 499) at UMS, using video we collected in summer 2013.

**12. Project Title:** Modeling Spatial-Temporal Fishing Effort of the West Coast Salmon Fishery

**Project Description:** Our project focuses on using genetic stock information and digital traceability systems to develop a spatial-temporal bio-economic model of effort distribution of West Coast salmon. We are conducting analysis on fine temporal and spatial data, modeling of fisherman's location choice decisions, modeling of spatial-temporal distribution of effort, and spatial econometric analysis. Predictions from this model will provide fishery managers with a characterization of fishermen behavior (allocation of effort in time and space) that can be used to design optimal finer spatial-temporal management tools for reducing by-catch of weak salmon stocks and avoiding long term closures of the salmon fishery.

**Thematic Area Addressed:** Economics and Social Science

**Lead Scientist(s):** Gil Sylvia, Oregon State University

**NOAA Collaborator(s):** Peter Lawson, NOAA/NMFS; Dan Holland, NOAA/NMFS

**LMRCS Collaborator(s):** Tao Gong, University of Maryland Eastern Shore;

**LMRCS Research Student(s):** Smit Vasquez Caballero, OSU (PhD)

**Start Date:** 1 September 2012

**End Date:** 31 August 2013

**Project Results:** Progress for this project during the months of March thru August was restricted due to the availability of our LMRCS Research Student, Smit Vasquez Caballero, who was preparing to take his doctoral written preliminary examination along with finishing the core courses to fulfill the PhD curriculum in Applied Economics, at Oregon State University. Smit successfully passed the required written preliminary exam at the end of June of this year. Soon after taking this preliminary examination, Smit fully committed to continue working on our project and accomplish complete data collection and management of the West Coast Salmon Genetic Stock Identification Collaboration (WC-GSI) database for a proper economic data analysis. Additionally, we had our first conference call among partner collaborators and we are currently scheduling an all-day collaborators meeting in Corvallis, Oregon on October 25<sup>th</sup> to discuss research progress and plan further work. During March we attempted to recruit a summer undergraduate intern. Only one candidate was deemed acceptable (out of 5 applicants), but declined our offer, so the position was not filled.

After submitting the appropriate documentation to the Collaborative Research on Oregon Ocean Salmon (Project CROOS), Oregon Salmon Commission, and WC-GSI, Smit obtained, managed and constructed a data set that contains Oregon and California salmon catch data recorded since 2006. The data set contains a total of 53,213 observations from 270 fishermen. Each observation provides detailed information on fishing ground locations such as date, time, depth, latitude, longitude of capture as well as detailed information on fishermen and vessel characteristics. This database will serve as the primary source for our analysis but it will need to be complemented by fish ticket data from the Pacific States Fishery Commission (PSFC). We are currently contracting a fishery financial analyst who has the required permissions to extract twenty years of fish ticket data from the PSFC (about 120,000 trip observations) and provide it in a form to complement our data set. We expect the data set to be ready for preliminary analysis by October of this year.

On July 18<sup>th</sup>, we had a Skype conference call between Dan Holland (NOAA-NFSC), Gil Sylvia (Project PI), and Smit Vasquez-Caballero (PhD student). During this meeting we discussed the progress of our project, especially characteristics

of the WC-GSI dataset. Additionally, we discussed Smit's PhD academic and dissertation timeline. As a follow up to this meeting, we are organizing a day-long Marine Resources Economics workshop on October 25<sup>th</sup> at Oregon State University campus. The workshop will serve the general purpose of sharing ongoing research about marine resources economics among local marine economists and graduate students, and the specific purpose of hearing inputs on our LMRCS project. Project collaborators will be discussing research progress, focusing on data currently collected. We will define the empirical strategy and we will discuss survey design if more information is needed. Tentatively, all project collaborators will attend the research planning meeting/workshop, as well as other interested faculty and graduate students, a total of 12 participants are expected. TAB funds will be used to cover travel expenses for our NOAA and LMRCS collaborators.

To date, no funds from our LMRCS TAB grant have been used given that our research is still in progress and we have not incurred any expenses. The original end date for the project was 31 August 2013, however we are unable to provide results of the project given that our work is still in progress. We are also unable to predict if we will finish our project by the end of this year, so a no-cost extension may be necessary for us to provide support for our collaborator to attend the research planning meetings as well as contract the service of a financial analyst to acquire fish ticket data. Progress of our work will be shared with the Oregon Salmon Commission and at the WC-GSI meeting later this year. Additionally Smit will present a poster during the 2013 Heceta Head Coastal Conference Student Poster Session, taking place on October 26<sup>th</sup> in Florence, OR.

**How will results be incorporated into NOAA Fisheries operations?** : N/A (project still in progress)

**How will results be incorporated into LMRCS research and curriculum?** N/A (project still in progress)