



**Performance Report for Cooperative Agreement No: NA11SEC4810002  
for the Period from March 1, 2014 to August 31, 2014**

**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 LMRCSC 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 LMRCSC 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 39 new students, and provided direct financial support to 88 students (19 Ph.D., 24 M.S., 45 B.S.) who received training in NOAA core science disciplines during this reporting period. In addition, 65 undergraduate and graduate students, who did not receive direct support from the Center, benefited from center programs and infrastructure. Eighteen (18) students graduated (13 BS, 5 MS, 0 Ph.D.) from the Center during this reporting period, and three Ph.D. students are scheduled to complete their degree by December 2014. Twelve (12) students interned at NOAA labs/facilities (NOAA Panama City, FL; Sandy Hook, NJ; NWFSC, AFSC and NOAA Cooperative Oxford Lab, MD) or labs of LMRCSC partner institutions. Among the recent graduates of the LMRCSC are: Andrea Stoneman (M.S., DSU) who is taking part in the NOAA Observer Program, Shadaesha Green (B.S., HU) currently in a graduate degree program at UMCES-IMET, Camille Gaynus (B.S., HU) who is in a Ph.D. program in ecology at the University of California Los Angeles, and Brittany Carmon (B.S., HU) who is in a M.S. program at Yale University. Additionally, Briana Jones (B.S., UMES) has just been offered admission for a master’s program at James Cook University, Australia. 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-four (34) 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 1,148 students, including the Coast Camp for Youth at Savannah State University (#=130 students), CREST-CISCEP SEEL program at UMES (#=7 students), and other programs for middle- and high school students that reached more than 900 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 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. Twenty-four (24) NOAA scientific and administrative personnel were engaged in LMRCSC education and outreach, scientific research and administrative functions. NOAA LMRCSC Research Cruise was not held in summer 2014 because NOAA vessel was not available. However, some of the LMRCSC students participated in offshore research aboard a commercial vessel, and LaTreese Denson (M.S., OSU) took part in the NOAA SEFSC larval billfish cruise.

In support of Goal 3, twelve (12) collaborative projects funded by the LMRCSC for 2013-2014 were conducted, and 12 new projects were selected for funding in 2014-2015. 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, research conducted by LMRCSC scientists and students in collaboration with NOAA scientists have generated valuable data needed to improve existing population and ecosystem models for management and conservation of commercially important species such as Chinook Salmon on the West Coast, Deep Sea red crabs and Black Sea Bass in the northwest Atlantic, forage fishes in the Northern California Current and Chesapeake Bay systems, and protected species such as loggerhead sea turtles. Additionally, LMRCSC research has enhanced our understanding of the behavior of blue crab fishermen in Chesapeake Bay, and the mechanisms by which probiotic bacteria improve the survival and, therefore, production of oyster larvae in hatcheries. 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 43 presentations (oral and poster) at scientific meetings (34 of which were made by students), and published 25 articles in refereed journals and books, 10 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 ~\$1.85 million was leveraged with NOAA EPP funds 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 indicates 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 (**# = 183; 30 Ph.D., 30 M.S., 116 B.S.**) and graduated (**# = 11; 0 Ph.D., 1 M.S., 10 B.S.**) in NOAA-mission sciences in the past six months
  - Number of students who were trained (**# =216; 31 Ph.D., 36 M.S., 126 B.S**) and graduated (**# =18; 0 Ph.D., 5 M.S/PSM, 13 B.S.**) in NOAA-mission sciences in the past six months;
  - Number of students who completed experiential opportunities at NOAA facilities (**# =7**);
  - Number of EPP funded students who were hired by NOAA (**# = 0**), NOAA contractors (**# =1**) and other environmental, natural resource, and science agencies at the Federal (**# = 1**), State (**# = 1**), local and tribal levels, in academia and the private sector;
  - Number of NOAA science and administrative personnel engaged in CSC Education and Outreach, Scientific Research, and Administrative functions (**# = 27**)
  - Number of collaborative research projects undertaken between NOAA and MSI partners in support of NOAA operations (**# = 12**);
  - Number of students (**# = 3**) and faculty (**# = 22**) 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, post-doctoral fellows, and students) sponsored by NOAA EPP (**# =25**);
  - Funds leveraged with NOAA EPP funds (including student support) (**# = ~\$1.85 million**); and,
  - Number of outreach participants engaged in NOAA mission relevant learning opportunities (**~2,500**).
-

**Summary of LMRCS Performance Measures of Success (Education and Outreach Programs) for 2013 - 2014**

	Proposed in the Implementation Plan  12 months	Accomplished (Sep. 1, 2013 – Feb. 28, 2014)  6 months	Accomplished (Mar. 1, 2014 – Aug. 31, 2014)  6 months (this period)	Accomplished (Jul. 1, 2013 – Aug. 31, 2014)  12 months
Activities/Programs	2013 – 2014	2013 - 2014	2013 - 2014	2013 - 2014
# K-12 Students participating in NOAA related science activities	1,000	448 - 548	1148	1,596 – 1,696
# of students trained in NOAA related Sciences	90	141	271	412
# B.S. Students who graduate in NOAA core Sciences	24	11	13	24
# M.S. Students who graduate in NOAA core Sciences	11	6	5	11
# Ph.D. Students graduating in NOAA core Sciences	4	2	0*	2
# of internships at NOAA/other labs.	33	3	16	19
# of Courses to be offered via Virtual Campus or online	5	15	10	25
Amount of leveraged funds (\$) for education and outreach	500K	\$1.5 million	943K	2,443K
# of student presentations at conferences	80	56	34	90
# of NOAA/LMRCS Fisheries Cruises	1	0	0	0
# of student co-authored publications	18	11	10	21
# of individuals impacted by outreach activities	>1,000	745 - 945	>1000	1,745 – 1,195

\*Three LMRCS Ph.D. students are scheduled to complete their degree in December 2014

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

	Proposed in the Implementation Plan  12 months	Accomplished (Sep. 1, 2013 – Feb. 28, 2014)  6 months	Accomplished (Mar. 1, 2014 – Aug. 31, 2014)  6 months (this period)	Accomplished (Sep. 1, 2013 – Aug. 31, 2014)  12 months
Activities	2013 - 2014	2013 - 2014	2013 - 2014	2013 - 2014
1. Science Meeting date	March	0	Oct. 29, 2014	Oct. 29, 2014
2. # of TAB Proposals funded	10 to 16	12	12	12
4. # of proposals funded (leveraged funding)	12	32	27	27
5. # of scientific presentations at conferences	120 (80*)	63(56*)	43(34*)	106(90*)
6. # of theses & dissertations produced	12	8	5	13
7. # of peer-reviewed publications	15*-30	21(11*)	25(10*)	46(21*)
8. Amount of leveraged funds (\$)	\$3 million	~\$1.9 million	~\$1.85 million	~\$3.75 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 11.

2. **Status of Benchmarks due during the performance period:** The LMRCSC met or exceeded most of the benchmarks considering that the accomplishments reported during this period are for six months. Compared with the one year benchmarks indicated in the 2013-2014 implementation plan, the LMRCSC met or exceeded most of its performance measures of success of education and outreach programs, especially with regard to the numbers of students trained in NOAA related sciences (90 vs 412), B.S. graduates (24 vs 24), M.S. graduates (11 vs 11), student presentations at professional meetings (80 vs 90), and numbers of journal articles co-authored by students (18 vs 21). However, the

LMRCSC proposed to graduate 4 PhDs in 2013-2014, but graduated 2 PhDs, although 3 additional Ph.D. students are scheduled to complete their program by December 2014.

**3. Status of Special Award Conditions (if applicable) Due During the Performance Period:**

All special award conditions have been met or will be met by October 1, 2014.

**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 24.

**5. Identification of All Collaborative Research Activities Undertaken During the Award Period:**

This is provided below under TAB funded projects on page 24.

**6. Report on the Administrative and Research Meetings Conducted in Support of Activities Under this Award**

Meetings conducted during this reporting period include monthly meetings of the Executive Committee, and conference calls by CSC Directors. The annual science meeting and the EPP Biennial Forum on Science and Education will be held during the next reporting period. Planning for these meetings is underway.

**7. Status of Recruitment (including students, staff and post-doctorates):** Dr. Maurice Crawford, the new Deputy Director of the LMRCSC was hired in August 2014. HU recruited Dr. Aurea Rodriguez as Assistant Research Professor.

**8. Status of Faculty/NOAA Staff Exchanges:** No staff exchanges occurred during this reporting period.

**9. Status of Budget to Date (Expended and Remaining Funds):** Expended = \$2,001,967; Remaining = \$786,696

**10. Progress on LMRCSC Student Development Plan (SDP) Implementation:** Students have been asked to complete student development plans in collaboration with their advisors. We are in the process of collecting those plans.

**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:** Several courses were offered to students at the center using the virtual campus facility (Tables 7 a,b).
- b) **Provide students with research experiences on Center campuses:** All LMRCSC 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 the form of internships. In addition to the internships listed in Table 4, both graduate and undergraduate students participate in research activities during the regular semester. For Example, at SSU, 11 students are performing research on campus on topics including marine mammals, benthic ecology, fish and shrimp ecology, paleo-oceanography, and ocean acidification.
- c) **Organize seminars for faculty and students:** The LMRCSC has established a center-wide seminar series that is attended by center scientists and students. Presentations at these seminars have been by scientists from the center and other institutions. Seminars given during this reporting period are listed in Table 8.

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

- a) **Train students to develop skills to teach, to co-mentor, to give and to receive feedback:** At SSU this semester graduate students in the M.S. program are learning best research practices in a Directed Research course guided by Dr. Hoskins but taught in a group/peer teaching format. Graduate students reviewed undergraduate research papers over the summer in the REU program and in individual labs. Drs. Carla Curran and Hoskins require peer editing in their labs before documents are submitted to advisors. Within the REU program at UMES, three Science Communication seminars focused on giving and receiving constructive criticism to peers in order to improve writing and presentation quality.
- 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. All RSMAS PhD students are obliged to be TA for one semester at a minimum; many do two semesters to get the support associated with the TA. All the labs associated with the LMRCSC at SSU use a peer mentoring format in which undergraduates co-mentor each other and graduate students mentor undergraduates and peers. This occurs in all labs but is required of all LMRCSC fellows and interns.

- 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. All RSMAS students are required to do proposals for their internships (MPS), thesis (MSc) and dissertation (PhD). UM offers grant writing courses for all graduate students. Many RSMAS students attend these courses.
- d) Students are also encouraged to apply for scholarship opportunities assisted by their advisors. As an example, in spring 2014, Wilmelie Cruz-Marero applied for a scholarship from the Marine Aquarium Societies of North America. She was assisted by her advisor Dr. Brad Stevens.
- e) **Enable students to identify career opportunities and to develop interviewing and networking skills:** At SSU, Dr. Jolvan Morris has been training undergraduates in interviewing as a qualitative research tool and is also developing a session on successful interviewing that she will lead at the forum.

At UMCES, Our students are encouraged to participate in the PROMISE Program. Maryland's Alliance for Graduate Education and the Professoriate (AGEP) is an NSF-funded, university system-wide effort for the state of Maryland to facilitate underrepresented STEM graduate student and postdoctoral professional development and pathways to careers. It provides professional development seminars and workshops as well as networking opportunities. UMBC leads the alliance (<http://promiseagep.wordpress.com>). IMET has established an Entrepreneurs Program with funding from the Philip E. and Carole R. Ratcliffe Foundation to help our young scientists cultivate the leadership and business skills necessary to bring their bench research into practical applications in the areas of sustainable energy resources, environmental remediation and sustainable aquaculture.

- f) **Create opportunities for students to develop collaborative leadership skills and to have leadership experiences:** At UMES, LMRCSC students were included as co-moderators of sessions during the annual university wide symposia at UMES, planned by the Graduate School collaboratively with the LMRCSC faculty, which took place April 17, 2014. At SSU, Graduate students are encouraged to lead seminar discussions, bridge their research across other M.S. programs, and contact local, regional and national agencies (especially NOAA) to seek research needs. The institutional PI makes these introductions when necessary, however students have been very successful in making these connections with the state DNR and the SEFSC as independent researchers.

UMCES-IMET students assist in planning of events, including UMCES Convocation and MEES Colloquium, participate in Entrepreneurs Program, self-govern through active Graduate Student Association, and student representatives participate at Faculty Meetings and UMCES Graduate Council Meeting.

- g) **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 communications 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.

During this reporting period, UMES REU students participated in eight hours of workshops on science communication in which the students received instruction on writing scientific manuscripts and creating and presenting oral and poster presentations. The students were then asked to prepare papers, oral presentations, and posters about their work and to provide constructive criticism to their peers.

SSU M.S. students who were admitted during the fall are required to write and defend their M.S. proposals by the first Monday of May each year. One-on-one training is offered by Dr. Hoskins to all LMRCSC fellows. Other M.S. students are guided through this process by their advisors.

RSMAS graduate students are offered the opportunity to attend a short one-week scientific writing course. The majority of the RSMAS-LMRCSC students take that course and funding for it is provided by the LMRCSC.

All UMCES-IMET Ph.D. students are required to write research proposals that are submitted to, and approved by their advisory committee before they advance to candidacy, submit 2-3 papers arising from their thesis research, and submit abstracts to relevant meetings.

- h) **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.

At SSU, A budget management workshop was offered in May to any person interested in learning external fund development and management. Two faculty members, all LMRCSC supported students (5) and staff (2), and one other non-LMRCSC staff member attended. Participants learned expenditure tracking and how to perform account reconciliation with business office records.

- i) **Create opportunities for students to participate in NOAA's mission and LMRCSC research-related seminars:** LMRCSC students participated in LMRCSC'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.

RSMAS LMRCSC students are invited to participate in NOAA SEFSC-RSMAS training activities associated with their area of research. Most such activities are associated with quantitative fisheries training and therefore it is quantitative fisheries LMRCSC-RSMAS students that the training. An example of such an activity is advanced R programming course conducted through CIMAS.

- j) **Encourage students to participate in summer internships at NOAA labs and labs at LMRCSC partner institutions:** Internship opportunities available at NOAA labs, LMRCSC and at various agencies, particularly USFWS have been made available to students. At IMET, these opportunities arise primarily from TAB projects. For instance, students working on the Schreier/Schott project on probiotics for oyster larvae aquaculture spend some time each summer in the laboratory of Dr. Gary Wikfors, NOAA-NMFS Milford Laboratory. Jan Vicente, LMRCSC graduate student spent a few months working with the Hawaiian Island Humpback Whale National Marine Sanctuary (HIHWNMS), Pearl Harbor, participating in the development of a fish identification guide, assisting in development of a proposal entitled "Exploration of the Mesophotic Reefs of the Au'au Channel" and providing outreach to families on the importance of the HIHWNMS.

- k) **Encourage students to make oral and/or poster presentations at professional meetings:** Student oral and poster presentations are listed in Appendix IV. During this period, students were also asked to begin preparing abstracts for presentations to be made at the 2014 NOAA EPP Biennial Forum on Science and Education.

- l) **Enhance Social/Personal Development of students:**

- **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.

At SSU, all syllabi are printed with a disability statement that refers them to the Office of Counseling and Disability Services. This office also has resources to help students manage stress. Conflict and stress management skills are also being taught in the above mentioned Directed Research course.

- **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. We are working to compile a list of student and alumni profiles. Currently, we are aware of six current and 41 former students who have profiles on LinkedIn with marine-related affiliations in their profile.

IMET students are encouraged to join Research Gate and /or Linked in. IMET's Associate Director, Dr. Nick Hammond, provides guidance on professional behavior and how to maintain an appropriate web presence.

- **Create opportunities for students to net-work:** Social interactions and development of LMRCSC students occurred during this period through the LMRCSC Facebook page and the Graduate Student Association at UMES. The annual Regional Research Symposium was held at UMES on April 17, 2014 and co-sponsored by the LMRCSC. Students submitted abstracts and participated in this symposium,

which provided networking opportunities with students for several other universities. The UMES REU summer 2014 interns participated in a peer-mentoring program with the nearby Maryland Sea Grant REU program.

SSU initiated an annual Research Day four years ago that is patterned after the 2007 NOAA Summit on Environmental Entrepreneurship that was produced in 2007 as part of the of NOAA Environmental Entrepreneurship grant. Students presented their research in this year's event held in April. Others attended the National Marine Educator's Association (NMEA), the Southeast Estuarine Research Society (SEERS), and the Association for the Sciences of Limnology and Oceanography (ASLO) meetings. Students are always encouraged (and often escorted) to meeting receptions and poster sessions.

At IMET, students are encouraged to be active participants in the Graduate Student Association (GSA), in collaboration with the GSA at UMB. LMRCS students are supported to attend professional meetings, do field studies with other organizations, and participate in the University of Maryland System PROMISE program, <http://promiseagep.wordpress.com>.

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

For the period of **March 1, 2014 to Aug. 31, 2014**, the following tasks were accomplished in support of the goals and objectives of the LMRCS:

### 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 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.

LMRCS-IMET uses its summer undergraduate internship program as a pipeline for graduate students. Successes in the last year have been Shadaesha Green, graduate of Hampton University, who was an intern with Dr. Sook Chung and has just entered the UMCES-MEES Ph.D. program with Dr. Chung as mentor.

**Activities and Accomplishments: - Recruitment into Marine Science Programs:** Thirty-nine (39) students were recruited into the LMRCS (Table 1).

- Rebecca Castro was recruited as a Marine and Environmental Science (MES) major, with a double major in Biology at HU.
- Keeli Howard and Diamond Sydnor were recruited from the School of Journalism to pursue a minor in MES at HU
- Austin Flinn, a Master's in Professional Science (MPS) student in Marine Affairs and Policy, was recruited to conduct an internship with Dr. David Die (RSMAS) to conduct fishery socio-economics research in Port Salerno, Florida.

**Table 1. Students recruited into LMRCS from March 1, 2014 to Aug. 31, 2014**

First Name	Last Name	Academic Institution	Degree Program	Expected Graduation Date
Prosper	Ikpeama	DSU	B.S., Biology	May-15
Nichelle	Smith	HU	B.S. MES	May-15
Lawren	Beane	HU	B.S. Mathematics	May-17
Austin	Flinn	RSMAS	MPS	Dec-14
David	Alexander	UMCES	B.S.	15-May

Rachel	Banks	UMCES	B.S.	14-May
David	Billups	UMCES	B.S.	16-May
Shanai	Brown	UMCES	B.S.	15-Dec
Erica	Dasi	UMCES	B.S.	15-May
Nicholas	Dawson	UMCES	Ph.D.	15-May
Kevia	DeLorme	UMCES	B.S.	16-May
Shadaesha	Green	UMCES	Ph.D.	14-May
Ammar	Hanif	UMCES	Ph.D.	16-May
Ikenna	Ikpeama	UMCES	B.S.	15-May
Taylor	Kline	UMCES	B.S.	15-Dec
Krista	Kraskura	UMCES	B.S.	15-May
Manuel	Olmeda	UMCES	B.S.	15-Dec
Jonathan	Peake	UMCES	B.S.	16-May
Cloee	Grainger	UMES	B.S. Biology	May-16
Derek	Burton	UMES	M.S.	May-16
Audy	Peoples	UMES	M.S.	May-16
Rebecca	Peters	UMES	M.S. Ecology	May-16
Marcus	Hughes	UMES	B.S.	May 15
Brandon	Adkins	UMES (Summer intern)	B.S.	May-16
Esther	Akinsoyinu	UMES	B.S.	May-16
Consuelo	Barton	UMES (Summer intern)	B.S.	May-18
Reniece	Buchanan	UMES (Summer intern)	B.S.	May-16
Spencer	Davis	UMES	B.S.	May-18
Najja	Gay	UMES (Summer intern)	B.S.	May-16
Tiana	Jones	UMES	B.S.	May-16
Mason	King	UMES	M.S.	May-16
Sabrina	Klick	UMES	Ph.D.	May-18
John	McCants	UMES	B.A.	May-16
Alexa	McLeod	UMES (Summer intern)	B.S.	May-18
Alexis	Parker	UMES (Summer intern)	B.A.	May-18
Anjene	Parker	UMES	B.S.	May-18
Veronica	Pereira	UMES (Summer intern)	B.S.	May-16
Kasondra	Rubalcava	UMES (Summer intern)	B.S.	May-16
Cara	Schweitzer	UMES	Ph.D.	May-18

**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, 2014 are listed in Table 2. Those who graduated during this reporting period are presented in Table 3. Among the students who graduated are 5 M.S., and 13 B.S. students.

To enhance the interests of new students, and to develop the collaborative and mentoring skills of experienced students, SSU established near-peer pairings with undergraduate and graduate students. Also, students met with faculty mentors more frequently during this award period.

**Table 2. Students who received direct support during the funding period (March 1, 2014 to Aug. 31, 2014).**

	First Name	Last Name	Academic Institution	Degree	Type	Amount
1	Kevin	Coles	DSU	B.S.	Stipend	\$5,491.37
2	Chardonay	Elliott	DSU	B.S.	Stipend/tuition	\$3,784.10
3	Prosper	Ikpeama <sup>u</sup>	DSU	B.S.	Stipend/housing	\$6,420.00
4	Andrew	Kluge	DSU	B.S.	Tuition	\$3,000.00
5	Aicha	Toure <sup>u</sup>	DSU	B.S.	Tuition	\$3,000.00
6	Hillary	Dean <sup>u</sup>	DSU	M.S.	Stipend/tuition/travel	\$14,955.14
7	Nivette	Perez-Perez <sup>u</sup>	DSU	M.S.	Stipend/tuition/travel	\$22,393.65
8	Andrea	Stoneman	DSU	M.S.	Stipend/tuition	\$8,761.67
9	Shadaesha	Green <sup>u</sup>	HU	BS	Stipend	\$2,000.00
10	Camille	Gaynus <sup>u</sup>	HU	BS	Stipend	\$1,200.00
11	Symone	Gyles <sup>u</sup>	HU	BS	Stipend	\$2,000.00
12	Brittany	Carmon <sup>u</sup>	HU	BS	Stipend	\$1,600.00
13	Joshua	Miller <sup>u</sup>	HU	BS	Stipend	\$600.00
14	Larry	Redd Jr <sup>u</sup>	HU	MS	Stipend	\$9,000.00
15	Renita	Bostic <sup>u</sup>	HU	MS	Stipend	\$4,500.00
16	Joshua	Williams <sup>u</sup>	HU	BS	Stipend	\$1,250.00
17	Nichelle	Smith <sup>u</sup>	HU	BS	Stipend + Travel	\$4,000.00
18	Joalene	Mason <sup>u</sup>	HU	BS	Stipend	\$400.00
19	Ashlee	Ward <sup>u</sup>	HU	BS	Stipend	\$800.00
20	Marisa	Tukpah	HU	BS	Stipend	\$1,000.00
21	Aniema	Nzesi <sup>u</sup>	HU	BS	Stipend	\$2,500.00
22	Marisa	Litz <sup>u</sup>	OSU	PhD	EPP GRTS, tuition and stipend	\$36,000.00
23	Matt	Ramirez <sup>u</sup>	OSU	MS	LMRCSC	\$7,345.00
24	Jessica	Andrade <sup>u</sup>	OSU	MS	LMRCSC	\$6,000.00
25	LaTreese	Denson <sup>u</sup>	OSU	MS	LMRCSC	\$20,000.00
26	Smit	Vasquez-Cabellero <sup>u</sup>	OSU	PhD	LMRCSC	\$22,000.00
27	Chante	Davis <sup>u</sup>	OSU	PhD	LMRCSC	\$22,000.00
28	Paul	Arkwright <sup>u</sup>	SSU	MS	Fellowship	\$1,666.66
29	Tiffany	Ward <sup>u</sup>	SSU	MS	Fellowship	\$3,623.58
30	Keya	Jackson <sup>u</sup>	SSU	MS	Fellowship	\$1,999.98
31	Crystal	Smith <sup>u</sup>	SSU	MS	Fellowship	\$4,999.98
32	Eric	Parks <sup>u</sup>	SSU	BS	Travel	\$532.00
33	Brandon	Adkins <sup>u</sup>	UMES	B.S.	Travel/Stipend	\$8,047.70
34	Esther	Akinsoyinu <sup>u</sup>	UMES	B.S.	Stipend/Tuition	\$3,570.00
35	Derrick	Alcott	UMES	PSM	Stipend/Tuition	\$6,610.45
36	Laura	Almodovar-Acevedo <sup>u</sup>	UMES	Ph.D.	Stipend/Tuition	\$12,035.20

37	Consuelo	Barton <sup>u</sup>	UMES	B.S.	Travel Stipend/Tuition	\$7,741.54
38	Jaime	Belanger	UMES	PSM	Stipend/Tuition	\$6,610.45
39	Tedra	Booker <sup>u</sup>	UMES	Ph.D.	Travel/Stipend/Tuition	\$9,631.95
40	Reniece	Buchanan <sup>u</sup>	UMES	B.S.	Travel/Stipend	\$7,717.30
41	Derek	Burton <sup>u</sup>	UMES	M.S.	Travel	\$1,470.09
42	Kenya	Bynes <sup>u</sup>	UMES	B.S.	Travel/Stipend	\$7,717.30
43	Dwight	Collins-Nixon <sup>u</sup>	UMES	B.S.	Salary	\$2,278.00
44	Wilmellie	Cruz-Marrero <sup>u</sup>	UMES	M.S.	Travel/Stipend/Tuition	\$11,464.90
45	Dan	Cullen	UMES	Ph.D.	Travel/Stipend/Tuition	\$7,149.22
46	Spencer	Davis <sup>u</sup>	UMES	B.S.	Travel Stipend/Tuition	\$5,289.34
47	Eric	Evans <sup>u</sup>	UMES	Ph.D.	Travel	\$397.88
48	Najja	Gay <sup>u</sup>	UMES	B.S.	Travel/Stipend	\$7,206.90
49	Shadaesha	Green <sup>u</sup>	UMES	Ph.D.	Travel/Stipend	\$6,544.00
50	Marcus	Hughes <sup>u</sup>	UMES	B.S.	Travel	\$2,060.00
51	Tiana	Jones <sup>u</sup>	UMES	B.S.	Salary	\$1,020.00
52	Susan	Kelly	UMES	PSM	Travel/Stipend/Tuition	\$6,610.45
53	Mason	King	UMES	M.S.	Salary	\$5,060.00
54	Sabrina	Klick	UMES	Ph.D.	Salary	\$2,240.00
55	Hector	Malagon <sup>u</sup>	UMES	M.S.	Travel/Stipend/Tuition	\$9,019.98
56	Stephanie	Martinez-Rivera <sup>u</sup>	UMES	Ph.D.	Travel/Stipend/Tuition	\$12,760.20
57	John	McCants <sup>u</sup>	UMES	B.A.	Stipend	\$2,580.00
58	Alexa	McLeod <sup>u</sup>	UMES	B.S.	Travel/Stipend/Tuition	\$6,863.34
59	Alexis	Parker <sup>u</sup>	UMES	B.A.	Salary	\$714.00
60	Anjene	Parker <sup>u</sup>	UMES	B.S.	Travel Stipend/Tuition	\$5,289.34
61	Audy	Peoples <sup>u</sup>	UMES	M.S.	Travel/Stipend	\$1,470.09
62	Veronica	Pereira <sup>u</sup>	UMES	B.S.	Travel/Stipend	\$7,717.30
63	Kasondra	Rubalcava <sup>u</sup>	UMES	B.S.	Travel/Stipend	\$7,717.30
64	Cara	Schweitzer <sup>u</sup>	UMES	Ph.D.	Travel/Stipend/Tuition	\$5,463.40
65	Daniel	Sweeney	UMES	PSM	Tuition	\$1,790.00
66	Ariana	Uwaibi <sup>u</sup>	UMES	B.S.	Travel Stipend/Tuition	\$7,253.34
67	Justin	Wilson <sup>u</sup>	UMES	M.S.	Stipend/Tuition	\$11,271.39
68	Dominique	Lazarre <sup>u</sup>	RSMAS	Ph.D	Stipend and travel	\$7,836.90
69	Rolando	Santos <sup>u</sup>	RSMAS	Ph.D	Stipend and travel	\$12,357.74
70	Karlissa	Calwood <sup>u</sup>	RSMAS	Ph.D	Stipend	\$14,568.00
71	Riva	Winters <sup>u</sup>	RSMAS	Ph.D	Stipend	\$7,500.00
72	Aneese	Williams <sup>u</sup>	RSMAS	MPS	Stipend	\$6,125.00
73	Christopher	Brown	RSMAS	BS.	Stipend	\$1,382.16
74	Dominik	Dousseau <sup>u</sup>	RSMAS	BS.	Stipend	\$1,612.80
75	Rachel	Banks <sup>u</sup>	UMCES	B.S.	Stipend/travel/lab fees	\$5,642.00
76	David	Billups <sup>u</sup>	UMCES	B.S.	Stipend/travel/lab fees	\$5,694.00
77	Shanai	Brown <sup>u</sup>	UMCES	B.S.	travel	\$32.00
78	Erica	Dasi <sup>u</sup>	UMCES	B.S.	Stipend/travel/lab fees	\$7,591.00
79	Kevia	DeLorme <sup>u</sup>	UMCES	B.S.	Stipend/travel/lab fee	\$5,694.00
80	Kathleen	Gillespie <sup>u</sup>	UMCES	Ph.D.	stipend	\$8,477.00
81	Shadaesha	Green <sup>u</sup>	UMCES	Ph.D.	lab fee	\$1,000.00

82	Ammar	Hanif <sup>u</sup>	UMCES	Ph.D.	Stipend/tuition	\$4,608.00
83	Ikenna	Ikpeama <sup>u</sup>	UMCES	B.S.	Lab fee	\$1,000.00
84	Taylor	Kline <sup>u</sup>	UMCES	B.S.	Travel	\$32.00
85	Krista	Kraskura <sup>u</sup>	UMCES	B.S.	Travel	\$32.00
86	David	Marsan <sup>u</sup>	UMCES	Ph.D.	stipend	\$6,689.00
87	Manuel	Olmeda <sup>u</sup>	UMCES	B.S.	Stipend/travel/lab fee	\$6,300.00
88	Jonathan	Peake <sup>u</sup>	UMCES	B.S.	Travel	\$62.50
89	Jan	Vicente <sup>u</sup>	UMCES	Ph.D.	Supplies and materials	\$575.00
90	Taylor	Ransom <sup>u</sup>	UMCES	M.S.	Stipend	\$4,039.00

<sup>u</sup>Underrepresented minority

**Table 3. Students who graduated from March 1, 2014 to Aug. 31, 2014.**

First Name	Last Name	Academic Institution	Degree	Date	Post-Graduation Information
Andrea	Stoneman	DSU	M.S.	Aug-14	NMFS fish observer
Shadaesha	Green	HU	B.S.	May-14	Ph.D. program at UMD College Park
Camille	Gaynus	HU	B.S.	May-14	Ph.D. program at UCLA
Brittany	Carmon	HU	B.S.	May-14	M.S. program at Yale
Joalene	Mason	HU	B.S.	May-14	Engineering Industry
Ashlee	Ward	HU	B.S.	May-14	Engineering Industry
Aniema	Nzesi	HU	B.S.	May-14	Unknown
Brian	Murry	SSU	M.S.	May-14	Working as a technician at SSU
Dawn	Franco	SSU	M.S.	May-14	Working at GA DNR
Simone	Lax	SSU	B.S.	May-14	Applying for positions
Eric	Parks	SSU	B.S.	May-14	Applying to OSU for grad school
Sami	Saryou	SSU	B.S.	May-14	Unknown
Allison	Williford	SSU	B.S.	May-14	Looking for a position
Christopher	Brown	RSMAS	B.S.	May-14	
Jessica	Mazile	UMES	B.S.	May-14	Volunteering and applying for Physician's Assistant program at UMES for Fall 2015
Jaime	Belanger	UMES	M.S.	May-14	Continuing in previous Program Manager position at Sassafra Environmental Education Management
Derrick	Alcott	UMES	PSM.	May-14	Ph.D. program University of Massachusetts, Amherst
Briana	Jones	UMES	B.S.	May-14	Accepted into M.S. degree program at James Cook Univ., Australia

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. Table 4 shows students who worked at NOAA labs or LMRCS C partner institution labs.

**Table 4. Students who worked at NOAA labs or LMRCS C partner institution labs (March 1, 2014 to Aug. 31, 2014)**

First Name	Last Name	Institution	Degree	Facility	Time Period	Activity or Title of Research Project
Prosper	Ikpeama	DSU	B.S.	UMCES-IMET	6/2014-8/2014	Probiotics/oyster larvae
Hillary	Dean	DSU	M.S.	NOAA Panama City, FL	8/2014-9/2014	Sturgeon
Nivette	Perez-Perez	DSU	M.S.	NOAA Sandy Hook Lab	5/2014-9/2014	Deep sea crabs
Aniema	Nzesi	HU	B.S.	OSU REU Program, TAB project	June – Aug	Microsatellite markers isolation (ESTSSR's) for association tests of reproductive phenotypes (GnRH FSH and LH) in the context of environmental variability for chinook salmon.
Marisa	Litz	OSU	Ph.D.	NOAA NWFSC		Development of a Bioenergetics Model for juvenile Chinook salmon to evaluate the effects of climate change and prey quality on growth
Jessica	Andrade	OSU	M.S.	NOAA AFSC		Northern rock sole ( <i>Lepidopsetta polyxystra</i> ) anti-predatory behavioral responses to elevated carbon dioxide concentrations
LaTreese	Denson	OSU	M.S.	NOAA SEFSC (cruise)		Larval billfish cruise
Derek	Burton, Jr.	UMES	M.S.	NOAA Oxford Cooperative Lab	Summer 2014	Land Use Impacts On Estuarine Ecosystem Services
Audy	Peoples	UMES	M.S.	NOAA Oxford Cooperative Lab	Summer 2014	Testing trace metal and pesticides in tissue of marine mammals stranded in Maryland
Shadaesha*	Green	UMES	Ph.D.	UMCES-IMET REU	Summer 2014	Understanding the molecular mechanisms of reproductive biology of the deep-sea red crab, <i>Chaceon quinque-dens</i>
Marcus*	Hughes	UMES	B.S.	UMCES-IMET REU	Summer 2014	Confirming Dominant Species of Gut Microbiome Menhaden
Jan	Vicente	UMCES	Ph.D.	HIHWNMS	3/6/2014	Survey of microbial communities in mesophytic reefs

Sixty-seven (67) undergraduate and graduate students, who did not receive direct support from the LMRCS C, benefited from the programs offered by the Center and/or infrastructure established by the LMRCS C during this reporting period. Names of the students are listed in Table 5.



**Table 5. Students who did not receive direct support but benefited from the program offered or infrastructure established by the LMRCS**

	<b>First Name</b>	<b>Last Name</b>	<b>Institution</b>	<b>Degree</b>
1	Kris	Roeske	DSU	M.S.
2	Matthew	Stone	DSU	M.S.
3	Amy	Comer	DSU	M.S.
4	Symone <sup>u</sup>	Johnson	DSU	M.S.
5	James	Kilfoil	DSU	M.S.
6	Malik <sup>u</sup>	Breland	HU	B.S.
7	Krista <sup>u</sup>	Kraskura	HU	B.S.
8	Austin	Flinn	RSMAS	M.P.S
9	David <sup>u</sup>	Alexander	UMCES	B.S.
10	Shanai <sup>u</sup>	Brown	UMCES	B.S.
11	Nicholas	Dawson	UMCES	B.S.
12	Taylor	Kline	UMCES	B.S.
13	Jonathan	Peake	UMCES	B.S.
14	Kennard <sup>u</sup>	Roy	UMES	B.S.
15	Kingsley <sup>u</sup>	Nkeng	UMES	B.S.
16	Addis <sup>u</sup>	Bedane	UMES	B.S.
17	Abena <sup>u</sup>	Okyere Acheampong	UMES	B.S.
18	Iheoma <sup>u</sup>	Ngoka	UMES	B.S.
19	Ijeoma <sup>u</sup>	Ngoka	UMES	B.S.
20	Chelsea <sup>u</sup>	Richardson	UMES	B.S.
21	Samir <sup>u</sup>	Karim	UMES	B.S.
22	So Jin	Park	UMES	B.S.
23	Jessica <sup>u</sup>	Mazile	UMES	B.S.
24	Matthew <sup>u</sup>	Maxwell	UMES	B.S.
25	Bernadette <sup>u</sup>	Ezeabikwa	UMES	Ph.D.
26	Evantae <sup>u</sup>	Hunter	UMES Geoscience Bridge	B.S.
27	Malek <sup>u</sup>	Dennard	UMES Geoscience Bridge	B.S.
28	Mario <sup>u</sup>	McGhee	UMES Geoscience Bridge	B.S.
29	Tyler <sup>u</sup>	Bullock	UMES Geoscience Bridge	B.S.
30	Shurell <sup>u</sup>	Hester	UMES Geoscience Bridge	B.S.
31	Christian <sup>u</sup>	Mobley	UMES Geoscience Bridge	B.S.
32	Danielle <sup>u</sup>	Burbank	UMES Geoscience Bridge	B.S.
33	Isaac <sup>u</sup>	Carter	UMES Geoscience Bridge	B.S.
34	Nathaniel <sup>u</sup>	Jones	UMES Geoscience Bridge	B.S.
35	Jermill <sup>u</sup>	Thompson-James	UMES Geoscience Bridge	B.S.

36	Chareema <sup>u</sup>	Harris	UMES Geoscience Bridge	B.S.
37	Danielle	Brittingham	UMES Geoscience Bridge	B.S.
38	Assante <sup>u</sup>	Thomas	UMES	B.S.
39	Kevin <sup>u</sup>	McCarthy	UMES	B.S.
40	Shanice <sup>u</sup>	Speight	UMES	B.S.
41	Kimberly <sup>u</sup>	Moreno	UMES	B.S.
42	Keilon <sup>u</sup>	Robinson Jr.	UMES REU	B.S.
43	Natan-EL <sup>u</sup>	Mensah-Sowah	UMES REU	B.S.
44	Alexis	Sturm	UMES REU	B.S.
45	Samantha <sup>u</sup>	Peart	UMES REU	B.S.
46	Wyntin <sup>u</sup>	Goodman	UMES REU	B.S.
47	Kendra <sup>u</sup>	Wood	UMES	B.S.
48	Austin <sup>u</sup>	Durham	UMES Geoscience Bridge	B.S.
49	August	Fuller	UMES REU	B.S.
50	Cloee <sup>u</sup>	Grainger	UMES REU	B.S.
51	Heather	Wolfer	UMES	M.S.
52	Baruch	Volkis	UMES	Ph.D.
53	Dana <sup>u</sup>	McNair	UMES	M.S.
54	Detbra <sup>u</sup>	Rosales	UMES	M.S.
55	Juan <sup>u</sup>	Alvarez	UMES	M.S.
56	Abdalfafiz	Ahemedaltayb	UMES	M.S.
57	Orighoye <sup>u</sup>	Omatseye	UMES	M.S.
58	Rebecca	Peters	UMES	M.S.
59	Ejiroghene <sup>u</sup>	Mayor	UMES	Ph.D.
60	Ozuem <sup>u</sup>	Oseji	UMES	Ph.D.
61	Efeturi <sup>u</sup>	Oghenekaro	UMES	Ph.D.
62	Kristen	Lycett	UMES	Ph.D.
63	Dev	Gurung	UMES	Ph.D.
64	Blessing <sup>u</sup>	Edje	UMES	Ph.D.
65	Xavier <sup>u</sup>	Henry	UMES	Ph.D.

<sup>u</sup>Underrepresented Minority

**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, software, and supplies as well as facilities provided by the LMRCSC, or participate in workshops paid for and organized by the LMRCSC.

**Career Development Assistance:** Several research support teams have developed naturally as LMRCSC students at SSU have identified each other's common interests and need for assistance. These relationships transcend lab associations. Examples are listed in Table 6a.

UMES students were offered the opportunity to take classes in boater safety and first aid to increase safety in the field. U.S. Coast Guard taught a Maryland Basic Boating Safety class at Paul S. Sarbanes Center on May 29 and 30, 2014. Each student passed and received the Maryland Basic Boating Safety Certificate (Table 6b). First Aid/CPR/AED were offered on May 15 at the Sarbanes Center taught by Pat Hill from the American Red Cross (Table 6c)

**Table 6a: Research support teams developed at SSU.**

<b>Coordinated Peer/Near Peer Teams</b>	<b>Research Area</b>
Keya Jackson, Dr. Jolvan Morris	Fishery stakeholder interviews/oral history
Tiffany Ward, Shaneese Mackey, Tisheena Howard	Oyster reef monitoring
Morris Smith, Cleavon Morris, Michael Blankenship	Benthic sampling (Brittlestar bed)
Jessica Thompson, Noelle Hawthorne Mathies, Darius Sanford	Marine mammal surveys, strandings
Tiffany Ward & Crystal Smith	Nonparametric data analysis
Paul Arkwright, Keya Jackson	Fisherman stakeholder engagement
Darius Sanford, Isaac McClellan	Fiddler crab collection and population measurement

**Table 6b. UMES students who participated in boater safety course**

<b>First Name</b>	<b>Last Name</b>	<b>Degree program</b>
Wilmelie	Cruz-Marrero	M.S.
Eric	Evans	Ph.D.
Samir	Karim	B.S.
Mason	King	M.S.
Kristen	Lycett	M.S.
Stephanie	Martinez-Rivera	M.S.
Iheoma	Ngoka	B.S.
Ozeum	Oseji	Ph.D.
Cara	Schweitzer	Ph.D.
Baruch	Volkis	Ph.D.
Justin	Wilson	M.S.

**Table 6c: UMES students who participated in first aid training course**

<b>First name</b>	<b>Last name</b>	<b>Degree program</b>
Laura	Almodovar-Acevedo	Ph.D.
Wilmelie	Cruz-Marrero	M.S.
Daniel	Cullen	Ph.D.
Eric	Evans	Ph.D.
Reine	Fowajuh	B.S.
Samir	Karim	B.S.
Hector	Malagon	M.S.
Ejiro	Mayor	Ph.D.
Ozeum	Oseji	Ph.D.
Stephanie	Rivera-Martinez	M.S.
Justin	Wilson	M.S.

**Build strong peer networks through student collaboration:** The Center has a Facebook web page, where potential students and those interested in the LMRCSC participate in discussions on a range of topics, including research projects, employment opportunities, and post-doctoral fellowships.

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

- **LMRCSC Exit Evaluation:** No exit evaluations were received during this period.
- **LMRCSC Cruise Evaluation:** No cruise took place during this period.
- **Evaluation Forms for interns and mentors:** No internship evaluation forms were received during this period.

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

**Activities and Accomplishments:** 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 including AFS and ASLO. Their presentations are listed in Appendix IV.

**Monitoring student progress:** LMRCSC utilizes the online Student Tracker database as prescribed by NOAA for tracking student progress and outcomes. The Center maintains a series of online evaluation forms for the LMRCSC program overall, which graduating students are requested to submit, and for specific recurring activities such as the LMRCSC research cruise. We are also in the process of implementing the Student Development Plan, which students complete in collaboration with their advisors each semester in order to help track their progress.

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

**Scholarship:** The following students received awards or scholarships during this reporting period:

- Juan Alvarez, M.S. student (UMES) received the NSF Graduate Research Fellowship Program
- Tiana Jones, B.S. (UMES) received the USFWS Resource Assistants Fellowship.
- Jeanette Davis was awarded Knauss Fellowship for 2015:  
<http://seagrant.noaa.gov/FundingFellowships/KnaussFellowship/FinalistsCurrentFellows/2015Class.aspx>
- Shadaesha Green was awarded 2-year Louis Stokes Alliances for Minority Participation Fellowship (LSAMP).

**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.

**Atlantic Estuarine Research Society AERS):** Several LMRCSC students and faculty at UMES attended and presented papers at the AERS scientific meeting that was held in March in Ocean City, MD.

**Engagement with NOAA:** All LMRCSC graduate students are required to have a NOAA scientist on their research committee, and the most appropriate individuals are identified early in the student’s graduate program. Seven LMRCSC students worked at NOAA labs under the guidance of NOAA scientists during this reporting period.

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

### Activities and Accomplishments:

**Center Director and Staff:** The position of LMRCSO Deputy Center Director was filled when Dr. Maurice Crawford joined the LMRCSO in August 2014.

**Executive Committee (EC):** The EC met via conference call monthly during this reporting period.

**Center Core Administration (CCA):** Several meetings were held with members of the CAA during this reporting period especially related to the planning for the NOAA EPP 2014 Forum.

**LMRCSO Board of Visitors (BOV):** The BOV meeting is scheduled to be held on October 30, 2014.

**Center Faculty and Staff Positions:** Dr. Aurea Rodriguez will join the HU LMRCSO faculty in October 2014 as a Research Assistant Professor; Dr. Andriy Horodysky who occupied the LMRCSO position of Research Assistant Professor at HU has received a tenure track position at HU. Interviews have been concluded for the position of the LMRCSO Research Assistant Professor of Resource Economics. The position will be filled by December 2014.

### 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 partner institutions via the web.

IMET provided Crystal Smith (SSU) with the genomic data (August 2014) that was needed to complete the TAB obligations under that award. These data greatly enhanced the value of the information provided in her thesis. SSU has procured NVivo, EndNote, and Natural Reader software for use by students and faculty to enhance research productivity.

**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 LMRCSO 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 LMRCSO 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.

### 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:** 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. Seven courses were offered in Spring 2014, and 5 courses are currently being offered over via IVN, Go to Meeting, or Blackboard (Table 7a,b).

University of Maryland Interactive Video Network (IVN) courses:

**Table 7a. Courses offered at the LMRCSC during Spring Semester 2014**

Course number	Course Title	Instructor	Students (online)
MEES 688	Marine Population Dynamics	David Die	Nivette Perez-Perez (DSU) Matthew Stone (DSU) plus several RSMAS students
MEES 608L	Marine Microbial Ecology	Chen, F and Hill, RT - IVN Course	Detbra Rosales (UMES), Sabrina Klick (UMES)
MEES 688-0401	Bayesian Statistics	Dr. Elizabeth Babcock – taught using Go – to - Meeting	Derek Alcott (UMES), Jaimie Belanger (UMES), Susan Kelly (UMES), plus students at RSMAS
MEES 688-0301	Business & Fisheries Management Ethics	Dr. Nicole Buzzeto-More – taught using Blackboard	Derek Alcott (UMES), Jaime Belanger (UMES), Susan Kelly (UMES), Daniel Sweeney (UMES)
MEES 640-0101	Introduction to Environmental & Resource Economics	Dr. Mohammad Ali, Dr. Stephan Tubene, Dr. Tao Gong, Dr. Kristy Wallmo (NOAA), Dr. Ayeisha Brinson (NOAA) – Taught using Blackboard	Dereck Alcott (UMES), Jamie Belanger (UMES), Susan Kelly (UMES), Daniel Sweeney (UMES), Symone Johnson (DSU), Hilary Dean (DSU), Amy Comer(DSU)
MEES 608I	Harmful Algal Blooms	Dr. Kevin Sellner	Kristen Lycett (UMES), Juan Alvarez (UMES)
MEES 628	Fisheries Oceanography	Dr. Elizabeth North	Juan Alvarez (UMES), Laura Almodovar-Acevedo (UMES), Stephanie Revera-Martinez (UMES)
MEES 661 I – IVN	Physics of Marine Environments	Drs. Bill Boicourt and Victoria Coles	Mason King (UMES)
MEES 631 – IVN	Fish Ecology	Drs. David Secor and Thomas Miller	Justin Wilson (UMES), Wilmelie Cruz-Marrero (UMES)

**Table 7b. Course Offered at the LMRCSC during Fall Semester 2014**

Course number	Course Title	Instructor	Students (online)
MEES 643	Risk and Decision Analysis in Natural Resources Management	Mohammad Ali - taught using Blackboard	Daniel Sweeney (UMES)
MEES 688P	Personnel Development, Management and Evaluation	Michael Costello - taught using Blackboard	Daniel Sweeney (UMES), Michele Traver (UMES)
MEES 682 - IVN	Fisheries Science and Management	David Secor and Michael Wilberg	Stephanie Martines-Ramirez (UMES), Laura Almodovar-Acevedo (UMES), Justin Wilson (UMES), Wilmelie Cruz-Marrero (UMES)
MEES 608D -IVN	Scientific Writing and Communication	Elizabeth North	Stephanie Martines-Ramirez (UMES), Detbra Rosales (UMES), Laura Almodovar-Acevedo (UMES), Justin Wilson (UMES), Wilmelie Cruz-Marrero

MEES 610 - IVN	Land Margin Interactions	Lora Harris & Tom Fisher	Mason King (UMES)
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**Seminars:** Seminars presented to students and faculty are presented in Table 8.

**Table 8. LMRCS Seminar Series (Feb. 6, 2014 to Aug. 14, 2014)**

Date	Presenter	Title
2/20/2014	Dr. Andrea Johnson, Assistant Research Professor, UMES	Trash to treasure – a story of the American monkfish
2/27/2014	Dr. Maurice Crawford Associate Professor, Elizabeth City State University	The Ecology of Submerged Aquatic Vegetation or How to Grow a Scientific Career
2/6/2014	Dr. Lisa Methratta, Versar, Inc.	Environmental Drivers of Species Distribution on the Northeast U.S. Continental Shelf
8/14/2014	Dr. Tara Wade, Post-Doc, USDA	Modeling Field-level Conservation Tillage Adoption with Aggregated Choice Data

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

**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 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. Twelve (12) students worked at NOAA labs, Center institutions or other agencies in summer 2014 (Table 4).

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

The Center’s research is grouped into the four key thematic areas, associated with NOAA’s research priorities. This research agenda is implemented collaboratively among faculty and students across the seven partnering institutions. LMRCS research undergoes a rigorous scientific review process. Each year, LMRCS 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 research is of high quality and aligned with NOAA-NMFS research priorities. Each year, LMRCS 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 2013-2014 and are currently being completed (Table 9).  
 12 projects were selected for funding for 2014-2015.

**Table 9. Projects Funded by the LMRCSC for 2013 - 2014**

Project Number	PI Name	Title	Theme
14-01	Michael Banks (OSU)	Microsatellite Markers Isolation (EST-SSR's) for Association Tests of Reproductive Phenotypes (GnRH, FSH and LH) in the Context of Environmental Variability for Chinook Salmon.	EFH
14-02	Tao Gong (UMES)	Socioeconomic Factors Affecting Entry-stay-exit Behavior of the Blue Crab Fishermen in Maryland	FSE
14-03	Selina Heppell (OSU)	Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles (Year 2)	QF
14-04	Andrij Horodysky (Hampton Univ)	Effects of temperature and feed type on gastric evacuation of aquacultured pompano ( <i>Trachinotus carolinus</i> )	AC
14-05	Jessica Miller (OSU)	Trophic Ecology of Forage Fishes: Linking Primary Productivity to Fisheries Production in the Northern California Current	QF
14-06	Joe Pitula (UMES)	<i>Dinophysis</i> sp. in the Maryland Coastal Bay Ecosystem	EFH
14-07	Al Place (UMCES/IMET)	Diet and feeding of menhaden using molecular identification based on cox1 and 18S sequences	QF
14-08	Eric Schott (UMCES/IMET)	Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture	AC
14-09	Bradley Stevens (UMES)	Improving management of deep-sea red crabs ( <i>Chaceon quinquegens</i> ): Reproductive biology, maturity, and stock structure	QF
14-10	Bradley Stevens (UMES)	Augmenting the Black Sea Bass, <i>Centropristis striata</i> , Stock Assessment, Year 2: Assessing the importance of fixed and fluid estuarine habitats	QF
14-11	Shari Wiley (Hampton Univ)	Effects of climate change and anthropogenic stressors on piscivore-planktivore trophic interaction	QF
14-12	Crystal Smith (SSU)	Profile of EPS-Producing bacteria and diatoms in coastal Georgia sediments	EFH

### TAB Project Summary

**14-01 - Project Title:** Microsatellite Markers Isolation (EST-SSR's) for Association Tests of Reproductive Phenotypes (GnRH, FSH and LH) in the Context of Environmental Variability for Chinook Salmon

**Project Abstract:** Research proposed here addresses two primary steps in developing and testing functional markers that may indeed provide more relevant information for climate change studies than attained using neutral markers: 1) we propose to isolate microsatellites linked to the expression of reproductive traits (RT) in Chinook salmon, 2) we propose to test information they provide on population sub-structuring among Chinook of the Siletz River in Oregon against comparative data attained using neutral microsatellites. This work will form the grounding of a PhD that will also develop models to help understand how the micro-evolutionary processes of gene flow, genetic drift and selection are correlated with the biological and physical features of a river (riverscape). We also propose to host a summer student internship to join research on this project realizing gains from collaboration between a Marine Fisheries Genetics Program from Oregon State University and an Ecophysiology/Habitat Program from Hampton University. Findings from this project will better inform NOAA about Chinook salmon population sub-structuring and how this relates to landscape and environmental parameters in their mission to conserve and manage coastal and marine ecosystems and resources.

**Thematic Area Addressed:** Aquaculture

**Lead Scientist(s):** Dr. Michael A. Banks, Oregon State University

**NOAA Collaborator(s):** Dr. Pete Lawson (NOAA, NWFSC)

**LMRCSC Collaborator(s):** Dr. Andrij Hyrodysky (Hampton University)

**LMRCSC Research Student(s):** Chante Davis (PhD, OSU)

**Start Date:** 1 Sept 2013 **End Date:** 31 August 2014



**Results of project to date:** 1017 Chinook were sampled and genotyped at 15 neutral microsatellite loci and 2 clock genes. The total number of alleles and allelic richness was similar among samples; there were no departures from Hardy-Weinberg expectations and heterozygosity ranged between 0.81 and 0.95. Genetic differentiation was estimated using  $G''_{ST}$  and pairwise comparisons identified four temporally and spatially distinct subpopulations. We presented evidence for two primary population structuring forces. The physical barrier at the waterfalls combined with temporal behavioral factors among subpopulations as well as the trap affects the largest population structuring revealed by this study. A peer review manuscript has been completed to provide a preliminary and comparative study for the reproductive trait microsatellite study that will be conducted to fulfill this TAB project. Hampton University (HU) undergraduate student Aniema Nzesi as well as HU faculty member Andrij Hyrodysky have been invited and scheduled to participate in an NSF funded Research Experience for Undergraduates (REU) and our seminar program at OSU's Hatfield Marine Science Center this summer. Chante and Aniema will begin isolating reproductive trait microsatellites at the start of the REU in early June 2014 and conclude with writing up their findings for peer review publication.

**How will results be incorporated into NOAA Fisheries operations?** Findings from this project will better inform NOAA about Chinook salmon population sub-structuring and how this relates to landscape and environmental parameters in their mission to conserve and manage coastal and marine ecosystems and resources.

**How will results be incorporated into LMRCS research and curriculum?** Research, analysis, presentation and write-up experience and knowledge exchanged between the students and faculty participating in this project will contribute to LMRCS research and curriculum through exposing participants to advances in riverscape genetics with population genomics.

**14-02 - Project Title:** Socioeconomic Factors Affecting Entry-stay-exit Behavior of the Blue Crab Watermen in Maryland

**Project Abstract:** The purpose of this project is to examine the effects of socioeconomic factors on the entry-stay-exit decision of the blue crab watermen in Maryland. Phase I of the study was to collect qualitative data, which included 16 interviews with watermen to gain insight on the socioeconomic factors that affect their participation in blue crab fishery in Maryland. Phase II of the study incorporated the results in Phase I into a random utility model and conducted an econometric analysis using harvest as well as market 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, University of Maryland Eastern Shore

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

**LMRCS Collaborator(s):** Gil Sylvia (OSU)

**LMRCS Research Student(s):** Alexis Parker (Undergraduate, UMES), John McCants (Undergraduate, UMES)

**Start Date:** 1 Sept., 2013

**End Date:** 31 August, 2014

**Results of project:** The purpose of the Phase II part of the study was to examine the effects of socioeconomic factors that affect the probability of entry and exit behaviors of watermen in Maryland blue crab fishery by estimating a multinomial logistic model. Harvest data from 2002 to 2010 were analyzed, and the empirical results found that the probability of entry and exit decisions was significantly related to the average retail price, abundance of alternative fishing species, and water quality. The probability of watermen to enter or stay in the fishery was more likely to increase for an increase in the average retail price. The probability of entry into (or stay in) the blue crab fishery was more likely to increase for a decrease in the abundance of alternative fishing species. The probability of watermen to enter or stay in the blue crab fishery was more likely to increase with better water quality.

**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 LMR CSC research and curriculum?** The project results will be incorporated into LMR CSC 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 watermen in Maryland will be incorporated into studying fishermen's participation behavior in other federally managed fisheries. The results will also be incorporated into contents of courses 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.

**14-03 - Project Title:** Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles (Year 2)

**Project Abstract:** Loggerhead sea turtles experience pronounced ontogenetic shifts during their life cycle, transitioning between diets and habitats at critical sizes. These changes may be reflected in individual growth trajectories, and ultimately population dynamics, as the factors that affect growth rates vary spatially and temporally among habitats. The primary objectives of this study are to combine skeletochronological, stable isotope, and trace element analyses of humerus bones to examine variation in juvenile growth, foraging ecology, and habitat associations. Results indicate that turtles follow one of two life histories, supporting previous satellite-tagging studies that first presented these alternate life history pathways. Additionally, analyses indicate this ontogenetic shift is coupled with an increase in growth, though the relationship is not straightforward. Individual growth dynamics do not differ between turtle displaying these alternate life histories. Results from this study 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. Assessment models for sea turtle species are generally data-poor, so this study has direct relevance to NMFS management efforts.

**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)

**LMR CSC Collaborator(s):** Tara Cox (SSU)

**LMR CSC Research Student(s):** Matthew Ramirez (MS, OSU), Eric Parks (UG, SSU)

**Start Date:** 1 Sept 2013

**End Date:** 31 August 2014

**Results of project to date:** We have now analyzed multiple growth layers in the humerus bones of 84 juvenile loggerhead turtles for stable carbon and nitrogen isotopes. Individuals were classified into one of four life-history pathways: discrete shifters (abrupt increase in isotope signatures in one year,  $n=24$ ), facultative shifters (gradual increase in isotope signatures over multiple years,  $n=16$ ), non-shifters (consistent pelagic or benthic isotope signatures,  $n=27$ ), and undetermined shifter (could not be classified due to missing data points,  $n = 17$ ). We suggest variance in nitrogen isotope values within turtles is driven by occupancy of habitats with different geographic baselines (neritic vs. oceanic). We estimated the size at transition between habitats to be 55.0 cm SCL, similar to what has been observed in other studies. We also found that up to one third of turtles undergo facultative ontogenetic shifts and that these extended transitions can last up to eight years, much longer than previously thought. Intraspecific variation in the timing, duration, and prevalence of ontogenetic shifts may ultimately alter our understanding of loggerhead population dynamics. Analysis of paired isotope and growth data indicates that growth is generally maximized at the time of transition between oceanic and neritic habitats, but that the relationship is not what would be predicted by ontogenetic theory. Theory predicts turtles would make these transitions when growth begins to decline in one habitat to favor higher growth in another habitat, but we found evidence of increasing growth, on average, prior to ontogenetic shifts. Furthermore, maximal growth is often achieved prior to as opposed to after these transitions. Individual growth dynamics do not differ between turtle displaying these alternate life histories. It has become clear there is no straightforward relationship between sea turtle growth rates and foraging ecology and habitat use.

**Pilot Project #1** – Paired collagen and bulk bone samples were analyzed for carbon ( $\delta^{13}\text{C}$ ). Matthew Ramirez found there to be a constant offset between bulk bone dust and collagen  $\delta^{13}\text{C}$  values, and no difference in  $\delta^{15}\text{N}$ . The dataset was combined with another study and a non-LMR CSC collaborator is preparing a manuscript for publication. Matthew Ramirez will be a co-author.

**Pilot Project #2** (Trace elements of sea turtle bone) – Eric Parks returned to Corvallis in summer 2014 to expand the trace element pilot project from summer 2013 to a full study. In total, 54 sea turtle bones were analyzed for 10 trace elements. Eric Parks and Matthew Ramirez are currently analyzing the data.

**Other LMRCS C Projects** – Matthew Ramirez and Larisa Avens used extra LMRCS C and other leveraged funds to implement two new pilot studies applying the techniques Matthew Ramirez perfected throughout his thesis research. One is investigating the application of laser ablation to the study of adult loggerhead nesting remigration intervals, while the other is investigating the application of laser ablation and stable isotope analysis to the study of Kemp’s Ridley sea turtle growth and habitat use.

**How will results be incorporated into NOAA Fisheries operations?** Results from this study will 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. Matt Ramirez will be working with other students on new growth models for sea turtles; those models will become part of the quantitative methods “tool box” that NMFS is currently developing to help managers evaluate sea turtle population status and the impacts of bycatch mortality.

**How will results be incorporated into LMRCS C 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 LMRCS C. 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 LMRCS C.

**14-04 - Project Title:** Effects of temperature and feed type on gastric evacuation of aquacultured pompano (*Trachinotus carolinus*)

**Project Abstract:** As the demand for Florida pompano continues to increase, aquaculture practices must be refined to optimize growth to satisfy a growing market. This project investigated the gastric evacuation of aquacultured juvenile Florida pompano fed three different diets at three temperatures to direct production of young life stages. Juvenile pompano were fed diets of frozen mysid shrimp, NOAA Montlake meal, and Otohime EP2 fish pellets at 20°C, 25°C, and 30°C. During the experiment, three fish were randomly sampled from the total population every 60 min and euthanized in MS-222 solution. Fish were then weighed (g), measured (SL), and frozen immediately for a period of 24-48h prior to dissections. The stomach and its contents were then emptied, patted dry, and weighed. A pilot gastric evacuation study was conducted January 21, 2014 using commercial Otohime EP2 fish meal; results indicated gastric evacuation was completed with an 11-12h time period after initial feed. A follow-up pretrial study was then conducted testing commercial EP2 fish meal to frozen mysid on March 12, 2014. Results from the March study indicated that juvenile pompano fed the frozen mysid diet completed gastric evacuation within a 6h time period. However, juvenile pompano fed Otohime EP2 fish pellets completed gastric evacuation at the 10h time period. Due to different growth rates according to diet, pompano fed NOAA Montlake and Otohime EP2 pellets have had gastric evacuation experiments conducted at 30°C, 25°C, and 20°C thus far. Results have indicated that the Otohime EP2 diet leads to faster gastric evacuation of juvenile pompano at 30°C, 25°C, and 20°C; however, anecdotal observations indicated that pompano fed NOAA Montlake diet had a higher average body weight and size compared than pompano fed the Otohime EP2 diet. Results from this study indicate that 30°C is an optimum temperature for pompano evacuation independent of the diet tested. If funded, an additional growth study will be conducted to formally compare the growth rates of juvenile pompano fed Otohime EP2 compared to NOAA Montlake meal.

**Thematic Area:** Aquaculture

**PI Name:** Andrij Horodysky (Hampton University)

**Collaborators:** Deidre Gibson (Hampton), Michael Schwarz (VA Tech)

**LMRCS C Research Student(s):** Larry Redd, Jr.

**NOAA Partners:** Ronald Johnson

**Start Date:** January 2014 **End Date:** August to Dec 2014 (pending no-cost extension)

**Results to Date:** A pilot trial consisting of 105 juvenile pompano was conducted using Otohime EP2 feed (a common feed for this species) at 27°C on January 21, 2014 and completed on February 2, 2014. Results indicated that gastric evacuation was complete at approximately hours 11-12 after initial feeding. The longer-than-expected duration may have been due to

incomplete evacuation before the experimental feeding, thus a second pilot trial was planned. The second pilot trial was conducted with 100 juvenile pompano divided into two groups of 50. Group 1 was fed Otohime EP2 and Group 2 was fed frozen mysids until satiation. The results of the second pilot trial indicated that juvenile pompano have a faster rate of digestion and assimilation of the frozen mysid shrimp diet than the commercially prepared Otohime EP2 diet. Juvenile pompano fed frozen mysid shrimp showed complete gastric evacuation at approximately the 6 hour time-point; whereas, fish fed the Otohime EP2 diet completed gastric evacuation at hour 10. The combined results confirm both the initial pilot trial (EP2 timelines are similar), as well as literature observations (mysid evacuation is similar to short digestion time for actual prey items in pompano). Experimental results of pilot trials refined the protocol for the three treatments used in this study. The experimental population of pompano (1600 individuals) were ordered from Troutlodge in late February and delivered in early March. Fish were very undersized (mean: 0.2g) relative to the expected 0.5g. Fish were divided equally into experimental tanks and fed individual diets until reaching the appropriate range to conduct the study at each temperature. The gastric evacuation of juvenile pompano (mean: 23.9-24.5g) at 30°C was conducted June 30, 2014 and completed on July 1, 2014. The results indicated that pompano fed the NOAA Montlake diet completed gastric evacuation approximately at hour 14; however, pompano fed the Otohime EP2 diet completed gastric evacuation at approximately hours 13-14 after initial feeding. The gastric evacuation of juvenile pompano (mean: 23.2-25.9g) at 25°C was conducted July 14, 2014 and completed July 18, 2014. The results indicated pompano fed the NOAA Montlake diet approximately at hours 15-16 after initial feeding; however, pompano fed the Otohime EP2 diet completed gastric evacuation at hour 14. On July 28, 2014 the gastric evacuation of juvenile pompano (22.1-32.5g) was conducted and completed on August 1, 2014 at 20°C. The results indicated pompano fed the NOAA Montlake diet approximately at hours 15-16 after initial feeding; however, pompano fed the Otohime EP2 diet completed gastric evacuation at hours 14-15. The results of the experimental procedure confirmed that gastric evacuation rates are affected by temperature. Additionally volumetric experiments were conducted on the juvenile pompano of both NOAA Montlake and Otohime EP2 diets at 30°C, 25°C, and 20°C testing the relationship of fish mass (g) to volume of water displaced (ml). The results indicate that there is strong positive linear relationship between fish mass (g) and water displaced (ml), thus displacement can be used as a nonlethal proxy for evacuation.

Pompano fed the frozen mysid diet encountered very slow growth indicating the mysid diet would not be sustainable financially or from a productivity standpoint for aquaculture of juvenile pompano. On August 27, 2014 pompano on the frozen mysid diet were weighed with the average pompano ranging 4.08-4.46g. An additional trial will be conducted in late September testing the gastric evacuation of juvenile pompano at 30°C and 20°C fed the mysid diet.

**How will results be incorporated into NOAA Fisheries operations?** We are working with Dr. Ronald Johnson, Acting Program Manager, Environmental and Fisheries Sciences division, NOAA NWFS. The results from this study will provide the first data on the performance of NOAA's Montlake feed on aquacultured Florida pompano, a rapidly growing candidate species for aquaculture. There is great potential for the refinement of the feed through this work. Further, if growth on Montlake feed is superior to other commercial (Otohime) or frozen (mysid) feeds (as anecdotally suggested by our results), there is the potential for Montlake feed (or its formulation and macronutrient component ratios) to be designated as an optimal feed for the culture of the species. Lastly, the development of protocols for feed type and temperature may serve as standards for culture of pompano, and temperature-specific evacuation may be used to inform/develop feed frequency protocols for the species.

**How will results be incorporated into LMRCSC research and curriculum?** Dr. Horodysky used the data from this project in his departmental elective Ichthyology lecture (Spring 2014) and will do so in future semesters of his departmental required Biometry course (Spring semesters).

**14-05 - Project Title:** Trophic Ecology of Forage Fishes: Linking Primary Productivity to Fisheries Production in the Northern California Current

**Project Abstract:** In the Northern California Current, the copepod species community oscillates seasonally between a diverse, lipid-poor, warm-water assemblage and a less diverse, lipid-rich, boreal assemblage. There is also substantial inter-annual variation in the boreal copepod community present during the productive, summer upwelling season. This variation in the copepod community is highly correlated with the Pacific Decadal Oscillation, the dominant climate index in the region. It is hypothesized that larval fish experience enhanced growth when the boreal copepod community dominates due to their enhanced lipid content as prey although this hypothesis has not been tested. Therefore, we examined seasonal and inter-annual variation in the species-, lipid-, and fatty acid (FA)-composition of the phytoplankton and copepod communities in relation to growth of young-of-the year northern anchovy (*Engraulis mordax*). The species- and FA-composition of the

phytoplankton and copepod communities co-varied across seasons and years. Total lipids and the proportion of wax esters increased within the copepod community during summer upwelling and there was a clear delineation between the FAs present within the “warm-water” and “boreal” copepod communities. Seasonal variation in anchovy growth was related to the copepod species present and their FA composition. Anchovy growth was positively related to the proportion of 16:1w7, an indicator of diatom consumption, and negatively related to the proportion of 18:4w3, an indicator of flagellate consumption, in copepods. Variation in copepod FAs was highly correlated with water temperature and salinity, providing support for climate-mediated variation in prey quality that influences growth, and potentially survival, of higher trophic levels.

**Thematic Area Addressed:** Quantitative Fisheries

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

**NOAA Collaborator(s):** William T. Peterson, NOAA NWFSC

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

**LMRCSC Research Student(s):** Marisa Litz (PhD, OSU), and Nichelle Smith (UG, HU)

**Start Date:** 1 Sept 2013

**End Date:** 31 August 2014

**Results of project to date:** We have completed all data collection and laboratory analysis for this project. Data analysis, synthesis, and writing are in progress. We envision three manuscripts dealing with the following aspects of the project: 1) the 18-month time series that describes variation in the species-, lipid-, and fatty acid (FA)-composition of the phytoplankton and copepod communities collected off Newport, Oregon; 2) a spatial comparison of the species-, lipid-, and fatty acid (FA)-composition of the copepod community across the Northern California Current coastal waters from Central Oregon to northern Washington state; and 3) a determination of how the growth of young-of-the-year northern anchovy (*Engraulis mordax*) varies seasonally and inter-annually in relation to the biochemical climatology of lower trophic levels. Overall, we have documented strong seasonal co-variance in the species-, lipid-, and fatty acid (FA)-composition of the phytoplankton and copepod communities. There was a distinct increase in total lipids and the proportion of wax esters within the copepod community during summer upwelling and clear delineation between the FAs present within the “warm-water” and “boreal” copepod communities. However, there is also spatial variation in the species-, lipid-, and fatty acid (FA)-composition of the phytoplankton and copepod communities that may contribute to observed growth variation in higher trophic levels, such as juvenile Chinook salmon. Seasonal variation in larval and juvenile anchovy growth was related to the copepod species present and their FA composition. Anchovy growth was positively related to the proportion of 16:1w7, an indicator of diatom consumption, and negatively related to the proportion of 18:4w3, an indicator of flagellate consumption, in copepods. Variation in copepod FAs was highly correlated with temperature and salinity of coastal waters, providing support for climate-mediated variation in prey quality that influences growth, and potentially survival, of higher trophic levels.

LMRCSC students have been extensively involved in this project. LMRCSC PhD student Marisa Litz worked on all aspects of this project, including data collection, lipid extraction and quantification, derivitization of fatty acids, statistical analysis and writing, and she will present some of the results at the Eastern Pacific Oceanographic Conference this month in Oregon. Hampton University undergraduate Nichelle Smith participated as a summer intern in 2014 at OSU's Hatfield Marine Science Center. Her project focused on the phytoplankton component. She was trained by NOAA personnel on species identification and quantification of phytoplankton collected in coastal waters. She also participated in one of the biweekly cruises to collect the phytoplankton and zooplankton data. Her 6-week internship at OSU is being followed up at HU where she will complete species identification of a subset of the samples collected in 2012 and 2013. She will work with Miller and Gibson on development and application of appropriate statistical approaches to compare and contrast the phytoplankton species community with the lipid and fatty acid composition of that community and examine how it changes across seasons in relation to physical variables, such as winds, currents, and water temperature and salinity. Nichelle will present a poster on her research at the NOAA EPP Forum this fall in Maryland.

**How will results be incorporated into NOAA Fisheries operations?** Currently, NOAA NWFSC maintains an Ocean Indicator Website (<http://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/index.cfm>). A variety of indicators have been developed over the last decade, the underlying mechanistic relationships behind these strong correlative relationships are not well-understood and have not been empirically evaluated. Our project directly tests one of the proposed mechanistic linkages regarding the linkage between ecologically important grazers (copepods) and their predators (early stages of forage fish). The results will facilitate the establishment of appropriate and effective indicators and they also provide an empirical basis for generating hypotheses related to the future effects of climate variation on the species-, lipid-, and fatty acid (FA)-

composition of the phytoplankton and copepod communities and potential effects on the early growth of northern anchovy, an important forage fish.

**How will results be incorporated into LMRCS research and curriculum?** As this project is a LMRCS research effort, it is well-integrated into LMRCS research. The effort has involved two LMRCS faculty (Miller & Gibson), other OSU scientists (Copeman), and NOAA-OSU Cooperative Science Institute staff (Morgan). Both a graduate student (Litz) and an undergraduate student (Smith) have been involved in the data collection, analysis, and synthesis. Miller teaches an undergraduate/graduate course on the Early Life History of Fishes and the results of this research will be incorporated in the Fall 2014 course offering at OSU.

**14-06 - Project Title:** *Dinophysis* sp. in the Maryland Coastal Bay Ecosystem

**Project Abstract:** Diarrhetic shellfish poisoning (DSP) is caused by the release of okadaic acid (OA) from toxin-producing dinoflagellate bloom species. The two dinoflagellate genera associated with DSP are *Dinophysis* and *Prorocentrum*. *Dinophysis* has been observed in the Maryland Coastal Bays in both 2011 and 2012. We will conduct a *Dinophysis* sp. survey so as to monitor for the presence and temporal manifestation of this harmful algal species. In addition we will quantify the accumulation of okadaic acid in shellfish tissue, as this compound has the ability to disrupt shellfish development. This work will be performed in the context of larger studies analyzing water quality and ecosystem health, and thus will inform management decisions prior to further expansion of this bloom-forming species.

**Thematic Area Addressed:** Essential Fish Habitats

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

**NOAA Collaborator(s):** Steve Morton, NOAA Center for Coastal Environmental Health and Biomolecular Research, Charleston, SC

**Other Federal Partner(s):** Eric Sherry, National Park Service

**LMRCS Collaborator(s):** J. Sook Chung, UMCES-IMET

**LMRCS Research Student(s):** Detbra Rosales (MS, UMES)

**Start Date:** 1 Sept 2013

**End Date:** 31 August 2014

**Results of project to date:** This summer we initiated a project to survey for *Dinophysis* sp. in the Maryland Coastal Bays. To date, this genus has not been detected at levels to initiate any specific alerts concerning its potential threat as a HAB. However, the frequency of its detection has been increasing. Thus it is likely that the potential for a serious HAB event is increasing. This summer, graduate student Detbra Rosales was trained in several methods for collection and detection of this genus. She conducted plankton trawls in conjunction with filtering of water samples at selected sites. In addition, we collected various filter feeders (such as oysters and clams) and extracted DNA from their guts. After DNA isolation, we performed DNA-based PCR and cloning methodologies to detect *Dinophysis* sp. Detection levels were low, and at only one site (St. Martin's River that feeds into Assawoman Bay, in April) was it detected. Not surprisingly, this site is one of the most degraded locations in the MCB, due to its proximity to a waterfront housing community. No *Dinophysis* sp. was detected in clams, but Detbra was able to detect other dinoflagellates that were filtered from the environment.

Ms. Rosales learned DNA isolation and cloning methods. In addition, she was able to generate sequence data for the *Dinophysis* from St. Martin's River. This sequence has been deposited into the National Center for Biotechnology Information GenBank. In future months she will characterize the dinoflagellates from the clam species. Collectively, as a first year student, she has been given a solid foundation for her future thesis studies in characterizing HABs and other resident dinoflagellates in this ecosystem.

In Dr. Sook Chung' portion of the project (which included training of an undergraduate intern) the effect of okadaic acid on the food consumption, molting and survival of blue crab larvae was examined using different doses at 1, 0.25, 0.0625, 0.0156 uM, and the same concentrations of DMSO as vehicle controls. Three different early life stages of the blue crab were exposed for 96 hrs: zoeal stage at 2-3 and 6-7 and megalopal stage.

Results: The effect of OA was dependent on a specific life stage of the blue crab.

a) Zoeal stage at 2-3:

**Food consumption:** OA had no effect on food consumption, compared to controls (ASW and vehicle controls). Molting rate was lower at 1, 0.25, and 0.0625 uM than two controls and at 0.0156uM. Mortality (%) was significantly higher in all OA

treated groups than ASW control. However, DMSO also had some negative effect on molting, compared to ASW.

b) Zoeal stage at 6-7 and megalopae: No differences between the tested and control groups were noted in all parameters that were examined for this study.

**For expression analysis of the samples:** cDNAs have been prepared and their quality was tested with a reference gene, AK primers. II media and megalopae/C1 samples have been kept for measuring the OA levels in these samples using OA ELISA.

**How will results be incorporated into NOAA Fisheries operations?** We anticipate that this project will serve as a management tool for the recreational fishery that is located in the Maryland Coastal bays ecosystem, as *Dinophysis* is a HAB species.

**How will results be incorporated into LMRCS research and curriculum?** The results will be a test case for how a degraded ecosystem impacts the development of HAB, and their impact on shellfish health. It can be presented both in MEES seminar courses and in BIOL 601 (Environmental Microbiology).

**14-07 - Project Title:** Analyzing diets of Atlantic menhaden using metabarcoding

**Project Abstract:** Atlantic menhaden is a key forage species that serves as a trophic link between the plankton and predator fishes and birds. Identification of food organisms is difficult because the prey organisms are small and fairly easily digested such that traditional microscopic identification of stomach contents is somewhat limited potentially excluding insights into the predator-prey interactions of these forage fishes. As a result the understanding of larger scale processes such as food web interactions and energy flow through an ecosystem can be biased. This project is to develop and verify molecular techniques, based on *cox1* DNA, as a tool to identify species in stomach contents of these fish and to compare them with those found in plankton. Existing molecular databases (National Center for Biotechnology Information and Barcode of Life) will be utilized for identification of gut and plankton species. Identification by barcoding will also be verified by traditional microscopic methods.

**Thematic Area Addressed:** Quantitative Fisheries

**Lead Scientist(s):** Allen Place, UMCES-IMET

**NOAA Collaborator(s):** Kevin Friedland, NOAA-NMFS

**LMRCS Collaborator(s):**

**LMRCS Research Student(s):** Ammar Hanif, MS

**Start Date:** 1 March 2014

**End Date:** 31 August 2014

**Results of project to date:** 16S sequencing results have been analyzed on a total of 20 menhaden juveniles collected from the Choptank River and Gulf of Mexico. Diets were also analyzed by Dr. Stacy Smith of Delaware State University using stable isotopes. With the help of Bing Ma from the Institute of Genomic Science, MacQIIME was used to analyze and assemble raw reads. This resulted in over 2 million quality reads for diversity analysis with the help of Dr. James White from Respherbio using R. The analysis gave five points:

1. Looking at alpha-diversity metrics, the raw number of OTUs (observed\_species), the chao1 estimator (chao1), good's coverage, and fisher's alpha diversity all support the notion that the Gulf menhaden samples are significantly more diverse than the Atlantic menhaden samples. This suggests that in terms of unique species in the environment, the Gulf menhaden samples have more on average than Atlantic menhaden samples.

2. The other two alpha diversity estimators (Shannon and Simpson\_reciprocal) also measure diversity, but in a different context. They actually show reverse diversity between Gulf menhaden and Atlantic menhaden samples. These two metrics suggest that although Gulf menhaden samples are more diverse in general, the Gulf menhaden samples have a few very dominant OTUs (e.g. Stramenopiles) that dwarf the membership of other OTUs, which is why we see this contrast in diversity.

3. At the phylum level, we observed many differences including enrichment of Cyanobacteria in Gulf menhaden samples ( $P=0.0048$ ), and enrichment of Acidobacteria ( $P=2e-4$ ), Chloroflexi ( $P=0.001$ ), Actinobacteria ( $P=0.0052$ ) and Proteobacteria ( $P=0.0186$ ) in Atlantic menhaden samples.

4. At the class level, we see that Anaerolineae is enriched in Atlantic menhaden samples ( $P=2e-4$ ). An Acidobacteria class, Sva0725 is dramatically ( $P=2e-4$ ) enriched, and Alphaproteobacteria is significantly enriched ( $P=0.0024$ ) in the Atlantic menhaden samples.

In contrast, sequences assigned to Cyanobacteria chloroplast were highly enriched in the Gulf menhaden group ( $P=0.007$ ).

5. At the OTU-level table, we see why the Gulf menhaden samples look significantly more diverse. There are a large number of OTUs that are uniquely observed in the Gulf menhaden samples, with literally observations in the Atlantic menhaden samples. If we control the False Discovery Rate to 5%, there are 547 differentially abundant OTUs between Gulf menhaden and Atlantic menhaden groups. Sequencing of these same samples using 18S primers are currently being done and will be analyzed to look at the diet. Also, DNA is being extracted and tested for amplification from adult and juvenile menhaden stomachs and intestine to compare microbiome and diet between the two life stages.

**14-08 - Project Title:** Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture.

**Project Abstract:** Our previous LMRCSF-funded project demonstrated that we could quantify genetically modified probiotic and pathogenic bacterial strains throughout an oyster larvae challenge experiment. In this project we repeated a previous challenge experiment in order to eliminate cross-contamination problems that our quantification identified from previous studies. In addition, we examined the effectiveness of exposing larvae of selected marine species to the probiotic.

**Thematic Area Addressed:** Aquaculture

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

**NOAA Collaborator(s):** Dr. Gary Wikfors and Ms. Diane Kapareiko, NEFSC, Milford, CT

**LMRCSF Collaborator(s):** Dr. Dennis McIntosh, DSU

**LMRCSF Research Student(s):** Ikenna Ikpeama (DSU)

**Planned Start Date:** 1 September 2013    **End Date:** 31 December 2014

**Results of project to date:** As part of on-going studies on improving shellfish aquaculture, the Milford Lab isolated several bacteria from digestive glands of eastern oysters or bay scallops that have inhibitory effects against known shellfish-pathogen bacterial *Vibrio* sp. B183. One strain, *Vibrio* sp. OY15, has been the focus of our collaborative studies and we have been examining the spatial and temporal relationships for OY15 and B183 during larval challenge experiments by applying quantitative assays for strain enumeration. This approach was assisted by developing vectors containing structural genes for the green fluorescent (GFP) and red fluorescent proteins (RFP) and introducing these into strains OY15 and B183, respectively, providing unique genetic tags for these bacteria. During the summer of 2014, the LMRCSF research student visited the Milford lab and participated in an oyster larvae challenge experiment using these strains and returned to IMET with samples for analysis. This experiment repeated the challenge that was done in the summer of 2012, but included safeguards that eliminated cross-contamination of treatment containers, which was shown to be a problem in previous trials. At IMET, DNA was isolated from larvae and qualitative PCR experiments using gene-specific primers designed for *gfp* and *rfp* gene sequences, as well as 16S rRNA and 18S rRNA gene sequences (for total bacteria and oyster genomes, respectively) confirmed the absence of contamination between samples. Analyzing these samples by quantitative PCR is currently in progress.

In addition to the oyster larvae studies, we have begun to examine the probiotic activity of OY15 with other select marine species. Experiments were done at DSU examining the effect of OY15 on growth and viability of larvae of the saltwater bait species *Fundulus heteroclitus* in four-week exposure trials. Our preliminary studies indicated that growth rates for OY15-treated larvae were significantly greater than untreated larvae, suggesting that the probiotic provided some stimulatory activity. These experiments will be repeated and future experiments will also examine dosing and concentrations as well as quantifying OY15 at different times post exposure by qPCR assays to determine retention and clearance rates.

Finally, draft genome sequences for both strains OY15 and B183 were generated at IMET and we have submitted the sequences to GenBank, where they were annotated and released to the public (accession numbers JPIL00000000 and JPQB00000000 for OY15 and B183, respectively). The genome sequencing projects were described in two *Genome Announcements* manuscripts that acknowledge LMRCSF funding:

**How will results be incorporated into NOAA Fisheries operations?** Results will provide further insight into the interaction of oyster larvae and other marine species with probiotic strains. They will be used to develop strategies for inhibiting



pathogenic bacterial activity as well as determining the focus of further studies into the mechanisms of action of the probiotic bacteria. The studies will also allow us to determine the next set of questions that need to be addressed in order to gain understanding into these processes.

**How will results be incorporated into LMRCSC research and curriculum?** The project will provide a foundation for continued collaboration between Delaware State and IMET scientists, which will be used to develop a multi-year grant proposal submission to NRAC at the end of 2014.

**14-09 - Project Title:** Improving management of deep-sea red crabs (*Chaceon quinque-dens*): Reproductive biology, maturity, and stock structure

**Project Abstract:** Deep sea red crabs support a small but valuable federally-managed fishery along the US Atlantic coast, but little is known about their biology, abundance, growth, age, or reproduction, causing major uncertainties about the status and management of the red crab stock. Preliminary data collected during NOAA cruises in January 2011 and 2012 and July 2013 indicated that female red crabs have biennial reproduction. We had proposed to collect red crabs from 8 sites along the east coast but NOAA budgets did not allow us time on their research vessels this year, so samples were collected during two cruises aboard commercial vessels. Reproductive tissues, hormones, and age structures were collected to determine reproductive cycles, age/size at maturity, and seasonality of reproduction. This information is vitally important for management and conservation of red crab populations.

**Thematic Area Addressed:** Quantitative Fisheries

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

**NOAA Collaborator(s):** Larry Jacobson

**LMRCSC Collaborator(s):** J. Sook Chung (UMCES-IMET)

**LMRCSC Research Student(s):** Stephanie Martinez-Rivera (PhD, UMES), Justin Wilson (MS, UMES), Shadaesha Green (UG, Hampton)

**Start Date:** 1 Sept 2013

**End Date:** 31 August 2014

#### **Results of project to date:**

Background: During three previous NOAA-sponsored LMRCSC cruises in 2011, 2012, and 2013, red crabs were captured from three depth intervals (250-450 m, 450-650 m, and 650-850 m) at four sites in the Mid-Atlantic Bight from Block Island Canyon to Norfolk Canyon. During those trips we measured >2500 crabs and collected gonads from 245 crabs. In Spring 2014, Stephanie Martinez began doing histological preparations on gonad tissues collected during 2013, and Justin Wilson began to investigate the use of crab eyestalks for aging of red crabs. Shadaesha Green participated in the 2013 cruise, and is now a graduate student working with Dr. Chung. This project has three primary goals: 1) determine seasonality of reproduction, fecundity, and size at 50% sexual maturity (SM<sub>50</sub>) for male and female red crabs; 2) determine if hard structures can be used to estimate age and growth of crabs, and 3) characterize the physiological regulators of reproduction in red crabs.

Sampling: In 2014, red crabs were collected during two 5 day trips aboard a commercial vessel (the Hannah Boden), from The Atlantic Red Crab Company, by S. Martinez and S. Green (July), and B. Stevens and J. Wilson (September). Approximately 200 crabs were dissected and another 300 measured. Tissue samples collected were ovary, testes, vas deferens, hepatopancreas, midgut, eyestalks, stomach, muscle, and blood. Crabs were measured and sexed, and gross morphology was recorded including the presence, size and color of ovaries and external eggs. We expect to participate in another sampling trip in November of this year.

Size and maturity: During 2013-14 the samples from 2011 (n=168), 2012 (n=78) and 2013 (n=77) were prepared for histological analysis. Some were photographed, and the area of spermatophores and oocytes were measured using the ImageJ software. An REU student was employed to begin summarizing oocyte measurements and help define stages of reproduction.

Age Estimation: During the past year we began focusing on age determination of red deep-sea crab using a technique developed by Kilada et al. (2012), who found growth rings or bands in the gastric mill and eyestalks that can be used for age determination. Samples of both structures were obtained on both research trips. Preliminary samples were sent to Raouf Kilada who verified the technique for this species, and estimated the age of one crab at 9 yo. In late summer, Justin Wilson

began preparing gastric mill tissues for sectioning, and will examine them for presence of growth rings later this year. [Kilada, R., B. Sainte-Marie, R. Rochette, N. Davis, C. Vanier, and S. Campana. 2012. Direct determination of age in shrimps, crabs, and lobsters. Canadian journal of fisheries and aquatic sciences 69:1728-1733]

**Endocrinology:** The objective of this goal is to characterize the physiology and biochemistry of red crabs in order to determine their seasonal reproductive patterns, and endocrine regulation of reproduction. Partial cDNA sequence of vitellogenin(VTG) has been obtained for establishing qPCR assay and evaluating the levels of VtG transcripts. In addition, we obtained the partial cDNA sequence of red deep sea crab CHH and established the presence of molt-inhibiting hormone and crustacean female sex hormone in the sinus gland using PAGE-Western blot analysis and immunohistochemistry.

**New projects:** In addition to the planned projects, we have supported three additional projects. 1) Live red crabs were taken to the NOAA J.J. Howard Laboratory at Sandy Hook, where Delaware State graduate student Nivette Perez-Perez began hatching the larvae and raising them to determine feeding and temperature conditions required for larval survival. This work is preliminary to a study on effects of ocean acidification that will be conducted in 2015. 2) We also collected midgut samples for Dr. Indu Sharma of Hampton University, who is examining them to determine the microbiomes present within the red crab digestive system. 3) Leg muscle samples were collected for Dr. Chuck Jagoe of FAMU who will analyze them for the presence of heavy metals and other contaminants.

**How will results be incorporated into NOAA Fisheries operations?** The federally-managed fishery for red crabs is conducted using industry-agreed size and catch limits, but little is known about their biology, abundance, growth, age, or reproduction. We are providing basic information on life history, reproduction, age, growth, and maturity that will lead to improved management of the red crab population and fishery based on biological benchmarks. This information will be invaluable for setting goals for sustainable management of this marine resource.

**How will results be incorporated into LMRCS research and curriculum?** Three graduate students and one undergraduate student have been trained in anatomy and dissection protocols for deep-sea red crabs and histological preparation. Results of this research will be incorporated into a class proposed for Spring 2015 by Dr. J. Sook Chung 'Comparative and Molecular Endocrinology MEES 698M. In addition, we will propose to offer a one-week practical workshop in quantitative histology during winter of 2015.

**14-10 - Project Title:** Augmenting the Black Sea Bass, *Centropristis striata*, Stock Assessment, Year 2: Assessing the importance of fixed and fluid estuarine habitats

**Project Abstract:** Black sea bass (BSB, *Centropristis striata*) support important commercial and recreational fisheries in the Mid Atlantic Bight. Adults live offshore, but juveniles depend on reef and hard bottom habitats in estuaries in the summer and early fall. We hypothesize that BSB recruitment is associated with the availability of oyster reefs in the Chesapeake, and annual variability in temperature, precipitation and salinity. In Year 1, we began developing a habitat suitability model to determine preferred habitats of BSB in the Chesapeake, and test the model by sampling a variety of known and unknown habitats. In Year 2 we wish to expand the range of sampling and determine when sonic tagged fish leave Chesapeake Bay. This proposal addresses two of the LMRCS research themes including "Quantitative Fisheries" and "Essential Fish Habitat", as well as several NOAA Strategic Goals.

**Thematic Area Addressed:** Essential Fish Habitat

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

**NOAA Collaborator(s):** Howard Townsend, Chesapeake Bay Office

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

**LMRCS Research Student(s):** Laura Almodóvar Acevedo (PhD, UMES)

**Start Date:** 1 Sept 2013

**End Date:** 31 August 2014

**Results of project to date:**

**Model development :** After an extensive literature research on the minimum, maximum and optimum temperature and salinity for black sea bass growth, we started to develop a Growth Rate Potential (GRP) model based on Kitchell et al. (1977, J. Fish. Res. Board Can. 34: 1922-1935). Initial development of the GRP was based on temperature, and will eventually be expanded with the addition of salinity data. This model was linked to the Chesapeake Regional Ocean Modeling System (ROMS) with a code written in R by Mejs Hasan to create a Habitat Suitability Model based on

temperature and salinity. We compared a high flow year with a low flow year to determine which had more suitable habitat for black sea bass and the model showed that years with lower river flow had more suitable habitat for them. The preliminary results of the model were presented through poster at the 2014 ASLO Ocean Sciences Meeting in Honolulu.

**Telemetry:** Prior to starting the telemetry portion of the project we met with Dr. Dave Secor and Dr. Mary Fabrizio (VIMS) in order to learn about fish tagging and tracking. We received eight black sea bass from the Chesapeake Bay and we have been keeping them for general observations of behavior and to practice inserting the tags. One practice tag, VEMCO V7-1L 180Hz, was acquired. This tag was used as a model for building other practice tags of the same shape, size and weight. We practiced the tagging insertion surgery and established the protocol. Almost all the materials for the project have been bought, including several VEMCO V7-1L 180Hz tags which we hope to insert starting in September. The tags only last from 2-3 months and we expect black sea bass to leave the bay in October. We have communicated with other researchers who are doing biotelemetry and have receivers in the Chesapeake Bay to inform them of our project, and received permission from the US Navy to obtain the data created when fish with our tags go through their array at the mouth of Chesapeake Bay.

**Fish sampling:** Sampling was done from July to October. Trap strings were set up and different baits were used to determine which one was the most effective. Traps were deployed for 24 hours in areas for different habitat types. No black sea bass were found in the areas sampled. Next year we'll deploy the traps where the Habitat Suitability Model suggests the fish might be. Fish that will be tagged in summer 2014 are expected to be detected by a continuous monitoring system previously established across the mouth of the Chesapeake Bay.

**How will results be incorporated into NOAA Fisheries operations?** The results of this work are already being integrated into a large-scale ecosystem model developed by the Chesapeake Bay Office of NOAA, and will be used to predict habitat associations for black sea bass, and impacts of habitat change on habitat availability. Although few juvenile fish were found, sampling will occur in 2014 in other areas where the model predicts that fish will occur.

**How will results be incorporated into LMRCS research and curriculum?** This project will expand upon earlier work using acoustic tags to track croaker (Dr. Andrea Johnson), and will help UMES develop experience and expertise with fish tagging and tracking.

**14-11 - Project Title:** Effects of climate change and anthropogenic stressors on piscivore-planktivore trophic interaction

**Abstract:** The purpose of this project is to (1) determine effects of increased chlorophyll and phytoplankton on bottom-up fishery dynamics and on the stability of the food-web structure; (2) predict the impacts of rising temperatures on the long-term sustainability of the Chesapeake Bay striped bass fishery; (3) determine long-term implications of increased phytoplankton blooms and rising temperatures on trophic interactions in the Chesapeake Bay Ecosystem and (4) provide harvesting recommendations to management based on estimated long-term commercial fishery stocks.

**Thematic Area:** Quantitative Fisheries

**Lead Scientists:** Ira Walker, Hampton University and Andrij Horodysky, Hampton University

**NOAA Collaborators:** Dr. Howard Townsend, NOAA Chesapeake Bay Office

**LMRCS Research Student(s):** Renita Bostic (MS, HU), Joshua Williams (UG, HU), and Lawren Beane (UG, HU)

**Start Date:** September 2013

**End Date:** August 2014

**Results of project to date:** The main focus of the research effort performed during this last period was to conduct a study to determine systematic patterns existing between variations in sea-surface temperature in the Chesapeake Bay and the rate of recruitment, particularly for striped bass. The EWE model was used to produce the time series of predicted biomass for YOY, resident adult and migratory adult striped bass. The sea-surface temperature data originated from the Chesapeake Biological Laboratory at the University of Maryland Center for Environmental Science.

The distributions showed the variations of biomass of the two adult groups with sea-surface temperature. The data were plotted separately for two six months periods, namely, the first period was from January to June and the second period was from July to December. The biomass for both adult groups during the first six months of the year shows a decrease with temperature and in the case of the 1956 data there is a marked decline in biomass for temperatures less than 16.5°C. For higher temperatures within the same time period the biomass shows a slight increase except for the 1955 data where there is evidence of a decrease in biomass. During the second half of the year the biomass distribution for the adult resident group exhibits a sharp decline around 24°C. However, such a precipitous decline is not demonstrated in the case of the adult

migratory striped bass. These findings should not be overly generalized since several studies have discovered significantly varied responses of fish stock to climatic changes (Garrod & Colebrook 1978, Rodionov 1995, Sundby 2000, Brunel & Boucher 2006).

The correlation coefficient was calculated to measure the relationship between biomass and sea-surface temperature which included the effect of incremental lag periods of one month intervals. The data show that the correlation coefficient was positive for certain intervals of lag and became negative for other intervals. These results indicate an out of phase relationship between sea-surface temperature and the response of biomass over a twelve month period, and that the overall trend was periodic. The increment in lag separating maximum positive and maximum negative correlations was approximately six months. Equation (1) shows how the correlation coefficient was calculated with a lag of  $\Delta\tau$  (one month) for  $N$  months.

$$\rho = \frac{\sum_i^N (B_{i+\Delta\tau} - \bar{B})(T_i - \bar{T})}{\sqrt{\sum_i^N (B_{i+\Delta\tau} - \bar{B})^2} \sqrt{\sum_i^N (T_i - \bar{T})^2}} \quad (1)$$

These results demonstrate the cyclical behavior of biomass with time and are consistent with the anadromous migratory pattern of the striped bass. The migration of striped bass is significantly regulated by the fact that the preferred temperature range for striped bass is from 55°F to 68°F (12.7°C to 20°C). During the spring months, striped bass swim inland towards freshwater tributaries to spawn. They then travel back to coastal waters to thrive for a period of time. As the sea-surface temperature increases during the summer months the migratory striped bass leave the Chesapeake Bay to travel further north to cooler temperatures. However, the resident fish continue to inhabit the Chesapeake Bay and waters near the mouth of the river tributaries. During subsequent months the migratory striped bass return to the Chesapeake to stay for a period of time only to then migrate further south where warmer temperatures prevail as winter approaches. The periodicity of the biomass distribution gives evidence to the fact that the Ecopath/Ecosim software is a very reliable model of the population dynamics that occur in the Chesapeake Bay since the periodicity of striped bass due to their migratory pattern is exhibited in the data. These results are particularly salient since the biomass data and the sea-surface data were derived from two independent sources.

One of the more important metrics used to evaluate the health of fish stock is the recruitment. In one report (Wood, R. J. and Austin, H. M., 2008) the researchers conducted a multispecies study of the variability of fish recruitment patterns within the Chesapeake Bay using data over a span of six years. They employed locally weighted regression modeling along with principal component analysis and found that decadal-scale variability (annual) accounted for 62% of the variance, whereas interannual variability accounted for only 38 percent. Their results showed that the recruitment of anadromous fish was favored at the expense of shelf-spawning estuarine-dependent fishes. The survivability of adolescent striped bass to full maturity is an essential marker of its sustainability. To assess this survivability, a metric was devised which served as a measure of the rate of recruitment for striped bass. In this study, the quantity in Equation (2) is called the recruitment index (RI), which is the difference in the production per unit biomass between the YOY fish and either of the two adult stanzas, i.e. resident and migratory:

$$\Delta(P/B) = \frac{1}{B_A} \frac{dB_A}{dt} - \frac{1}{B_{YOY}} \frac{dB_{YOY}}{dt} \quad (2)$$

where  $t$  is the time in months,  $B_A$  is the biomass for adult striped bass and  $B_{YOY}$  is the biomass for young-of-years striped bass. For an equilibrium state,  $\Delta(P/B)$  is equal to zero and because in general, survivability of pre-adult fish is not 100 % due to both natural mortality and harvesting, the same metric will be negative, but will demonstrate a favorable trend as its value approaches zero. Estimates of the derivatives in Equation (2) were determined by using five-point numerical schemes, which are shown in Equations (3) and (4) (Hildebrand, F. B., 1974).

$$\frac{dB_{i-2}}{dt} \approx \frac{1}{12\Delta t} (-25B_{i-2} + 48B_{i-1} - 36B_i + 16B_{i+1} - 3B_{i+2}) \quad (3)$$

$$\frac{dB_{i+2}}{dt} \approx \frac{1}{12\Delta t} (3B_{i-2} - 16B_{i-1} + 36B_i - 48B_{i+1} + 25B_{i+2}) \quad (4)$$

RI for both adult resident and migratory striped bass were calculated. Logarithmic trend lines were calculated for each set of data along with the coefficient of determination  $R^2$ . The data can be interpreted to suggest that for the striped bass an increase in sea surface temperature has a deleterious effect on the survivability of adolescent fish stock. Sea-surface data for more years are forthcoming from the Chesapeake Biological Laboratory at the University of Maryland Center for Environmental Science. It is anticipated that the additional data will result in a concomitant improvement in the coefficients of determination  $R^2$ .

**How will results be incorporated into NOAA Fisheries operations?** These results provide further validation of the reliability of the Ecopath/Ecosim software package as a predictor of fish population dynamics in the Chesapeake Bay. Furthermore, these data also provide guidance to the fisheries management scientists that show the overall trend in recruitment and hence survivability of striped bass as a function of sea-surface temperature. If ocean warming occurs due to global warming, then the logarithmic mathematical model of the trend line that was calculated in this study can be used to give projections of the recruitment index (RI). This will have significant consequences in the criteria they select to effectively manage the population of important fish stock.

**How will results be incorporated into LMRCSC research and curriculum?** These results will form the basis for a journal article that will be submitted to a peer-refereed journal and will be one of the central topics to be included in the master's thesis of the Hampton University LMRCSC graduate student.

#### 14-12 - Project Title: Profile of EPS-Producing bacteria and diatoms in coastal Georgia sediments

**Project Abstract:** The upper millimeters of benthic substrates contain microbes that secrete extracellular polymeric substances (EPS) into the surrounding environment. EPS have important functions in microbial motility and community formation. The present study assessed the amount of microbial EPS in sediment samples collected from Williamson Island, GA and County Club Creek, GA and examined seasonal fluctuations in EPS abundance. Samples were collected from intertidal and subtidal sediments in November 2011 and November 2012. Genetic information from 12 sediment samples were gathered using sequence variation from the 16S ribosomal gene. This technique was used to characterize the taxonomy of the microbial community by amplifying the hypervariable (V4) region of the gene. The sequencing was completed using the MiSeq system where the barcodes generated in the amplification step are loaded into a reagent cartridge and put on the instrument. This study is relevant to NOAA's vision of a healthy and diverse marine ecosystem by studying an important process in the ecosystem that affects trophic relationships. The identification of the key primary producers that secrete (EPS) into coastal sediments is essential to our understanding of suitable habitat for infauna, and consequently, the commercially important species that feed upon them.

**Thematic Area Addressed:** Essential Fish Habitat

**Lead Scientist(s):** Crystal Smith, Savannah State University

**NOAA Collaborator(s):** Dr. Dionne Hoskins, NOAA/Savannah State University

**LMRCSC Collaborator(s):** Dr. Allen Place, Institute of Marine and Environmental Sciences  
University of Maryland Center for Environmental Sciences

**LMRCSC Research Student(s):** Crystal Smith (MS, SSU)

**Start Date:** 1 Sept 2013

**End Date:** 31 August 2014

**Results of project to date:** Ninety-eight percent (98%) of surface samples were from kingdom Bacteria, the most prevalent (46-73%) phylum was Proteobacteria, and Gammaproteobacteria and Flavobacteria were the dominant Class of bacteria in the majority of surface samples ranging from 26-61% for Gammaproteobacteria and Flavobacteria ranging from 9-29%. The microbial community was compared and analyzed at the taxonomic rank of Order using a Chi Square. Nineteen percent of Order Actinomycetales was found on Williamson Island and 80% on Country Club Creek. There was a significance difference ( $p < 0.0001$ ) between the percentage of Actinomycetales. There was a significant difference ( $p = 0.0074$ ) between the 80% of Aeromonadales found on Williamsons and 29% found on Country Club Creek. The percentage of

Alteromonadales was significantly ( $p < 0.0001$ ) higher (91%) on Williamson Island than Country Club Creek (8%). There was not a significant difference ( $p = 0.3551$ ) between Bacillales, it was highest on Country Club Creek at 55% compared to 44% on Williamson Island. There was 53% of Campylobacteriales found on Country Club Creek and 46% on Williamson Island. There was not a significant difference ( $p = 0.3191$ ) in the percentages found. There was a significance difference ( $p = 0.0003$ ) between the 83 % of Chromatiales found on Country Club Creek and the 18% found on Williamson Island. There was not a significant difference ( $p = 0.4460$ ) between the 60% of Clostridiales on Country Club Creek and the 39% on Williamson Island. There was not a significant difference ( $p = 0.099$ ) between the Flavobacteria found on Country Club Creek that measured 55% and the 44% measured on Williamson Island. The percentage (4%) of Oceanospirillales on Williamson Island was significantly higher ( $p < 0.0001$ ) than the percentage (95%) of Oceanospirillales on Country Club Creek. Seventy three percent of Pseudomonadales were found on Country Club Creek and 26% on Williamson Island; there was a significant difference ( $p < 0.0001$ ) between the two sites. Rhizobiales on Country Club Creek were measured at 75% and 24% on Williamson Island. There was not a significant ( $p = 0.4407$ ) difference between the two sites. There was a significant difference ( $p = 0.0004$ ) between the 68% of Rhodobacteriales on Country Club Creek and the 31% of on Williamson Island. The percentage (62%) of Thiotrichales on Country Club Creek was not significantly higher ( $p = 0.7428$ ) than the percentage of (37%) Thiotrichales found on Williamson Island. Some of the microbial communities at both sites were unidentifiable. There was not a significant difference between quarters 1, 3, and 4 ( $p = 0.7145$ ,  $0.7430$ , and  $0.9483$  respectively) of the microbial community at Williamson Island and Country Club Creek. There was not a surface sample taking at Williamson Island in quarter 2. Additionally, there was not a significant difference ( $p = 0.7633$ ) within quarters 1, 3, and 4 at Williamson Island or a significant difference ( $p = 0.9466$ ) within quarters 1, 2, 3, and 4 at Country Club Creek.

**How will results be incorporated into NOAA Fisheries operations?** To address a lack of information, we assessed and characterized the communities present, and would like to incorporate our data and published data on the EPS these communities produce to identify the groups that are likely to contribute most to this pool of organic matter in sediment. Identifying the microbial community was important so that we could better characterize what type of particulate organic carbon is present. If we can consider this information with what we know from the microbiological literature we may begin to be able to roughly speculate the composition of biofilm-facilitated POC being made available. These results can be incorporated into NOAA Fisheries operations by offering a glimpse into the principal components of understanding benthic micro-habits. EPS are beneficial to understanding links between fish life stages and the habitats in which they reside as well as the nutrients made available to commercially important species such as shrimp and crabs. The more scientists understand these micro-benthic habitats the more NOAA scientist are to accomplishing NOAA's mission of stewardship of living marine resources through science-based conservation and management, and the protection and restoration of healthy ecosystems.

**How will results be incorporated into LMRCSC research and curriculum?** These results are a part of graduation research being completed by LMRCSC graduate student Crystal Smith. This research seeks to provide connections between habitat quality and nutrient availability to recruited species through identification of key microbial communities, and determine if there is seasonality in species secreting EPS. While the types of EPS that are present may be determined analytically, the specific components of the microbial community that are making specific types of EPS are enigmatic. This research could be introduced to undergraduates as a core curriculum class to learn from the micro-benthos upward to the other trophic levels.

### **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 of the LMRCSC Research Committee were held during this reporting period. CSC-CSC joint research projects were discussed and the LMRCSC annual Science meeting scheduled to take place in October 2014 was planned.
- 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 \$1,853,732 (Appendices II and III)

**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 2013 - 2014 to conduct research are: Eric Schott (UMCES-IMET), Joseph Pitula (UMES), Andrij Horodysky (HU), Andrea Johnson (UMES), and Shari Wiley (HU).

**NOAA LMRCSC Scientific and Educational cruise aboard the NOAA Ship Delaware II**

No LMRCSC research cruise was conducted in 2014 because the NOAA ship was not available.

## **SCHOLARLY PRODUCTIVITY**

In the current reporting period, LMRCSC students and faculty made 43 presentations at scientific meetings, and published 25 articles in refereed journals (Appendix IV).

**Grantsmanship:** A total of \$1.85 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, \$183,579 came from NOAA, whereas \$1,670,153 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?** Thirty-nine (39) students were recruited to the center during this period. One new faculty, Dr. Maurice Crawford joined the LMRCSC at UMES as Deputy Center Director.
- 2. What are the new education programs (degree certificate programs, etc.)?** HU has recently revised its undergraduate curriculum to ensure that the students are trained for competitive graduate programs.
- 3. Students receiving direct and indirect support from the LMRCSC.** One hundred fifty-three (153) students were supported. Of those, 88 were supported directly while 65 were supported indirectly.
- 4. What outreach activities (e.g. workshops, conferences, seminars) have the Cooperative Science Center coordinated as part of the project?**
  - HU partnered with Chesapeake Experience to conduct two Kayak camps for 9-12 and 12-15 year olds. The camps were designed to engage students in learning about the various organisms in the Chesapeake Bay, Bay water quality, and a host of other activities through kayaking, a research cruise, and field trips. The campers, and educators were filmed for the “View from HU” while collecting water quality and microorganisms on the RV Aquaria III. This program will air in late fall 2014.
  - SSU students participated in the following activities: Graduate seminar (spring), GIS Day (November), NOSB (Fall-Spring), School Visits, Career Nights, Science Night, Earth Day at Forsyth Park (April), FareWhale (May), Coastal Wetland Days (May), SSU Open campus days (2 during summer).
  - Chung, JS lead a week-long Summer Marine Science Education Program for rising 9<sup>th</sup> graders, supported by a NSF grant: July 21-25, 2014 (<http://www.umces.edu/imet/SMSEP>). She also talked to 25 middle school students GT (Gifted and Talented) Summer Center: <http://www.marylandpublicschools.org/MSDE/programs/giftedtalented/centers>: Chesapeake Bay Watershed Investigations at the National Aquarium by NAIB on Aug. 05, 2014. Furthermore, she talked to 24 people (18 high school students and 6 adults) from Northwest Tri-County Intermediate Unit, Central Tech, Erie, PA.
  - Davis J. Scholarship Ministry at Empowerment Temple Methodist Church raised funds to assist students in the city of Baltimore with college tuition and assist with SAT preparation and the college application process. She also

helped to raise awareness about Marine Sciences through tours and presenting graduate research and experiences to local high school students.

- Hanif, A. is working with Towson State University Scitech program teachers and administrators on refreshing the field guide used for identifying organisms on biofilm disks used in their Baltimore Inner Harbor biofilm education module. He also spoke with 10-15 rising high school seniors from BioTechnical Institute of Maryland program about college and graduate school, current work on menhaden, bioinformatics, and LMRCS program. He involved BioTechnical Institute of Maryland, Lab Associates program student in Towson's Scitech biofilm documentation project.
- Schott, E.J. gave public lecture to the winter lecture series of Phillips Wharf Environmental Center, at Tilghman Island (Harrison's Chesapeake Restaurant), "Health of the Bay from The Blue Crab Perspective" on March 4, 2014. [www.stardem.com/life/article\\_fdbab76a-922c-5cb6-a663-f70e25397a35.html](http://www.stardem.com/life/article_fdbab76a-922c-5cb6-a663-f70e25397a35.html). He also gave aquarium students tour and lecture on crab mortality and ecology as well as tour of the IMET and lecture on "One in a million: blue crab life cycle and mortality" to Gifted and Talented middle school program (M Madero leader).
- Vicente, J. volunteered for NOAA showcase workshop event sponsored by the Department of Energy, and made a fish field identification guide of over 60 fish species of the Hawaiian Islands to help teachers identify fish from the "Big Island reef exhibit" in the Daniel K. Inouye Regional Center. He also assisted in writing the introduction to the proposal "Exploration of the Mesophotic Reefs of the Au'au Channel" that would provide funding for the Hawaiian Island Humpback Whale National Marine Sanctuary to conduct surveys in mesophotic reefs found in the sanctuary. He volunteered at North Shore Ocean Fest 2014 celebrated in Turtle Bay HI, helped setup booths and tents for exhibits promoting the protection of coral reefs of Hawaii, and helped man NOAA's HWNMS booth, teaching kids and families about the importance of the HIWNMS mission during the celebration for Ocean Fest 2014. He volunteered as a citizen of science during Ocean Sampling Day 2014. Filtered over 200 L of seawater collected from 3 sites in NOAA's HIWNMS. He was a presenter in outreach activity to the Baltimore Urban Debate League, Baltimore, Maryland. Talk entitled "Marine Sponges: From Microbes to Ecosystems: and group discussion between Jan Vicente and high school students on ocean exploration and development in the earth's oceans.

#### **K-12 Education and Outreach Programs:**

- **SSU Coast Camp for Youth:** 130 students participated in Coast Camp in summer 2014. Students were divided into 4 classes: lower elementary (7-8 years), higher elementary (9-10 years), middle school (11-13 years), and high school (14-18 years). Each class was taught by 3-4 counselors. By serving a broad age group and being affordable, the SSU Coast Camp offers strong, accessible science instruction and long term exposure to marine science for a diverse audience of youth.
- UMES hosted 80 middle school students at the Paul S. Sarbanes Coastal Ecology Center (PSSCEC) in spring 2014 for hands-on activities to learn about the Maryland Coastal Bays.
- **CREST CISCEP Student Enrichment and Experiential Learning (SEEL):** This program is funded by NSF and was leveraged with LMRCS funds. LMRCS faculty hosted and mentored 7 high school students from Worcester, Wicomico and Somerset county public schools in Maryland for 7 weeks during summer of 2014. Students conducted research alongside their mentors, LMRCS graduate students and REU undergraduates and produced posters and Powerpoint presentations of their results which were presented at a symposium on August 2, 2014.
- **Teacher Development Workshop:** This is another component of the CREST CISCEP program funded by NSF and leveraged with LMRCS funds. UMES offered a workshop for K-12 science teachers in July, 2014, 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.
- **Research Experiences for Undergraduates in Marine and Estuarine Sciences:** The LMRCS is a site of an REU program funded by NSF, and with additional support from the LMRCS. In summer 2014 thirteen (13) interns (8 supported with NSF funds; 5 with LMRCS funds) participated in various activities such as research, seminars, workshops, and field trips. The program ended on August 7 with a 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 LMRCSC 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 LMRCSC institutions after participating in the internship program.



*REU and SEEL students prepare to explore the Maryland Coastal Bays by Kayak.*



*REU interns Kenya Bynes (center left) and Renice Buchanan (center right) examine sea urchins collected in Brutons Bay, Virginia with SEEL students Jordan Waters and Tanvi Valsangikar during a field trip to VIMS, ESL.*

- Geosciences Bridge Program:** The LMRCSC worked collaboratively with other NOAA Cooperative Science Centers, CSCs (NCAS, CREST and ECSC) and established a summer geosciences bridge program at UMES. Eighteen (18) students participated in the program in summer 2014. They were exposed to the various areas of geosciences via hands-on activities and field trips. In addition, they took a college level math class as well as freshman orientation class. Eight of the 18 students enrolled at CSC institutions in fall 2014 after completing the program.



*Geosciences students participate in a map analysis activity instructed by Dr. S. Reddy Jackson State Univ)*

- Website:** The LMRCSC web site ([www.umes.edu/lmrcsc](http://www.umes.edu/lmrcsc)) is continuing to be 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 LMRCSC partner institutions also has its own website that is directly linked to the LMRCSC main web page

**Facebook:** LMRCSC Technical Monitor Jeanine Cody created an LMRCSC 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 (374) individuals, including many students, have signed up as 'fans' of the site. Partner institutions also maintain Facebook pages. At SSU, daily posts are made by the outreach coordinator.

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

- Jeanette Davis: awarded Knauss Fellowship for 2015:  
<http://seagrant.noaa.gov/FundingFellowships/KnaussFellowship/FinalistsCurrentFellows/2015Class.aspx>
- Shadaesha Green: awarded 2-year Louis Stokes Alliances for Minority Participation Fellowship (LSAMP).
- Student Development:** Support was provided by the Ratcliffe Family Foundation for Environmental Entrepreneurs Fellowships, a new effort to help young scientists cultivate the leadership and business skills necessary to bring their bench research into commercial markets for environmental science applications.
- Leveraged support for IMET summer interns from Morgan State University, the Gudlesky Family Foundation, Virginia Seafood Agriculture Research and Extension Center (VSAREC).

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

The LMRCSC educational, research and outreach activities have resulted in several contributions during this reporting period. 216 students from B.S. to doctoral levels were trained in NOAA core sciences. Eighteen (18) students graduated (0 Ph.D., 5 M.S., 13 B.S). Twelve (12) projects funded through the TAB for 2013-2014 are being completed,

and 12 new projects have been selected for funding for 2014-2015; \$1.85 million in external funding is supporting Center-related activities.

**2. How many students participated in Center projects or activities?** 216 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. 2583 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.

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

- Joalene Mason
- Ashley Ward
- Shadaesha Green: awarded 2-year Louis Stokes Alliances for Minority Participation Fellowship (LSAMP).
- Jeanette Davis: awarded Knauss Fellowship for 2015:



<http://seagrant.noaa.gov/FundingFellowships/KnaussFellowship/FinalistsCurrentFellows/2015Class.aspx>  
Jeanette Davis (Ph.D. student, UMCES-IMET)

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

- Marisa Litz, PhD student in Fisheries working with Dr. Jessica Miller, OSU LMRCS Project Director, is a recipient of NOAA's new graduate pilot program, the Graduate Research and Training Scholar Award, which is designed to support graduate students to conduct research at NOAA facilities.
- Shadaesha Green has been accepted into University of MD, IMET and is receiving LMRCS and LSAMP funding
- Camille Gaynus (HU B.S. graduate) has a full scholarship for a Ph.D. degree program in Ecology at UCLA.
- Brittany Carmon (HU B.S. graduate) is attending graduate school at Yale University.

***Students who received Training at NOAA Laboratories or at Center Institutions:*** 12 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 LMRCS have access to tools and training they would not have had were it not for the LMRCS. 65 students at the Center institutions who are not directly funded by the LMRCS are benefiting from the infrastructure and equipment made available to the institutions by the LMRCS. The LMRCS has secured leveraged funding (~\$1.85 million) that has enabled the Center institutions to recruit and support more students than they would otherwise be able to support.

LMRCS 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 K12 modules. Faculty have been able to apply for other base funding for research fellowships because of the prior funding provided by the LMRCS. Finally, travel and research funding from the LMRCS that allowed students to travel to NOAA labs helped publicize the quality of LMRCS 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 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?**

This period, students were involved in research in the following areas;

- Marine Biotechnology: Red Crab study
- Aquaculture/Fisheries
- Marine science related engineering
- Fisheries Modeling
- Oyster reef monitoring

**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?**

- **University-wide-** The LMRCSC has provided infrastructure for research conferences at SSU via faculty, student research, and poster boards. It has also provided the fellowship mentoring model and the postdoctoral fellow development model.
- **Local Community & Region-** SSU hosts regional NOSB competition and GIS Day
- **National-** LMRCSC students have traveled nationally to conduct research and to present the results of that research to national labs and conferences. The LMRCSC is increasing the number of students especially those belonging to underrepresented minority groups who are trained in NOAA related science disciplines, thereby positively impacting the future workforce.

**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 Who Collaborated with LMRCSC Scientists and Students during this reporting period (March – Aug. 2014)**

NOAA Scientists	NOAA Lab	Role at the LMRCSC
Matthew Poach	NOAA NEFSC Sandy Hook, NJ	DSU graduate student committees/research projects
Lonnie Gonsalves	NOAA Oxford Lab, MD	DSU research projects
Thomas Hurst	NOAA AFSC, Newport, Oregon	Adjunct faculty, committee member, mentor, Collaborator on TAB
Laurie Weitkamp	NOAA NWFSC, Newport, Oregon	Committee member of graduate student
Richard Brodeur	NOAA NWFSC, Newport, Oregon	NOAA GRTS mentor for Litz
Jeffrey Seminoff	NOAA SEFSC, Beaufort, NC	Adjunct faculty, mentor, Collaborator on TAB project
Larisa Avens	NOAA SWFSC, La Jolla, CA	Adjunct faculty, committee member, Collaborator on TAB project
Dan Holland	NOAA NQFSC	Committee member, Collaborator on TAB project
Peter Lawson	NOAA NWFSC	Committee member, Collaborator on TAB project
Andi Stephens	NOAA NWFSC	Committee member
Bill Peterson	NOAA NWFSC	Collaborator on TAB project
Tom Minello*	NOAA SEFSC Galveston Lab	Serves on MS committees at SSU (Tiffany Ward)
Kristy Wallmo*	Fishery Statistics and Economics Division	Serves on MS committees at SSU (Muhammad Cochran)
Chris Liese*	SEFSC	Serves on MS committees at SSU (Keya Jackson)
Eric Robillard*	NEFSC	Serves on MS committees at SSU (Dawn Franco)
Brent Stoffle	NOAA-SEFSC	NMFS mentor for Austin Flinn's internship in the socio-economic profile of Port Salerno fishing community.
Kevin Friedland	NOAA/NE Fisheries Science center	Al Place, menhaden project collaborator, member Ammar Hanif's thesis committee
Robert Goldberg	NOAA Milford Lab	Assembling a program to monitor the prevalence of pathogens of the blue crab ( <i>Callinectes sapidus</i> ) in the Northern limit of its range
Gretchen Messick	Cooperative Oxford Lab	Collaborator with Sook Chung, Feng Chen, and Eric Schott on several projects

James Morris	NOAA/Center for Coastal Fisheries	AI Place, Eric Schott collaborator
Jose A. Rivera	NOAA/NMFS	Member Jan Vicente's thesis committee
Jim Sullivan	NOAA's Coastal Goal Team, NOAA Sentinel Site Program, Silver Spring	Collaborator with Feng Chen; member of Marsan's thesis committee
Fran Van Dolah	NOAA/NCCOS	Rose Jagus, AI Place collaborator on OHH dinoflagellate project
Gary Wikfors/Diane Kapareiko	NOAA Milford Lab	Eric Schott/Howard Schreier collaborator; Understanding Interaction of Probiotic & Pathogenic Bacteria in Oyster Larvae Hatchery Culture

**Appendix II. Current leveraged funding from NOAA to LMRCS institutions**

Author	Funding Agency	Title of Project	Start/End Date	Amount	Current 6 month period
Gibson, D. & Horodysky, A. (HU)	VA NOAA Sea Grant	Sustainable Fisheries and Aquaculture Outreach, Education and Training for Under-Represented Groups and Aquaculture Producers	6/1/13 - 1/31/15	\$41,449	\$10,362
Schott E. (IMET)	NOAA Sea Grant	Monitoring for outbreaks of a fatal blue crab virus in waters with shedding systems	02/01/12-01/31/15	\$194,185	\$32,364
Miller, J. (OSU)	NOAA	Trophic ecology of forage fishes	10/1/2013-9/30/2014	\$25,000 in staff and ship time	\$7,500
Hurst, T. & Miller, J. (OSU)	NOAA	Northern rock sole ( <i>Lepidopsetta polyxystra</i> ) anti-predatory behavioral responses to elevated carbon dioxide concentrations	On-going	\$15,000 in staff and supplies	\$15,000 in staff and supplies
Place, AR (IMET)	NOAA	PCM HAB: Mitigating <i>Microcystis</i> in the Chesapeake Bay (MMIC) Diet and feeding of menhaden using barcoding identification based on cox1 sequences to enable the linking of primary productivity to fisheries	09/01/00-08/31/14	\$585,802	\$73,225
Jagus, R. (IMET)	NOAA MD Sea Grant	Determination of the impacts of trap fishing on Mid-Atlantic benthic habitats, with emphasis on structure-forming invertebrates	05/28/13-05/27/15	\$77,277	\$19,319
Stevens, B.G. (UMES), R. Lipcius (VIMS)	NOAA Bycatch Reduction Program		2/1/14 -1/31/15	\$103,235	\$25,809
<b>Total</b>					<b>\$183,579</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
Horodysky, A., Gibson, D., Cuker, B. (HU)	NSF	Educational Partnerships in Climate Change and Sustainability	June 1, 2012 to July 31, 2015	\$55,000	\$9,167
Gibson, D. (HU)	NSF	Communicating Ocean Science to Informal Networks	Sept. 1, 2011 to Aug. 31, 2014	\$54,000	\$6,750
Ramirez*, M. (OSU)	NSF	Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles			\$15,000
Banks*, M. (OSU)	Siletz Tribe	Microsatellite Markers Isolation (EST-SSR's) for Association Tests of Reproductive Phenotypes (GnRH, FSH and LH) in the Context of Environmental Variability for Chinook Salmon.			\$5,000
Curran, C. (SSU)	US Dept. Ed.	HBCU Graduate Program	2009-2015	\$3,000,000	\$250,000
Chen, F. & Hill, R.T. (IMET)	MIPS	Manure and Bio-Flocculation in Algal Technology	08/01/13-02/28/15	\$70,263	\$17,566
Chen, F. (IMET)	CCEMC	An innovative and highly efficient microalgae-based carbon sequestration system to reduce CO2 emission and produce biofuels in all climates	04/01/14-04/30/16	\$500,000	\$125,000
Chung, J.S. (IMET)	NSF	Functional Roles of a Novel Crustacean Female Sex Hormone in Sex Differentiation and Developing Secondary Sex Features of Crustaceans	05/01/12-04/30/16	\$435,507	\$54,438
Chung, J.S. (IMET)	EPA	Uptake and Effects of Dispersed Oil Droplets and Emulsified Oil by Estuarine Crustacea	05/01/12-04/30/16	\$139,393	\$17,424
Hill, R.T. (IMET)	NSF	The Role of Bacterial Symbionts of Marine Sponges in Nitrogen Fixation	09/01/09-08/31/14	\$353,417	\$35,342
Jagus, R. & Place, A.R. (IMET)	NIH/NSF	Translation regulation of gene expression in toxic dinoflagellates	01/09/12-01/31/2018	\$1,953,810	\$162,817
Place, A. R. (IMET)	NIEH	Combining bioavailability assays with modeling to predict PCBs in fish after remediation.	09/21/11-07/31/15	\$225,750	\$28,219
Schott E. (IMET)	DNR	Development, validation, and application of molecular detection tools for a virus infecting <i>Mya arenaria</i> soft shell clams in Chesapeake Bay	10/01/11-06/30/14	\$68,578	\$11,430
Schott E. (IMET)	FWC	Blue crab population disease assessment	10/28/13-10/27/14	\$10,000	\$5,000

Jiang, Li, Lee, Chen, Ozbay, G. (DSU)	USDA-AFRI	Inactivation of enteric foodborne viruses in high risk foods by non-thermal Processing technologies.	2/1/2011 - 1/31/2016	\$2,000,000	\$200,000
Stevens, B.G. (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
Chigbu, P., 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
Chigbu, P. & 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
Chigbu, P. (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
Gibson, D., Horodysky, A., Cuker, B. (HU)	NSF (HRD-HBCU-UP)	Targeted Infusion Project: Educational Partnership in Climate Change and Sustainability (EPiCCS)	9/1/11 – 8/31/14	\$300,000	\$50,000.00
<b>Total</b>					<b>\$1,670,153</b>

#### Appendix IV: Presentations and Publications

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

[DSU: 0 Presentations, 0 student presenter](#)

[HU: 0 presentations, 0 student presenter](#)

[OSU: 0 presentations, 0 student presenter](#)

[RSMAS: 1 presentation, 1 student presenter](#)

Santos R.\* Linking Everglades Restoration Effects to Fisheries Habitat: Influence of SAV seascape structure and fish predation risk. conference on ecological and ecosystem restoration elevating the science and practice of restoration a collaborative effort of NCER and SER July 28-August 1, 2014 New Orleans, Louisiana USA.

[SSU: 4 Presentations, 3 student presenters](#)

Hoskins, D. Reflections on African American Stakeholder Involvement: Three Coastal Georgia Cases. In: Environment, Economy, Equity - Exploring the Third "E", 9th Annual Georgia Environmental Conference, August 20-22, 2014.

Brinton\*, B. and Curran M.C. (2014). Does temperature affect synchronization between reproduction of the bopyrid isopod parasite *Probopyrus pandalicola* and molting of its grass shrimp host? Southeastern Society of Parasitologists (Apr 2014) **Won Best Graduate Presentation**

Brinton\*, B. and Curran M.C. (2014). The effect of temperature on synchronization between reproduction of the bopyrid isopod parasite *Probopyrus pandalicola* and molting of its grass shrimp host. American Society of Parasitologists

Curran, M.C., C. Kovacs\*, and T. M. Cox. Where's that dolphin and who's it hanging out with? Using a marine mammal to teach students about math and geography. NMEA Annapolis (July 2014)

**UMES: 14 Presentations, 11 student presenters**

- Chen, N., Chigbu, P., Ishaque, A.B., May, E.B. and Duan, S. (2014). Dissolved barium as tracer of groundwater input in Maryland Coastal Bays. Presented at the Atlantic Estuarine Research Society spring meeting, Ocean City, MD, March 27-29, 2014.
- Chigbu, P., Malinis\*, L., Malagon\* H. and Doctor S. (2014). Temporal and spatial patterns in the abundance of Sand Shrimp, *Crangon septemspinosa* in the Maryland Coastal Bays. Presented at the Atlantic Estuarine Research Society (AERS) symposium, Ocean City, MD, April 2014.
- Gong, T. and Jones\*, J. (2014). Socioeconomic factors affecting entry-stay-exit behavior of the blue crab watermen in the Chesapeake Bay. University of Maryland Eastern Shore 2014 Regional Research Symposium, Princess Anne, MD. April 17, 2014
- Lycett\*, K. and Pitula, J. (2014). Ecological and genetic investigations of *Hematodinium perezii*, a parasite of Blue Crabs. National Shellfisheries Association Meeting, Jacksonville, FL. 31 March, 2014.
- Lycett\*, K. and Pitula, J. (2014) Ecological and Genetic Investigations of *Hematodinium perezii*, a parasite of Blue Crabs. University of Maryland Eastern Shore Regional Research Symposium, Princess Anne, MD. 17 April, 2014.
- Lycett\*, K., and Pitula, J. (2014). Molecular-based ecological investigations of *Hematodinium perezii*, a crustacean parasite. Joint Aquatic Science Meeting, Portland, OR, 22 May, 2014.
- Mayor\*, E. and Chigbu, P. (2014). Macrobenthic invertebrate abundance and distribution in the Maryland Coastal Bays. Atlantic Estuarine Research Society (Spring Meeting) March 2014, Ocean City, MD.
- Morales-Núñez, A.G. and Chigbu, P. (2014). Abundance, species composition, and distribution of amphipods (Crustacea) in relation to macroalgae in the Maryland Coastal Lagoons. Presented at the Atlantic Estuarine Research Society spring meeting, Ocean City, MD, March 27-29, 2014.
- Oghenekaro, E.U.\* and Chigbu, P. (2014). Distribution and abundance of *Evadne nordmanni* and *Pleopis polyphemoides* (Cladocerans) in the Maryland Coastal Bays. Atlantic Estuarine Research Society (AERS) spring 2014 meeting, Ocean City MD. March 28-29<sup>th</sup> 2014.
- Oghenekaro, E.U.\* and Chigbu, P. (2014). Seasonality and spatial distribution of cladocerans in the Maryland Coastal Bays. University of Maryland Eastern Shore School of graduate studies 5<sup>th</sup> annual regional research symposium. April 17<sup>th</sup>, 2014.
- Parveen, S., Rodgers, C.\*, Chigbu, P., Jacobs, J., Rhodes, M. and Harter-Dennis, J. (2014). Prevalence of *V. vulnificus* in Blue Crabs (*Callinectes sapidus*), seawater, and sediments of the Maryland Coastal Bays. Presented at the American Society of Microbiology meeting, Boston, MA, May 17-20, 2014.
- Parveen, S., Rodgers, C.\*, Chigbu, P., Jacobs, J., Rhodes, M., J. Harter-Dennis, J. (2014). Incidence of *Vibrio parahaemolyticus* in Blue Crabs (*Callinectes sapidus*), water and sediments of Maryland Coastal Bays in the United States. Presented at the VIBRIO 2014 Conference, Edinburgh, Scotland, UK, 1-4 April 2014.
- Peoples\*, A. and Driscoll, C. (2014). MD DNR Sea Turtle & Marine Mammal Stranding Summary. Mid-Atlantic Zoonotic and Vector Borne Disease Inter-Agency Workgroup (MAZV). Department of Agriculture, Annapolis, MD. August 20, 2014
- Stevens, B.G. (2014). Depth and Size Distribution of Deep-Sea red crab, *Chaecon quinque-dens*, in the mid-Atlantic Bight. Presented at the National Shellfisheries Association Meeting, Jacksonville, FL, March 29, 2014.

**Other Presentations by Undergraduates and High School Interns: 5 Presentations, 5 student presenters**

- Ahemedaltayb, A.\* , Oghenekaro\*, E.U., and Chigbu, P. (2014). Abundance and Biomass *Anchoa mitchilli* in the Maryland coastal Bays. NSF CREST Student Enrichment and Experimental Learning (SEEL) Program. UMES Carver Hall. August 1<sup>st</sup> 2014.
- Bynes\*, K., Malagon\* H., Alvarez\*, J. and Chigbu, P (2014) Spot (*Leiostomus xanthurus*): Juvenile population distribution and abundance in Maryland Coastal Bays. Research Experience for Undergraduates (REU) Symposium, UMES Paul Sarbanes Coastal Ecology Lab, August 2014.
- Goodman\*, W., Valsangikar, T., Gurung, D., Chen, N. (2014) Kinetic Study of Exoenzymatic Alkaline Phosphatase Activity in the Maryland Coastal Bays UMES REU 2014 Final Symposium Assateague island MD August 2014
- Grainger, C\*, Malagon\*, H., Alvarez, J. and Chigbu, P. (2014). Growth and mortality of juvenile Spot (*Leiostomus xanthurus*) in the Maryland Coastal Bays. Research Experience for Undergraduates (REU) Symposium, UMES Paul Sarbanes Coastal Ecology Lab, August 2014.



Rubalcava\* K., Alvarez\* J., Malagon\*, H. and Chigbu, P. (2014). Interannual variations in the recruitment of Spot (*Leiostomus Xanthurus*) in the Maryland Coastal Bays. Research Experience for Undergraduates (REU) Symposium, UMES Paul Sarbanes Coastal Ecology Lab, August 2014.

**UMCES: 4 Presentations, 2 student presenters**

- Li, Y.T. Substrate specificity and positional preference of *Chlamydomonas* diacylglycerol acyltransferases critical for stress-related biosynthesis of triacylglycerol” at the 16th International Conference on the Cell and Molecular Biology of *Chlamydomonas*, Pacific Grove, CA, June 8-13, 2014.
- Marsan, D.\*, Rigaud, S, DiToro, D, Church, T. A sharper image of Delaware Bay; Using the natural radionuclides <sup>210</sup>Po and <sup>210</sup>Pb to model estuarine rates of biogeochemical processing. ASLO Ocean Science Meeting, Oahu, Hawaii, 2014.
- Park, H-Y, J. Lie, L. C. Blasiak, R. T. Hill, E. F. Merino, M. B. Cassera and L. H. Rakotondraibe. 2014. Antimalarial dipeptide from a *Streptomyces* species associate of the sponge *Xestospongia muta*. Public Health Preparedness for Infectious Diseases Conference, The Ohio State University. Columbus, Ohio.
- Vicente J\* (2014) “Impact of ocean acidification on sponge skeletogenesis: are the glass blowers of the reef at risk?” and staff discussion on the impact of invasive sponges on the Hawaiian archipelago.

**Other Presentations by Undergraduates and High School Interns: 13 Presentations, 13 student presenters**

- Alexander, D,\* Saito, K. Anaerobic digestion of marine aquaculture waste. Living Marine Summer Research Day, IMET, August 2014.
- Billups, D.\* and Du, J. Characterization of myopathic genetic mutations in *Danio rerio* (zebrafish) Living Marine Summer Research Day, IMET, August 2014.
- Brown, S,\* Flowers, E, and Schott, EJ. Variability of the RNA-dependent RNA polymerase in comparison to less conserved segments of RLV (Reo-Like Virus) *Callinectes sapidus*. Living Marine Summer Research Day, IMET, August 2014.
- Dasi, E.,\* Jones GD & Jagus, R. Using a yeast eIF4E knockout strain to assess the function of eIF4Es from dinoflagellates. Living Marine Summer Research Day, IMET, August 2014.
- Dawson, N,\* \*Hanif, A. Williams, E. & Place, AR. Quantifying dominant menhaden gut microbiome species in Choptank River water samples. Living Marine Summer Research Day, IMET, August 2014.
- DeLorme, K,\* Davis J. & Hill, RT. Bacterial diversity of the Hawaiian alga, *Bryopsis* sp. Living Marine Summer Research Day, IMET, August 2014.
- Green, S,\* Chung, J., Stevens, B. Examining the reproductive regulators of the female deep sea red crab, *Chaceon quinque-dens*. Living Marine Summer Research Day, IMET, August 2014.
- Hughes, M,\* \*Hanif, A. Williams, E. & Place, AR. Quantifying the dominant species within the stomach microbiome of menhaden. Living Marine Summer Research Day, IMET, August 2014.
- Ikpeama, I,\* Schott, E. & Schreier. Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture. Living Marine Summer Research Day, IMET, August 2014.
- Kline, T,\* & Wong, TS. Generation of double transgenic zebrafish: PCR screening approach to identify homozygotes. Living Marine Summer Research Day, IMET, August 2014.
- Kraskura, K.\* & Chung, JS. The effects of okadaic acid on the growth physiology of the blue crab, *Callinectes sapidus* Living Marine Summer Research Day, IMET, August 2014.
- Olmeda, M.\* & Li, YT. Growth, astaxanthin biosynthesis and triacylglycerol accumulation in the green alga *Chlorella zofingiensis* under different culture conditions. Living Marine Summer Research Day, IMET, August 2014.
- Peake, J.\* & Zohar, Y. Sustainable Sushi: Development of a system and protocol for the larval rearing of Atlantic Bluefin Tuna Living Marine Summer Research Day, IMET, August 2014.

**Poster Presentations (\*Students)**

**DSU: 2 posters, 2 student presentations**

- Perez-Perez, N.M.\*, Smith, S.L., Gonsalves, L., Stoneman, A.T\*, Ozbay, G. (2014) Effects of Environmental Changes on Otolith Growth of Atlantic Menhaden (*Brevoortia tyrannus*) from the Choptank, River, MD. Delaware State University Graduate Student Symposium, April 2014
- Stoneman, A.T.\*, Smith, S.L., Ozbay, G. (2014) The Effect of Ocean Acidification on the Otolith Growth in Larval Stage Estuarine and Marine Fish. Delaware State University Graduate Student Symposium, April 2014.

[HU: 0 posters, 0 student presenters](#)

[OSU: 6 posters, 3 student presenters](#)

- Davis, C.D.\* & Banks, M.A. (2014). Fine-scale population structure among Chinook salmon (*Oncorhynchus tshawytscha*) of the Siletz River in Oregon: A prelude for incorporation of riverscape genetics. Pacific Estuarine Research Society (PERS), Newport, OR, May 3 – 5, 2014
- Giannico, G. R., \*\*Nordholm, K., Miller, J. A. (2014) Contribution of Subyearling Migrant Coho Salmon (*Oncorhynchus kisutch*) Life Histories to Spawning Populations on the Southern Oregon Coast. 2014 American Fisheries Society Meeting, Quebec City, Canada. *Oral Presentation*
- Miller, J. A., \*\*DiMaria, R. A., Hurst, T. P. (2014) Patterns of Larval Source Distribution and Mixing in Early Life Stages of Pacific Cod (*Gadus macrocephalus*) in the Southeastern Bering Sea. 2014 American Fisheries Society Meeting, Quebec City, Canada. *Oral Presentation*
- Miller, J. A., Peterson, W. T., Copeman, L., Morgan, C. A., \*Litz, M. C. N. (2014) Seasonal variability in the composition and biochemistry of the copepod community within the Northern California Current: implications for juvenile salmon growth and survival. 2014 Ocean Sciences Meeting. Honolulu, HI. *Poster Presentation*
- Miller, J. A., Peterson, W. T., Copeman, L., Morgan, C. A., \*Litz, M. C. N. (2014) Seasonal variability in the composition and biochemistry of the copepod community within the Northern California Current: implications for juvenile salmon growth and survival. 2014 Salmon Ocean Ecology Meeting. Santa Cruz, CA. *Poster Presentation*
- Ramirez, M.D.\*, Avens, L., Seminoff, J.A., Goshe, L., and Heppell, S. S. (2014) Sea turtle ontogeny and growth: evidence of continuous ontogenetic shifts using skeletochronology and stable isotope analysis. Joint Meeting of Ichthyologists and Herpetologists, Chattanooga, TN. *Oral Presentation*

[RSMAS: 0 presentations, 0 student presenters](#)

[SSU: 6 posters, 6 student presenters](#)

- Ward\*, T, Hoskins DL, Ogburn M. The evaluation of natural and restored intertidal oyster reefs in coastal Georgia. National Shellfisheries Association meeting, Jacksonville. March 29-31, 2014
- Smith\*, C., Sturdivant\*, L., Onyeokoro\*, L., Hoskins, D.L. (2014) Extraction of extracellular polymeric secretions using the ethanol precipitation method. ASLO Ocean Sciences Meeting Hawaii, March 2-7, 2014
- Arnold\*, A. and C. Pride. Latitudinal Variations of Diatom Communities of the Georgia Inner Shelf (December 2013). Georgia Southern University Research Symposium, Statesboro, GA, April 15, 2014.
- Daniels\*, K. and C. Pride. Sediment Properties along the Georgia Coast (South Atlantic Bight). SSU 4<sup>th</sup> Annual Research Conference, Savannah, GA, April 8, 2014.
- Arnold\*, A. and C. Pride. Latitudinal Variations of Diatom Communities of the Georgia Inner Shelf (December 2013). SSU 4<sup>th</sup> Annual Research Conference, Savannah, GA, April 8, 2014.
- Brinton, B.\* and M.C. Curran, M.C. Does the bopyrid parasite *Probopyrus pandalicola* affect the predation preferences of mummichogs by altering the behavior and/or camouflage of the grass shrimp *Palaemonetes pugio*? NMEA Annapolis (July 2014)

[UMES: 6 posters, 6 student presenters](#)

- Gurung\*, D., Chen, N., Waguespack, Y., (2014). Phosphorus Cycling in Maryland Coastal Bays, Atlantic Estuarine Society, Ocean City, MD, March 28, 2014
- Malagon\*, H. and Chigbu, P. (2014). Influence of Environmental Factors on Distribution and Abundance of Summer Flounder in the Maryland Coastal Bays. Atlantic Estuarine Research Society (AERS) symposium, Ocean City, April 2014.
- Malagon\*, H., Mayor\*, E. and Chigbu, P. (2014). Using GIS to Map the Spatial Distributions and Abundance of Summer Flounder and its Major Prey Organisms in the Maryland Coastal Bays. Sixth International Symposium on GIS/ Spatial Analyses in Fishery and Aquatic Sciences, Tampa, Florida, August 2014.
- Mayor\*, E., Kennedy, V., Pierson, J. and Chigbu, P. (2014). Population Biology of Mysids in the Maryland Coastal Bays. UMES School of Graduate studies - 5th Annual Regional Research Symposium. April 2014, UMES-Princess Anne MD.
- Oseji\*, O., Chen, N., Chigbu, P., and Waguespack, Y. (2014). HPLC Determination of the Phytoplankton Functional Community Structure in the Maryland Coastal Bays. UMES Graduate Symposium, April 17, 2014

Rosales\*, D., Lycett, K. and Pitula, J. (2014). Molecular Approaches to Identifying Harmful Algal Blooms In The Context Of Ecological Investigations of (*Hematodinium* sp.) JASM 2014 Joint Aquatic Science Meeting, Portland Oregon, May18-23, 2014

#### **Other Presentations by Undergraduates, and High School Student Interns:**

##### UMES: 4 posters, 4 student presenters

Goodman\*, W., Valsangikar, T., Gurung, D., and Chen, N. (2014) Kinetic Study of Exoenzymatic Alkaline Phosphatase Activity in the Maryland Coastal Bays UMES REU 2014 Final Symposium Assateague island MD August 2014

Acheampong, A.O\*, Oghenekaro\*, E.U., Oseji, O.F., and Chigbu, P. (2014). Effect of "Brown Tide" (*Aureococcus anophagefferens*) on Survival Rate of Copepods. University of Maryland Eastern Shore School of graduate studies 5<sup>th</sup> annual regional research symposium, Princess Anne, MD. April 17<sup>th</sup>, 2014.

Mazile, J.\*, Oghenekaro\*, E.U., Ishaque, A. and Chigbu, P. (2014). Influence of Environmental Factors on Larval Crab Distribution in the Maryland Coastal Bays. University of Maryland Eastern Shore School of graduate studies 5<sup>th</sup> annual regional research symposium. Princess Anne, MD. April 17<sup>th</sup>, 2014.

Ahemedaltayb, A.\*, Oghenekaro\*, E.U., and Chigbu, P. (2014). Abundance and Biomass *Anchoa mitchilli* in the Maryland coastal Bays. NSF CREST Student Enrichment and Experimental Learning (SEEL) Program. UMES Carver Hall. August 1<sup>st</sup> 2014.

##### UMCES: 0 posters, 0 student presenters

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

##### DSU: 3 publications, 3 student co-authors (NOAA mission relevant publications are in bold)

Kocovsky, P.M., Stoneman, A.T.\*, Kraus, R.T. (2014) Ecology and population status of Trout-perch (*Percopsis omiscomaycus*) in western Lake Erie. *Journal of Great Lakes Research* 40 (1) 208-214

García-Ríos, C.I., Pérez-Pérez, N.M.\*, Fernández-López, J. & Fuentes, F.A.. (2014) Calibrating the chitons (Mollusca Polyplacophora) molecular clock with the mitochondrial DNA cytochrome C oxidase I gene. *Revista de Biología Marina y Oceanografía* 49 (2): 193-207

Janiak, C.R.\*, McIntosh, D. (2014) Performance of two egg collector designs for use with Mummichogs *Fundulus heteroclitus*. *North American Journal of Aquaculture* (accepted)

##### **Non peer-reviewed**

Smith, S.L., Schlacke, R. (2014) Application of Green Technology to Enhance Student Learning: Supercritical Fluid Carbon Dioxide Extraction, EDULEARN14 Proceedings, 2091-2094.

Ozday, G., Sriharan, S., Fan, C., Prakash, A. & San Juan, F. (2014) Application of Geographic Information System (GIS) in Environmental Science and Sustainable Agricultural Education, EDULEARN14 Proceedings

##### HU: 1 publication, 0 student co-authors (NOAA mission relevant publications are in bold)

**A.J. Adams, A.Z. Horodysky, R.S. McBride, K. Guindon, J. Shenker, T.C. MacDonald, H.D. Harwell, R. Ward, & K. Carpenter. (In press) Global conservation status and research needs for tarpons (Megalopidae), ladyfishes (Elopidae), and bonefishes (Albulidae). *Fish and Fisheries*. 15 (2), 280-311.**

##### **Submitted**

M. Kalinoski, A. Hirons, A. Horodysky, R. Brill, Spectral sensitivity, luminous sensitivity, and temporal resolution of the visual systems in three sympatric temperate coastal shark species. Submitted to: *Journal of Comparative Physiology A*.

C.D Braun, M.B Kaplan, A.Z Horodysky and J.K. Llopiz. Satellite telemetry elucidates physical processes driving billfish behavior in the Atlantic Ocean. *Animal Biotelemetry*.

J.E. Graves and A.Z. Horodysky. The challenges of estimating post-release mortality of istiophorid billfishes caught in the recreational fishery. *Fisheries Research*.

[OSU: 13 publications, 0 student co-authors \(NOAA mission relevant publications are in bold\)](#)

- Arnold, LM\*\*, and SS Heppell. (2014). Testing the robustness of data-poor assessment methods to uncertainty in catch and biology: a retrospective approach. *ICES Journal of Marine Science*. doi:10.1093/icesjms/fsu077
- Cianelli, L, M Hunsicker, A Beaudreau, K Bailey, L Crowder, C Finley, C Webb, J Reynolds, K Sagmiller, JM Anderies, D Hawthorne, J Parrish, S Heppell, F Conway, and P Chigbu. (2014). Transdisciplinary graduate education in marine resource science and management. *ICES Journal of Marine Science*. doi: 10.1093/icesjms/fsu067
- Claiborne, A. M.\*\*, Miller, J. A, Weitkamp, L. A., Teel, D. J., Emmett, R. L. (2014). Evidence for selective mortality in marine environments: the role of fish migration size, timing, and production type. *Marine Ecology Progress Series (In Press)*
- Grüss, A, J Robinson, SS Heppell, SA Heppell, and BX Semmens. (2014). Conservation and fisheries effects of spawning aggregation marine protected areas: What we know, where we should go, and what we need to get there. *ICES Journal of Marine Science*. doi:10.1093/icesjms/fsu038
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[RSMAS: 0 publications, 0 student co-authors](#)

[SSU: 4 publications, 3 student co-authors](#)

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**UMES: 2 publications, 1 student co-authors (NOAA mission relevant publications are in bold)**

Rodgers, C.\*, Parveen, S., Chigbu, P., Jacobs, J., Harter-Dennis, J. & Rhodes, M. (2014). Prevalence of *Vibrio parahaemolyticus*, and *V. vulnificus* in Blue crabs (*Callinectes sapidus*), seawater, and sediments of the Maryland Coastal Bays. Journal of Applied Microbiology (In Press).

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**UMCES-IMET: 3 publications, 3 student co-authors (NOAA mission relevant publications are in bold)**

Davis, J.\* and R. T. Hill (2014). Draft genome sequence of Hawaiian sea slug symbiont *Vibrio* sp. strain ER1A. Genome Announc. 2:e00820-14. doi: 10.1128/genomeA.00820-14.

Montalvo NF\*, \*Davis J, \*Vicente, J. R Pittiglio, Ravel, J. & Hill, RT. (2014). Integration of culture-based and molecular analysis of a complex sponge-associated bacterial community. PLoS ONE 9(3): e90517. doi:10.1371/journal.pone.0090517)

Thongda, W, Chung, JS, Tsutsui, N, Zmora, N, \*Katenta, A. (2014). Seasonal variation in the reproductive activity of the blue crab, *Callinectes sapidus*: vitellogenin expression and levels of vitellogenin in the hemolymph during ovarian development. CBP 23535 -Molecular and Integrative Physiology A Sep 10. pii: S1095-6433(14)00181-0. doi: 10.1016/j.cbpa.2014.08.019. [Epub ahead of print]

## Appendix V: Acronyms

### Table of Acronyms

AFSC	Alaska Fisheries Science Center
DSU	Delaware State University
Hampton U.	Hampton University
NEFSC	Northeast Fisheries Science Center
NWFSC	Northwest Fisheries Science Center
MS	Master of Science Student
OSU	Oregon State University
PhD	PhD Student
PIFSC	Pacific Islands Fisheries Science Center
SEFSC	Southeast Fisheries Science Center
SSU	Savannah State University
UMES	University of Maryland Eastern Shore
UMCES	University of Maryland Center for Environmental Science
UMCES-IMET	UMCES Institute for Marine and Environmental Technology
UM-RSMAS	University of Miami, Rosenstiel School of Marine and Atmospheric Science
SWFSC	Southwest Fisheries Science Center
UG	Undergraduate Student

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