Performance Report for Cooperative Agreement No: NA11SEC4810002
for the Period from July 1, 2012 to Feb. 28, 2013

University of Maryland Eastern Shore

Living Marine Resources Cooperative Science Center

Paulinus Chigbu, Ph.D. (Principal Investigator & Director, LMRCSC)
Bradley Stevens (Co-Principal Investigator & Distinguished Research Scientist)
University of Maryland Eastern Shore (Lead Institution)

Stacy Smith, Ph.D. (Co-Principal Investigator)
Delaware State University

Deidre Gibson, Ph.D. (Co-Principal Investigator)
Hampton University

Dionne Hoskins, Ph.D. (Co-Principal Investigator)
Savannah State University

Jessica Miller, Ph.D. (Co-Principal Investigator)
Oregon State University

Rosemary Jagus, Ph.D. (Co-Principal Investigator)
University of Maryland Center for Environmental Science, IMET

David Die, Ph.D. (Co-Principal Investigator)
RSMAS/University of Miami

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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 15 new students, and provided direct financial support to 64 students (17 Ph.D., 17 M.S., 30 B.S.) who received training in NOAA core science disciplines during this reporting period. Besides, 40 students who did not receive direct support from the Center benefited from center programs and infrastructure. Fifteen (15) students graduated (7 BS, 6 MS, 2 Ph.D.) from the Center during this reporting period, whereas fifteen (15) students interned at NOAA labs or labs of LMRCSC partner institutions. Furthermore, the Center linked students to professional networks and employment opportunities in marine and fisheries science by providing support for them to attend scientific meetings such as the 2013 ASLO Aquatic Sciences meeting in New Orleans, LA where twenty-four (24) presentations were made by center students, and fall 2012 American Fisheries Society (AFS) meeting where 3 students presented their research results.

In order to maintain a pipeline of students into the marine sciences, the Center conducted summer 2012 activities for grades K-12 which impacted between 200 and 300 students, including the Coast Camp for Youth at Savannah State University (#=100), CREST-CISCEP SEEL program at UMES (#=7), and the SciTech program at IMET in which >100 Baltimore area high school students participate annually, the Upward Bound Marine and Estuarine Science Program at UMES that reaches 25 high school students, and activities in marine science conducted at local schools by LMRCSC faculty and graduate students.

To accomplish Goal 2, the Center used the Virtual Campus for curriculum development and seminars and expanded it to include courses which were offered online between Center partners and to students including a NOAA NEFSC contractor and a NOAA employee located in Woods Hole, MA enrolled in the Professional Science Master's (PSM) degree program at UMES. Seminars and several courses offered through the University of Maryland interactive video network (IVN) were made available to Center students during this reporting period. Twenty-nine (29) NOAA scientific and administrative personnel were engaged in LMRCSC education and outreach, scientific research and administrative functions. Courses that are part of the "essential curriculum" recommended by NOAA Fisheries for training fisheries scientists were offered in fall 2012 (Fish Ecology, Fishery Survey Sampling) and winter 2013 (Ecosystem Modeling for Fisheries: Ecopath with Ecosim) or are currently being offered to students at the Center this spring 2013 (Marine Population Dynamics, Introduction to Fish Population Dynamics and Stock Assessment, Multivariate Statistics). The Articulation Agreement document signed by six LMRCSC partners has led to cross registration between partners for these courses.

Six students interned at NOAA Science labs during the reporting period. No NOAA LMRCSC Winter Cruise was held in January 2013 because of the decommissioning of the research vessel Delaware II.

The LMRCSC continued its Seminar Series by featuring presentations by two NOAA scientists and a seminar by Brad Stevens. These seminars were made available to students and scientists at the Center using the Virtual Campus technology.

In support of Goal 3, twelve (12) collaborative projects funded by the LMRCSC for 2011-2012 were completed in December 2012; 12 new projects were funded for 2012-2013, following the review of submitted proposals by the TAB, and are currently underway. These collaborative projects address various aspects of NOAA's Next Generation Strategic Plan Goal (NGSG): "*Healthy Oceans - Marine fisheries, habitats, and biodiversity sustained within healthy and productive ecosystems*", and objectives: (1) Improved understanding of ecosystems to inform resource management decisions, (2) Recovered and sustained marine and coastal species, (3) Healthy habitats that sustain resilient and thriving marine resources and communities, and (4) Sustainable fisheries and safe seafood for healthy populations and vibrant communities. They also address some of the goals, objectives and priorities listed in NMFS 2007 Strategic Plan for Fisheries, such as Seafood safety (e.g. Organic contaminants in monkfish, *Lophius americanus*), research on Abundance and Life History of fish stocks (e.g. Development of *in-situ* assessment and observation methods for black sea bass, *Centropristis striata*), sustainable and environmentally sound aquaculture through the development of alternative feeds such as plant-based proteins (e.g. Taurine – the missing ingredient for development of fish free diets for aquaculture), and impacts of anthropogenic factors and environmental change on species (e.g. Temperature preference of Atlantic Croaker under normoxic and hypoxic conditions). The on-going and future research projects at the Center are intended to meet the mission of NOAA Fisheries: "*Stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems*". The TAB and NOAA scientists' involvement also ensures that the LMRCSC has a strong linkage with the mission of NOAA: "*To understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social and environmental needs*".

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

In the current reporting period, LMRCSC students and faculty made 59 presentations (oral and poster) at scientific meetings (31 of which were made by students), and published 10 articles in refereed journals, 4 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 ~$1.2 million was collectively awarded in grants to the LMRCSC institutions during this reporting period, which has directly impacted and will continue to have positive impacts on Center activities. These funds enhanced LMRCSC research through support of its faculty and students and by development/enhancement of infrastructure.

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

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

- Number of students from underrepresented communities who were trained **(# = 58; 16 Ph.D., 13 M.S., 28 B.S.)** and graduated **(# = 11; 2 Ph.D., 2 M.S., 7 B.S.)** in NOAA-mission sciences in the past six months
- Number of students who were trained **(# =64; 18 Ph.D., 16 M.S., 30 B.S)** and graduated **(# =15; 2 Ph.D., 6 M.S/PSM, 7 B.S.)** in NOAA-mission sciences in the past six months;
- Number of students who completed experiential opportunities at NOAA facilities **(# = 6);**
- Number of EPP funded students who were hired by NOAA **(# = 0)**, NOAA contractors **(# = 0)** and other environmental, natural resource, and science agencies at the Federal, State **(# = 1),** local and tribal levels, in academia and the private sector;
- Number of NOAA science and administrative personnel engaged in CSC Education and Outreach, Scientific Research, and Administrative functions **(# = 29)**
- Number of collaborative research projects undertaken between NOAA and MSI partners in support of NOAA operations **(# = 12);**
- Number of students **(# = 0)** 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, postdoctoral fellows, and students) sponsored by NOAA EPP **(# = 10);**
- Funds leveraged with NOAA EPP funds (including student support) **(# = ~$1.2 million);** and,
- Number of outreach participants engaged in NOAA mission relevant learning opportunities **(between 200 and 300).**

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

	Proposed in the Implementation Plan	Accomplished (Jul. 1, 2012 – Feb. 28, 2013) 6 months
Activities/Programs	**2012 - 2013**	**2012 - 2013**
# K-12 Students participating in NOAA related science activities	1000	Between 300 and 300
# of students trained in NOAA related Sciences	84	64
# B.S. Students who graduate in NOAA core Sciences	24	7
# M.S. Students who graduate in NOAA core Sciences	9	6
# Ph.D. Students graduating in NOAA core Sciences	4	2
# of internships at NOAA/other labs.	33	15
# of Courses to be offered via Virtual Campus or online	5	6
Amount of leveraged funds ($) for education and outreach	500K	600K
# of student presentations at conferences	80	31
# of NOAA/LMRCSC Fisheries Cruises	1	0
# of student co-authored publications	15	4
# of individuals impacted by outreach activities	>1000	Between 200 and 300

Summary of LMRCSC Performance Measures of Success (Research Programs)

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

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

INTRODUCTION

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

The following are the goals and objectives of the LMRCSC:

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

Objective 1.1: Recruit students from under-represented groups into marine and fisheries science disciplines
Objective 1.2: Increase retention and degree completion rates for students in marine and fisheries sciences programs
Objective 1.3: Assess the value-added outcomes of degree programs in marine and fisheries sciences at the partner institutions
Objective 1.4: Link students to professional networks and employment opportunities in marine and fisheries sciences

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

Objective 2.1: Use state-of-the-art, research-based curricula to provide students with the highest quality education in marine and fisheries sciences
Objective 2.2: Use Virtual Campus technology to provide students with the opportunity to learn from some of the nation's leading scholars in marine and fisheries sciences
Objective 2.3: Ensure that curricula of degree programs at partner institutions address current challenges and emergent needs within the profession

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

Objective 3.1: Integrate the Center's research agenda with NOAA Fisheries research priorities in four key thematic areas: quantitative fisheries, essential fish habitat, fisheries socioeconomics, and aquaculture.
Objective 3.2: Foster collaborative research programs to strengthen the research capacities of partner institutions by leveraging the significant strengths and resources of research universities as infrastructure for capacity building
Objective 3.3: Develop faculty recruitment and retention practices that ensure that the collective capacity of scholars affiliated with the Center represents significant concentrations of strength in the four key research thematic areas

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

Summary

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

This is provided below from pages 10 to 32.

2. Status of Benchmarks due during the performance period: The Center met or exceeded some of the benchmarks (e.g. number of students trained in NOAA related sciences, number of M.S. students graduated and number of thesis and dissertations produced) for the present 6 month semi-annual report, but apparently fell short of others (e.g. number of B.S students graduated in NOAA related sciences, and number of student co-authored publications). However, a relatively larger number of LMRCSC students graduate in spring which falls in the next reporting period, than in the fall. The performance measures are summarized on page 6 above.

3. **Status of Special Award Conditions (if applicable) Due During the Performance Period:** The following special award conditions were met during the last reporting period and the documents were submitted to NOAA EPP as required.

(a) LMRCSC Strategic Plan (b) Implementation Plan (c) Science Plan (d) Student Development Plan (e) Post-doctoral Program Plan (f) CSC-CSC Joint Project, and (g) Quarterly Budget Spending Plan. Dr. Margaret Sexton, a Biological Oceanographer, was hired by the LMRCSC in Feb. 2013 to assist the Center Director in performing administrative duties of the LMRCSC.

4. **Identification of the NOAA-mission Research and Report on the Impact of the Research on NOAA's Mission. In addition, provide the planned and actual duration and status of the research activity that is in support of NOAA's mission.** This is provided below under TAB funded projects, pages 21 to 28.
5. **Identification of All Collaborative Research Activities Undertaken During the Award Period:** This is provided below under TAB funded projects, pages 21 to 28.
6. **Report on the Administrative and Research Meetings Conducted in Support of Activities Under this Award**

(a) Meetings conducted during this reporting period include, monthly meetings of the Executive Committee, Science Committee Meetings, and conference calls by CSC Directors. Discussions during the EC meetings included: strategies for increasing the number of papers published by LMRCSC students, NOAA EPP requirements that all TAB funded projects must include undergraduate and graduate students as participants in research, identification of center students for internship opportunities at NOAA labs, and potential impacts of budget reductions on the LMRCSC

7. **Status of Recruitment (including students, staff and post-doctorates):** Fifteen (15) students were recruited during this reporting period (please see Table 1). The Center is currently in the process of filling the position of Postdoctoral Research Associate.
8. **Status of Faculty/NOAA Staff Exchanges:** Dr. Andrea Johnson (UMES) made several short visits to NOAA NMFS Woods Hole Lab to conduct research.
9. **Status of Budget to Date (Expended and Remaining Funds):** Of the $2,550,000 awarded to the LMRCSC in 2012-2013, $493,416.46 has been spent whereas $2,056,584 is remaining. The largest amount of the center funds is spent during the summer research and internship period.
10. **Progress on LMRCSC Student Development Plan (SDP) Implementation:** The LMRCSC SDP focuses on three broad, but interrelated, areas that are known to influence educational success, namely academic/educational development, professional/career development, and social/personal development, facilitated using the Individual Student Development Plan (ISDP).

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

a) **Offer rigorous courses in marine and fisheries science that include those considered essential for training fisheries scientists using the Centers virtual campus facility:** Among the courses that have been developed and offered online by the LMRCSC are Survey Sampling; Marine Population Dynamics; Introduction to Fish Population Dynamics and Stock Assessment; Ethics in Business, Fisheries Management and Resource Economics; Multivariate Statistics; Risk and Decision Analysis; and Bayesian Statistics. In addition, the LMRCSC has established a new degree program-Professional Science Master's in quantitative fisheries and resource economics.

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 form of internships. Sixteen (16) LMRCSC students interned at NOAA labs or in the labs of partner institutions during this reporting period.

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 monthly seminars have been by scientists from the center and other institutions. Graduate students, particularly those supported by CREST-CISCEP center leveraged with LMRCSC funds have also give presentations of their research work to faculty and students.

Enhance Professional/Career Development of students.

a) Train students to develop skills to teach, to co-mentor, to give and to receive feedback: In fall 2011 the LMRCSC paid an external consultant with expertise in Education who conducted a two day LMRCSC Teaching Assistant (TA) workshop attended by about 30 students that included center-supported and non-center supported students. During this reporting period, the LMRCSC organized a Scientific Communications workshop in December

2012 presented by Dr. Bill Dennison (University of Maryland Center for Environmental Science, Horn Point Lab). Nineteen (19) students attended the workshop.

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. LMRCSC graduate students at UMES including Kristin Lycett (M.S. student), Heather Wolfer (M.S. student) participated in mentoring activities of middle- and high school students that involved hands-on activities to demonstrate to the students research activities in marine and environmental sciences.

c) Enhance student's skills in writing grant proposals and completing application forms for scholarships and fellowships: Graduate students at LMRCSC are required to take a Scientific Communications course or its equivalent that includes developing and writing a grant proposal. With the assistance of LMRCSC faculty and staff, LMRCSC students were encouraged to apply to various scholarships and fellowships during this reporting period including NOAA Sea Grant fellowship (e.g. Ammar Hanif, Ph.D., IMET), Hall Bonner Scholarship (e.g. Tiara Moore, M.S., HU), McKnight Fellowship (e.g. Xaymara Serrano, Ph.D. and Rolando Santos, Ph.D. RSMAS) and NOAA undergraduate scholarships (two students at HU).

d) Enable students to identify career opportunities and to develop interviewing and networking skills: No center-wide **Professional Development Workshop** or LMRCSC Weekend was organized during this reporting period. However, through the recently developed "Network of NOAA Cooperative Science Centers for training high school students in geosciences", the LMRCSC collaborated with NCAS, ECSC and CREST and distributed materials to high school science teachers as well as give presentations to high school juniors and seniors on geoscience career and educational opportunities at the centers. As a result, we have received several applications from high school students who plan to participate in the 6 week summer geosciences program in summer 2013.

e) Create opportunities for students to develop collaborative leadership skills and to have leadership experiences: LMRCSC students are included as co-moderators of sessions and as judges of posters and oral presentations during the annual university wide symposia at UMES, planned collaboratively with the LMRCSC faculty. LMRCSC faculty and students are also involved in the planning of the next UMES symposium that will be held on April 16, 2013.

f) Create opportunities for students to enhance their written and oral communication skills especially as it relates to translating discipline-based concepts, methods and practices in ways that experts from other fields will find understandable: Several activities and programs have been held at the LMRCSC institutions to enhance students' oral and written communication skills, including LMRCSC sponsored seminars, symposia, conferences, and the scientific communications workshop held in December 2012. Written communication is enhanced through preparation of scientific reports as part of research experiences of undergraduates, and writing of proposals. LMRCSC graduate students are also required to prepare and submit a manuscript to a journal before completing their degree programs.

g) Create opportunities for students to learn budget management: Budget developments and critiques are components of the Scientific Communications course that graduate students are required to take before completing their degrees. This course was taught at UMES in fall 2012 as part of the PSM program, and was made available online via Blackboard and Adobe Connect to students at other LMRCSC partner institutions.

h) 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.

i) Encourage students to participate in summer internships at NOAA labs and labs at LMRCSC partner institutions: Sixteen (16) LMRCSC undergraduate and graduate students participated in summer internships or research activities at NOAA labs, non-LMRCSC institutions, and/or at LMRCSC institutions, including UMCES-IMET, OSU, UM-RSMAS and UMES during this reporting period

j) Encourage students to make oral and/or poster presentations at professional meetings: Thirty-one (31) presentations were made by LMRCSC students at professional meetings during this reporting period.

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

a) **Provide opportunities for students to develop skills related to conflict and stress management**: **Professional Development Workshop** with modules on conflict management and **strategies to reduce stress** was not offered during this reporting period.

b) **Guide students to develop professional profile on an established professional social networking site to document NOAA mission-relevant STEM career progress:** No action was taken on this during the reporting period.

c) **Create opportunities for students to net-work:** Social interactions and development of LMRCSC students occurred during this reporting period through various means, including the LMRCSC Facebook page, meetings at professional conferences (e.g. ASLO 2013, AFS 2012), and the Graduate Student Association at UMES.

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

For the period of **July 1, 2012 to Feb. 28, 2013**, the following tasks were accomplished in support of the goals and objectives of the LMRCSC:

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 LMRCSC partner institutions offer a full range of degrees (bachelors, masters, and Ph.D.) in marine and fisheries sciences.

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

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

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

- During this reporting period, Andrea Johnson, and P. Chigbu attended the ASLO Aquatic Sciences Meeting in New Orleans, LA (Feb 17-22, 2013) with several LMRCSC students. As a result of interactions with students, new students (e.g. Wilmelie Cruz-Marrero, Juan Pablo Alvarez) have applied to UMES graduate program and will enroll in fall 2013.
- The addition of Oregon State University to the Center has continued to yield significant dividends for the Center's training efforts in Stock Assessment and Resource Economics:
    - Matt Ramirez, a MS student, began his studies at OSU in Fall 2012. Dr. Selina Heppell is Matt's mentor and they received TAB funds for his thesis research, "*Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles*." They are collaborating with Dr. Tara Cox at SSU, Larisa Avens (NOAA's SEFSC), and Dr. Jeffery Seminoff (NOAA's SWFEC).
    - Two summer interns, Ashley Silver from HU and Xana Hermillos from Evergreen State College in Olympia, Washington, participated in research activities at OSU's HMSC during summer 2012. Ashley worked on Dr. Miller's TAB-funded project to understand how climate variation influences growth and survival of early life stages of northern rock sole (*Lepidopsetta polyxystra*) in the Gulf of Alaska. This research is a collaborative effort with Dr. Thomas Hurst at NOAA's AFSC. Ashley also gave a presentation, "*Growth trends of northern rock sole along Kodiak Island, Alaska*," at ASLO's 2013 Aquatic Science Meeting in New Orleans, LA in February. Xana helped OSU launch a new project focused on understanding how biochemical changes in plankton communities cascade through the food web and influence the growth of young anchovy as well as assisting with the rock sole research. Xana's summer research experience was instrumental in her acceptance to a graduate program at University of Texas. She will begin a MS program at University of Texas Marine Science Institute in Fall 2013!

IMET Internships: The UMCES IMET hosted 7 undergraduate interns in summer 2012 who were supported with LMRCSC funds. Some of the students were recruited from non-LMRCSC institutions to create an opportunity for them to gain

information on the research and educational activities at the Center institutions so that they might consider applying to the institutions for graduate degrees. These students conducted guided research on LMRCSC projects alongside Center researchers in IMET's aquaculture and biotechnology facilities.

Fifteen (15) students were recruited to the LMRCSC during this reporting period (Table 1).

Table 1. Students recruited into LMRCSC from July 1, 2012 to Feb. 28, 2013

First Name	Last Name	Academic Institution	Degree Program	Expected Graduation Date
Derrick	Alcott	UMES	PSM, Quantitative Fisheries	Spring 2014
Susan	Kelly	UMES	PSM, Quantitative Fisheries	Spring 2014
Jaime	Belanger	UMES	PSM, Quantitative Fisheries	Spring 2014
Limary	Rivera-Santana	UMES	PSM, Quantitative Fisheries	Spring 2014
Tiara	Moore	HU	M.S. Biology/Environmental	Spring 2014
Dwayne	Dorsey	HU	M.S., Mathematics	Spring 2014
Stephen	Sawyer	HU	M.S., Biology	Spring 2014
Shani	Johnson	HU	Post baccalaureate, Biology	Fall 2014
Keya	Jackson	SSU	M.S., Marine Science	Fall 2014
Brian	Baker	UMES	B.S., Environ. Science	Fall 2016
Joshua	Miller	HU	B.S. Marine Science	Spring 2016
Joalene	Mason	HU	B.S. Engineering	Spring 2016
Ashlee	Ward	HU	B.S. Engineering	Spring 2016
Benjamin	Alston	HU	B.S. Engineering	Spring 2016
Andrew	Kluge	DSU	B.S., Biology	Spring 2015

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

Activities and Accomplishments: Students who received financial support from July 1, 2012 to February 28, 2013 are listed in Table 2, whereas those that graduated are presented in Table 3. Among the students who graduated are 2 Ph.D, six M.S., and 7, B.S.

Table 2. Students who received direct support during the funding period (July 1, 2012 to Feb. 28, 2013).

First Name	Last Name	Academic Institution	Degree	Type	Amount
Jan	Vicente Raczkowski	UMCP	Ph.D.	Stipend/Tuition/Travel	$11,627.83
Aaron	Watson	UMCP	Ph.D.	Stipend/Tuition/Travel	$19,495.40
Jeanette	Davis	UMCP	Ph.D.	Stipend/Tuition/Travel	$23,883.56
Kathleen	Gillespie	UMCP	Ph.D.	Stipend/Tuition/Travel	$24,233.65
Ammar	Hanif	UMCP	M.S./Ph.D.	Stipend/Tuition/Travel	$19,844.21
Erica	Dasi*	UMBC	B.S.	Stipend/Tuition/Travel	$20,515.04
Miera	Armstead*	UMCP	B.S.	Stipend, Travel	$5,161.46
Travonya	Kenly*	Cheyney Univ.	B.S.	Stipend, Travel	$5,601.26
Erica	Igwacho*	UMBC	B.S.	Stipend, Travel	$10,114.31
Ihuoma	Njoku*	UMBC	B.S.	Stipend, Travel	$6,099.23
Kahil	Simmonds*	Stevenson U.	B.S.	Travel	$32.00
Tedra	Booker	UMES	Ph.D.	Travel/Tuition	$2,493.83
Micheline	Brice	UMES	Ph.D.	Stipend	$820.31

Daniel	Cullen	UMES	Ph.D.	Stipend/Tuition/Travel	$19,280.30
Rehab	El Fadul	UMES	Ph.D.	Travel	$521.26
Eric	Evans	UMES	Ph.D.	Travel	$399.26
Jhamyllia	Rice	UMES	Ph.D.	Stipend/Tuition	$15,601.14
Marisa	Litz	OSU	Ph.D	Stipend/tuition	$25,750
Smit	Vazques Caballero	OSU	Ph.D.	Stipend/Tuition/Travel	$25,750
Chante	Davis	OSU	Ph.D.	Stipend/tuition	$19,150
Dominique	Lazarre	UM-RSMAS	Ph.D.	Stipend/Travel	$19,643.00
Rolando	Santos	UM-RSMAS	Ph.D.	Stipend/Travel	$17,225.34
Xayamara	Seranno	UM-RSMAS	Ph.D.	Stipend	$2,333.00
Dwight	Ebanks	UM-RSMAS	Ph.D.	Stipend/Tuition/Travel	$29,124.00
Hector	Malagon	UMES	M.S.	Stipend	$8,975.46
Courtney	McGeachy	UMES	M.S.	Tuition	$559.00
Belita	Nguluwe	UMES	M.S.	Stipend	$2,554.39
Candace	Rodgers	UMES	M.S.	Stipend/Tuition	$13,324.08
Emily	Tewes	UMES	M.S.	Stipend/Tuition/Travel	$16,746.24
Noelle	Hawthorne	SSU	M.S.	Stipend	$9,999.96
Tiffany	Ward	SSU	M.S.	Stipend/Travel	$2,499.99
Crystal	Jackson	SSU	M.S.	Stipend/Travel	$1,793.42
Denson	Latreese	OSU	M.S.	Stipend/Tuition/Travel	$6,600
Matthew	Ramirez	OSU	MS	Stipend/tuition/travel	$9,125.00
Ashley	Silver	HU	M.S.	housing/travel	$375
Dwayne	Dorsey	HU	M.S.	Stipend	$2,400.00
Tiara	Moore	HU	M.S.	Stipend/Tuition	$18,000.00
Hillary	Dean	DSU	M.S.	Stipend/Travel	$22,894.47
Cory	Janiak	DSU	M.S.	Stipend/Tuition/Travel	$15,252.02
Andrea	Stoneman	DSU	M.S.	Stipend/Tuition/Travel	$16,861.09
Shaneese	Mackey	SSU	B.S.	Stipend	$691.20
Britni	Seider	SSU	B.S.	Stipend	691.20
Brittany	Carmon	HU	B.S.	Stipend	$6,500
Jonathan	Garing	HU	B.S.	Stipend	$4,563
Camile	Gaynus	HU	B.S.	Stipend	$6,500
Shadaesha	Green	HU	B.S.	Stipend/Travel	$6,500
Symone	Gyles	HU	B.S.	Stipend	$4,563
Joshua	Miller	HU	B.S.	Stipend	$1,000.00
Shani	Johnson	HU	Post bacc.	Wages	$3,000.00
Joalene	Mason	HU	B.S.	Wages	$180.00
Ashlee	Ward	HU	B.S.	Wages	$180.00
Benjamin	Alston	HU	B.S.	Wages	$180.00
Xana	Hermosillo*	Evergreen State/OSU	B.S.	Stipend/Housing/Travel	$7,325
Aicha	Toure	DSU	B.S.	Stipend	$4,412.30
Kevin	Coles	DSU	B.S.	Stipend	$5,004.48
Brian	Baker	UMES	B.S.	Stipend	$5,688.25
Nivette	Perez-Perez	UMES	B.S.	Travel	$5,307.90
Kennard	Roy	UMES	B.S.	Stipend	$4,000.00

Christopher	Stewart	UMES	B.S.	Travel/Stipend	$5,428.26
Nikkia	King	UMES	B.S.	Stipend	$5,050.00
Abosede	Adeyiga*	Cheyney University	B.S.	Salary, Fringe, Travel	$5,710.76
SaQuaia	Weaver*	Morgan State	B.S.	Salary, Fringe, Travel	$5,816.52
Matthew	Dill	HU	B.S.	Stipend/Travel	$2,154.38
James	McCullars	SSU	B.S.	Stipend/Travel	$2,650.30
TOTAL					**$565,756.06**

The students marked asterisks in Table 2 above are undergraduate students from non-LMRCSC institutions who spent summer 2012 interning and gaining research experience at IMET or UMES. These students are potential recruits to LMRCSC for graduate education.

Table 3. Students who graduated from July 1, 2012 to Feb. 28, 2013.

First Name	Last Name	Academic Institution	Degree	Date	Post-Graduation Information
Lonnie	Gonsalves	UMES	Ph.D.	Dec., 2012	Working as a Research Fisheries Biologist, NOAA COL, MD
William	Gardner	UMES	Ph.D.	Dec. 2012	Looking for a position
Whitney	Dyson	UMES	M.S.	Dec., 2012	Looking for a position
Courtney	McGeachy	UMES	M.S.	Dec., 2012	Grants Manager, National Fish & Wildlife Foundation, Washington D.C.
Baejin	Paemoller	UMES	M.S.	Dec., 2012	Looking for a position
Jessica	Blaylock	UMES	PSM	Dec. 2012	NOAA Woods Hole, MA
Matthew	Breece	DSU	M.S.	Aug., 2012	
Amy	Cannon	DSU	B.S.	Dec., 2012	Applying for graduate programs
Robert	Kiser	SSU	BS (Marine Science)	Dec 2012	Applying for graduate programs
Javar	Henry	SSU	BS (Marine Science)	Dec 2012	Applying for graduate programs
Ana	Reyes	SSU	BS (Marine Science)	Dec 2012	Working in Hawaii
Sharamie	Ware	SSU	BS (Marine Science)	Dec 2012	Looking for a position
Michael	Knowles	SSU	BS (Marine Science)	Dec 2012	Looking for a position
Paul	Awkwright	SSU	BS (Marine Science)	Dec 2012	Applying to SSU M.S. program
Dontrece	Smith	SSU	MS (Marine Science)	Dec 2012	Working as a NOAA fisheries observer, Northeast


December 2012 LMRCSC graduates at UMES: Pictured (left): Lonnie Gonsalves (left), William Gardner (right) completed their Ph.D. degree in MEES; Pictured (right): Whitney Dyson completed a M,S, degree in MEES

Retention and degree completion rates are higher in academic programs that engage students in collaborative research with faculty members. Projects funded by LMRCSC involve both undergraduate and graduate students as active research participants. Students work as research collaborators with faculty and scientists at NOAA facilities. During the academic year, students participate in research projects at their home institutions. During the summer, students are involved in

research at their home institutions, at other LMRCSC campuses, or at NOAA laboratories. Table 4 shows students who worked at NOAA labs or LMRCSC partner institution labs.

Table 4. Students who worked at NOAA labs or LMRCSC partner institution labs (Jul. 1, 2012 to Feb. 28, 2013)

First Name	Last Name	Institution	Degree	Facility	Time Period	Activity or Title of Research Project
Kate	Fleming	DSU	M.S.	NMFS lab-Panama City, FL	July-August 2012	
Briana	Jones	UMES	B.S.	NOAA	June to August, 2012	Student worked as part of NOAA EPP Undergraduate Scholarship
Miera	Armstead	UMCP	B.S.	UMCES-IMET	June to August, 2012	Metabolic potential of the cultured bacteria from the Hawaiian mollusk *Elysia Rufescens*
Travonya	Kenly	Cheyney Univ.	B.S.	UMCES-IMET	June to August, 2012	Exploring taurine biosynthesis pathways in cobia and zebrafish
Erica	Igwacho	Morgan St.	B.S.	UMCES-IMET	June to August, 2012	Detection of a fatal reo-like virus among the *Callinectes sapidus* population in the northeast region of the US
Abosede	Adeyiga	Cheyney Univ.	B.S.	UMCES-IMET	June to August, 2012	Carbohydrate metabolism in the blue crab *Callinectes sapidus*
SaQuaia	Weaver	Morgan St.	B.S.	UMCES-IMET	June to August, 2012	Construction of an oyster larvae probiotic bacterium that expresses green fluorescent protein to study host-bacterial interactions
Ihuoma	Njoku	UMBC	B.S.	UMCES-IMET	June to August, 2012	Genetic diversity of *Hematodinium* and other dinoflagellate species in Maryland coastal waters
Coleman	Ewell	HU	B.S.	Scripps Inst of Oceanography	June to August, 2012	Student worked on mechanism of coloration in Nudibranchs
Noelle	Hawthorne	SSU	M.S.	Gray's Reef NMFS	June to August, 2012	Noelle's project was on Separating Behavior from Environmental Interference: Controls in a Marine Acoustic Telemetry Study.
Erica	Parks	SSU	B.S.	Smithsonian Env. Res. Center	June to August, 2012	
Robert	Kiser	SSU	B.S.	Woods Hole Ocean. Inst	June to August, 2012	
Roy	Kennard	UMES	B.S.	NOAA COL	June to August, 2012	Student conducted research as part of the NOAA Cooperative Oxford Lab Integrated Ecosystem Assessment
Courtnee	DePass	UMES	B.S.	NOAA Woods Hole Lab	June to August, 2012	Courtnee worked on "Contrasting Biogenic Silica Concentrations in the North and South Atlantic
Kihoto	Kitonga	UMES	B.S.	NOAA Woods Hole Lab	June to August, 2012	Kihoto researched Factors Affecting Light Attenuation in Seagrass Beds.

Forty-nine (49) students who did not receive direct support from the LMRCSC, benefited from the programs offered by the Center and/or infrastructure established by the LMRCSC 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 LMRCSC

First Name	Last Name	Classification/Institution
Ejiroghene*	Mayor	Ph.D. student, UMES
Efeturi*	Oghenekaro	Ph.D. student, UMES
Ozuem*	Oseji	Ph.D. student, UMES
Baruch*	Volkis	Ph.D. student, UMES
David*	Gurung	Ph.D. student, UMES
Limary**	Rivera-Santana	PSM student, UMES
Michelle**	Traver	PSM student, UMES
Susan**	Kelly	PSM student, UMES
Derrick**	Alcott	PSM student, UMES
Jaime**	Belanger	PSM student, UMES
Jessica**	Blaylock	PSM student, UMES
Evan**	Lindsay	PSM student, UMES
Salah	Elbashir	M.S. student, UMES
Rizwana	Tasmin	M.S. student, UMES
Sara	Elmahdi	M.S. student, UMES
Jabari	Hawkins	M.S. student, UMES
Kristin	Noell	M.S. student, UMES
Erika	Weaver	M.S. student, UMES
Olivia	Martin	M.S. student, UMES
Marvin	Webb	M.S. student, UMES
Kristen*	Lycett	M.S. student, UMES
Heather*	Wolfer	M.S. student, UMES
Dana*	McNair	M.S. student, UMES
Kris	Roeske	M.S. Graduate Student/DSU
Ken	Hannum	M.S. Graduate Student/DSU
Brian	Reckenbeil	M.S. Graduate Student/DSU
Amy	Cannon	B.S. Undergraduate Student/DSU
Addis*	Bedane	B.S. student, UMES
William*	Boley	B.S. student, UMES
Courtney*	DePass	B.S. student, UMES
Kihoto*	Gitonga	B.S. student, UMES
Tiana*	Jones	B.S. student, UMES
Samir*	Karim	B.S. student, UMES
Antoine*	McKnight	B.S. student, UMES
Kingsley*	Nkeng	B.S. student, UMES
Alexander*	Nyarko	B.S. student, UMES

Acheampo*	Okyere	B.S. student, UMES
Sylvia*	Ossai	B.S. student, UMES
So-Jin*	Park	B.S. student, UMES
Abey*	Zeleke	B.S. student, UMES
Robert	Dumas	B.S. student, chemistry, SSU
Eric	Parks	B.S student, marine science, SSU
Tisheena	Howard	B.S. student, marine science, SSU
Imani	Haynes	B.S. student, History (former Marine Sciences), SSU
David	Waldburg	B.S. student, Biology, SSU
Jyosi	Blair	B.S. student, Marine Sciences, SSU
Amber	Allen	B.S. student, Biology, SSU
Keya	Jackson	M.S. student, Marine Sciences, SSU
Candicee	Childs	H.S. student, Early College, SSU

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

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

Career Development Assistance: Four LMRCSC students were assisted to identify and apply for scholarships and fellowships during this reporting period. In addition, LMRCSC faculty and staff reviewed application materials for several graduating students applying for professional positions. On Tuesday, December 4, 2012, the LMRCSC organized a Scientific Communications workshop that was attended by 19 students (Table 6). The workshop was led by Dr. Bill Dennison (Vice President for Science Applications, University of Maryland Center for Environmental Science, Horn Point Lab).

Table 6. UMES Graduate Students Who Participated in the Scientific Communications Workshop

#	First Name	Last Name	Affiliation
1	Salah	Elbashir	UMES, Food Science & Technology
2	Rizwana	Tasmin	UMES, Food Science & Technology
3	Kristin	Lycett	UMES, CREST Center
4	Efeturi	Oghenekaro	UMES, CREST Center
5	Heather	Wolfer	UMES, CREST Center
6	Ozuem	Oseji	UMES, CREST Center
7	Evan	Lindsay	UMES, Professional Science Master's Program
8	Emily	Tewes	UMES, LMRCSC
9	Daniel	Cullen	UMES, LMRCSC
10	Jabari	Hawkins	UMES Food Science & Technology
11	Ejiroghene	Mayor	UMES, CREST Center
12	Sara	Elmahdi	UMES, Food Science & Technology
13	Baruch	Volkis	UMES, CREST Center
14	Candace	Rodgers	UMES, LMRCSC
15	Kristin	Noell	UMES, Toxicology Program
16	Erika	Weaver	UMES, Toxicology Program
17	Olivia	Martin	UMES, Toxicology Program
18	Tedra	Booker	UMES, LMRCSC
19	Marvin	Webb	UMES, Toxicology Program

Build strong peer networks through student collaboration: The Center has a Facebook web page, where potential students and those interested in the LMRCSC participate in discussions on a range of topics, including research projects, employment opportunities, and postdoctoral fellowships. Fifteen (15) LMRCSC students participated in the ASLO Aquatic Sciences meeting held in February, 2013 in New Orleans, LA which provided an opportunity for them to network with their peers and professionals from various institutions.

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

- **LMRCSC Exit Evaluation:** Two exit evaluations were submitted during this reporting period.
- **LMRCSC Cruise Evaluation**: No research cruise was held during this reporting period.
- **Evaluation Forms for interns and mentors**: No forms were submitted during this reporting period.

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

Activities and Accomplishments: Students who did not receive direct student support, but who benefited from Center programs and infrastructure were 49 in number. Additionally, the infrastructure that the LMRCSC has provided for the Center MSIs has made a huge difference in the type of research that can be done which has enabled the Center to leverage funds from various agencies. The Center leveraged ~$1.2 million from external sources during this reporting period.

Monitoring the career paths of LMRCSC students is critical in determining the extent to which the Center is meeting NOAA's workforce development goals. The LMRCSC provides updates on graduates who have found employment or graduate opportunities as a result of their work at the Center to the Student Tracker database housed at NOAA EPP three times each year. Since 2001, the LMRCSC has contributed significantly to the research and teaching infrastructure at the partner institutions, which has been detailed in previous reports. More recently, the presence of the LMRCSC has resulted in additional investment by the Universities and leveraged programs, indicative of the importance which the partner universities place on the Center.

New videoconference facility: This facility, with two new monitors and a camera, is used as part of the LMRCSC's Virtual Campus for distance learning courses, student committee meetings, seminars, thesis and dissertation defenses and research collaboration. For example, the facility was used for Ph.D. dissertation defenses of Lonnie Gonsalves and William Gardner that were made available to faculty at LMRCSC institutions during this reporting period. It was also used for sessions of the LMRCSC seminar series each of which had a minimum of 25 participants in attendance center-wide.

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

Post Graduate Tracking: Collection of career information on LMRCSC alumni is a continuing activity at the Center. The LMRCSC has in the past 10 years graduated 382 students (286 B.S/B.A, 83 M.S/M.A, 13 Ph.D.). Fifteen (15) of the graduates have worked, or are currently work for NOAA. Leonard Pace (B.S., HU) was employed at NOAA until 2011 and now works for NSF. Matthew Taylor (B.S., HU), a 2009 REU intern in the lab of P. Chigbu at UMES, was hired in 2011 as Fisheries Observer at the NOAA NMFS Alaska Fisheries Science Center. Current LMRCSC student Jacklyn James is employed as a Survey Technician in NOAA's Office of Marine and Aviation Operations in Atlanta, GA. Some of the students who graduated during this reporting period have secured admission to pursue graduate degrees or are working (see Table 3). Keya Jackson who obtained a B.S. degree from HU in spring 2012 began M.S. degree program at SSU in fall 2012.

Scholarship: Ammar Hanif (Ph.D., UMCES-IMET) was awarded a two-year graduate fellowship by Maryland Sea Grant that will enable him to work on the LMRCSC joint CSC project entitled "Diet and feeding of menhaden using barcoding identification based on cox1 sequences to enable the linking of primary productivity to fisheries". Stipend and tuition for LMRCSC OSU student, LaTreese Denson have been covered through OSU's Minority Pipeline fellowship, an award designed to encourage students who show exceptional promise as leaders in their fields! Xaymara Serrano and Rolando Santos (RSMAS) continued to receive funding during this period from the McKnight Fellowship to support their PhD work.

Tiara Moore who recently completed a master's degree at HU received a Hall Bonner Scholarship to attend Old Dominion University's PhD program.

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.

American Fisheries Society: Three LMRCSC students presented a paper or poster at the AFS meeting held in St. Paul, MN in fall 2012. LMRCSC PhD student and NOAA EPP Graduate Sciences Program scholar Lonnie Gonsalves who completed his degree in fall 2012 is President-Elect for the Equal Opportunity Section, a post he assumed at the 2012 national meeting in August. UMES-PSM student and NOAA contractor Michele Traver continues to serve as Chair for the AFS Equal Opportunity Section's Mentoring for Opportunity Section student travel award.

Association of the Sciences of Limnology and Oceanography (ASLO): Fifteen (15) LMRCSC students presented papers or posters at the ASLO Aquatic Sciences meeting held in February, 2013 in New Orleans, LA which provided an opportunity for them to network with their peers and professionals from various institutions.

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

- LMRCSC students were encouraged to apply for scholarships and fellowships. During this reporting period, 4 students applied for NOAA scholarships or other scholarships or fellowships.
- Six LMRCSC students worked at NOAA labs under the guidance of NOAA scientists.

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

Activities and Accomplishments:

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

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

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

***LMRCSC Board of Visitors* (BOV):** The BOV, consisting of the Presidents of the LMRCSC partner institutions or their designees, last met at HU on Nov. 1, 2012. The next BOV meeting is scheduled for Nov. 1, 2013 and will be hosted by DSU.

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

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

Activities and Accomplishments - ***Leveraging significant intellectual capital at partner institutions to advance educational programs and inform curriculum development*:** CSC Directors had several conference calls during the reporting period and discussed current and potential collaborative research and educational programs. The CSC Directors also discussed plans for recruiting students for the "network of CSCs and high schools program to train high school students in geosciences, which will accept its first cohort in Summer 2013.

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

Ensuring that curricula delivered at each partner institution are highly coordinated with the "essential curriculum" for marine and fisheries sciences, as identified by NOAA-NMFS: Curricula at partner institutions are highly aligned with NOAA-NMFS priorities. Each January or February since 2007, LMRCSC has offered an educational and scientific cruise that introduces students to the use of oceanographic equipment and that trains them in "blue water" fisheries research. The cruise has been conducted in collaboration with the NOAA Northeast Fisheries Science Center. Because of the de-commissioning of the research vessel, *Delaware II,* the winter cruise was discontinued. The LMRCSC made plans to begin in 2013 a summer research cruise in collaboration with NOAA, but because of the Budget Sequestration, the center has been informed that the cruise will not take place. Examples of NOAA scientists collaborating with scientists and students at the LMRCSC are presented in Appendix I.

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

Activities and Accomplishments:

***Increased use of the Virtual Campus*:** The Virtual Campus was used to provide courses to students, hold student committee meetings, Executive Committee meetings, and thesis and dissertation defenses. The Virtual Campus concept was expanded to include not only courses offered through videoconferencing, but also in an online format (Table 7a). Fish Ecology, Fisheries Survey Sampling, and Scientific Communications were offered to students in fall 2012. In winter 2013, Dr. Howard Townsend (NOAA Chesapeake Bay Office) who is an adjunct faculty at UMES offered a two week intensive course on Ecosystem Modeling for Fisheries: Ecopath with Ecosim model. Eleven students enrolled in the course including 5 LMRCSC and PSM students (Table 7b).

Three courses are currently being offered to center students during spring 2013 using the virtual campus facility, Introduction to Population Dynamics and Stock Assessment, Marine Population Dynamics, and Multivariate Statistics (Table 7c). Dr. David Die (RSMAS) teaches the Marine Population Dynamics course. Four students from UMES and five from DSU are enrolled in the course in addition to four RSMAS students. Dr. Die visited UMES and DSU in January 2013, delivered lectures for the class from each of the two campuses, and met with the students to mentor them on the material for the class and career prospects. He will repeat the visit to DSU in April towards at the end of the semester.

University of Maryland Interactive Video Network (IVN) courses: Several University System of Maryland MEES courses were offered in Fall 2012 and are currently being offered this spring 2013 semester to LMRCSC students and others at UMES.

Table 7a. Courses offered online at the LMRCSC in Fall 2012 as part of the PSM Degree Program

Course Number	Course Title	Instructor	Students (online)
MEES 688	Fish Ecology	Paulinus Chigbu, Eric May	Derek Alcott (PSM, UMES), Susan Kelly (PSM, UMES), Limary Rivera-Santana (PSM, UMES), Jaime Belanger (PSM, UMES), Hector Malagon (M.S., UMES)
MEES 688	Fisheries Survey Sampling	Bradley Stevens	Hillary Dean (DSU) Derrick Alcott (PSM, UMES) Susan Kelley (PSM, UMES) Limary Rivera Santana (PSM, UMES) Jaime Belanger (PSM, UMES) Hector Malagon (M.S., UMES/LMRCSC)
MEES 688	Scientific Communications	Madhumi Mitra, Paulinus Chigbu, Joseph Pitula, Douglas Ruby, Bradley Stevens	Derek Alcott (PSM, UMES), Susan Kelly (PSM, UMES), Limary Rivera-Santana (PSM, UMES), Jaime Belanger(PSM, UMES)

Table 7b. Course Offered at the LMRCSC during Winter Semester 2013

Course number	Course Title	Instructor	Students (online)
MEES 688	Ecosystem Modeling for Fisheries: Ecopath with Ecosim Model	Howard Townsend (Adjunct Faculty, UMES; NOAA COL)	Susan Kelly (PSM, UMES) Limary Rivera Santana (PSM, UMES) Hector Malagon (M.S., UMES/LMRCSC) Tunde Adebola Efeturi Oghenekaro (Ph.D., UMES/CREST) Ejiroghene Mayor (Ph.D., UMES/CREST) Ammar Hanif (M.S., UMCES-IMET) James Kilfoil (DSU) Andrea Stoneman (DSU/LMRCSC) 2 students from UM College Park

Table 7c. Courses Offered Online at the LMRCSC during Spring Semester 2013 as Part of the PSM Degree Program

Course number	Course Title	Instructor	Students (online)
MEES 642	Intro. Fish Pop. Dynamics & Stock Assessment	Chigbu & Alade	Derrick Alcott (PSM, UMES) Susan Kelly (PSM, UMES) Limary Rivera Santana (PSM, UMES) Jaime Belanger (PSM, UMES) Michele Traver (PSM, UMES) Hector Malagon (M.S., UMES/LMRCSC)
MEES688	Marine Pop. Dynamics	David Die (RSMAS)	Derrick Alcott (PSM, UMES) Susan Kelly (PSM, UMES) Limary Rivera Santana (PSM, UMES) Jaime Belanger (PSM, UMES) Hector Malagon (M.S., UMES/LMRCSC) James Kilfoil (DSU) Amy Comer (DSU) Hillary Dean (DSU) Symone Johnson (DSU)
MEES 644	Multivariate Statistics	Malik Malik	Derek Alcott (PSM, UMES), Susan Kelly (PSM, UMES), Limary Rivera-Santana (PSM, UMES), Jaime Belanger (PSM, UMES), Hector Malagon (MEES, UMES), Ozeum Oseji (MEES, UMES), Anthony Pokoo-Aikins (UMES)

Seminars: The LMRCSC Seminar Series continued in this reporting period (Table 8). The presentations were made available at LMRCSC partners via the Virtual Campus. Dr. Louise Copeman, OSU/NOAA research scientist, gave a well-received seminar on December 7th, 2012, entitled "Marine Lipids Research: applications for fisheries, trophic ecology and aquaculture." OSU MS student LaTreese Denson, who takes courses on the main campus and lives in Corvallis, frequently meets with her advisor, Dr. David Sampson, via Skype.

Table 8. LMRCSC Seminar Series (July 1, 2012 to February 26, 2013)

Date	Presenter	Title
Sept. 7, 2012	Dr. Brad Stevens (UMES)	Exploring Gulf of Alaska Seamounts with the submersible Alvin
Oct. 5, 2012	Dr. Howard Townsend (NOAA CBO)	Ecosystem-based fisheries management and modeling in the Chesapeake Bay
Dec. 7, 2012	Louise Copeman (NOAA/NWFSC)	Marine Lipids Research: applications for fisheries, trophic ecology and aquaculture

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

Activities and Accomplishments:

***Engage undergraduate and graduate students in cutting-edge research experiences in marine and fisheries sciences, including learning experiences at NOAA facilities with NOAA mentors*:** One of the defining characteristics of the student academic experience at LMRCSC is extensive participation in scientific research. Undergraduate and graduate students work alongside faculty as collaborators on a range of research projects related to NOAA-NMFS priorities. Many of the projects involve student research at NOAA facilities under the guidance of NOAA mentors. Fifteen (15) students worked at NOAA labs, Center institutions or other agencies in summer 2012 (Table 4).

Research Goal 3: Develop an exemplary capacity for scientific collaborations among partner institutions in the fields of marine and fisheries sciences - The Center's research is grouped into the four key thematic areas, associated with NOAA's research priorities. This research agenda is implemented collaboratively among faculty and students across the seven partnering institutions. LMRCSC research undergoes a rigorous scientific review process. Each year, LMRCSC convenes a Technical Advisory Board (TAB) to guide the Center in its research agenda. The

TAB reviews and provides recommendations on the Center's research plan, and ensures that LMRCSC research is of high quality and aligned with NOAA-NMFS research priorities. Each year, LMRCSC issues a Request for Proposal (RFP) within the Center institutions, which seeks proposals for research projects that will be funded by the Center. Proposals are evaluated by the TAB, based on scientific merit, congruence with NOAA-NMFS research priorities, and level of involvement of students in the proposed research. An average of 12 research projects is selected for funding each year.

Activities and Accomplishments:

- Twelve projects funded in 2011-2012 were completed in December 2012 (Table 9a). Additional 12 projects were funded in 2012-2013 and are currently underway (Table 9b).

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

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

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

Table 9b. Projects Funded by the LMRCSC for 2012 - 2013

PI	Title	Amount
1. Andrew Baker (RSMAS)	Do elevated nutrients increase the susceptibility of essential reef fish habitat to climate change stressors? A field experiment in the Florida Keys using novel genetic tools	$27,869
2. Dwight Ebanks (RSMAS)	Influence of Aqueous hypercapnia on cobia, *Rachycentron canadum*, pre-fertilization and larval stages of development	$43,445
3. Tao Gong (UMES)	Socioeconomic factors affecting entry-stay-exit behavior of the blue crab fishers in the Chesapeake Bay	$46,088
4. Selina Heppell (OSU)	Analysis of variability in foraging ecology and juvenile growth to improve an assessment model for loggerhead sea turtles	$38,367
5. Andrea Johnson (UMES)	Organic Contaminants in monkfish, *Lophius americanus*	$28,174
6. Diego Lirman (RSMAS)	The role of seascape characteristics of submerged aquatic vegetation as fisheries habitat	$50,593
7. Jessica Miller (OSU)	Evaluating the effects of prey quality on tissue lipids, taurine and growth in juvenile Chinook salmon *(Onchorynchus tshawytscha*) with a controlled feeding study	$54,596
8. Joseph Pitula (UMES)	Dinoflagellate Community Structure within a Maryland Coastal Bay Ecosystem	$32,885
9. Eric Schott (IMET)	Understanding the interaction of probiotic and pathogenic bacteria in oyster larvae hatchery culture	$34,753
10. Bradley Stevens (UMES)	Augmenting the Black Sea Bass, *Centropristis striata*, Stock Assessment: Assessing the importance of fixed and fluid estuarine habitats	$38,186
11. Bradley Stevens (UMES)	Development of *in-situ* assessment and observation methods for black sea bass, *Centropristis striata*, Year 3	$43,044
12. Gill Sylvia (OSU)	Modeling Spatial-Temporal Fishing Effort of the West Coast Salmon Fishery	$41,451

TAB Project Summary

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

Project Summary: The American monkfish or goosefish, *Lophius americanus* is one of the most important commercial finfish species in the northeastern USA. As bottom dwellers, monkfish are often in direct contact with sediments which may often contain contaminants such as trace metals, polychlorinated biphenyls (PCBs) and dioxins, but very little information is available on contaminant concentrations in monkfish tissue from the U.S. Thus, the objectives of this study are to: 1) determine the concentrations of organic contaminants such as PCBs, DDTs, chlordanes and PBDE flame retardants in monkfish muscle, liver and gonads collected from three sites in the northwestern Atlantic Ocean; 2) Correlate concentrations of each contaminant with lipids in each tissue 3) Correlate concentrations with the age/length data 4) Determine if there are spatial variation in concentrations of contaminants and lipids and 5) Examine the utility of selected contaminants as tracers in the delineation of *L. americanus* habitats. Additional monkfish samples (*n*=19) have been collected by gillnet by our industry collaborators in January, 2013 from Mud Hole, New Jersey. Fish were stored on ice and transported to UMES for processing. Total length (TL), body weight, and the weights of muscle, liver, and gonads were measured. The samples of muscle, liver, and gonads were wrapped in aluminum foil, and then frozen at -20^{o}C for organic contaminant analyses. Sampling is still ongoing for the third site: Franklin Swell, Massachusetts. Six monkfish liver, muscle and gonads were processed during the summer of 2012 for organic contaminants in Dr. Deshpande's Lab at the J.J. Howard Marine Sciences Laboratory in Sandy Hook by Ms. Bediako. We plan to analyze 34 PCB congeners, 24 organochlorine pesticides, and 27 flame retardant PBDE congeners in monkfish liver, muscle and gonads collected from the three sites by our industry collaborators and during the NOAA-LMRCSC research cruise. This project was funded again in 2012-2013.

Thematic Area Addressed: Essential Fish Habitat

Lead Scientist(s): Andrea Johnson; Ashok Deshpande
NOAA Collaborator(s): Ashok Deshpande, James J. Howard Marine Sciences Lab., Sandy Hook, NJ
LMRCSC Collaborator(s): NA
LMRCSC Research Student(s): Bernice Bediako (Ph.D. Student, UMES)

2. **Project Title:** Temperature effects on pre- and post-settlement processes in Gulf of Alaska northern rock sole (*Lepidopsetta polyxystra*): integrating across early life stages
Project Description: A critical area of fisheries science is identifying the role of climate in regulating biological productivity. Northern rock sole (NRS) supports a high value fishery for roe in the Gulf of Alaska. However our understanding of the factors regulating recruitment variation of this stock remains limited, as have the potential impacts of climate change. We are examining seasonal and interannual variation in early life history characteristics of northern rock sole in relation to regional climate variability. Otolith structural analysis of 8+ years of archived samples will allow us to determine spawning and hatch date, hatch size, and growth rates during the larval and juvenile stages. We will examine seasonal and interannual variation in these early life history characteristics in relation to climate variation throughout early life. Ultimately, the larger goals of this extended project are to quantify the environmental forcing factors that drive population productivity in pre-recruit stages of NRS and apply our understanding of these mechanisms to evaluate the potential for climate-induced changes in population dynamics and potential fishery yields.
Results of project: Ashley Silver, a MS in Environmental Science at Hampton University, was recruited as an intern during summer 2012. She was in residence at the Hatfield Marine Science Center from June through August 2012 has and worked with Drs. Miller (OSU) and Hurst (NOAA) on the initial stages of research, which included extraction and preparation of juvenile northern rock sole otoliths and development of basic mathematical models to examine seasonal and interannual variation in juvenile growth within two Alaskan nursery areas located on Kodiak Island. Initially, seasonal and interannual variation in size and growth of juveniles during their first summer in two nursery areas in Kodiak Island, Holiday Beach and Pillar Creek Cove were examined. There are persistent size differences between these two nursery areas in early summer; juveniles are 10 to 15% larger at Holiday Beach. However, this size difference increases throughout the season and by August, Holiday Beach juveniles are often >30% larger than those at Pillar Creek Cove. We are developing population growth histories for fish collected from both sites in July and August from 2005 to 2010 to determine how much of the observed variation in size can be accounted for by post-settlement growth variation versus carry-over effects from the larval stage. Future work will focus on determining if there is variation in hatch or settlement dates between these two nursery areas and quantifying the effects of local temperature variation on growth patterns.
Thematic Area Addressed: Quantitative Fisheries and Essential Fish Habitat (climate change)
Lead Scientist(s): Jessica Miller, Oregon State University
NOAA Collaborator(s): Thomas Hurst, NOAA Alaska Fisheries Science Center
LMRCSC Collaborator(s): Deidre Gibson, Hampton University
LMRCSC Research Student(s): Ashley Silver (MS Student); Xana Hermillos (Undergraduate Student)

3. Project Title: Development of *in-situ* assessment and observation methods for black sea bass, *Centropristis striata*, Year 2
Project Description: Black sea bass (*Centropristis striata*) (aka BSB) support an important commercial and recreational fishery in the Mid Atlantic Bight. Trawl surveys conducted by NOAA are not effective in sampling the heterogeneous inshore habitats, so there is no acceptable index of abundance for adult black sea bass. We are developing quantitative methods for assessing abundance of black sea bass in inshore waters using *in-situ* video technology. In year 1, we placed cameras on BSB traps to determine fish abundance, and determined that baited traps caught more fish than unbaited traps. In year 2, we compared fish counts using a stand-alone platform with two different camera types against hook-and-line CPUE at two sites. Cameras were deployed in 30-min sets, and fishing was conducted by 3 fishers during four drifts past each camera deployment, for 8 sets per day, over 8 separate days. Mean counts (from video) and mean size of fish were greater at Site 2, where live bottom was present, than at Site 1, where no live bottom was observed. Hook-and-line CPUE was correlated with video counts across both sites, but not within each site. Consistency between these data sets implies that video counts can provide reliable estimates of relative abundance of fish between sites.
Thematic Area Addressed: Quantitative Fisheries; Essential Fish Habitat

Lead Scientist(s): Bradley G. Stevens (UMES)
NOAA Collaborator(s): Vincent Guida, NEFSC, J.J. Howard Research Laboratory, Sandy Hook, NJ
LMRCSC Collaborator(s): Elizabeth Babcock, University of Miami, RSMAS.
LMRCSC Research Student(s): Dan Cullen (PhD Student, UMES), Yannick Nkeng (REU student, UMES).

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

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

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

Thematic Area Addressed: Quantitative Fisheries
Lead Scientist(s): Adam Tulu (UMES); Dr. Rosemary Jagus (UMCES-IMET), and Dr. Ali Ishaque (UMES)
NOAA Collaborator(s): Dr. Chris Chambers (NOAA Fisheries Service, NMFS)
LMRCSC Research Student(s): Adam Tulu (UMES)

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

Project Summary: Eutrophication has led to seasonal hypoxia in the Chesapeake Bay mainstem during warmer months, with unknown physiological and behavioral consequences for demersal fishes such as Atlantic croaker. We therefore assessed the influence of oxygen concentrations on croaker temperature preferences using an experimental shuttlebox system that simultaneously tracked fish, acquired data, and digitally controlled experimental conditions in response to movements of the subject. Following overnight acclimation to the chamber, thermoregulatory behaviors of croaker were recorded during 24 h experimental trials at normoxia (> 90% saturation), mild hypoxia (~ 50% 0_2 saturation), and severe hypoxia (~ 25% O_2 saturation). Croaker thermoregulated over a broad temperature range (17-27 °C) under normoxia, preferring 25 °C. Fish preferred cooler waters under decreasing oxygen conditions, with bimodal preferenda of 17 and 22 °C under moderate hypoxia, and a unimodal preference for 17 °C under severe hypoxia. Temperature preferences exhibited

diel differences under normoxic conditions but not during exposure to hypoxia. Behavior of Atlantic croaker can be strongly driven by ambient oxygen conditions, with fish actively selecting the coolest waters available under the most severe hypoxia.
Thematic Area Addressed: Essential Fish Habitat
Lead Scientist(s): Dr. Andrea K. Johnson, UMES-LMRCSC
NOAA Collaborator(s): Dr. Richard Brill, NMFS-NEFSC
LMRCSC Collaborator(s): Dr. Andrij Z. Horodysky, HU-LMRCSC
LMRCSC Research Student(s): Heather Wolfer, UMES graduate student: Cedric Shamley, HU graduate student; Malik Breland, HU undergraduate student

6. Project Title: The role of seascape characteristics of submerged aquatic vegetation as fisheries habitat
Project Summary: We evaluated the structure of nektonic communities found on continuous and fragmented seagrass seascapes (SCS and SFS, respectively) to understand how the spatial configuration of seagrass patches influences associated fauna. The relationship between the habitat (SAV) and the associated fauna is of key relevance to the management of Biscayne Bay since the spatial patterns of nearshore habitats will be directly affected by the activities and projects of the Comprehensive Everglades Restoration Plan (CERP). The seascape was mapped using satellite images, and the fish and invertebrate community was sampled at night using seine nets. The community assemblages sampled differed significantly between SCS and SFS habitat configurations. SFS habitats had higher abundance of the pink shrimp *Panaeus duorarum* and the code goby *Gobiosoma robustum*, and SCS habitats had higher abundance of the sardine *Herengula sp*. and the pinfish *Lagodon rhomboides*. Larger individuals of grey snappers and bluestriped grunts were found in SFS compared to SCS habitats. These results help conceptualize the potential future effects of water management practices on the spatial composition and configuration of nearshore SAV communities where changes in the delivery of freshwater could induce shifts in the abundance, assemblage composition, and distribution of fish and invertebrate species within nearshore SAV habitats of Biscayne Bay.
Thematic Area Addressed: Essential Fish Habitat
Lead Scientist(s): Diego Lirman, Ph.D. (University of Miami – RSMAS)
NOAA Collaborator(s): Simon Pittman, Ph.D. (NOAA Center for Coastal Monitoring and Assessment); Joe Serafy, Ph.D. (NOAA Southeast Fisheries Science Center, RSMAS)
LMRCSC Collaborator(s): Andrij Horodysky, Ph.D. (Hampton University)
LMRCSC Research Student(s): Rolando O. Santos, M.S. (Ph.D. student, University of Miami – RSMAS)

7. Project Title: Sensory ecology of Atlantic sturgeon: ecophysiological auditory and visual performance measures
Project Summary: This project investigated the auditory and visual systems of recently ESA-listed Atlantic sturgeon as assays of essential fish habitat, predator-prey interactions, and anthropogenic stressors. The auditory systems of sturgeon demonstrate fairly poor performance compared to most other fishes, with auditory brainstem responses evident only to the lowest frequency stimuli at the highest (i.e. loudest) sound pressure levels. Atlantic sturgeon are most likely vector-sensitive hearing generalists attuned only to particle motion. These results suggest that intensely loud impulsive sounds (i.e., marine construction and seismic exploration for oil and gas) would be detectable by sturgeon and may directly cause sublethal and/or lethal consequences. Their fairly insensitive auditory systems suggest, however, that sturgeon are unlikely to be significantly hampered by increases in coastal background noise (i.e., human transportation, military, and shipping activities, personal watercraft, and wind farm operations). We were unable to successfully record electroretinographic b-wave responses from the eyes of sturgeon despite numerous attempts using a variety of non-invasive electrode combinations. It may have been possible to record ERGs with more invasive techniques requiring dissection, such as isolated retinal preparations and/or retinal brush electrodes; however, as the species was listed under ESA during this project, we did not pursue surgical techniques that would have required euthanasia. Collectively, audition and vision are likely far less important to sturgeon behavior and ecology than olfaction and gustation. This project directly supported the mission of NOAA-Fisheries and provided research experience for a graduate and undergraduate student on a NOAA-relevant fisheries species.
Thematic Area Addressed: Essential Fish Habitat
Lead Scientist(s): Dr. Andrij Z. Horodysky, HU-LMRCSC
NOAA Collaborator(s): Dr. Richard Brill, NMFS-NEFSC
LMRCSC Collaborator(s):
Research Student(s): Cedric Shamley, HU graduate student; Malik Breland, HU undergraduate

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

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

Results of project: Taurine concentrations in fish feeds, livers and fillet muscle tissues from Sablefish being utilized in fishmeal reduction studies by NOAA/NWFSC in Seattle, WA were assayed. In both muscle and liver, taurine concentrations mimic the pattern of the diets, with the plant protein diet with taurine supplementation having lower concentrations than control fish being reared on a standard, commercial trout feed. We have begun the primer design and verification steps to be able to measure transcript levels of the genes involved in the biosynthesis of taurine when NOAA conducts a broader grow out of sablefish on diets containing a graded level of taurine. Results of this work are helping to establish the minimum taurine requirement and its effects at different inclusion levels for several commercially important species in aquaculture. We believe that taurine plays a major role in allowing the reduction and elimination of fishmeal as the aquaculture industry seeks fishmeal replacements from more sustainable, plant protein based sources. Aiding the ability to reduce fishmeal and possibly fish oil through taurine inclusion and the use of sustainable products will greatly enhance the ability of the aquaculture industry to increase global production to meet the ever increasing global demand for high quality, safe seafood.

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

Thematic Area Addressed: Aquaculture

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

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

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

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

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

Project Summary: Seawater and doliolids were obtained from the Skidaway Institute of Oceanography for culture maintenance. From the three phorozooids obtained to initialize the culture, we were able to acquire approximately 50 gonozooids, on which pilot feeding experiments were conducted. Most of the acquired gonozooids failed to produce eggs and subsequent larvae, therefore the culture did not survive. We then focused on the requirements for model development, therefore we mined unpublished data from earlier research to quantify feeding rates of phorozooids, which were then compared with published rates for gonozooids. Our culturing experience during the first half of the 2012 grant year indicated that the phorozooid and gonozooid stages are quite similar apart from their reproductive behaviors. Therefore, we applied published rates and conversion factors for gonozooids to phorozooids. Thus, the structure for a preliminary working model of doliolid population dynamics is in place, and the data exist to support the necessary assumptions in this climate driven population dynamics model. It has been suggested that future climate change and variability will affect plankton and planktivorous fish food web structure and function and that Doliolid blooms may alter this trophic structure. The findings from our research will improve our understanding of the impacts of a projected temperature increase on doliolids, and its implications for plankton and fish food web structure and function. In addition, the results of this study provide information that is needed for ecosystem-based management planning.

Thematic Area Addressed: Essential Fish Habitat, Quantitative Fisheries

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

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

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

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

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

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

Planned and actual results of project: The long-term goal of this study is to investigate potential environmental reservoirs and associated biotic factors of blue crab disease in the MCB. We will be exploring the spatial and temporal dynamics of *Hematodinium sp.*, along with other dinoflagellate species, through PCR-based assays. We will also explore the community structure of the putative free-living dinospore life cycle stage. The study area will include bays with different levels of anthropogenic and agricultural impacts and a historical presence of *Hematodinium* sp. This will give us greater insight into how disease transmission may occur, and what the possible biotic reservoirs for disease may be. The mode of infection of blue crabs, particularly in its natural environment, remains unknown. These studies are designed to contribute information relative to these potential modes. By correlating these observations with seasonal cycles in oxygen concentrations and potential algal blooms, we will have a more complete picture of those factors that contribute to this disease of crabs.

Thematic Area Addressed*:* Essential Fish Habitats

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

NOAA Collaborator(s):

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

LMRCSC Research Student(s): Kristin Lycett (M.S. student, UMES)

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

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

Specific objectives of the project:

1. Determine the early and late season *Hematodinium* sp. and reovirus (RLV) prevalence in blue crabs within the DE NERR.

2. Measure *Hematodinium* sp. and RLV prevalence in blue crabs of mixed age/size classes along a climatic and latitude gradient from DE Bay to southern Massachusetts.

3. Establish and enhance a network to conduct long term crab disease monitoring in the region, to enable correlations between disease, crab abundance, and climate change.

A summer intern (Erica Igwacho) from Morgan State University was trained in molecular detection of crab pathogens, crab health, and field sampling methods. Graduate student Ammar Hanif has completed his master's dissertation and is continuing to pursue a Ph.D. degree at IMET. Summer intern Igwacho completed the virus analysis of 2011 crabs from Barnegat Bay, NJ. She extracted RNA, conducted quantifications, and followed that with quantitative PCR to detect the blue crab reovirus. Her qPCR data showed that RLV is indeed present at low prevalence in NJ waters.

Analysis of 2011 samples from NJ (Barnegat Bay) have shown *Hematodinium* and reovirus. This is the farthest north that *Hematodinium* has been observed. Even farther north, near the west end of Long Island, we have detected the most northerly presence of RLV. Blue crabs are not a federally managed species. However, interactions with state and federal scientists in MD, DE, CT, and MA demonstrate how relevant this research is to the management of blue crabs, which support a $160 million fishery in the US. It is reasonable to expect that in the Northeast, with the growing recreational and commercial harvest of blue crabs, supply and disease issues will arise. In the spring of 2011 we were contacted to help investigate the cause of a blue crab die-off in CT. This underscores the relevance of the proposed survey to multi-state crab health monitoring.

Thematic Area Addressed: Essential Fish Habitat

Lead Scientist(s): Eric J Schott (UMES-IMET)
NOAA Collaborator(s): Ron Goldberg (NOAA-NMFS, Milford Lab)
LMRCSC Collaborator(s): Dennis McIntosh (DSU)
LMRCSC Research Student(s): Ammar Hanif (Graduate student, IMET)

12. Project Title: Using otolith elemental analysis to classify natal grounds of spawning summer flounder, *Paralichthys dentatus*, and spot, *Leiostomus xanthurus*
Project Summary: The goals of this project are to assess the stock structures of summer flounder, *Paralichthys dentatus,* and spot, *Leiostomus xanthurus,* in the Delaware and Chesapeake bays. Of the five objectives originally proposed, we are currently working on two: 1) collecting and ageing juvenile fish by counting right sagittal otolith rings; and 2) training and engaging LMRCSC undergraduate and graduate students in fisheries research that is aligned with and relevant to NOAA's mission. To date, LMRCSC-funded undergraduate student, Aicha Toure, and graduate student Hillary Dean have collected juvenile flounder and juvenile spot from Woodland Beach, Smyrna, DE, Ted Harvey Conservation Area, Kitts Hummock, DE, and Cape Henlopen State Park, DE. They collected juvenile flounder and spot through the end of October 2012. The students also collected adult summer flounder and adult spot from August through October at Fowler Beach, DE, and Blackbird Creek, DE. The students extracted and prepared otoliths for ageing. The students then prepared the second sagittal otolith from each fish to be examined for their elemental constituents (Ba:Ca, Mg:Ca, Sr:Ca and Mn:Ca). The otoliths will be analyzed using Laser Ablation Inductively Coupled Plasma Mass Spectrometry.
Thematic Area Addressed: Essential Fish Habitat, Quantitative Fisheries
Lead Scientist(s): Stacy Smith (DSU)
NOAA Collaborator(s):
LMRCSC Collaborator(s): Eric May (UMES)
LMRCSC Research Student(s): Aicha Toure (Undergraduate, DSU); Hillary Dean (M.S. student, DSU)

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 annual Science meeting scheduled to take place in March 2013 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 ~$1.2 million (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.

- Among the early-career faculty who received funding from the LMRCSC for 2011-2012 and 2012-2013 to conduct research are: Eric Schott (UMCES-IMET), Andrij Horodysky (HU), Andrea Johnson (UMES), and Stacy Smith (DSU).

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

- Andrea Johnson (UMES) made several short visits to NOAA NMFS Woods Hole Lab to conduct research. She has also been provided opportunities to gain administrative experience by being appointed as Associate Director and Education Coordinator of the LMRCSC leveraged Center, CREST-CISCEP funded by NSF.

NOAA LMRCSC Scientific and Educational cruise aboard the NOAA Ship Delaware II
LMRCSC Cruise 2013: No research cruise was conducted in January 2013 because the research vessel, Delaware II has been de-commissioned.

SCHOLARLY PRODUCTIVITY

In the current reporting period, LMRCSC students and faculty made 59 presentations at scientific meetings, and published 10 articles in refereed journals (Appendix IV).

Grantsmanship: A total of ~$1.2 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, ~$20,000 came from NOAA, whereas $1.2 million 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?

Sixty-four (64) students (Tables 1-4) participated in academic programs, training, workshops, conferences or seminars during this reporting period.

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

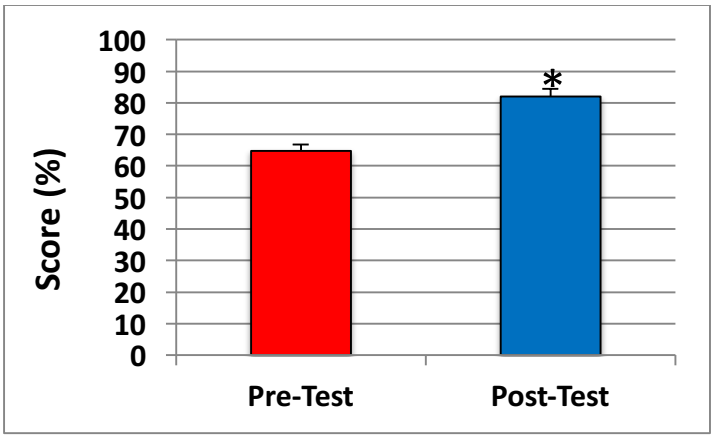
3. Students receiving direct and indirect support from the LMRCSC. Sixty-four (64) students received direct support, whereas 49 students received indirect support from the LMRCSC during this reporting period.

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

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

- **SSU Coast Camp for Youth:** LMRCSC offers its month-long summer marine science camp to ~100 youth at SSU each summer. Planning for the 2013 summer program began during this reporting period and is continuing. The SSU Coast Camp, coordinated by Dr. Dionne Hoskins, is designed to teach students how to be better stewards of the marine environment using NOAA's 7 ocean literacy principles. Students are divided into 4 classes: lower elementary (7-8 years), higher elementary (9-10 years), middle school (11-13 years), and high school (14-18 years). Each class is taught by 3-4 counselors. By serving a broad age group and being affordable, the SSU Coast Camp offers strong, accessible science instruction and long term exposure to marine science for a diverse audience of youth.
- **A New Collaborative Educational Program with The Suitland Technology Education Engagement Resource (STEER) Center:** The LMRCSC established a new collaborative program with middle and high schools from Prince Georges' County, Maryland through STEER Center to expose the students to marine and environmental science. On November 16, 2012, 34 middle- and high school students (15 from Drew Freeman middle school, 6 from Gwnn Park High School, 12 from Suitland High School, and 1 from Wise High School) visited the LMRCSC at UMES. The students took part in hands-on activities dealing with phytoplankton, zooplankton and the use of hematology techniques to assess the health of Atlantic Croaker. The students, who also did a campus tour of UMES, were guided by five LMRCSC graduate students, three undergraduates, and UMES faculty, Drs. Andrea Johnson and P. Chigbu.

Pre- and post-tests results showed that the students significantly improved their knowledge of the aquatic environment as a result of the instruction they receives as indicated in the graph below.



- **CREST CISCEP Student Enrichment and Experiential Learning (SEEL):** This program is funded by NSF and was leveraged with LMRCSC funds. LMRCSC faculty will host and mentor 7 high school students from Worcester, Wicomico and Somerset county public schools in Maryland for 7 weeks during summer of 2013. Students will conduct research along-side their mentors, LMRCSC graduate students and REU undergraduates and produce posters and Powerpoint presentations of their results which will be presented at a symposium that will be held at UMES on August 9, 2013. Planning for summer 2013 SEEL program has begun.
- **Teacher Development Workshop:** This is another program funded by NSF and leveraged with LMRCSC funds. UMES will offer a workshop for K-12 science teachers in July, 2013, designed to provide hands on lessons in lab and field research in marine and environmental science which can be infused into existing K-12 science curricula. Five teachers who participated in the program in 2012 conducted research projects under the guidance of Drs. Paulinus Chigbu, Andrea Johnson and other UMES faculty and produced a lesson plan for use in the classroom. We have continued to hold conference calls with the teachers to determine the impact of their training on instructions to students. LMRCSC scientists and staff have begun planning for the summer 2013 Teacher Development Workshop. Applications for the 2013 program are currently being received from teachers.
- **Website**: The LMRCSC web site (www.umes.edu/lmrcsc) is currently being updated. The new site highlights linkage with NOAA and Center accomplishments and make them more accessible to the user. The site includes biographic information for faculty and graduate students at each Center partner. Each of the 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. Two hundred forty-eight (248) individuals, including many students, have signed up as 'fans' of the site.

SECTION III – SUCCESS STORIES (SCIENTIFIC AND STUDENT ACCOMPLISHMENTS)

- The Center established the Network of NOAA Cooperative Science Centers and High schools for training High School Students in the Geosciences. This collaboration of LMRCSC, ECSC, NCAS and CUNY-CREST will train approximately 20 graduating high school seniors in marine geology, physical oceanography and atmospheric science, marine biology, marine chemistry/biogeochemistry, and remote sensing/GIS through an intensive 6-week residential program. Many of these students will enter CSC undergraduate programs following their participation. The first cohort of high school seniors will be trained in July 2013.
- Eight new M.S. students were added to the Center during this reporting period: Tiara Moore (HU), Dewayne Dorsey (HU), Stephen Sawyer (HU), Keya Jackson (SSU), Derrick Alcott (PSM), Susan Kelly (PSM), Jaime Belanger (PSM), and Limary Rivera-Santana (PSM).
- One PSM student at UMES, Jessica Blaylock, graduated in December 2012 and has continued to work at NOAA NEFSC, Woods Hole, MA.

- Dominique Lazarre, a PhD student at RSMAS, participated in the 2013 ASLO meeting as part of the Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S) program. Dominique has now been selected to participate in phase II on this program and will attend ASLO in 2014.

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. Sixty-four (64) students from B.S. to doctoral levels were supported and trained in NOAA core sciences. Fifteen (15) students graduated (2 Ph.D., 6 M.S., 7 B.S). Twelve (12) projects funded through the TAB for 2011-2012 were completed, and 12 new projects are underway for 2012-2013; $1.2 million in external funding is supporting Center-related activities.
- The Center's doctoral graduate, Larry Alade, a NMFS employee, is co-teaching Introduction to Fish Population Dynamics and Stock Assessment with P. Chigbu this spring 2013.
- Andrij Horodysky who was occupying a Research Assistant position fully funded by the LMRCSC has transitioned to a 9 month position with HU freeing funds that will be used to hire a new Research Assistant Professor.

2. How many students participated in Center projects or activities? Sixty-four (64) 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. Between 200 and 200 K-12 students participated in the Center educational and outreach activities.

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

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

- Courtney McGeachy who graduated with M.S. degree in MEES from UMES in fall 2012 is now employed as grants manager at National Fish and Wildlife Foundation, Washington, D.C.
- Rebeccah Hazelkorn (SSU) was trained in marine mammal necropsy as an LMRCSC fellow. That experience and the completion of her degree made her a successful applicant at the Mote Marine Laboratory to continue this type of work in Florida. She now processes manatee strandings up and down the Florida coast.

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

- Ammar Hanif (IMET graduate student) was awarded a two-year graduate fellowship by Maryland Sea Grant.
- Stipend and tuition for LMRCSC OSU student, LaTreese Denson have been covered through OSU's Minority Pipeline fellowship.
- Xaymara Serrano and Rolando Santos (RSMAS) continued to receive support during this period from the McKnight Fellowship to support their PhD work.
- Tiara Moore (HU graduate) received a Hall Bonner Scholarship to attend Old Dominion University's PhD program.

Students who received Training at NOAA Laboratories or at Center Institutions

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

4. To what extent have the projects or activities enhanced and improved outreach, education, training and NOAA related research at the institutions? Students supported under the LMRCSC have access to tools and training they would not have were it not for the LMRCSC. Forty-nine (49) students at the Center institutions who are not directly funded by the LMRCSC are benefiting from the infrastructure and equipment made available to the institutions by the LMRCSC. The LMRCSC has secured leveraged funding (~$1.2 million) that has enabled the Center institutions to recruit and support more students than they would otherwise be able to support.

LMRCSC activities and infrastructure have created a model upon which other outreach and training programs have been built. Other marine science outreach programs at SSU feed into the Coast Camp. SSU Coast Camp has become the testing ground for K12 modules. Faculty have been able to apply for other base funding for research fellowships because of the prior funding provided by the LMRCSC. Finally, travel and research funding from the LMRCSC that allowed students to travel to NOAA labs helped publicize the quality of LMRCSC faculty and students, thereby improving our collaborative and recruitment success.

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

6. In what specific NOAA science, service or stewardship activities (e.g. NOAA research cruises; weather forecast modeling, etc.) were students involved? The NOAA LMRCSC research cruise was not conducted in January 2013 because of the de-commissioning of the research vessel, Delaware II.

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

- The Center is having a significant positive impact nationally on the number of students trained in NOAA-related STEM disciplines.
- The Professional Science Master's degree program in quantitative fisheries and resource economics at UMES, leveraged with LMRCSC funds, won the 2013 Council of Historically Black Graduate Schools/Educational Testing Services (CHBGS/ETS) Award for Excellence and Innovation in Graduate Admissions. The award in the amount of $2,500 was presented to P. Chigbu (LMRCSC Director and PSM Director) in Greenville, SC on February 21, 2013.
- LMRCSC supported graduate students participated in teaching STEM lab courses to more than 100 students enrolled each year in the Department of Natural Sciences at UMES.
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- **University-wide**- Because so many innovative approaches to research growth, recruitment, and outreach have been pioneered by the LMRCSC at SSU, Dr. Dionne Hoskins is usually recruited to help with such efforts as the university tries to replicate them. The EPP program funded the first ever research conference at SSU under the Environmental Entrepreneurship program. Now the Office of Sponsored Programs uses that model for the SSU annual research day. They use poster boards originally ordered from NOAA EPP funds for the student poster session.
  At SSU all science camps confer with the LMRCSC Coast Camp before planning, and rely on the LMRCSC to provide guidance on registering to be a free lunch site, and coordinating programming in the STEM complex.
  Because of the cohesion in program planning that the LMRCSC brought to the already cooperative Marine Science faculty at SSU, the college and vice president's office typically confer with the LMRCSC (in addition to the Marine Science program coordinator) to discuss long term changes for the Marine Science degree programs.
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- **Local Community & Region-**As a tightly-knit program, the Marine Sciences at SSU enjoyed a good reputation for years. However, funding from the LMRCSC allowed SSU to introduce innovative outreach and training programs with funding that bridged challenging partnerships between public, private, and government partners. Consequently, the LMRCSC at SSU now has more demand for cooperative programs than it can satisfy with existing funds and staff. The LMRCSC is active in several area schools, with the county resource conservation commission, and with area private research institutions. LMRCSC faculty mentor the center students, are faculty mentors for new SSU faculty, serve on regional boards and are society officers (e.g. Dr. Curran- SEERS).

- **National-** While transcontinental partnerships may be costly, they allow LMRCSC faculty to be engaged in national and international level research on issues immediately important to U.S. marine resources. LMRCSC faculty offer their skills and perspectives as program chairs (e.g. Dr. Hoskins-ASLO 2013 meeting), independent experts (e.g. Dr. Sue Ebanks- Ogeechee River Fish Kill, and Dr, Matt Gilligan on Diversity in Marine Education), and mentors. Dr. Deidre Gibson (HU) served as a member of the organizing committee of the ASLO 2013 International conference that was held in New Orleans, LA. Dr. Bradley Stevens (UMES) continues to serve as Associate Editor of the Journal of Crustacean Biology. Dr. Paulinus Chigbu was recently appointed as a member of the National Sea Grant Advisory Board, and continues to serve as Technical Advisor to the Advisory Committee to the United States National Section, International Committee for the Conservation of Atlantic Tunas (ICCAT). LMRCSC funding supports some of the travel that makes national participation possible.

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

APPENDICES

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

NOAA Scientists	NOAA Lab	Role at the LMRCSC
Larry Alade*	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participates in teaching the Fish Stock Assessment course at UMES
Ayeisha Brinson	NOAA NEFSC Woods Hole Lab, MA	Participated in teaching Intro. to Environmental and Resource Economics course at UMES
Ambrose Jearld	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participated in teaching the Fish Stock Assessment course at UMES; serves as member of Advisory Committee of the CREST-CISCEP center at UMES
Mike Fogarty	NOAA NEFSC Woods Hole Lab, MA	Participated in teaching the Fish Stock Assessment course at UMES. Member of LMRCSC External Advisory Committee
Dvora Hart	NOAA NEFSC Woods Hole Lab, MA	UMES Adjunct Faculty. Participated in teaching the Fish Stock Assessment course at UMES; Served on graduate student committee
Rich McBride*	NOAA NEFSC Woods Hole Lab, MA	Collaborates with Andrea Johnson (UMES); serves on graduate committee of Evan Lindsay (PSM graduate student)
Ashok Deshpande*	NOAA NEFSC, Sandy Hook Lab	Collaborates with Eric May and Andrea Johnson; Will Gardner (UMES Ph.D. student) worked in his lab at NOAA
Chris Chambers	NOAA NEFSC, Sandy Hook Lab	Collaborated with Ali Ishaque (UMES), Rose Jagus (IMET); Adam Tulu (UMES Ph.D. student) worked in his lab at NOAA
Vince Guida*	NOAA NEFSC, Sandy Hook Lab	Jacklyn James (UMES graduate student) worked in his lab at NOAA; collaborates with Brad Stevens; serves on graduate committee of Emily Tewes (UMES)
Beth Phelan*	NOAA NEFSC, Sandy Hook Lab	Collaborated with Brad Stevens; Courtney McGeachy (UMES M.S. student) worked with her at NOAA, and she served on Courtney's thesis committee
Anne Richards*	NOAA NEFSC Woods Hole Lab, MA	Collaborates with Andrea Johnson (UMES); Serves on graduate student committee; Worked with Dan Cullen (UMES graduate student) and Belita Nguluwe (UMES graduate student)
Elizabeth Brooks	NOAA NEFSC Woods Hole Lab, MA	Served as mentor of Jessica Blaylock (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Kate Andrews	NOAA NEFSC Beaufort, NC	Served as mentor of Jeff Kipp (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Richard Brill*	NOAA NEFSC/VIMS	Collaborates with Andrea Johnson (UMES) & Andrij Horodysky (HU); Serves on graduate student committees
Bruce Vogt	NOAA Chesapeake Bay Office, MD	Served as mentor of Andrew Turner (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Howard Townsend*	NOAA Chesapeake Bay Office, MD	UMES Adjunct Faculty. Collaborates with P. Chigbu and Brad Stevens; Served as mentor of Andrew Turner (UMES PSM Graduate Student) during summer 2011 internship at NOAA; taught Ecosystem modeling course: Ecopath with Ecosim to LMRCSC students in winter 2013
Doug Wilson*	NOAA NEFSC Chesapeake Bay Office, MD	Serves as a member of External Advisory Committee of LMRCSC
Gary Wikfors*	NOAA NEFSC Milford Lab	Collaborates with Eric Schott (IMET); Gulnihal Ozbay (DSU); Serves on Graduate Student committee
Gary Shepherd*	NOAA NEFSC Woods Hole Lab, MA	Works with Brad Stevens (UMES) and Dan Cullen (UMES graduate student)
Kristy Wallmo*	NOAA Headquarters, Silver Spring, MD	LMRCSC Technical Monitor; UMES Adjunct faculty. Participates in teaching Intro. to Environmental and Resource Economics course; serves as chair of LMRCSC TAB. Partnered with Dionne Hoskins and Tara Cox, and served on graduate committee of Muhammad A. Cochran who worked on Qualitative Assessment and Comparison of Georgia's Shrimp

		and Blue Crab Fisheries and Fishermen's Perception of Fisheries Management. She also worked with Dionne Hoskins and LMRCSC students, Mone't Murphy and Imani Haynes on History of African-Americans in Georgia's Coastal Fisheries
David Tomberlin*	NOAA Headquarters, Silver Spring, MD	UMES Adjunct Faculty. Participates in teaching Intro. to Environmental and Resource Economics course; collaborates with Tao Gong (UMES)
Mark Brady	NOAA Northeast Regional Office, Gloucester, MA	Served as mentor of Leonardo Matthews (UMES PSM Graduate Student) during summer 2011 internship at NOAA
Kevin Chu	NOAA Southwest Regional Office	Member Employer Advisory Board of the Professional Science Master's degree Program that was leveraged with the LMRCSC.
Jim Nance*	NOAA SEFSC Galveston, TX	Member, External Advisory Committee of the LMRCSC
Gretchen Messick*	NOAA NCCOS Cooperative Oxford Lab, MD	Collaborates with Eric Schott (IMET)
Bob Wood*	NOAA NCCOS Cooperative Oxford Lab, MD	Serves as a member of Employer Advisory Board of the PSM degree Program that was leveraged with the LMRCSC.
John Jacobs*	NOAA NCCOS Cooperative Oxford Lab, MD	UMES Adjunct Faculty. Collaborates with Eric May (UMES), Served on graduate thesis committee of UMES student (Lonnie Gonsalves), and currently serves on Candace Rodgers (UMES) thesis committee
Frank Morado	NOAA NWFSC, Seattle, WA	Collaborates with Joseph Pitula (UMES)
Margaret Miller	NOAA SEFSC, Miami, FL	Collaborates with Daniel Benetti (RSMAS) and RSMAS graduate student (Dwight Ebanks)
Joe Serafy*	NOAA SEFSC	Collaborates with Diego Lirman (RSMAS) and serves on graduate committee of Rolando Santos (Ph.D. student, RSMAS)
Tom Hurst*	NOAA AFSC	Collaborates with Jessica Miller (OSU)
Ed Farley*	NOAA AFSC	Serves on graduate committee of Shari Mullen (UMES graduate student)
Jamal Moss*	NOAA AFSC	Serves on graduate committee of Shari Mullen (UMES graduate student); Shari conducts her research at AFSC.
Andi Stephens*	NOAA NWFSC	Serves on graduate committee of LaTrese Denson (OSU graduate student)
Pete Lawson*	NOAA NWFSC	Serves on graduate committee of Smit Vasquez Caballero (OSU graduate student)
Dan Holland*	NOAA NWFSC	Serves on graduate committee of Smit Vasquez Caballero (OSU graduate student)
Matthew Poach*	NOAA NEFSC, Sandy Hook ,NJ	Serves on graduate committee of Andrea Stoneman (DSU)
Marc Turano*	NOAA/North Carolina Sea Grant	Serves on graduate committee of Cory Janiak (DSU)
Greg McFall*	GRNMS	Partnered with Matthew Ogburn and Dionne Hoskins and served on graduate committee of Noelle Hawthorne who worked on Acoustic tagging of commercially important fish using Gray's Reef
Sarah Fangman*	GRNMS	Partnered with Matthew Ogburn and Dionne Hoskins and served on graduate committee of Noelle Hawthorne who worked on Acoustic tagging of commercially important fish using Gray's Reef
Tom Minello	NOAA Galveston, Texas	Collaborated with Matthew Ogburn and Dionne Hoskins who advised LMRCSC student, Tiffany Ward on Oyster Reef Restoration
Howard Schnabolk	NOAA Charleston, SC	Collaborated with Matthew Ogburn and Dionne Hoskins who advised LMRCSC student, Tiffany Ward on Oyster Reef Restoration
Porter Hoagland	NOAA NEFSC	Worked with Dionne Hoskins, Tara Cox and LMRCSC student Sanya Compton whose project dealt with Stakeholder Communication in Coastal Zone Management Policy

		Development in Small Island Developing States
Brice Semmens*	NOAA NWFSC	Serves as a member of the committee of Dominique Lazarre (Ph.D. student, RSMAS)

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

Appendix II. Current leveraged funding from NOAA to LMRCSC institutions

Author	Funding Agency	Title of Project	Start/End Date	Amount	Current 6 month period
Johnson, A.K (UMES) and R.A. Richards (NOAA)	NOAA NMFS-Monkfish Set Aside Program	Influence of temperature on the distribution and catch rates of monkfish, *Lophius americanus*.	5/1/11-4/30/13	$ 79,899	$19,974.75
TOTAL					**$19,974.75**

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

Author	Funding Agency	Title of Project	Start/End Date	Amount	Current 6 month period
Frischer, M. (SKIO), Gibson, D.(HU) G. Paffenhöfer	NSF	Doliolid Blooms: What are the Driving Variables? Investigations of Trophic Interactions	1/1/09-12/21/12	$75,688	$12,614.67
Smith, S. (DSU), Ozbay, G. (DSU)	USDA-NRCS	The efficacy of heavy use area protection (HUAP) pads to decrease runoff of nonpoint source pollution into the Chesapeake Bay watershed.	8//11/2011-12/31/2012	$99,435.92	$49,717.96
Ozbay, G. (DSU)	USDA-CBG	"Enhancing Geographic Information System Education and Delivery through Collaboration: Curricula Design, Faculty, Staff, and Student Training and Development, and Extension Services.	9/1/2010-8/30/2013	$299,996	$49,999.33
Ozbay, G. (DSU)	USDA-AFRI	Inactivation of enteric foodborne viruses in high risk foods by non-thermal Processing technologies.	2/1/2011-1/31/2016	$2,000,000	$200,000.00
Curran, C.(SSU)	US Dept of Edu	THBCU Graduate Program	2009-15	$3,000,000	$250,000.00
Gilligan, M.(SSU)	NSF	Research Experience for Undergraduates	2009-14	$291,434	$48,739.00
Pride, C.(SSU), C. Curran, (SSU), P. Verity	NSF	New GK12: Building Ocean Literacy in a Coastal Community Through Science	2009-14	$2,214,884	$221,488.40
P. Chigbu, J. 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	~$500,000.00
P. Chigbu, K. Wallmo (NOAA), J. Okoh, J. Keane-Dawes, S. Tubene (UMES)	NSF	Professional Science Master's degree in Quantitative Fisheries and Resource Economics	5/1/10 – 9/30/13	~$700,000	$116,666.00

E. May, A. Allen (UMES)	USDA Capacity Bldg Grant	Capacity Building Grants Program, Watershed Level Examination of Urea Use as Fertilizer and the Production of the Biotoxin Domoic Acid	10/1/10 – 9/30/13	$499,950	$83,325.00
A, Allen, E. May (UMES	USDA Capacity Bldg Grant	Development of A Subsurface Application Technology for Dry Poultry Litter to Protect Air and Water Quality	10/1/10 – 9/30/13	$599,000	$99,833.33
Gibson, D., Horodysky, A., Cuker, B.	NSF (HRD-HBCU-UP)	Targeted Infusion Project: Educational Partnership in Climate Change and Sustainability (EPiCCS)	11/1/11 – 10/31/14	$300,000	$50,000.00
TOTAL					**$1,182,383.69**

Appendix IV: Presentations and Publications
Oral Presentations (*Students)

Bush, C*. and Ishaque, A.I. (2013). Determination of CECs in water samples and vitellogenin content in male striped killifish and mummichog fish tissue from the MCBS. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Cannon, A.*, Smith S.L., Khatiwada, R. & Ozbay G. (2012). Wastewater Discharge in Delaware Inland Bays Tidal Canal: A Case Study on Heavy Metal Contaminants. Atlantic Estuarine Research Society, Fall Meeting 2012, Oct. 11-13, Chincoteague, VA.

Davis, J.* & Hill, R.T. (2012). Characterization of the bacterial symbionts of the Hawaiian mollusk, *Elysia rufescens* and its mucus. MEES Colloquium, October, 2012.

Elfadul, R.A.*, May, E.B., Chen, N. & Ishaque, A.B. (2013). Determination of contaminants of emerging concerns (CECs) in Maryland Coastal Bays. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Gillespie, K.*, Choi, E. & Jagus, R. (2012). Characterization of the zebrafish eIF4E family members. MEES Colloquium, October, 2012.

Green, S.R.*, Gibson, D. & Elliott, D. (2013). Feeding rates of phorozooids of the doliolid, *Dolioletta gegenbauri.* ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Hawthorne N.C.* & Ogburn, M.B. (2012). Separating behavior from environmental interference: Controls in a marine acoustic telemetry study. SEERS, Univ. of North Florida Oct 19-21, 2012.

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Janiak, C.* & McIntosh, D. (2012). Evaluation of mummichog egg deposition in a large-scale laboratory setting: farming instead of fishing? Atlantic Estuarine Research Society, Fall Meeting 2012, Oct. 11-13, Chincoteague, VA.

Janiak, C.* & McIntosh, D. (2012). Developing sustainable egg collection methods for the mummichog: frequency of collection and collector depth. Northeast Aquaculture Conference & Exposition, Dec. 12-15, Groton, CT.

Litz, M.*, Emmet, R. & Claiborne, A. (2012). Spatial and temporal influences of the Columbia River plume on community structure of forage fish and other pelagic nekton over the Washington and Oregon shelf . Poster presentation at ICES/PICES Symposium on Forage Fish Interactions: Creating the tools for ecosystem based management of marine resources. Nantes, France, 2012

Mayor, E.*, Kennedy, V., Pierson, J. & Chigbu, P. (2013). Population biology of mysids in the Maryland coastal bays. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Moore, T. N.* & Cuker, B. E. (2013). Sediment oxygen demand and orthophosphate release in the Hampton River tributary of the Chesapeake Bay. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA

Oseji, O.F.*, Chen, N., Chigbu, P. & Waguespack, Y.Y. (2013). Chromatographic analysis of phytoplankton pigments from the Maryland Coastal Bays. ASLO 2013. Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Perez-Perez, N.M.*, Wolfer, H.* & Johnson, A.K. (2013). Effects of hypoxia on the immune system of Atlantic croaker (*Micropogonias undulatus*) in the Chesapeake Bay, USA. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Reckenbeil, B. A.* & Ozbay, G. (2012). A Novel oyster mitigation technique to utilize shoreline riprap as a location for stocking: a study assessing oyster survival. Atlantic Estuarine Research Society, Fall Meeting 2012, Oct. 11-13, Chincoteague, VA.

Sherman M. & Curran MC. (2012). Is the survivorship of the daggerblade grass shrimp *Palaemonetes pugio* affected by the bopyrid *Probopyrus pandalicola* during starvation at two different temperatures? SEERS, Univ. of North Florida Oct 19-21, 2012.

Silver, A.C* & Miller, J. (2013). Growth trends of northern rock sole along Kodiak Island, Alaska. Oral presentation at ASLO 2013 Aquatic Science Meeting in New Orleans, Louisiana

Stoneman, A. T.* & Smith, S.L. (2012). Effects of ocean acidification on otolith growth of the mummichog (*Fundulus heteroclitus*). 142nd Meeting of the American Fisheries Society. Minneapolis-St. Paul, MN, August 19-23.

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Walters, T. L.; Frazier, L. M.; Paffenhöfer, G. A. & Frischer, M. E. (2013). Molecular profiling of zooplankton gut content using PNA-PCR and denaturing high performance liquid chromatography (PNA-PCR-DHPLC). ASLO New Orleans February 18-22, 2013.

Watson, A.M.*, Buentello, A., Suarez J.S. & Allen R. Place (2012). Analysis of two non-gmo soy products as potential fishmeal replacements for juvenile cobia, *Rachycentron canadum.* MEES Colloquium, October, 2012.

Watson, A.M.*, Buentello, A., Suarez J.S. & Allen R. Place (2013). Analysis of two non-gmo soy products as potential fishmeal replacements for juvenile cobia, *Rachycentron canadum. ,* World Aquaculture Society 2013 Nashville, TN Feb 21-25th 2013.

Poster Presentations (*Students)

Breland, M.S.*, Horodysky, A.Z., Johnson, A.K., Brill, R.W., Bushnell, P.G. & Wolfer, H.* (2013). Behavioral thermoregulation of Atlantic croaker under hypoxic and normoxic conditions. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Brinton B, LaBarre J. & Curran, M.C. (2012). Effect of parasitization by *Probopyrus pandalicola* on the behavior of *Palaemonetes pugio* in the presence of a predator, *Fundulus heteroclitus* SEERS, Univ. of North Florida Oct 19-21, 2012

Carmon, B. N*.; Benaka, L.; Patrick, W. & Lambert, D. (2013) Development of a life history database for NOAA Fisheries. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA.

Chen, N., Chigbu, P., Ishaque, A.B. & May, E.B. (2013). Dissolved barium in Maryland Coastal Bays and its use as indicator of groundwater input. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Coles, K.* & D. McIntosh. (2012). Production of Mummichogs (*Fundulus heteroclitus*) using Biofloc Technology. Northeast Aquaculture Conference and Expo, Groton, CT. December 12-15.

Cullen, D.* & Stevens, B.G. (2012). Comparing baited and unbaited video to assess black sea bass (*Centropristis striata* L.) abundance. MEES Colloquium 2012, October 19-20, 2012.

Cullen, D.* & Stevens, B.G. (2012). Comparing baited and unbaited video to assess black sea bass (*Centropristis striata* L.) abundance. 142nd Annual Meeting of the American Fisheries Society, Minneapolis-St. Paul, MN. August 19-23, 2012.

Dean, H. A.*; Smith, S.L. & Ozbay, G. (2013). A stable isotopic and fatty acid food web comparison of atlantic menhaden (*Brevoortia tyrannus*) and gulf menhaden (*Brevoortia patronus).* ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Dean, H.A.*, Haponski, A.E. & Stepien, C.A. (2012). A genetic history of walleye (*Sander vitreus*) spawning in Cattaraugus Creek of the Seneca Nation: A Comparison of Pre- and Post-Stocking. Atlantic Estuarine Research Society, Fall Meeting 2012, Oct. 11-13, Chincoteague, VA.

DePass, C.C.*, Lam, P.J. & Auro, M.E. (2013). Contrasting biogenic silica concentration in the North and South Atlantic. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Evans, E.D.* & Chigbu, P. (2013). Abundance and distribution of bay anchovy, *Anchoa mitchilli*, eggs and larvae in the Maryland Coastal Bays. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Ferguson E, Sanger D. & Riekerk. (2012). An assessment of the fish communities comparability between two tidal creek systems SEERS, Univ. of North Florida Oct 19-21, 2012

Gaynus, C.J.* & Rubio, B. (2013). Human interactions with coasts and oceans. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Gut J, Reichmuth & Curran MC. (2012). Fish assemblages near the mouth of the Savannah River from Cockspur Island to Tybee Island, Georgia. SEERS, Univ. of North Florida Oct 19-21, 2012

Hanley A. & Curran MC (2012).. The effect of season on finfish abundance in trawls conducted along the coast of Georgia. SEERS, Univ. of North Florida Oct 19-21, 2012

Kiser, R. F.; Pineda, J. & Starczak, V. R. (2012). Recruitment and survival of the barnacle *semibalanus balanoides* in Woods Hole, Massachusetts, from 2004 to 2012 ASLO New Orleans February 18-22, 2013.

Kiser, R. & Curran MC. (2012). Temporal influences on the abundance and size distributions of flatfishes in a shallow estuarine creek in Georgia. SEERS, Univ. of North Florida Oct 19-21, 2012

Lycett, K.* & Pitula, J. (2013). Phylogenetic analysis of *Hematodinium*, an early branching member of the phylum Dinoflagellata. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Lycett, K.* & Pitula, J. (2012). Molecular parasitology: phylogenetic analysis of *Hematodinium*, an early branching dinoflagellate. MEES Colloquium 2012, Baltimore, MD. October 19-20, 2012.

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Morales-Nunez, A.G., Evans, E.* & Chigbu, P. (2013). The abundance, biovolume, and size distribution of *Mnemiopsis leidyi* in the Maryland Coastal Bays. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Nejstgaard, J. C.; Arora, V.; Birsa, L. M. & Jakobsen, H. H. (2013). Video assessment of microzooplankton swimming in response to predators. ASLO New Orleans February 18-22, 2013.

Noell, K.M.* & Pitula, J.S. (2013). Characterization of enzymatic activity of an aconitase orthologue *Perkinsus marinus*. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Nyarko, A.A.*, Chen, N. & Duan, S. (2013). Characterization of dissolved organic matter in Maryland Coastal Bays using fluorescence spectroscopy. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Oghenekaro, E.U.*, Chigbu, P., Tang, K. & Pierson, J. (2013). Mesozooplankton abundance and distribution in relation to environmental factors in the Maryland Coastal Bays. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

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Oseji, O.F.*, Chen, N., Chigbu, P. & Waguespack, Y.Y. (2012). Chromatographic analysis of phytoplankton pigments from the Maryland Coastal Bays. MEES Colloquium 2012, Baltimore, MD. October 19-20, 2012.

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Smith, C. J. & Hoskins, D. L. (2013). An assessment of microbial extracellular polymeric substance (eps) in coastal Georgia sediments. ASLO New Orleans February 18-22, 2013.

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Tewes, E.E.* & Stevens, B.G. (2012). Maryland offshore wind energy siting: investigating epibenthic communities using underwater video techniques. MEES Colloquium 2012, Baltimore, MD. October 19-20, 2012.

Tewes, E. E.* & Stevens, B. G. (2013). Maryland offshore wind energy siting: investigating epibenthic communities using underwater video techniques. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Tewes, E.E.* & Stevens, B.G. (2012). Maryland offshore wind energy siting: investigating epibenthic communities using underwater video techniques. 142nd Annual Meeting of the American Fisheries Society, Minneapolis-St. Paul, MN. August 19-23, 2012.

Thompson, K. A.* & Curran, M. C.(2013) Effect of parasitic trematodes *microphallus turgidus* on predation of grass shrimp *Palaemonetes pugio* by mummichogs *Fundulus heteroclitus* ASLO New Orleans February 18-22, 2013.

Wolfer, H.M.* & Johnson, A.K. (2013). Physiological and immune system effects of sub-lethal hypoxia on Atlantic croaker, *Micropogonias undulatus*, in Chesapeake Bay. ASLO 2013 Aquatic Sciences Meeting, New Orleans, LA. February 17-22, 2013.

Publications (*Students)

Published

Adams, A.J., **Horodysky**, A.Z., McBride, R.S., Guindon, K., Shenker, J., MacDonald, T.C., Harwell, H.D., Ward, R. & Carpenter, K. (2012). Global conservation status and research needs for tarpons (Megalopidae), ladyfishes (Elopidae), and bonefishes (Albulidae). *Fish and Fisheries*

Ammar H.*, Dyson, W.*, Bowers, H., Messick, G.A., Pitula, J., **Jagus**, R. McIntosh, D. & **Schott, E.J. (2013).** Evidence of Environmental *Hematodinium* sp., a parasite of the blue crab, *Callinectes sapidus,* in the coastal bays of Delaware and Maryland. Aquatic Biosystems. In press.

Chung, S.J, Maurer, L, Bratcher M,* Pitula JS & Ogburn, MB. (2012). Cloning of aquaporin-1 of the blue crab, *Callinectes sapidus*: its expression during the larval development in hyposalinity. Aquatic Biosystems 2012, 8:21 (3 September 2012)

Saul, S.E., J.F. Walter III, D.J. Die, D.F. Naar, & B.T. Donahue 2013. Modeling the spatial distribution of commercially important reef fishes on the West Florida Shelf. Fisheries Research, 143: 12-20

Gunzburger, L & Curran, MC. (2013). Counting Parasites: Using shrimp to teach students about estimation. National Sciences Education. 42: 9–13.

Martín, J., T. da S. Sousa, G. Crespo, S. Palomo, I. González, J. R. Tormo, M. de la Cruz, M. Anderson, **R. T. Hill**, **F. Vicente**, O. Genilloud & F. Reyes. (2013). Kocurin, a new anti-MRSA thiazolyl peptide from the marine-derived bacterium *Kocuria* sp. Mar. Drugs 11:387-398.

Murray, L., Gurbisz, C., **Gibson, D.,** et. al. (2012). Collaborative partnerships help bridge the gap between science and education, American Geophysical Union - EOS. Nov. 2012

Ogburn M, Criales M, Thompson RT. & Browder JA. (2013). Endogenous swimming activity rhythms of postlarvae and juveniles of the penaeid shrimp *Farfantepenaeus aztecus, Farfantepenaeus duorarum*, and *Litopenaeus setiferus*. Journal of Experimental Marine Biology and Ecology 440:149–155.

Vicente, J., A.* Stewart, B. Song, R. T. Hill & J. L. Wright. (2013). Biodiversity of actinomycetes associated with Caribbean sponges and their potential for natural product discovery. Mar. Biotechnol. DOI 10.1007/s10126-013-9493-4.

Waguespack*, M., Oseji O.*, May E., Mitra M. & Chen N. (2012.) HPLC Analysis of Phytoplankton Pigments in Maryland Coastal Bays. *Journal of Undergraduate Chemistry Research 11 (2) 68-71.*

Submitted

McComb, D.M., Frank, **T.M., Horodysky, A.Z.**, & Kajiura, S.M. Comparative visual function in predatory fishes from the Indian River Lagoon. Submitted to: *Physiological and Biochemical Zoology*

Appendix V. Acronym and LMRCSC Links

1. **Link to the LMRCSC Performance Reports -** http://www.umes.edu/LMRCSC/Default.aspx?id=16024
2. **Link to LMRCSC Leveraged CREST-CISCEP** - http://www.umes.edu/crest/Default.aspx?id=31676
3. **Link to the LMRCSC Leveraged PSM Program -** http://www.umes.edu/psm/Default.aspx?id=30892
4. http://www.umces.edu/imet/food-thought: Food for thought, featuring LMRCSC-IMET graduate student Aaron Watson.
5. http://bmoremedia.com/innovationnews/minorities071712.aspx: Minorities Sought For Careers In Environment, Marine Science, bmore, 07/17/2012. Featuring Dr. Rosemary Jagus, IMET
6. http://www.maritime-executive.com/pressrelease/students-selected-for-2012-noaa-scholarships-honoring-dr-nancy-foster/: Students Selected for 2012 NOAA Scholarships Honoring Dr. Nancy Foster, Maritime Executive, 07/12. Featuring LMRCSC-IMET graduate student, Jan Vicente
7. http://oceanacidification.wordpress.com/2012/06/19/noaa-scholarship-awarded-to-jan-vicente-to-study-the-impact-of-ocean-acidification-on-marine-sponges/: NOAA scholarship awarded to Jan Vicente to study the impact of ocean acidification on marine sponges, 07/12. Featuring Dr. Russell Hill (IMET) and LMRCSC-IMET graduate student, Jan Vicente
8. http://www.baltimoresun.com/health/bs-gr-harmful-algae-blooms-20120603,0,48411,full.story: Fish kills fade, troublesome algae remain, Baltimore Sun, 07/12. Featuring Dr. Allen R. Place, IMET

Appendix VI. TAB Project Reports

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

Project Description: Blooms of filter-feeding pelagic doliolids can restructure marine food webs and affect biogeochemistry, influencing the dynamics of both phytoplankton and copepod populations, which in turn are important prey for planktivorous fish. We assessed and modeled the influence of temperature and prey dynamics on doliolid feeding ecology and population dynamics. This study was complementary to Deidre Gibson's NSF-OCE funded research investigating variables driving doliolid bloom formation, and directly involved LMRCSC student interns. The broader goals of this project will require one or two additional years of study, with these second and third years involving more extensive modeling work and collection of field data for model validation. The first year, supported by the LMRCSC TAB, focused on obtaining the necessary data to build a preliminary working model of doliolid population dynamics. This project responded to LMRCSC Thematic Priorities in Quantitative Fisheries and Essential Fish Habitat and is consistent with the mission of NOAA-Fisheries.

Thematic Area Addressed: Essential Fish Habitat, Quantitative Fisheries
Lead Scientist(s): Dr. Deidre Gibson, HU-LMRCSC
NOAA Collaborator(s): Dr. Robert Wood, NOAA-NCCOS, Cooperative Oxford Lab
Dr. Xinsheng Zhang, NOAA-NCCOS, Cooperative Oxford Lab
LMRCSC Collaborator(s): Dr. David Elliott, UMCES-HPL; Dr. James Pierson, UMCES-HPL
Dr. Andrij Z. Horodysky, HU-LMRCSC
LMRCSC Research Student(s): Shadaesha Green, HU undergraduate

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

Results of Project:

(A) Doliolid collection and culturing: Seawater for doliolid culture maintenance was obtained from the Georgia continental shelf in May 2012 on a cruise aboard the R/V Savannah, Skidaway Institute of Oceanography. Doliolids were generously provided from the laboratory of G. A. Paffenhofer at Skidaway, and algal food cultures were generously provided from the J. Nejstgaard lab at Skidaway. Water was transported by Dr. Elliott and doliolids by Dr. Gibson and S. Green from Georgia to the UMCES Horn Point Laboratory in Maryland and the culture was maintained in a temperature controlled incubation chamber. From the three phorozooids obtained to initialize the culture, we were able to acquire ~50 gonozooids, on which S. Green performed pilot feeding experiments under the supervision of Dr. Gibson and Dr. Elliott. Most of the acquired gonozooids failed to produce eggs and subsequent larvae, with only one confirmed larvae produced after approximately three weeks of keeping the gonozooids in culture. We were able to rear this larva for approximately one week before it, as well as the surviving gonozooids, succumbed to suspected bacterial contamination of the culture seawater.

(B) Feeding and growth experiments: For logistic reasons, we then abandoned efforts to culture doliolids for further feeding and growth experiments. Instead, we focused on the requirements for model development, and for feeding, we mined unpublished data from Dr. Gibson's earlier research to quantify feeding rates of phorozooids, which were then compared with published rates for gonozooids. The model framework is fully developed, and for phorozooids, it relies on published temperature and food specific feeding and growth rates for gonozooids, applying these rates to other stages in the model. When necessary, these gonozooid specific rates can be corrected prior to application to phorozooids, using correction factors developed from the phorozooid-gonozooid comparisons.

(C) Individual based model (IBM) construction: The structure for the model is already developed as a MatLab code (Elliott unpublished), and the proper parameters for doliolids have been identified (Table 1) and are being incorporated into the model. Figure 1 shows the framework for the individual based model of doliolid population dynamics, as laid out in the project proposal. Terms denoted with a superscript 9 are those that still need to be parameterized after all available literature has been taken into account. Required terms include stage specific growth rates, feeding rates as necessary to predict growth rates, and mortality rates, as well as factors for converting doliolid size (length) to carbon content. As the figure indicates, some data are available for parameterization of these terms in some stages. Our culturing experience during the first half of the 2012 grant year indicated that the phorozooid and gonozooid stages are quite similar apart from their

reproductive behaviors. Therefore we are applying published rates and conversion factors for gonozooids to phorozooids (Table 1). Our comparative analysis of feeding and growth rates of phoro- and gono-zooids (previous section) helps to justify such an approach. Similarly, the feeding and growth rates and carbon contents of nurse-colonies are parameterized as the sum of these terms for all individuals contained within each colony (Table 1). We plan to evaluate this approach by comparing the resulting feeding rate estimates with available feeding rates reported for nurse-colonies (Paffenhofer and Koster, 2011), as part of the process of preparing a manuscript describing the model. The feeding and growth rates and carbon contents of larvae and oozooids are still unknown. Therefore, we keep track of the age of individual doliolids in the model, and use age at metamorphosis and cadophore formation (Figure 1) as the parameters determining the rate at which larvae grow into nurse-colonies. This approach requires the assumption that larval and oozooid stages are not food limited. Given the small size of these stages, this assumption seems reasonable under conditions where enough food exists to support a bloom nurse-colonies, phorozooids, and gonozooids. Thus, the structure for a preliminary working model of doliolid population dynamics is in place, and the data exist to support the necessary assumptions in this model. The doliolid specific model is not yet fully coded into MatLab. However, this process will be relatively simple to complete once necessary environmental data exist to force the model simulations for the South Atlantic Bight, and once field data are available to compare to model predictions, allowing model assessment, adjustment, and final validation.

Manuscript in preparation: The model final product will be described in a manuscript intended for publication in either an ecological modeling journal or a journal focusing on marine research on continental shelf regions.

The phorozooid feeding rate results will be described in a manuscript intended for publication in the Journal of Plankton Research or a journal focusing on marine research on continental shelf regions.

Presentations at regional, national, and international meetings: S. Green gave a presentation, co-authored with D. Gibson and D. Elliott, at the Spring 2013 Aquatic Sciences meeting in New Orleans, LA. The talk was entitled "Feeding rates of phorozooids of the doliolid *Dolioletta gegenbauri*", and was presented in the special session "Zooplankton responses to environmental stressors: From individual responses to larger scale implications". The talk presented the results of the data mining for phorozooid feeding, and presented preliminary model results as phorozooid growth rate predictions under various temperature and food conditions.

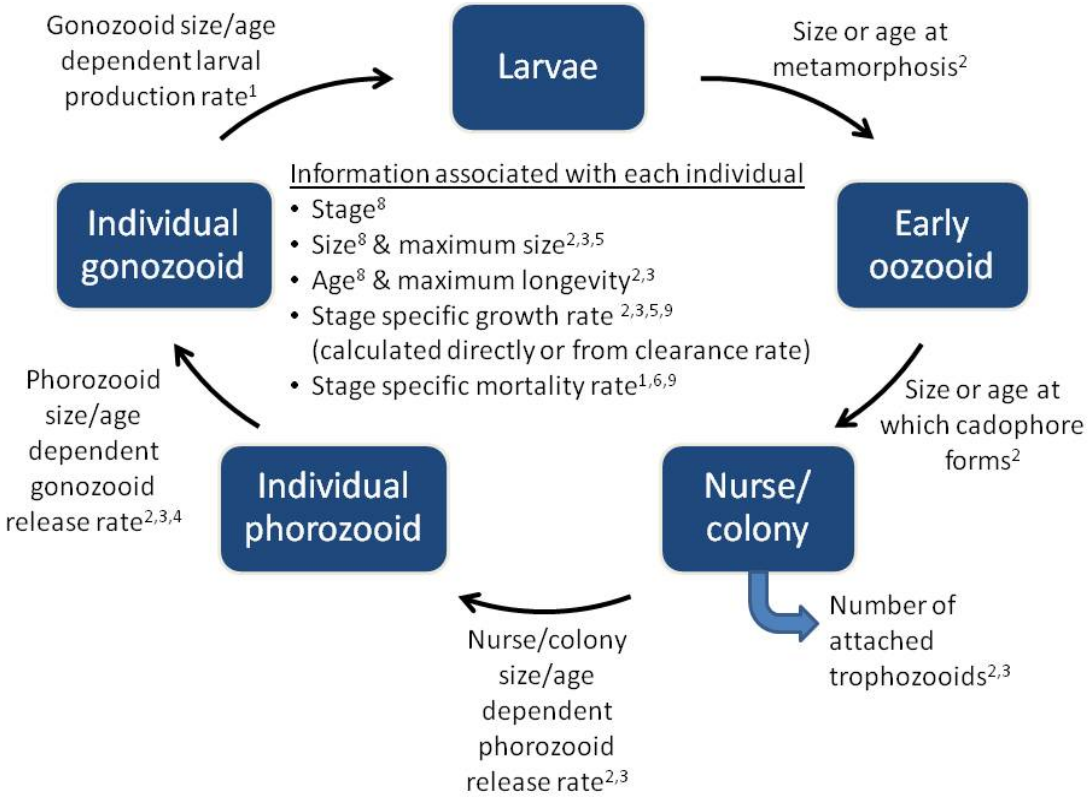

Figure 1. Doliolid life cycle as it is represented in the population model (omitting the egg stage). [1]Deibel 1982; [2]Paffenhöfer and Gibson 1999; [3]Paffenhöfer and Koster 2011; [4]Gibson and Paffenhöfer 2002; [5]Gibson and Paffenhöfer 2000; [6]Takahashi et al. 2010; [7]Haskell et al. 1999; [8]simulated in model; [9]measured or otherwise derived as part of this study.

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

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

Table 1. *Dolioletta gegenbauri* specific parameters for the individual based population model to simulate doliolid bloom dynamics.

Stage	Description	Value	Units	Source
Each stage	Ingestion rate	$I = F \times Sc \times W$ W = zooid or colony weight (µg C)	µg C µg zooid C^{-1} d^{-1}	
	Temperature dependent clearance rates	$F = 1.82 \times T - 17.6$ T = temperature (°C)	mL µg zooid C^{-1} d^{-1}	derived from Gibson & Paffenhofer 2000 raw data
	Food dependence of clearance rates	$Sc = e^{-0.0044C^{1.711}}$	C = food (µg C L^{-1})	"
	Gross growth efficiency	$GGE = e^{0.426-0.0457C}$ to a max of 0.84	"	"
	Mortality rates (including partial predation on colonies)	To Be Determined	d^{-1}	
Nurse/colony	Time from egg release to cadophore development	7	d	Paffenhofer & Gibson 1999
	Rate of trophozooid addition	2	d^{-1}	"
	Cadophore length	$L = \frac{\#\ trophozooids}{2}$	mm	Paffenhofer & Koster 2011
	Maximum cadophore length	80-150	mm	"
	Cadophore length when nurse stops feeding	3.4	mm	"
	Cadophore length at phorozooid production	13.6	mm	"
	Addition of phorozooids	0.59	mm cadophore^{-1} d^{-1}	Paffenhofer & Gibson 1999
	Lifetime phorozooid production	~1400		Deibel & Lowen 2011
	Longevity	~21	d	"
	Colony length-to-weight conversion	$L = 0.0083W - 6.571$	mm	derived
Phorozooid	Initial size at release	1.19	µg C	Paffenhofer & Koster 2011
	Maximum weight	48.96	µg C	"
	Size at gonozooid release	19.18	µg C	"
	Lifetime gonozooid production	~129		Deibel 1982
	Longevity	11	d	"
	Weight-to-length conversion	$W = 0.4643L^{2.3119}$	µg C	Gibson & Paffenhofer 2000
Gonozooid	Initial size at release	3.862	µg C	Gibson & Paffenhofer 2002
	Maximum weight	31.53	µg C	Deibel 1982
	Size at egg release	29.23	µg C	Paffenhofer & Gibson 1999
	Egg release rate	0.5	eggs d^{-1}	Paffenhofer & Koster 2011
	Longevity	12	d	"
	Weight-to-length conversion	$W = 0.4643L^{2.3119}$	µg C	Gibson & Paffenhofer 2000

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

Project Description: The purpose of this project was to examine the effects of socioeconomic factors on the entry-stay-exit decision of the blue crab fishers in the Chesapeake Bay. The empirical framework is developed based on a random utility model. Data including entry, stay, and exit behaviors and a set of personal, family, and vessel characteristics will be collected using a survey questionnaire. The macroeconomic and biological data will be collected from various government databases. Quantitative analysis will be performed using the multinomial logit model. A qualitative interview will also be conducted to triangulate the results found in quantitative analysis. The findings will be important 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; tgong@umes.edu

NOAA Collaborator(s): David Tomberlin, NOAA; david.tomberlin@noaa.gov

LMRCSC Collaborator(s): Gil Sylvia, Oregon State University; gil.sylvia@oregonstate.edu

LMRCSC Research Student(s): N/A

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

Results of project: An extensive literature review has been conducted to identify factors determining the entry-stay-exit behavior of watermen to the fishery. Three types of factors were found to be significantly predicting watermen' participation in fisheries: a) economic factors, such as harvesting costs (Ward & Sutinen, 1994) and revenue potential (Pradhan & Leung, 2004), b) stock status of the main target species (Tidd, Hutton, Kell, & Padda, 2011), and c) personal and vessel characteristics such as watermen's fishing experience (Ikiara & Odink, 2000). A survey was designed in collaboration with Drs. Doug Lipton (University of Maryland College Park) and Jorge Holzer (Maryland Department of Natural Resources (MDNR)) to collect a variety of data such as harvesting costs, operation costs, and labor costs from commercial crab license holders registered with the MDNR. An IRB application was filed and has been approved by the UMES' Institutional Review Board. The Principal Investigator met with Drs. Doug Lipton, David Tomberlin (NOAA), Jorge Holzer and several other researchers at UMCES in Annapolis to discuss data collection and potential areas to which this project could contribute. A follow-up meeting with MDNR has been set to seek an access to harvest data managed by MDNR and the sampling frame for data collection. Two watermen have been interviewed to explore factors affecting their decisions in participating in the blue crab fishery in the Chesapeake Bay. A preliminary analysis of these two interviews showed that environmental and economic factors were determinants of their behaviors in participating in blue crab fishery.

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 LMRCSC research and curriculum? The project results will be incorporated into LMRCSC research related to marine fisheries management and fisheries socioeconomics and curriculum such as environmental and resource economics.

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

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

Thematic Area Addressed: Quantitative fisheries & Essential Fish Habitat

Lead Scientist(s): Selina Heppell, Oregon State University; selina.heppell@oregonstate.edu

NOAA Collaborator(s): Larisa Avens, NOAA SEFSC; larisa.avens@noaa.gov

Jeffrey Seminoff, NOAA SWFSC: jeffrey.seminoff@noaa.gov

LMRCSC Collaborator(s): Tara Cox, Savannah State University; coxt@savannahstate.edu

LMRCSC Research Student(s): Matthew Ramirez, Oregon State University (MS)

Eric Parks, Savannah State University (undergrad)

Start Date: January 1 2013 **End Date:** August 31 2013

ABSTRACT: Time since awarding of LMRCSC TAB funding has been used for project organization and planning. To date, no laboratory analyses have been conducted for this project, though the project is moving forward as expected. A subset of bone samples has been chosen from the available samples at the SE Fisheries Science Center. In early April, Matthew Ramirez will travel to Beaufort, NC to meet with Larisa Avens to observe how skeletochronological analyses of the bone samples were conducted and to begin preparing samples for stable isotope analysis. Following this research visit, the bone samples will be shipped to Oregon State University. In early May, Matthew Ramirez will travel to La Jolla, CA for training in bone preparation for stable isotope analysis. Following this research visit, samples will be micromilled and then analyzed for isotopic signatures of carbon (δ^{3}C) and nitrogen (δ^{5}N) at Oregon State University. Laboratory work will commence mid-May and run through August. An undergraduate research intern from Savannah State University, Eric Parks, was chosen to assist with the laboratory work from mid-June to mid-August. Model development and refinement will start in the summer of 2013 and run through the fall. This project will address several of NOAA's research priorities and thematic areas in protected species population dynamics and will address the need for more quantitative training for students and increased representation in fisheries science.

Results of project: There are no results to report at this time. Stable isotope analysis of bone samples associated with the project will commence in April 2013 and run through August 2013. Data collected from these analyses will be used to improve the loggerhead sea turtle stock assessment model.

Presentations at regional, national, or international meetings: No presentations have been given to date. Results will be presented at meetings once available.

How will results be incorporated into NOAA Fisheries operations? Results from this study will provide one of the first detailed accounts of intraspecific variation in habitat usage throughout the juvenile life stage and its potential effects on growth and residence time in the loggerhead sea turtle, a protected marine species. The parameters will then be used to improve existing loggerhead population models for stock assessment and studying the impacts of fisheries bycatch on this species. Sea turtles are long-lived, late-maturing maturing animals that cannot be effectively monitored with nest counts alone, according to a recent report by the National Research Council. Thus, information gained through this study on the cryptic juvenile life-stage will be valuable to future application of a variety of quantitative tools. Assessment models for sea turtle species are generally data-poor, so this study has direct relevance to NMFS management efforts.

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

Project Title: Temperature preferences of Atlantic croaker under hypoxic and normoxic conditions

Thematic Area Addressed: Essential Fish Habitat

Lead Scientist(s): Dr. Andrea K. Johnson, UMES-LMRCSC

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

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

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

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

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

Results of project: Adult Atlantic croaker were obtained via hook and line and transported to the VIMS Eastern Shore Laboratory. Fish are being maintained in temperature controlled, filtered, sterilized, and oxygenated recirculating 1000 L aquaria maintained at 12 ppt and 25C. Tanks were assayed 1-5 times daily for temperature, salinity, oxygen, and ammonia levels.

At the time of a trial, a single croaker is removed from the holding tank and transferred to a ~ 100 gallon behavioral Shuttlebox tank maintained at normoxia at 22-24 C and 12 ppt salinity that was illuminated from below with infrared light sources. The system consists of two round chambers connected by a short raceway and includes two recirculation pumps, four dosage pumps (for inflow from warm and cold baths), two temperature mixing towers, a CCD video camera, and two fiber optic oxygen probes and four temperature probes (two for the system and two for the oxygen probes) to monitor temperature continuously (Fig 1). Custom ShuttleSoft software (Loligo Systems) tracks the movements of the animal throughout the Shuttlebox tank sections and controlled temperature accordingly. Changes in temperature are controlled by a DAQ instrument that regulates the activity of sets of pumps, depending on the position of the fish. Passage of the fish into the warmer side of the tank prompts the dosage pumps to increase the temperature in both tanks; the reverse occurs if the fish swims into the low temperature tank. A 2C temperature difference is constantly maintained between the two circular tank sections, regardless of the direction of change. Oxygen saturation is monitored via two fiber optic oxygen electrodes which measured the content of water returning from both mixing towers. Custom data acquisition software (DasyLab) controls the addition of nitrogen to the system to attain the desired experimental setpoint. Experiments were conducted for 24 hrs each at normoxia (> 90% O_2 saturation), moderate hypoxia (~50% O_2 saturation), and severe hypoxia (~25% O_2 saturation). Because the probes output oxygen content in uM/mL rather than % saturation, the percentages are approximate and temperature dependent. Full normoxia-hypoxia protocol data were obtained for 8 adult croaker; normoxia-only data have been collected for an additional three croaker to establish baseline behavior. In 2011, we obtained normoxia baseline data from three small juvenile croaker and full normoxia-hypoxia protocols from eight small juvenile fish in a shuttlebox ~1/10th of the volume of this tank. Atlantic croaker used in these experiments have been substantially larger than last year (by some 25-50mm on average); all were sexual mature. Croaker were euthanized, bled, and dissected at the end of each experimental period. Plasma chemistry analytes, electrolytes, hematocrits, and organosomatic indices of the liver, spleen, and gonads were measured. Control croaker (3 days at normoxia) exhibited fairly broad time-at-temperature distributions favoring warmer waters (> 20C), with similar distributions for each day of the experiment. Fish at normoxia exhibited a broad affinity for temperatures ranging from 19-27C, with modal T_{pref} of 25C (Fig 2). At 50% oxygen saturation, fish exhibited a bimodal affinity pattern for 19C and 23-24C, which may be indicative of fish moving between the 'warm' and 'cold' sections of the experimental tank sections searching for more optimal oxygen conditions. At 25% saturation, croaker decreased general activity levels in the Shuttlebox tank, strongly preferring cold water (mode: 17C). These results are consistent with general inferences into croaker physiology, as 25% oxygen saturation levels roughly correspond to the inflection point between aerobic metabolism and anaerobic debt (R Brill, J. Peyton, and A. Johnson, pers. obs). Glucose, phosphorus, and calcium levels in the plasma were significantly elevated in the hypoxic fish (Table 1). Hypoxic impacts on physiology place the organism under stress and hinder its ability to perform routine biological functions. These results indicate that benthic fishes experience deleterious physiological effects due to hypoxia.

Manuscript in preparation: We are working on a manuscript that will combine the croaker metabolic rate under hypoxia data (J.D. Payton, UMES) with the behavioral data in this project. Target submission Summer 2013.

Presentations at regional, national, and international meetings: Physiology in the Service of Fisheries Science - Providing Mechanistic Explanations Linking Environment and Behavior" by Andrij Horodysky, AFS 2012.

"Behavioral thermoregulation of Atlantic croaker under hypoxic and normoxic conditions" by Malik Breland, ASLO 2013

"Physiological and immune system effects of sublethal hypoxia on Atlantic croaker (*Micropogonias undulates*) in the Chesapeake Bay" by Heather Wolfer, ALSO 2013

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

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

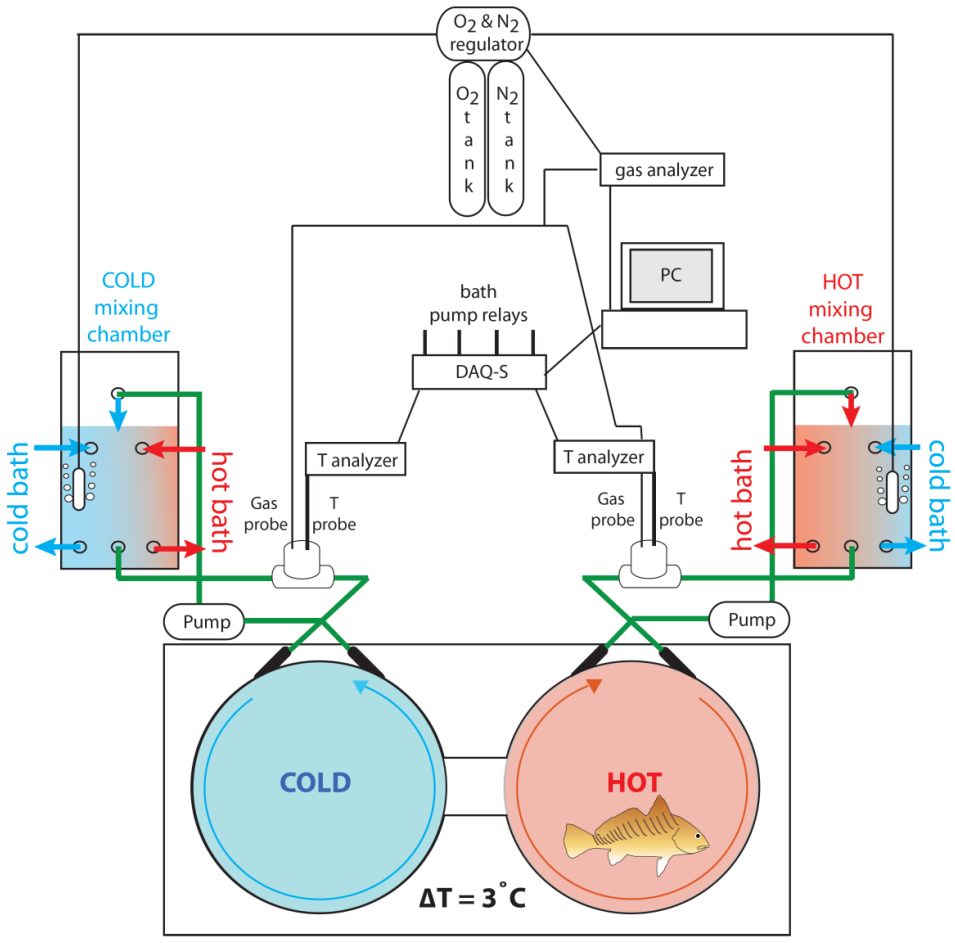

Figure 1 – Shuttlebox behavioral temperature thermoregulation system, including custom controls for maintaining levels of oxygen saturation. The tank system (lower panel) is lit from below by infrared floodlights and filmed from above by a CCD camera. Movements of the fish between chambers, as recorded by the camera and analyzed by the custom Shuttlebox software, affect the presentation of temperature stimuli experienced by the croaker, allowing the fish to select its preferred temperature. For each subject, separate experiments will be conducted at normoxia (> 90% oxygen saturation), moderate hypoxia (~50% oxygen saturation), and severe hypoxia (~25% oxygen saturation).

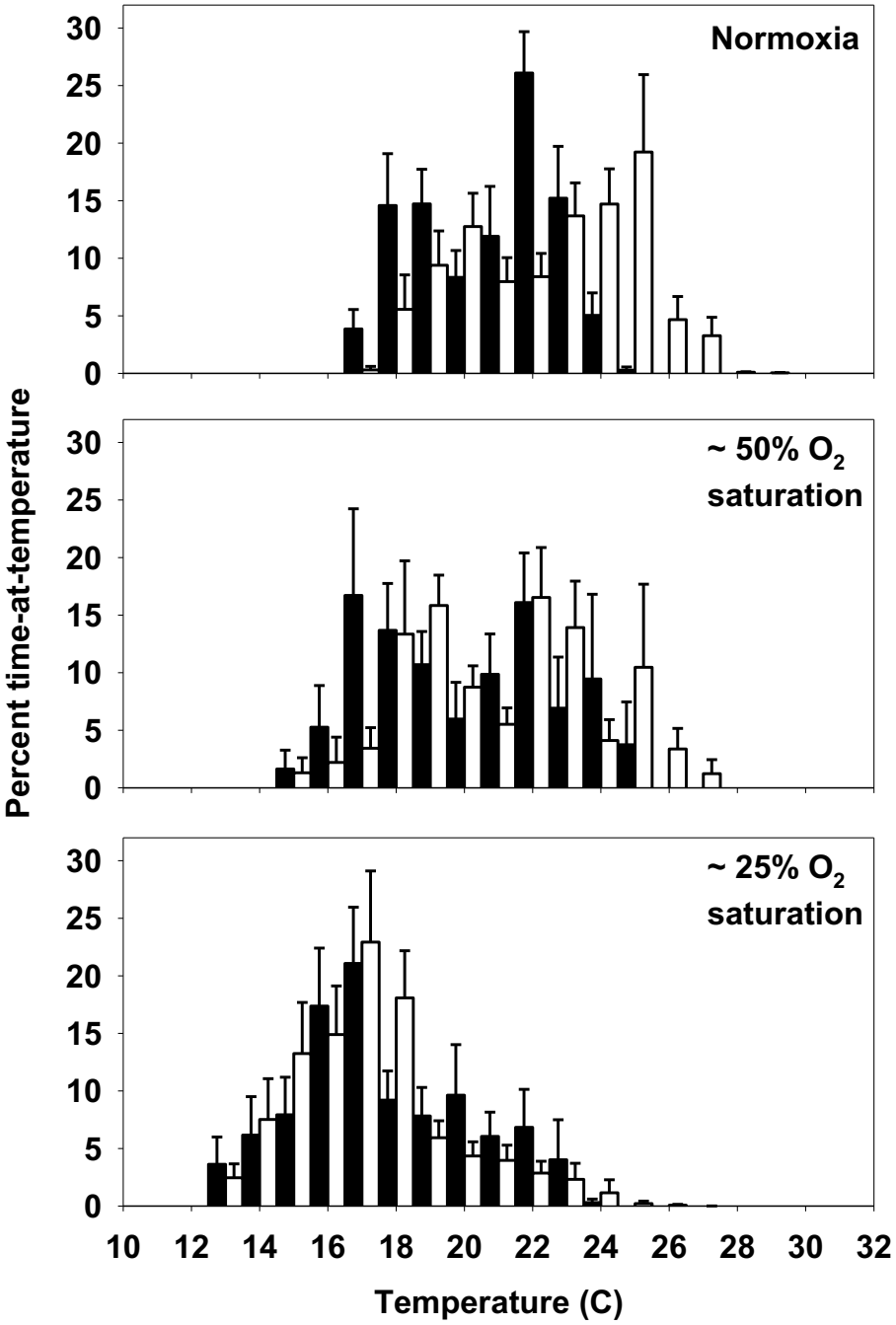

Figure 2. Time-at-temperature histograms demonstrating behavioral thermoregulation of adult Atlantic croaker (*Micropogonias undulatus*, *n* = 8) at normoxia and two levels of hypoxia. White bars reflect behavior during daylight hours, black bars reflect night hours.

Table 1. Mean and SEM values for all hematological analyses and organosomatic indices. Asterisk (*) denotes significance (ANOVA, P-value < 0.05).

		Control (n=6)		Hypoxia (n=8)	
Variable	**Unit**	**Mean**	**SEM**	**Mean**	**SEM**
TL	cm	25.8	0.69	27.6	0.46
Weight	g	199.8	11.8	270.6	12.6
HSI	%	1.09	0.14	1.12	0.07
GSI	%	0.65	0.13	0.83	0.10
SSI	%	0.07	0.01	0.07	0.01
PCV	%	23.7	5.61	29.5	1.84
Plasma protein	g/100mL	2.00	0.33	2.90	0.17
ALK	U/L	40.5	6.11	120.4	42.5
GGT	U/L	3.00	1.15	1.80	0.94
GOT	U/L	239.2	55.5	248.1	83.8
GPT	U/L	17.0	4.89	26.5	6.01
Glucose	mg/dL	28.8	5.15	71.4 *	5.24
Phosphorus	mg/dL	5.67	0.99	9.24 *	0.62
Calcium	mg/dL	6.36	0.34	9.44 *	0.52
Albumin	g/dL	0.17	0.03	0.36	0.07
Globulin	g/dL	2.13	0.24	3.07	0.07
Na^+	mmol/L	163.2	1.44	164.5	1.82
Cl^-	mmol/L	3.19	0.10	2.98	0.22
K^+	mmol/L	147.4	1.46	147.0	2.13

Project Title: Sensory ecology of Atlantic sturgeon: ecophysiological auditory and visual performance measures
Thematic Area Addressed: Essential Fish Habitat

Lead Scientist(s): Dr. Andrij Z. Horodysky, HU-LMRCSC

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

LMRCSC Collaborator(s)

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

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

Abstract/Project Description: This project investigated the auditory and visual systems of recently ESA-listed Atlantic sturgeon as assays of essential fish habitat, predator-prey interactions, and anthropogenic stressors. The auditory systems of sturgeon demonstrate fairly poor performance compared to most other fishes, with auditory brainstem responses evident only to the lowest frequency stimuli at the highest (i.e. loudest) sound pressure levels. Atlantic sturgeon are most likely vector-sensitive hearing generalists attuned only to particle motion. These results suggest that intensely loud impulsive sounds (i.e., marine construction and seismic exploration for oil and gas) would be detectable by sturgeon and may directly cause sublethal and/or lethal consequences. Their fairly insensitive auditory systems suggest, however, that sturgeon are

unlikely to be significantly hampered by increases in coastal background noise (i.e., human transportation, military, and shipping activities, personal watercraft, and wind farm operations). We were unable to successfully record electroretinographic b-wave responses from the eyes of sturgeon despite numerous attempts using a variety of non-invasive electrode combinations. It may have been possible to record ERGs with more invasive techniques requiring dissection, such as isolated retinal preparations and/or retinal brush electrodes; however, as the species was listed under ESA during this project, we did not pursue surgical techniques that would have required euthanasia. Collectively, audition and vision are likely far less important to sturgeon behavior and ecology than olfaction and gustation. This project directly supported the mission of NOAA-Fisheries and provided research experience for a graduate and undergraduate student on a NOAA-relevant fisheries species.

Results of project: Atlantic sturgeon were obtained from hatchery sources in MD; fish are of Canadian stock. Fish were transported by Drs. Brill and Horodysky to the VIMS campus and maintained in temperature controlled, filtered, sterilized, and oxygenated recirculating 1000 L aquaria at the VIMS Eastern Shore Seawater Lab, where they were maintained at 0 ppt and 25C. Tanks were assayed 1-5 times daily for temperature, oxygen, and ammonia levels.) A) AUDITORY ECOPHYSIOLOGY: Given the recent listing of the species under the Endangered Species Act, we circulated an anaesthetic dose of MS-222 into the experimental chamber via rather than using injectables to facilitate easier recovery of subjects. Auditory brainstem response (ABR) experiments were conducted on five sturgeon in August 2012 resulting in

five successful datasets and were compared to data recorded for longnose gar in 2011. For each fish, experiments on anesthetized fish involved stimuli from (i) a speaker that presented both pressure and particle motion components of sound (range: 100-2000 Hz), and (ii) a vibration mini-shaker that presented predominantly particle motion (range: 100-1000 Hz). The skull and extremely tough skin of sturgeon presented issues for proper placement and good conduction to facilitate recording using fine wire electrodes. We therefore used a dab of cyanoacrylate glue and conductive cream to temporarily attach noninvasive disk electrodes to each sturgeon's skull to facilitate good conduction and minimize recovery of fish after experiments. On the basis of morphology (lack of connection between the swim bladder and inner ear), we predicted that sturgeon would have poor auditory abilities compared to soniferous and nonsoniferous telosts we have studied previously. Atlantic sturgeon demonstrated ABR responses to speaker stimuli and shaker ball stimuli ranging from 100-500 Hz, with peak sensitivity at 100 Hz.

B) VISUAL ECOPHYSIOLOGY: We used whole-animal corneal electroretinography (ERG) to examine the response of Atlantic sturgeon visual systems to light stimuli varying in wavelength (spectral sensitivity), intensity (luminous sensitivity), and temporal properties (flicker fusion frequency, FFF). We have used this technique successfully in 15 fish species. Experiments were conducted for two sturgeon individuals in mid-August 2012. Previous work suggests that other sturgeon species have multiple cone mechanisms and are fairly sensitive to dim light. We were unable to successfully record electroretinographic b-wave responses from the eyes of sturgeon despite numerous attempts using a variety of non-invasive electrode combinations. It may have been possible to record ERGs with more invasive techniques requiring dissection, such as isolated retinal preparations and/or retinal brush electrodes; however, as the species was listed under ESA during this project, we did not pursue techniques that would have required surgery and euthanasia. Combined, these results suggest vision is far likely far less important to sturgeon behavior and ecology than olfaction and gustation.

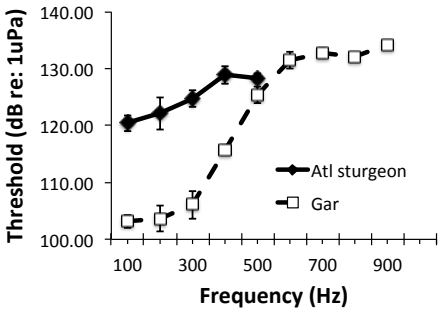

Fig. 1. Auditory Brainstem Response of Atlantic Sturgeon and longnose gar to speaker stimuli.

Manuscript in preparation: The sturgeon ABR data will be combined with our earlier longnose gar data into a comparative manuscript (target journal: Journal of Applied Ichthyology; target submission summer 2013).

Presentations at Conferences: Sturgeon hearing data were referenced in Dr. Horodysky's presentation at the 2012 national AFS meeting, Aug. 19-23, St. Paul, MN.

How will results be incorporated into NOAA Fisheries operations? The overall goals of this project are to provide sensory data relevant to the habitat use and resiliency to anthropogenic stressors and habitat degradation of a NOAA species of concern. Such data form baselines to better quantify potential impacts of habitat changes on spatial and temporal use of nursery habitats.

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

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

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

Thematic Area Addressed: Essential Fish Habitat

Lead Scientist(s): Andrea Johnson; Ashok Deshpande

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

LMRCSC Collaborator(s):

LMRCSC Research Student(s): Bernice Bediako (UMES)

Planned Start Date: January 2012 **Planned End Date:** December 2013

Planned and actual results of project: Additional monkfish samples (*n*=19) have been collected by gillnet by our industry collaborators in January, 2013 from Mud Hole, New Jersey (Table 1). Fish were stored on ice and transported to UMES for processing. Total length (TL), body weight, and the weights of muscle, liver, and gonads were measured (Table1). The samples of muscle, liver, and gonads were wrapped in aluminum foil, and then frozen at -20°C for organic contaminant analyses. Sampling is still ongoing for the third site: Franklin Swell, Massachusetts (Figure 1).

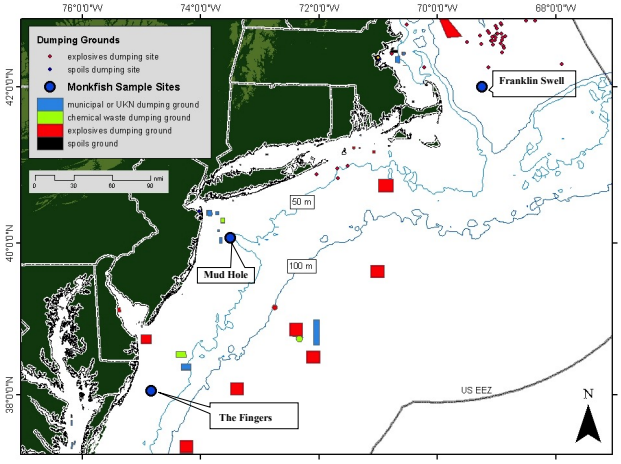

Figure 1. *L. americanus* sampling sites: Franklin Swell, MA, Mud Hole, NJ and the Fingers, MD and dumpsites in the northeastern US.

Six monkfish liver, muscle and gonads were processed during the summer of 2012 for organic contaminants in Dr. Deshpande's Lab at the J.J. Howard Marine Sciences Laboratory in Sandy Hook by Ms. Bediako. We plan to analyze 34 PCB congeners, 24 organochlorine pesticides, and 27 flame retardant PBDE congeners in monkfish liver, muscle and gonads collected from the three sites by our industry collaborators and during the NOAA-LMRCSC research cruise.

Table 1. Total length, sex, maturity stage, body weight, liver, gonad and spleen weights of monkfish (*n* = 19) collected from Mud Hole in the Northwest Atlantic Ocean.

Station	Fish ID	TL (cm)	Body Wt (kg)	Sex	Gonad Wt. (g)	Liver Wt. (g)	Spleen Wt. (g)	Maturity Stage
Mud Hole	RM-01	78.5	7.71	F	402	380	4.93	Developing
Mud Hole	RM-02	80.5	7.71	F	440	472	2.36	Developing
Mud Hole	RM-03	80.0	9.41	F	744	716	4.10	Developing
Mud Hole	RM-04	82.5	7.66	F	318	682	5.08	Developing
Mud Hole	RM-05	78.0	7.25	F	384	482	3.68	Developing
Mud Hole	RM-06	77.5	7.88	F	646	594	2.97	Developing
Mud Hole	RM-07	81.0	7.67	F	426	632	3.73	Developing
Mud Hole	RM-08	81.5	9.15	F	588	520	6.12	Developing
Mud Hole	RM-09	77.0	7.52	F	296	740	3.24	Developing
Mud Hole	RM-10	81.0	7.86	F	500	646	2.95	Developing
Mud Hole	RM-11	76.0	8.58	F	612	740	3.94	Developing
Mud Hole	RM-12	80.0	7.09	F	332	380	2.64	Developing
Mud Hole	RM-13	77.5	7.09	F	316	388	2.53	Developing
Mud Hole	RM-14	79.5	8.56	F	620	660	4.64	Developing
Mud Hole	RM-15	81.0	9.35	F	414	694	4.78	Developing
Mud Hole	RM-16	90.0	12.53	F	1520	1084	4.29	Developing
Mud Hole	RM-17	81.0	8.56	F	584	626	3.84	Developing
Mud Hole	RM-18	101.0	17.39	F	2554	1514	7.72	Developing
Mud Hole	RM-19	79.0	8.16	F	472	612	4.37	Developing

Future Plans: We propose to continue collecting monkfish samples so that we can establish baseline concentrations for organic contaminants in *Lophius americanus* and correlate contaminant concentrations with lipids in each tissue, and age/length data. In addition, we would like to determine if there is any spatial variation in the concentrations of contaminants and lipids and also evaluate the possibility of using specific contaminants as tracers in the delineation of monkfish habitats.

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

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

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

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

Thematic Area Addressed: Essential Fish Habitat

Lead Scientist(s): Diego Lirman, Ph.D. (University of Miami – RSMAS)

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

LMRCSC Collaborator(s): Andrij Horodysky, Ph.D. (Hampton University)

LMRCSC Research Student(s): Rolando O. Santos, M.S. (University of Miami – RSMAS)

Start Date: 05/01/2012 **End Date:** 12/01/2013

ABSTRACT: We evaluated the structure of nektonic communities found on continuous and fragmented seagrass seascapes (SCS and SFS, respectively) to understand how the spatial configuration of seagrass patches influences associated fauna. The relationship between the habitat (SAV) and the associated fauna is of key relevance to the management of Biscayne Bay since the spatial patterns of nearshore habitats will be directly affected by the activities and projects of the Comprehensive Everglades Restoration Plan (CERP). The seascape was mapped using satellite images, and the fish and invertebrate community was sampled at night using seine nets. The community assemblages sampled differed significantly between SCS and SFS habitat configurations. SFS habitats had higher abundance of the pink shrimp *Panaeus duorarum* and the code goby *Gobiosoma robustum*, and SCS habitats had higher abundance of the sardine *Herengula sp*. and the pinfish *Lagodon rhomboides*. Larger individuals of grey snappers and bluestriped grunts were found in SFS compared to SCS habitats. These results help conceptualize the potential future effects of water management practices on the spatial composition and configuration of nearshore SAV communities where changes in the delivery of fresh water could induce shifts in the abundance, assemblage composition, and distribution of fish and invertebrate species within nearshore SAV habitats of Biscayne Bay.

Results of project: The community assemblages differed significantly between continuous and fragmented habitat configurations. Fragmented habitats had higher abundance of the pink shrimp *Panaeus duorarum* and the code goby *Gobiosoma robustum*, and continuous habitats had higher abundance of the sardine *Herengula sp*. and the pinfish *Lagodon rhomboides*. The biomass of the nektonic community also differed between both seascape types, with larger individuals of grey snappers and bluestriped grunts found in fragmented compared to continuous habitats. Also, diversity and taxonomic distinctness indices were significantly higher within fragmented habitats.

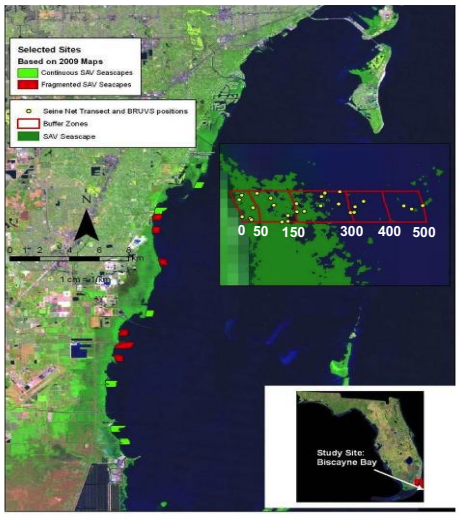

Figure 1. Illustration of the study area, the site selection scheme and the classification of sites based on seascape metrics. Red sites: Continuous SAV seascape (SCS), Green sites: fragmented SAV seascapes (SFS).

Presentations at regional, national, or international meetings: Mr. Santos presented his research findings at the Biscayne National Park Scientific Meeting in Homestead, Florida in February 2013 and will give an oral presentation at the 42nd Annual Benthic Ecology Meeting in March 2013 at Savannah State University. Dr. Lirman will provide an overview of

the project at the ASLO Meeting (remotely) in March 2013. Lastly, Mr. Santos will present at the CERF meeting in November 2013 in San Diego, CA.

How will results be incorporated into NOAA Fisheries operations? The products of our research benefit NOAA Fisheries directly by: (1) providing information on the role of vegetated benthos as essential fisheries habitats; and (2) documenting the impacts of coastal development and water management practices on benthic habitats and associated fisheries resources.

How will results be incorporated into LMRCSC research and curriculum? This study provides research opportunities and materials to students from underrepresented communities at the graduate and undergraduate level. To date, this project has employed three undergraduate minority students from LMRCSC partners who conducted directed research under the supervision of Dr. Lirman and Mr. Santos. One of these students is presenting a poster based on his work at the 2013 Benthic Ecology Meeting. In 2013, two additional summer internships will be offered to students from the LMRCSC consortium.

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

Project Description: This project will examine the effects of prey quality on growth and condition in the Upper Columbia River summer/fall Chinook salmon (*Onchorynchus tshawytscha*). Juvenile salmon will be acclimated to saltwater and fed formulated diets varying in the quality and quantity of lipid and taurine, and after 12 weeks, the effects of diet will be measured in growth and condition by measurements of tissue lipids, taurine, fatty acid composition, and otolith microstructure. This study will inform NOAA field collections of salmonids originating from the Columbia River Basin and provide enhanced research on diet, growth and recruitment dynamics to help understand how changing environmental conditions affect biological components of ecosystems (NMFS Objectives 1.15, 1.16).

Thematic Area Addressed: Quantitative Fisheries
Lead Scientist(s): Jessica Miller, Oregon State University, Hatfield Marine science Center, jessica.miller@oregonstate.edu
NOAA Collaborator(s): Robert Emmett, NOAA Fisheries, NWFSC
LMRCSC Collaborator(s): Allen Place, University of Maryland
LMRCSC Research Student(s): Marisa Litz, Oregon State University
Start Date: 1 Jan 2013 **End Date:** 31 December 2013

Results of project: This laboratory experiment is scheduled to commence in April 2013. Hence, much of the progress to date has primarily involved preparation. However, the analysis of taurine content in marine prey has been completed.

Project goals completed to date:

Granted permission to acquire 500 juvenile Chinook salmon (*Onchorhynchus tshawytscha*) from Priest Rapids Hatchery, Mattawa, Washington, in late April, 2013 by the Washington Department of Fish and Wildlife and Grant County Public Utility District

Acquired a fish transport permit from the State of Washington

Submitted Animal Care and Use Protocol (ACUP) and awaiting review and approval of the proposal by Oregon State University's Institutional Animal Care and Use Committee (IACUC)

Formulated diets developed in collaboration with NOAA Fisheries, Newport Field Station, Newport, OR

OSU provided specimens of juvenile fish and invertebrates that were collected in the North Pacific to Dr. Allen Place for determination of taurine levels. Analyses were completed in Fall 2012 and provide new information on natural levels of this amino acid that plays a key role in fish nutrition.

Designed set-up for the ten experimental 200 L tanks, and developing/testing flow-through system

Presentations at regional, national, or international meetings: None currently.

How will results be incorporated into NOAA Fisheries operations? Understanding the effects of prey quantity and quality on the growth of juvenile Pacific salmon can improve predictions of adult returns of federally endangered species. NOAA scientists studying juvenile salmon ocean ecology have developed the NOAA Columbia River Chinook and coho forecasting web-page (http://www.nwfsc.noaa.gov/ and click on "Ocean Conditions and Salmon Forecasting") to inform stakeholders and managers. These forecasts are based on indicators including basin-scale indicators, regional-scale indicators, and local indicators. To date, indicators are based on ocean conditions or on lower trophic level organisms such as zooplankton and ichthyoplankton community composition, although indicators that directly impact salmon, including estimates of prey quantity and quality, are in development. A better understanding of the direct effects of prey quality on juvenile salmon growth is needed to develop appropriate indicators.

How will results be incorporated into LMRCSC research and curriculum? This study complements the LMRCSC center-wide forage fish study. The OSU component of the forage fish study is focused on examining variation in lipids and fatty acids across the food web in the northern California Current, including phytoplankton, zooplankton, and larval and juvenile Northern anchovy. Early life stages of northern anchovy are an important component of the diet of Chinook salmon, a species of commercial and ecological interest. This laboratory study, and our related field efforts, provides valuable information on turnover rates that will improve interpretations of our field data.

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

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

Thematic Area Addressed: Economics and Social Science

Lead Scientist(s): Gil Sylvia , Oregon State University; gil.sylvia@oregonstate.edu

NOAA Collaborator(s): Peter Lawson, NOAA/NMFS; peter.w.lawson@noaa.gov

Dan Holland, NOAA/NMFS; dan.holland@noaa.gov

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

tgong@umes.edu

LMRCSC Research Student(s): Smit Vasquez Caballero (PhD student in Applied

Economics at OSU)

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

Results To date: Our project initially had a starting date of September 1st, 2012. Funding confirmation was given on September 13, 2012. As of today, the beginning of March 2013, we have accomplished the first two tasks on the initial project timeline; extended literature review and model selection. Since the beginning of the year Smit Vasquez Caballero, PhD student in Applied Economic at OSU, has completed a comprehensive meta-analysis on the environmental economic literature of "fishing locations choice modeling". This meta-analysis contains a literature review on environmental economics papers that undertake the task of obtaining an optimal spatial/temporal allocation of harvests of marine and non-marine resources through the use of spatial econometric techniques. A careful description of theoretical frameworks and empirical testing procedures are a central part of the analysis. A critical perspective, comparison, and contrast between the frameworks are provided. A summary of common challenges and gaps found in the literature are also delivered in this work. Components of this meta-analysis will give the basis for our literature review section on our final paper.

The meta-analysis exercise has helped us to identify a theoretical framework that will serve as the basis for the development of our empirical testing model. In particular, the Random Utility Model (RUM) has been favored in our analysis of fishing location choice. A key facet of this model that make its use appealing for the ocean salmon fishery is that it has important

theoretical advantage for dealing with highly spatial and temporal decision making as well as computational advantages for estimating welfare effect. Additionally, RUM results can be presented in aggregated form (i.e. aggregated predicted individual choices based on the significant explanatory variables that are the components of the utility), such as at a spatial level for all vessels; no assumption of homogeneity among individuals is required, and as in most economics-based choice models, it assumes that utility drives individual choice with a deterministic and a stochastic error component. Finally this theoretical framework allows choosing a wide variety of econometric models of discrete decision based on our data availability (i.e. whether we have choice-specific or individual-specific attributes).

In addition to the literature review and model selection, In January of this year, Smit Vasquez submitted a confidentiality form to the Collaborative Research on Oregon Ocean Salmon (Project CROOS), Oregon Salmon Commission, and West Coast Salmon Genetic Stock Identification Collaboration (WCGSI) to gain access to their raw database that contains Oregon and California salmon catch data recorded since 2006; as well as the database documentation. This database will serve as the primary source for our analysis but it will need to be complemented by fish ticket data form the Pacific States Fishery Commission. Fish ticket data will be obtained in the following weeks of this month.

Once all data has been collected, for the following month of April we are scheduling our first all day partner collaborators meeting on Seattle, WA; tentatively, attendees to the meetings are Gil Sylvia, Dan Holland, and Smit Vasquez Caballero (the rest of the collaborators will participate remotely). In such meeting we will discuss current advances of the project, in particular we want to discuss the applicability of our selected model and possible alternatives to the RUM theoretical framework. After this meeting, we will run preliminary data analysis and the results will be shared in a second meeting, at the end of June, with all collaborators in addition to our expected summer intern. A summer internship position description has been released to the LMRCSC university partners, so far we have received a few inquiries but we expect more as our closing day, May 1st, approaches.

It can be noted from the above description that our current progress has a four months lag to the original timeline included in our proposal. Thus, we expect to complete our project on December of 2013 as opposed to the 31st of August of this year. At this point we are unable to provide results of the project; we have not presented project progress in any formal meeting so far. We are expecting to provide some preliminary results at the end of September of this year so that the following months will be used to complete the research manuscript and share the results with collaborators, as well as the Oregon Salmon Commission and at the annual WCGSI meeting in November of this year.

Presentations at regional, national, or international meetings: N/A (project still in progress)

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

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

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

Project Summary: Due to changes in climate, water temperature in the Maryland Coastal Bays has been steadily rising, impacting blue crab populations through various changes in their environment. For example, dinoflagellate species may alter blue crab habitat through the impacts of blooms. In addition, one species (*Hematodinium perezi*) is a blue crab parasite. Recent evidence suggests that a stage in its life cycle occurs outside of the host within environmental reservoirs. To date, we have observed that the parasite can be detected within the water column in a bi-modal distribution. One peak occurrence is within the typical timeframe of crab disease, but the other peak occurs much sooner in the season of the observed infection cycle. We will explore the potential for this early detection event to represent the potential infective stage in the disease. In addition, we have data that the green crab, which normally harbors another species of *Hematodinium*, can also harbor *H. perezi*. This opens up significant questions regarding both the history of *Hematodinium* infection, and a deeper understanding of ecological factors which favor one parasite species over another. This project will also investigate the community population structure of various dinoflagellate species coincident with *H. perezi*. This will enable us to develop a more complete understanding of how various environmental changes within this ecosystem lead to specific bloom events, and also to discover potential reservoirs of a specific disease-causing agent.

Thematic Area Addressed: Essential Fish Habitat

Lead Scientist(s): Joseph Pitula, UMES jspitula@umes.edu

NOAA Collaborator(s):

LMRCSC Collaborator(s): Feng Chen, IMET

LMRCSC Research Student(s):

Start: November 1, 2012 Completion: September 1, 2013

Results of the Project: Since April of 2010, our laboratory has performed monthly environmental sampling of sites within the Maryland Coastal Bays, collecting\ sediment and water samples enriched for various plankton species. Our goal was to discover whether we could observe *Hematodinium* sp. in environmental sites.

The specific objectives of this proposal are:

1. To identify dinoflagellate communities within the Maryland Coastal Bays through analysis of clone libraries and DGGE assays.

2. To determine the sub-species composition of environmental reservoirs of *Hematodinium sp*. using PCR-based techniques.

For aim #1, we will be performing analysis of these communities using a PCR-based library approach. We have used this approach to report on the community structure within a specific location of the MCB (Table 1). The work for this proposal will commence in May.

Table 1. Dinoflagellate species present in water samples from Sinnickson, VA in 2010; Pitula et al, *Aquat Biosyst.* 8:16; doi: 10.1186/2046-9063-8-16.

	Hematodinium	**Other species**
April	15/16	1 unidentified nanoflagellate
June	2/13	10 *Heterocapsa rotundata, 1 Peridinium sp.*
July/August	13/25	3 *Gymnodinium sanguineum, 1* Gymnodinium *sp., 3 H. rotundata* and 5 unidentified dinoflagellates
October	10/16	2 *Pentapharsodinium tyrrhenicum*, 1 *G. simplex, 1 Gymnodinium sp., 1 H. rotundata* and 1 *Dinophyceae* sp.

For aim #2, we have generated preliminary data on the distribution of *H. perezi* in phytoplankton samples during 2012 (Figure 1). In addition, in a collaborative effort we have used a QPCR-based method to detect *H. perezi* within host crustaceans (Table 2). The very interesting aspect of this data is that *C. maenas* has only been known to be infected with a clade B species, yet our detection method is specific for the clade A form (such as *H. perezi*). Thus, there is an ecological component to the species-type which we have not previously appreciated.

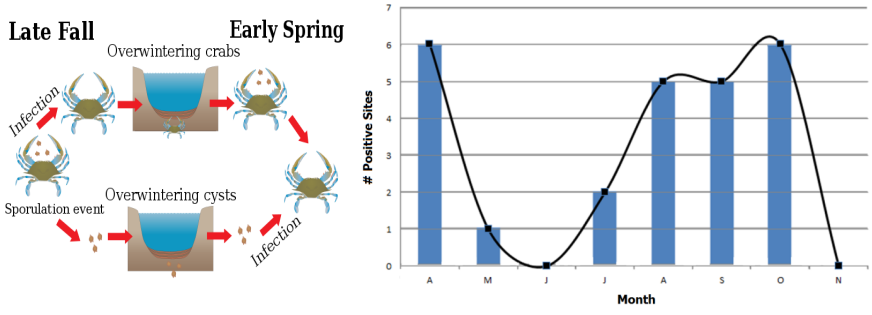

Figure 1. ***Detections in the MCB Water Column During 2012, and Two Possibilities for Infection of Blue Crabs.***

Table 2. Incidence of *H. perezi* in Indian River invertebrates. Variation in Temporal and Spatial Incidence of the Crustacean Pathogen *Hematodinium perezi* in Environmental Samples from Atlantic Coastal Bays. Hanif et al; *Aquat Biosyst.* Under revision.

Species	N	% Prevalence
Callinectes sapidus	19	79
Ovalipes ocellatus	1	100
Carcinus maenas	1	100
Palaemonetes pugio	12	0
Ilyanassa obsoleta	12	0
Orchestia grillus	7	0
Palaemonetes pugio	10	0

Scheduled presentations: Bioinformatics and Parasite Ecology…What Do We Really Know? Kristen Lycett and Joseph Pitula, 2013 Eastern Fish Health Workshop

How will results be incorporated into NOAA Fisheries operations? How will results be incorporated into LMRCSC research and curriculum? This work has served as a foundational study upon which a recent Maryland Sea Grant Pre-proposal was submitted (*Dinophysis* in the Maryland Coastal Bays; Pitula and Chung). In addition, Dr. Pitula is the instructor for the UMES graduate course in Environmental Microbiology, where this data and the organisms involved, will be discussed.

Project Title: Understanding the Interaction of Probiotic and Pathogenic Bacteria in Oyster Larvae Hatchery Culture.

Project Description: The focus of the project is to use gene-specific molecular tools to quantify the concentration of probiotic and pathogen bacteria present during the course of infection. Results from these studies will allow us to determine how long they are maintained by the oyster larvae as well as provide insight into where they may act.

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, Northeast Fisheries Science Center, Milford, CT

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

LMRCSC Research Student(s): To be determined.

Planned Start Date: 1 Jan 2013 **End Date:** 31 Dec 2013

Planned and actual results of project: As part of ongoing 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 B183. The characterization of one strain, OY15, was the focus of the 2009 TAB-funded project, which found that the strain was related to *Vibrio parahemolyticus*, produced extracellular amylase, lipase and metalloproteases, which likely contributed to its ability to act as a probiotic. Furthermore, while strain OY15 was found to have little influence on larval or culture water bacterial communities (as determined by 16S rRNA bacterial diversity analyses), it was hypothesized that its role as a probiotic was likely a result of direct interactions with the oyster itself, which is consistent with results from previous hemocyte and immunosuppression studies.

The focus of the present study is to begin understanding the spatial and temporal relationships for OY15 and B183 by applying quantitative assays that can be used to enumerate both strains from a variety of *in vivo* and *in vitro* treatments. This approach required the development of molecular tools to allow for a quantitative measure of OY15 and B183 DNA sequences. Our 2011 TAB-funded project demonstrated that the 16S-23S rRNA gene sequences were not satisfactory for

the development of gene-specific probes that would allow for unambiguous identification of each bacterium in a mixed population. Therefore, we developed vectors containing structural genes for the green fluorescent (GFP) and red fluorescent proteins (RFP) and introduced these into strains OY15 and B183, respectively, providing unique genetic tags for these bacteria. These strain constructs were then used for an oyster larvae challenge experiment last summer (2012) at the Milford Lab and were found to act like their untagged parent strains. Using oligonucleotide 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), we have developed a quantitative PCR (qPCR) procedure for determining the number of OY15 and B183 cells present in an oyster population and are presently evaluating our data from the 2012 experiment. The successful construction of strains carrying species-specific markers places us in an excellent position to determine OY15 and B183 prevalence and location, which are the focus of continuing studies. It is our intention to do short time-course studies to follow bacterial duration and clearing through the oyster larval population, which will be done this summer (2013) with the Milford team.

How will results be incorporated into NOAA Fisheries operations? Results will provide further insight into the microbial communities associated with oyster larvae and the interaction of probiotic strains with these communities. 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.

How will results be incorporated into LMRCSC research and curriculum? The project will be instrumental in providing Delaware State University students training in oyster spawning and aquaculture technology (done at the Milford Labs) and in modern microbial molecular ecology techniques, approaches that are not readily available in standard lab classes. The project will also provide a foundation for continued collaboration between the Milford Lab, Delaware State and IMET scientists, which will be used to develop a multi-year grant proposal submission in the not-too-distant future.

Project Title: Using Otolith Elemental Analysis to Classify Natal Grounds of Spawning Summer Flounder, *Paralichthys dentatus*, and Spot, *Leiostomus xanthurus*

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

Thematic Area Addressed: Essential Fish Habitat; Quantitative Fisheries

Lead Scientist(s): Stacy Smith (DSU), Eric May (UMES)

NOAA Collaborator(s):

LMRCSC Collaborator(s):

LMRCSC Research Student(s): Aicha Toure, Delaware State University; Hillary Dean, Delaware State University

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

Results of project: The overarching goals of this project are to assess the stock structures of summer flounder, *Paralichthys dentatus,* and spot, *Leiostomus xanthurus,* in the Delaware and Chesapeake bays. Of the five objectives originally proposed, we are currently working on two: 1) collecting and ageing juvenile fish by counting right sagittal otolith rings; and 2) training and engaging LMRCSC undergraduate and graduate students in fisheries research that is aligned with and relevant to NOAA's mission.

To date, LMRCSC-funded undergraduate student, Aicha Toure, and graduate student Hillary Dean have collected juvenile flounder and juvenile spot from Woodland Beach, Smyrna, DE, Ted Harvey Conservation Area, Kitts Hummock, DE, and Cape Henlopen State Park, DE. They collected juvenile flounder and spot through the end of October 2012 and also adult summer flounder and spot from August through October at Fowler Beach, DE, and Blackbird Creek, DE. The students extracted and prepared otoliths for ageing, and then prepared the second sagittal otolith from each fish to be examined for their elemental constitutents (Ba:Ca, Mg:Ca, Sr:Ca and Mn:Ca). The otoliths will be analyzed using Laser Ablation Inductively Coupled Plasma Mass Spectrometry.

Presentations at regional, national, or international meetings: The results will be presented at the Atlantic Estuarine Research Society meeting.

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

How will results be incorporated into LMRCSC research and curriculum? There are no plans to continue this research beyond December 2012; however, if significant results are found, we will attempt to reestablish this research and obtain funding for a graduate student to produce a thesis. In addition, we will further recruit undergraduate students to assist the graduate student. The results could be used in Fish Ecology courses as examples of interconnections between fish groups in adjacent bays.

Project Title: Development of in-situ Assessment and Observation Methods for Black Sea Bass, *Centropristis striata*, Year 2

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

Thematic Area Addressed: Quantitative Fisheries; Essential Fish Habitat

Lead Scientist(s): Bradley G. Stevens bgstevens@umes.edu

NOAA Collaborator(s): Vincent Guida, NEFC, J.J. Howard Research Laboratory, Sandy Hook, NJ Vincent.guida@noaa.gov

LMRCSC Collaborator(s): Elizabeth Babcock, University of Miami, RSMAS. ebabcock@rsmas.miami.edu

LMRCSC Research Student(s): Dan Cullen (PhD Student) University of Maryland Eastern Shore; Yannick Nkeng, undergraduate REU student.

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

Results of project:

Video Sampling – Sampling occurred on 8 days from 28 June to 3 August 2012 at two locations with structured habitat near Ocean City, MD. We deployed a rectangular steel camera frame (91 x 61 x 91 cm) with a Canon FS-30 camcorder in an Equinox HD-6 housing mounted looking outward in the center and 3 backup GoPro® HD Hero cameras faced outward from the sides. Eight 30 minute camera frame deployments were made at one site per day, and temperature and depth were measured during deployments. Video frames were systematically sampled at 30 sec intervals, and the Mean Count (average number of fish) was calculated.

Hook–and-line surveys – During camera frame deployments, three people fished simultaneously on the starboard side of the

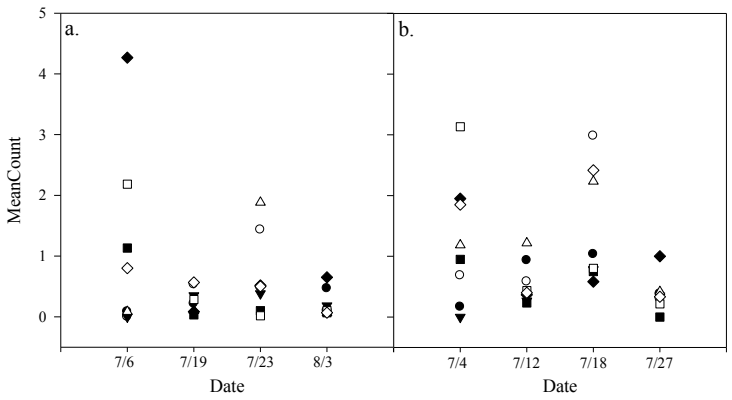

Figure 1. Range of Mean Count values by sampling date for site 1 (a) and site 2 (b).

boat with a three hook rig with bait (squid) for 3 min unless fish were hooked. Fishing occurred during 4 drifts past the camera deployment sites. All fish caught were identified and measured (TL, cm) prior to release, and presence of a nuchal hump was noted. Catch data were converted to CPUE as numbers per hook drop per camera set because fishing time varied between anglers and was inversely proportional to catch.

Preliminary Results – We collected over 120 hours of video during the sampling period (4 cameras x 4 hrs/day x 8 days). Videos from the main camera were analyzed unless fogging prevented it; in which case, one of the backup cameras was randomly chosen for processing. Observed habitat at Site 1 was sandy bottom with mud, shell, and gravel while Site 2 consisted of a mixture of sand, mud, rock, and live bottom habitat. Mean Count estimates varied by site and date with Site 2 generally having higher values (Figure 1). CPUE also varied by date and site (Figure 3), and except for 6 July, was higher at Site 2. The mean size of BSB caught was greater at Site 2 (27.3 ± 0.7 cm) than at Site 1 (27.0 ± 0.8 cm) for all categories of BSB, with or without a nuchal hump. To examine whether both sampling methods produced related measures of relative abundance, Mean Count and CPUE estimates were compared using Kendall's tau rank correlations for each site separately and both combined. A significant correlation was found for both sites combined (tau = -0.285, P = 0.001) but not separately (P > 0.05). Video counts and angler CPUE will be compared further using mixed effect models that incorporate factors including temperature, depth, date, and sampling time.

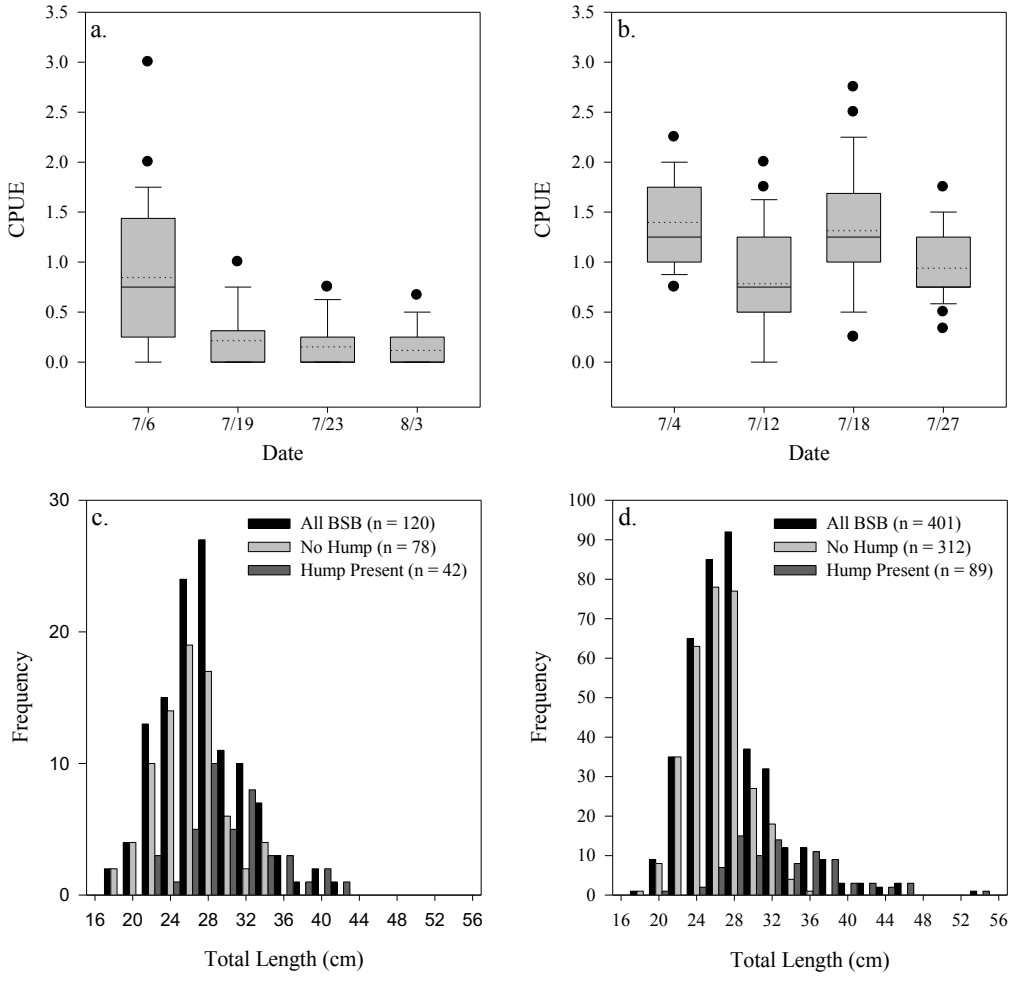

Figure 2. CPUE box-plots and length frequency distributions of BSB for (a,c) Site 1 and (b,d) Site 2. Boxes include the median (solid central line) and mean (dotted central line), black circles are outliers

Presentations at regional, national, or international meetings:

B. Stevens, D. Cullen, and C. McGeachy. "Using underwater video for assessing abundance and behavior of black sea bass and seafloor habitats". One NOAA Science Seminars: NOAA HQ, Silver Spring MD, 09/26/2012.

Dan Cullen and B. G. Stevens. Comparing Baited and Unbaited Video to Assess Black Sea Bass (*Centropristis striata* L.) Abundance (Poster). American Fisheries Society, St. Paul, MN, 8/22/12.

Courtney McGeachy and B. G. Stevens. Behavior of Black Sea Bass (*Centropristis striata* L.) Around Fish Traps. NOAA EPP Science Forum, March 2012, Florida A&M University, Tallahassee, FL.

Dan Cullen and B. G. Stevens. Comparing Baited and Unbaited Video to Assess Black Sea Bass (*Centropristis striata* L.) Abundance: Research in Progress (Poster). NOAA EPP Science Forum, March, 2012, Florida A&M University, Tallahassee, FL.

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

How will results be incorporated into LMRCSC research and curriculum? The data and techniques have been incorporated into a class taught by Dr. Stevens "Survey Sampling".

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

Project Description: Black sea bass (*Centropristis striata*) support important commercial and recreational fisheries in the Mid Atlantic Bight. Fish live offshore near the continental shelf edge during winter, juvenile fish migrate to estuarine habitats in the summer and early fall, and aggregate on reef and hard bottom habitats. The stock assessment states that overfishing is occurring and a long-term decrease in landings is observed. We hypothesize that the decline in black sea bass is associated with several variables in the Chesapeake Bay, including the decline in oyster reefs, as juveniles are dependent on estuarine reef and hard-bottom habitat, and variability in precipitation and resulting changes in salinity in the estuary. The goals of the study will be to develop a habitat suitability model to determine preferred habitats of black sea bass in the Chesapeake (based on fixed and fluid habitats). We will test the model with sampling at fixed areas of preferred habitats as well as adaptive sampling in areas where salinity may vary widely and occasionally be outside the preferred range. This proposal addresses two of the LMRCSC research themes including "Quantitative Fisheries" and "Essential Fish Habitat", as well as several NOAA Strategic Objectives including "improving stock assessments" (1.1), and delineating essential fish habitat (1.11).

Thematic Area Addressed: Quantitative Fisheries; Essential Fish Habitat
Lead Scientist(s): Bradley G. Stevens (UMES), Howard Townsend, NOAA Cooperative Oxford Laboratory
NOAA Collaborators: Steve Giordano and David Bruce, NOAA Chesapeake Bay Office – Cooperative Oxford Lab
LMRCSC Collaborator(s): Jessica Miller, OSU
LMRCSC Research Student(s): Laura Almodovar (UMES)
Start Date: 1 Jan 2013 **End Date:** 31 December 2014

Results of project: Work has not started yet (March 2013), but a graduate student (Laura Almodovar) has been recruited and will start working this spring.

Presentations at regional, national, or international meetings: None yet.

How will results be incorporated into NOAA Fisheries operations? The data will be part of a larger scale study of the importance of oyster reef habitats conducted by the NOAA Chesapeake Bay Office – Cooperative Oxford Lab, and will contribute to an ecosystem model of the Chesapeake Bay developed by Dr. Townsend.

How will results be incorporated into LMRCSC research and curriculum? Data and methods will be incorporated into classroom teaching of several courses, including Survey Sampling (Dr. Stevens), and possibly Ecosystem Modeling (Dr. Townsend).