



**Performance Report for Cooperative Agreement No: NA16SEC4810007  
for the Period from September 1, 2018 to February 28, 2019**

**University of Maryland Eastern Shore**

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

**Paulinus Chigbu, Ph.D. (Principal Investigator & Director, LMRCS)**  
**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

**Elizabeth Babcock, Ph.D. (Co-Principal Investigator)**  
RSMAS/University of Miami

# I. Accomplishments

There is the option to indicate “not yet started” and include the expected start date in this section. *NOTE: Images, tables, charts, or other graphics may be submitted in support of the Accomplishments section.*

## What are the major goals of the project?

The major goals of the LMRCSC are grouped as educational, research, and administrative goals.

### **Education Goals:**

1. Prepare the future workforce for marine and fisheries sciences through the relevant degree programs.
2. Strengthen collaborations across partner universities and professional networks to enhance academic programs in marine and fisheries sciences

### **Research Goal:**

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

### **Administration Goals:**

4. Organizational excellence for effective and efficient management of the programs and activities of the Center
5. Effectively communicate the activities and accomplishments of the Center
6. Assess and evaluate the Center’s goals and objectives

## What was accomplished under these goals (recipient must provide information for the 4 categories below)?

### 1. Major Activities:

#### ***Education Goals:***

***Student Recruitment Activities:*** The Center used this reporting period to engage in recruitment activities using various strategies including, but not limited to attending professional meetings and campus events. An accounting of these events is listed below by partner institution.

- HU** Handed out LMRCSC brochures, spoke to individual students with the required GPA, facilitated summer internship applications at UMES and SSU
- OSU** Advertised for opportunities on a variety of web platforms
- RSMAS** We held our annual graduate student recruitment event on Feb. 8, and interviewed 4 potential LMRCSC students for the class of 2019.
- SSU** We attended the ASLO conference and distributed program information. Met with ASLOMP students

#### ***Training and Preparation of students for careers in marine and fisheries science:***

The Center worked to plan the second “Literacy in NOAA mission related disciplines: A cohort experience” workshop to be held April 1-5 at UMES. Students will receive instruction from NOAA scientists and Center faculty, contribute to discussions, and participate in activities in the areas of Human Dimensions of Living Resource Management (i.e. Socio-economics); Ecosystem Science (life history, ecology, habitat assessment); Stock Assessment/Quantitative Ecology; Seafood Safety/Aquaculture; and the integration of all the areas. In the afternoons, students will take part in professional development discussions and activities. The tentative schedule of event along with

presenters is provided in Table 1.

Table 1: Tentative schedule of Literacy in NOAA Mission Related Disciplines: A Cohort Experience Workshop

Day	Morning Session - 8:30 am to Noon	Professional Development Session 1:00 pm - 2:30pm	Afternoon Session 2:45 - 6pm
Monday April 1, 2018	Welcome – Dr. Paulinus Chigbu Grant Writing Introduction - Dr. Bradley Stevens Sustainable Aquaculture - Dr. Rosemary Jagus & TBD	Cooperation and Collaboration in the Research Environment - Dr. Dionne Hoskins-Brown (SSU)	Sustainable Aquaculture - Dr. Rosemary Jagus & TBD
Tuesday April 2, 2018	Stock Assessment – Speakers: Dr. Elizabeth Babcock	Management/Professional Communication - - Victoria Young	Stock Assessment - Dr. Larry Alade (NOAA)
Wednesday April 3, 2018	Ecosystems Science - Speakers/Instructors - Dr. Jessica Miller; Dr. Chris Harvey (NOAA), Dr. Brian Wells (NOAA)	Grant Writing Collaboration work period - Dr. Bradley Stevens	Ecosystems Science - Speakers/Instructors - Dr. Jessica Miller; Dr. Chris Harvey (NOAA), Dr. Brian Wells (NOAA)
Thursday April 4, 2018	Human Dimensions – Kelly Beidenweg	Molecular Tools for the Environmental Biologist– Dr. Rosemary Jagus	Human Dimensions – Kelly Beidenweg
Friday April 5, 2018	Field trip to Deal Island, MD: a chance to observe blue crab fishery activities and hold discussions with stakeholders	Grant Writing Presentations	

**Enhanced engagement with NOAA Scientists to Identify Opportunities for NOAA**

**Experiential Training** – The Center has continued to enhance its engagement with NOAA scientists in order to identify mentors for LMRCS graduate and undergraduate students during the NERTO program and as members of their thesis or dissertation committees.

**Scott B. Gudes Public Service Graduate Scholarship in Marine Resource Conservation –**

Ms. Shadaesha Green (Ph.D. student, UMCES-IMET) is the second Scott B. Gudes Public Service Scholar in Marine Resource Conservation.

**Research Goal:**

Eleven (11) collaborative research proposals were recommended for funding in 2017-2018 following TAB review; the titles, names of lead PIs, and the research thematic areas to which they belong are presented in Table 2. These projects are well aligned with NOAA Fisheries research priorities. Seven of the lead PIs of the projects are located at LMRCS MSIs, hence the projects are helping to build sustainable capacities at the Center MSIs; eight of the lead PIs are graduate students.

**Table 2. TAB projects funded for FY 2018**

<b>Project #</b>	<b>Lead PI</b>	<b>Project Title</b>	<b>Research Thematic Area</b>	<b>Collaborators</b>
18-01	<b>Brittany King</b> , Ph.D. student, OSU	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	Social Science	K. Biedenweg, OSU; K. Werner, NOAA; S. Russell, NOAA
18-02	<b>S. Chung, IMET</b>	Baseline Data of Male Reproductive Status for Jonah Crab Management	Assessment	B. Stevens, UMES; Amanda Lawrence, M.S. student at IMET; B. Shank, NOAA
18-03	<b>LaTrese Denson</b> , Ph.D. student, RSMAS	Indices of abundance for King Mackerel in the Gulf of Mexico and South Atlantic improved by incorporating spatiotemporal and environmental variability	Assessment	E. Babcock, RSMAS; D. Hoskins-Brown, SSU; J. Walter, NOAA; J. Thorson, NOAA
18-04	<b>Tara Cox (SSU)</b>	Examining ecosystem health through contaminant analysis of common bottlenose dolphins ( <i>Tursiops truncatus</i> )	Assessment	C. Bonin Lewallen, HU; G. Ylitalo, NOAA
18-05	<b>Matthew Ramirez</b> , Ph.D. student, OSU	Integration of habitat-specific growth variation into assessment models: a case study in the Kemp's Ridley sea turtle	Assessment	S. Heppell, OSU; E. Babcock, RSMAS; J. Moore, NOAA; L. Avens, NOAA
18-06	<b>Detbra Rosales</b> , Ph.D. student, UMES	Assessing the Impacts of Harmful Dinoflagellates and <i>Vibrio</i> spp. on Oyster Aquaculture in the Delaware Inland Bays	Healthy Habitats	J. Pitula, UMES; J. Jacobs, NOAA
18-07	<b>Rebecca Wenker</b> , M.S. student, UMES	Cold-water corals in the Mid-Atlantic Bight: Age, colony complexity, and growth	Assessment	B. Stevens, UMES; V. Guida, NOAA
18-08	<b>Eric Lewallen, HU</b>	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys	Assessment	C. Bonin Lewallen, HU; L. Weitkamp, NOAA; L. Park, NOAA
18-09	<b>Brian Galvez</b> , M.S. student, DSU	Diet analysis of juvenile weakfish in the Delaware Bay using stomach content and stable isotope analysis	Assessment	S. Smith, DSU; M. Crawford, UMES; H. Townsend, NOAA
18-10	<b>Andre Price</b> , M.S. student, UMES	Feeding Ecology of Black Sea Bass at Selected Reef Sites using Gut Content and Stable Isotope Analyses	Assessment	B. Stevens, UMES; R. McBride, NOAA
18-11	<b>Enid Munoz</b> , M.S. student, UMES	Assessment of Microplastics and Polybrominated Diphenyl Ethers (PBDEs) in Scallops as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic, Southern New England, and Gulf of Maine Stock Fisheries	Healthy Habitats	A. Ishaque, UMES; A. Deshpande, NOAA; B. Sharack, NOAA

In addition, several projects supported with leveraged funds from various agencies including NOAA, NSF and USDA are on-going at the Center, and new proposals were developed and submitted to various agencies for funding.

**Data Management and QA/QC:** The Data Management course was offered again in Fall 2018. Thirteen (13) students were enrolled in it.

**Ethical Conduct of Research Training for Students and Faculty:**

- HU All scholars began training.
- OSU OSU FW has a course that all graduate students take that covers ethical conduct in research
- RSMAS Research Ethics (RSM 700) is offered every fall, and required for RSMAS graduate students
- UMES All students are required to complete the online CITI training in the Responsible Conduct of Research. Graduate students are advised to take MEES 608B: Responsible Conduct of Research

**Administration Goals:**

- a) Grant funds for FY 2019 have been subcontracted to LMRCSC institutions
- b) The Center advertised vacant personnel positions, including the Post-doctoral Research Fellow (SSU),
- c) Communication and Outreach Specialist (UMES) Tanisha Hankerson, and Coordinator for Budget and Data Management (UMES) Alex Kessie were hired and began work in November 2018.
- d) The Center conducted its monthly Executive Committee meetings, and Science Committee meetings

**2. Specific Objectives:**

The specific objectives of the project are listed under the goals below.

**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

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

**Objective 2.1:** Use relevant 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

**Objective 2.4:** Link students to professional networks and employment opportunities in marine and fisheries sciences

**Scientific Research Goal 3. Develop an exemplary capacity for scientific collaborations among partner institutions in the NOAA relevant 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: ecosystem change and prediction, stock assessment support, habitat research and protection, and safe seafood 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

**Administration Goal 4. Organizational excellence for effective and efficient management of the programs and activities of the Center**

**Objective 4.1:** Establish an Administrative Structure to enhance center operations and provide supportive environment for training and mentoring of students, and for research in marine and fisheries sciences

**Objective 4.2:** Monitor and ensure compliance with Center Award Conditions

**Administration Goal 5. Effectively communicate the activities and accomplishments of the center**

**Objective 5.1:** Develop infrastructure for effective and efficient internal and external communication

**Objective 5.2:** Develop an effective strategy for communication with students, faculty and administrators within the center, and increase visibility of the center through enhanced communication of its accomplishments to external stakeholders

**Administration Goal 6. Assess and evaluate the center's goals and objectives**

**Objective 6.1:** Assess and evaluate center educational programs

**Objective 6.2:** Assess and evaluate center research

**Objective 6.3:** Assess and evaluate administration

### 3. Significant Results:

#### ***Education Goals:***

Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 11 B.S. Twenty (20) students have been identified/recruited as members of Cohort 2 (2017-2018) including 9 Ph.D., 4 M.S., and 7 B.S. students. So far, fourteen (14) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 3 M.S. and 8 B.S. students. Recruitment for this period is on-going.

#### ***Recruitment of Rising Sophomores for Summer Experiential Training at the LMRCSC:***

Consistent with our goal specified in the Implementation Plan, rising sophomores are being recruited to participate in 2019 summer programs. Those students along with all sophomore undergraduates supported by the center, and unsupported students at partner institutions will receive guidance regarding applications to the Hollings and NOAA EPP Undergraduate Scholarships.

#### ***Scott B. Gudes Public Service Graduate Scholarship in Marine Resource Conservation:***

Ms. Shadaesha Green (Ph.D. student, UMCES) is the Scott B. Gudes Public Service Scholar in Marine Resource Conservation.

***Building of a Strong Center Cohort Community:*** The LMRCSC has developed plans for continuing to build a strong cohort community at the Center:

- a) The Cohort Experience Workshop will be held April 1-5, 2019 at UMES. Students will

participate in a variety of activities described in Table 1. Feedback from the students and instructors after the 2018 workshop have been used to improve the Cohort Experience workshop.

- b) Data Management course was taught in Fall 2018; and
- c) On November 6, 2018, Education Expert Dr. Victoria Young held an online forum for LMRCSC students to discuss the center and ask questions about requirements and expectations.
- d) Professional Development workshop was offered by Dr. Maggie Sexton biweekly for undergraduate students and monthly for graduate students during the academic year at UMES.
- e) At HU, students participate in weekly lab and monthly group meetings.

#### **Research Goals:**

Eleven collaborative proposals (Table 2) were funded/selected for funding by the LMRCSC after reviews by the Technical Advisory Board (TAB). Other research projects supported with leveraged funds from agencies such as NOAA, NSF, USDA, are on-going at the LMRCSC.

#### **Administration Goals:**

- a) Communication and Outreach Specialist (UMES) Tanisha Hankerson, and Coordinator for Budget and Data Management (UMES) Alex Kessie were hired and began work in November 2018.
- b) The Center held its monthly Executive Committee meetings during which plans to execute student development and professional activities were discussed.

#### **4. Key outcomes or other achievements:**

- a) A total of 57 students (23 in Cohort 1, 20 in Cohort 2, 14 in Cohort 3) have been recruited to the Center
- b) External Evaluation of the LMRCSC is continuing.
- c) New proposals have been submitted to various agencies to leverage funding in order to support additional students.

#### **What training and professional development were completed during the reporting period for Center post-secondary students, early professionals, postdocs, and faculty?**

Students recruited to the Center have begun taking courses to enable them acquire core competences in marine and fisheries science, and are defining their research projects. They have also discussed with their advisors the Student Development Plan.

- Thirteen (13) students enrolled in the Data Management for Scientists course that was offered in fall 2018.
- One Post-doctoral Fellow, Dr. Dan Cullen completed his six month residency at the NOAA Sandy Hook Laboratory.
- Six (6) students took part in NERTO internships at NOAA facilities under the supervision of NOAA scientists.

#### **How have the results been disseminated to communities of interest, including NOAA and other stakeholders?**

- Dr. Brad Stevens, LMRCSC Distinguished Research Scientist organized the annual meeting of the American Fisheries Society Tidewater Chapter that was held at Salisbury University, Salisbury, Maryland in February 2019. Five (5) LMRCSC students made presentations at the meeting.



- In addition, LMRCSC scientists and students have made several presentations of their work at many conferences.
  - For example, P. Chigbu served as a panelist at the UMCES Environmental Summit held at UMCES-IMET, Baltimore, MD., November 30, 2018, the theme of which was “Overcoming the challenges of inclusivity and diversity in STEM” Environmental Intelligence for the 21<sup>st</sup> century, during which he shared information about the LMRCSC programs, activities and accomplishments.
  - Dr. Victoria Young and LMRCSC PIs co-authored a poster entitled “The NOAA LMRCSC and its multifaceted approaches to facilitate student development and diversity in the marine sciences” that was presented at the American Meteorological Society meeting, Phoenix, AZ, January 6-10, 2019.

**What actions will be taken by the Center during the next reporting period to accomplish the goals?**

**Education Goals:** As examples, the Center will:

- a) Continue its efforts to recruit students into the Center; at present 14 students have been recruited into Cohort 3, including 3 Ph.D., 3 M.S. and 8 B.S.
- b) Offer to students a workshop on Literacy in NOAA related sciences in spring 2019.
- c) Work with sophomores supported during the Summer 2019, as well as other sophomores recruited during Fall 2019 to develop application packages for the NOAA undergraduate scholarship programs.
- d) Continue to engage NOAA scientists in order to enhance research collaborations and identify scientists to serve on graduate student thesis and dissertation committees; work with students to identify sites for NERTO.
- e) Continue to mentor students and encourage them to present research results at professional meetings, and publish their work in peer-reviewed journals.

**Research Goals:** As examples, the Center will:

- a) Continue to seek leveraged funds to support students.
- b) Select projects to fund after TAB review of the proposals
- c) Continue research on TAB funded projects and projects supported with leveraged funds.
- d) Continue efforts to publish results from prior awards and present at scientific meetings

**Administration Goals:** Examples are given below.

- a) Continue Executive Committee meetings
- b) Continue to collect data for evaluation of Center’s activities, programs, and accomplishments
- c) Continue to disseminate information about the Center to the public including producing Newsletters.
- d) Ensure that all students have taken Ethical Conduct of Research Training course
- e) Plan the LMRCSC Board of Visitors (BOV) meeting for 2019

## II. Products of Award

There are no limitations to the number of entries a Center submits. In reporting, keyword information can be directly pulled from Thomson Search and on Research.gov. *NOTE: Recipient may provide images, tables, charts, or other graphics in support of the Products section. Recipient may include high resolution photos.*



Within the Products section, recipient can list any products resulting from the FY16 CSC award, during the specified reporting period, such as:

**Degrees Awarded:** Stephanie Martinez-Rivera completed her Ph.D. at UMES in December, 2018.

**Publications in Journals:**

Tables 3 and 4 contain manuscripts published during this period and those currently under review. A justification of how each manuscript is associated with the LMRCSC is included to the right of the citation.

**Table 3a. Fourteen (14) publications (3 student authors identified by \*) produced by the Center; LMRCSC scientists are in bold**

Publications in journals	Justification	Status
Andrade, J.F.*, Hurst, T.P., & <b>Miller, J.A.</b> (2018). Behavioral responses of a coastal flatfish to predation-associated cues and elevated CO <sub>2</sub> . <i>J. of Sea Research</i>	2012 award student	2018
Forrestal, F.C., Schirripa, M., Goodyear, C.P., Arrizabalaga, H., <b>Babcock, E.A.</b> , Coelho, R., Ingram, W., Lauretta, M., Ortiz, M., Sharma, R. & Walter, J. (2019). Testing robustness of CPUE standardization and inclusion of environmental variables with simulated longline catch datasets. <i>Fisheries Research</i> 210: 1-13. doi:10.1016/j.fishres.2018.09.025	Leveraged	Published
Grüss, A., Drexler, M.D., Ainsworth, C.H., Roberts, J.J., Carmichael, R.H., Putman, N.F., Richards, P.M., Chancellor, E., <b>Babcock, E.A.</b> & Love, M.S. (2018). Improving the spatial allocation of marine mammal and sea turtle biomasses in spatially explicit ecosystem models. <i>Marine Ecology Progress Series</i> 602: 255-274. doi:10.3354/meps12640	Leveraged	Published
Grüss, A., Walter, J.F., <b>Babcock, E.A.</b> , Forrestal, F.C., Thorson, J.T., Lauretta, M.V. & Schirripa, M.J. (2019). Evaluation of the impacts of different treatments of spatio-temporal variation in catch-per-unit-effort standardization models. <i>Fisheries Research</i> 213:75-93. doi: 10.1016/j.fishres.2019.01.008	Leveraged	Published
Grüss, A., Drexler, M.D., Chancellor, E., Ainsworth, C.H., Gleason, J.S., Tirpak, J.M., Love, M.S., & <b>Babcock, E.A.</b> (2019). Representing species distributions in spatially-explicit ecosystem models from presence-only data. <i>Fisheries Research</i> 210: 89-105 doi:10.1016/j.fishres.2018.10.011	Leveraged	Published
Hurst, T.P., <b>Miller, J.A.</b> , Ferm, N., Heintz, R.A., & Farley, E.V. (2018). Spatial variation in potential and realized growth of juvenile Pacific cod in the Bering Sea. <i>Marine Ecology Progress Series</i> 590: 171-185	Leveraged	2018
Moore, T.N.* and Cuker, B.E. (2018). Sedimentary Oxygen Demand and Orthophosphate Release: Sustaining Eutrophication in a Tributary of the Chesapeake Bay. <i>Journal of Water Resources and Ocean Science</i> . 7:42-48. doi: 10.11648/j.wros.20180703.13	T.N. Moore was a LMRCSC supported student	Published

Pearcy, W. & <b>Miller, J.A.</b> (2018). Otolith microchemistry of coastal cutthroat trout from Marys and Willamette Rivers. <i>Northwestern Naturalist</i> , 99: 101-114	Leveraged	2018
Ramirez*, M.D., <b>Miller, J.A.</b> , Parks, E., Avens, L., Seminoff, J. A., Goshe, L.R., & Heppell, S.S. (2019). Trace element analysis of sea turtle humeri using LA-ICP-MS: applications to life history reconstruction. <i>Marine Ecology Progress Series</i>	LMRCSC Cohort 2 student	2019
Rosenberger, A., C. Zimmerman, D. Noakes, R. Taylor, E. Keeley, J. Musick, R. Phillips, <b>A. Horodysky</b> , M. Neilson, T. Ray, & J. Neilson. Salmonidae. In: <i>Diversity of North American Freshwater Fishes: Natural History, Ecology, and Conservation, Volume II.</i>	Horodysky is a TAB recipient.	Published
Schweitzer*, C.C., Lipcius, N.R. & <b>Stevens, B.G.</b> (2018). Impacts of multi-trap-line on benthic habitat containing emergent epifauna within the Mid-Atlantic Bight. <i>ICES Journal of Marine Science, Volume 75: 6, 2202–2212</i>	TAB Project	Published
Walters, T.; Lambole, L.; Lopez-Figueroa, N.; Rodriguez-Santiago, A.; <b>Gibson, D.</b> & Frischer, M. (2018). Diet and trophic interactions of a circumglobally significant gelatinous marine zooplankton, <i>Doliolita gegenbauri</i> (Uljanin, 1884), <i>Molecular Ecology, MEC-18-0609.</i>	HU PI	Published
Oseji, O.F.* , Fan, C., & <b>Chigbu, P.</b> (2019). Composition and dynamics of phytoplankton in the Coastal Bays of Maryland revealed by microscopic counts and diagnostic pigments. <a href="https://doi.org/10.3390/w11020368">Water doi.org/10.3390/w11020368.</a>	LMRCSC PI	Published
<b>Chung, J.S.</b> , Huang, X., Bachvaroff, T.R., Lawrence*, A., <b>Pitula, J.S.</b> & <b>Jagus, R.</b> (2019). Infection by <i>Callinectes sapidus</i> reovirus increases transcript levels of eukaryotic translation initiation factor 4E(eIF4E) family members and eIF4E binding protein (4E-BP) in the hemocytes and eyestalk ganglia of the blue crab, <i>C. sapidus</i> . <i>Journal of Shellfish Research</i> (In Press).	UMCES IMET PI	In Press

**Table 3b. Four (4) publications under review or accepted (5 student authored identified by \*) were produced by the center**

Publications under review or accepted	Justification	Status
Cruz-Marrero*, W., <b>Cullen, D.</b> , <b>Stevens, B.G.</b> & Gay, N.C. (2019). <i>In situ</i> habitat characterization of Maryland offshore wind sites; Developing sampling techniques for image data sets. Revision process for PloSOne.	Leveraged	Under Review
Cruz-Marrero*, W., Touhy, C., <b>Stevens, B.G.</b> & Appeldoorn, R.A. (2019). Comparing divers and camera sled surveys: an improvement for fisheries independent data for queen conch in Puerto Rico. Revision process for Proceedings	Leveraged	Under Review
Schweitzer*, C.C., <b>Horodysky, A.Z.</b> , Price*, A.L. & <b>Stevens, B.G.</b> (2019). Impairment indicators for delayed mortality in black sea bass ( <i>Centropristis striata</i> ) discards in the commercial trap fishery. under review: Conservation Physiology	TAB	Under Review

Schweitzer*, C.C. & <b>Stevens B.G.</b> (2019). The importance of soft coral sea whips ( <i>Leptogorgia</i> sp.) to fish abundance on artificial reefs in the mid-Atlantic Bight. under review: PeerJ	TAB	Under Review
Oghenekaro, E.U. & <b>Chigbu, P.</b> (2019). Population dynamics and life history of marine Cladocera in the Maryland Coastal Bays. Journal of Coastal Research.	Leveraged; LMRCSC PI	Under Review
<b>Chigbu, P.</b> , Malinis, L., Malagon, H.* & Doctor, S. (2019). Influence of temperature on the occurrence and distribution of sand shrimp ( <i>Crangon septemspinosa</i> ) in mid-Atlantic Coastal Lagoons. Journal of Crustacean Biology.	Leveraged; LMRCSC PI	Under Review

**Table 3c: One (1) dissertation was produced by the center; LMRCSC student is in bold.**

Theses/Dissertations	Justification
<b>Martinez-Rivera, S.</b> (2018). Reproductive biology of red deep-sea crab in the Mid-Atlantic Bight	Cohort 1 Student

### Conference Papers, Posters and Presentations:

The following tables contain presentations made during this period. A justification of how each manuscript is associated with the LMRCSC is included to the right of the citation.

**Table 4a. Seventeen (17) oral presentations (13 student presenters); LMRCSC Scientists in bold**

Oral presentations at professional meetings	Justification
Cruz-Marrero, W.*, Touhy, C. & <b>Stevens, B.G.</b> , Appeldoorn, R.A. (2018). Comparing divers and camera sled surveys: an improvement for fisheries independent data for queen conch in Puerto Rico. Gulf and Caribbean Fisheries Institute. San Andres, Colombia, November 2018.	LMRCSC Cohort 3 Student
Fenwick*, I., Salcedo, A., Leslie, J., Rogers, J. & <b>Gibson, D.</b> (2018). An Innovative Approach to Oyster Reef Restoration and Understanding Our Waterways. <i>90<sup>th</sup> Annual National Technical Association (NTA) Conference</i> . Hampton University, Sept. 26-28, 2018.	LMRCSC Cohort 1 student
Galvez*, B., Townsend, H. & <b>Smith, S.</b> (2019). Trophic ecology of Delaware Bay weakfish using stomach content and stable isotope analyses. Presented at the Association for Sciences of Limnology and Oceanography (ASLO) meeting, San Juan, PR, February 2019.	LMRCSC Cohort 1 student
<b>Gibson, D.</b> (2019). Hampton University's Impact on Marine Science Research. Presented at And Still I Rise symposium at Nauticus Museum, Feb. 2019.	LMRCSC PI at HU
<b>Gibson, D.</b> (2019). Underrepresented But Not Forgotten: The Making of a Marshall Scholar. Presented at the ASLO meeting, San Juan, PR, Feb. 2019.	LMRCSC PI at HU
Kleponis*, N. & <b>Heckscher, C.</b> (2019). The winter habitat of the protected species the red-throated loon. Presented at the Pacific Seabird Group Conference, Kauai, HI (2019).	LMRCSC Cohort 2 student
Layton*, J. (2019). The Feeding Ecology of Pacific Lampreys Assessed by Gut Fullness and Prey Identification. Presented at the ASLO meeting, San Juan, PR, Feb. 2019.	LMRCSC Cohort 2 student

Oliver*, I. (2018). Exploring Ocean optical Properties using Satellite and <i>in-situ</i> Data. National Technical Association, Hampton, Virginia September, 26-28, 2018.	LMRCSC Cohort 1 Student - NOAA EPP Undergraduate Scholar
Ramirez, M.D.*, Avens, L. & <b>Heppell, S.S.</b> (2018). Intrapopulation variation in resource use by Kemp's ridley sea turtles revealed through combined skeletal and stable isotope analyses. 11th International Conference on the Applications of Stable Isotope Techniques to Ecological Studies (IsoEcol 2018), Viña del Mar, Chile. Oral Presentation	LMRCSC Cohort 2 student
Ramirez, M.D.*, Avens, L., Goshe, L.R., Snover, M.L. & <b>Heppell, S.S.</b> (2019). Density-independent decline in Kemp's ridley somatic growth rates following the Deepwater horizon oil spill. International Symposium on Sea Turtle Biology and Conservation, Charleston, SC. Oral Presentation	LMRCSC Cohort 2 student
Rosales*, D., <b>Ozbay, G., Parveen, S.</b> , Jacobs, J. & <b>Pitula, J.S.</b> (2019). Harmful Algae Succession and Vibrio Association in the Delaware Inland Bays. AFS Tidewater Annual Meeting, Salisbury University, Feb. 2019	LMRCSC Cohort 1 student
Rubalcava, K.* & <b>Chigbu, P.</b> (2019). Influence of Environmental Factors on the Abundance and Growth of Spot ( <i>Leiostomus xanthurus</i> ), in the Maryland Coastal Bays. AFS Tidewater Chapter Meeting, Salisbury University, February 2019	LMRCSC Cohort 2 Student
Rubalcava, K.* & <b>Chigbu, P.</b> (2019). Recruitment and Density-dependent growth of Spot ( <i>Leiostomus xanthurus</i> ) in the Maryland Coastal Bays. ASLO 2019 San Juan, Puerto Rico.	LMRCSC Cohort 2 Student
Wenker, R.P. * & <b>Stevens, B.G.</b> (2019). Sea Whip coral ( <i>Leptogorgia virgulata</i> ) in the Mid-Atlantic Bight: Age, colony complexity and distribution. AFS Tidewater Annual Meeting, Salisbury University, February 2019.	LMRCSC Cohort 1 Student
Wenker, R.P. * & <b>Stevens, B.G.</b> (2019). Sea Whip coral ( <i>Leptogorgia virgulata</i> ) in the Mid-Atlantic Bight: Age, colony complexity and distribution. ASLO 2019 Aquatic Sciences Meeting. February 23-March 2. San Juan, Puerto Rico.	LMRCSC Cohort 1 Student
Das, N., Mayor, E. & <b>Chigbu, P.</b> (2019). Population dynamics of blue crabs in the Maryland Coastal Bays. ASLO, Puerto Rico, Feb. 24 to March 1, 2019.	LMRCSC PI
DaSilva, L.V., Ossai, S., <b>Chigbu, P. &amp; Parveen, S.</b> (2019). Characterization of <i>Vibrio vulnificus</i> isolated from environmental and blue crab samples collected from Maryland Coastal Bays. ASLO, Puerto Rico, Feb. 24 to March 1, 2019.	LMRCSC PI

**Posters: 22 (\*15 student presenters)**

Poster presentations at professional meetings	Justification
Best-Otubu, C.*, Crumrine, P. (2018). The effect of predator personality on intraguild predation in aquatic insects. 90th Annual National Technical Association, (NTA) Conference, Hampton University, September 26th - Sept 28th, 2018.	LMRCSC Cohort 1 Student
Cruz*, K., Rittman, J., Carter, N., Carter, K., Pressley, N., Milton, I.*, Layton, J.*, Smith, N.*, <b>Bonin, C.</b> & Lewallen, E.A. High-Throughput Genetic Techniques for Monitoring Black Sea Bass Abundance in the	LMRCSC Cohort 3 student

Denson*, L., <b>Babcock, E.A.</b> & Thorson, J. (2018). The effect of spatial and temporal variation on larval indices used for King mackerel in the northern Gulf of Mexico. Presented at Hamburg University for the International Council for the Exploration of the Seas Annual Science Conference, Hamburg, Germany, September, 2018. Poster Presentation	TAB, Cohort 2 student
Dorsey*, K., et al. (2018). Effect of Ocean Acidification on Auditory Neurobiology in a tropical Marine Fish. 90th Annual National Technical Association (NTA) Conference. Hampton University Sept. 26-28, 2018.	LMRCSC Cohort 2 student
Dorsey*, K., et al. (2019). Comparison of the Visual Neurobiology in a tropical Marine Fish Under Ocean Acidification. Presented at the ASLO meeting, San Juan, PR, Feb. 2019	LMRCSC Cohort 2 student
Fenwick*, I., et al. Herbivory Increases Energy Allocation Towards Reproduction in Small <i>Turbinaria ornata</i> . Presented at the ASLO meeting, San Juan, PR, Feb. 2019	LMRCSC Cohort 1 student
Freeman*, D.; Deshpande, A.; Lynch, J.; Lascelles, N.; Drayton, D.*; Brignac, K.; Jung, M.; <b>Hoskins-Brown, D.</b> : Comparing 2 Methods To Characterize The Chemical Components Of Marine Plastic Debris	LMRCSC Cohort 2 student
Hart, J.N.M., Ramirez, M.D. *, Chasco, B., Kenney, A., Nemyre, N., Piacenza, S.E., Rincon-Diaz, M.P., VanBemmel, M., <b>Heppell, S.S.</b> (2019). Identifying data needs for sea turtle demographic studies: a data gap analysis. International Symposium on Sea Turtle Biology and Conservation, Charleston, SC. Poster Presentation.	LMRCSC Cohort 2 student
Layton*, J.M., Bonin, C.A., Pressley, N., Park, L.K., Weitkamp, L.A. & Lewallen, E.A. (2018). Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys. <i>90<sup>th</sup> Annual National Technical Association (NTA) Conference</i> . Hampton University Sept 26-28, 2018.	LMRCSC Cohort 2 student
Mayes*, C., Horodysky, A., Bonin, C., Fogarty, M., Gibson, D., Wiley, S. & Lewallen, E.A. (2018). Ecosystem Based Approaches to Modeling Fish Species Distributions in the Atlantic. 90th Annual National Technical Association Conference, Hampton University, Hampton, VA, September 28-29, 2018.	LMRCSC Cohort 1 student
Milton*, I.A., Smith, N.N., Goebel, M., Krause, D., Lewallen, E.A., Barreto, F., Hoffman, J. & Bonin, C.A. (2018). Social Structure of Leopard Seal, <i>Hydrurga leptonyx</i> , at Livingston Island, Antarctica. <i>90<sup>th</sup> Annual National Technical Association (NTA) Conference</i> . Hampton University Sept 26-28, 2018.	LMRCSC Cohort 1 student
Milton*, I., et al. (2019). Coral Reef Structural Complexity Impacts Ecosystem Functions. Presented at the ASLO meeting, San Juan, PR, Feb. 2019.	LMRCSC Cohort 1 student
Pereiera*, V. & <b>Pitula J.S.</b> (2019). Exploring the parasitic Dinoflagellate <i>Hematodinium perezii</i> and Vibrio Bacteria Co-infection in the hemolymph of <i>Callinectes sapidus</i> from the Maryland Coastal Bays. AFS Tidewater Annual Meeting February 2019	Leveraged

Popovska, T., <b>Babcock, E.</b> , Ramirez, M.D.* , Avens, L., Goshe, L.R. & <b>Heppell, S.S.</b> (2019). A meta-analysis of somatic growth in sea turtles. International Symposium on Sea Turtle Biology and Conservation, Charleston, SC. Poster Presentation.	LMRCSC Cohort 2 student
Popovska, T., Ramirez, M.D. & <b>Babcock, E. A.</b> (2019). A meta-analysis of somatic growth in sea turtles. Presented at the International Sea Turtle Symposium, Charleston, South Carolina. February 2-8, 2019.	TAB
Smith*, N.N., Milton, I.A., Cox, T., Kellar, N., Trego, M., Morin, P., <b>Lewallen, E.A.</b> & <b>Bonin, C.A.</b> (2018). Assessing the utility of microRNAs as biomarkers for marine mammal health. <i>90<sup>th</sup> Annual National Technical Association (NTA) Conference</i> . Hampton University Sept 26-28, 2018.	LMRCSC Cohort 1 student
Smith*, N.N., et al. (2019). Sea Urchin Importance in cropping Algal Turf and Removing Sediment on Coral Reefs. Presented at the ASLO meeting, San Juan, PR, Feb. 2019.	LMRCSC Cohort 1 student
Tay*, S. & Kaltenberg, A. (2019). Seasonality of the Gulf Stream current velocity off Cape Hatteras, NC. Presentation at the Emerging Researchers National Conference in Washington D.C. Feb. 2019.	LMRCSC Cohort 2 student
VanBemmel, M., Ramirez, M.D.* , Chasco, B., Kenney, Hart, J.N.M., Nemyre, N., Piacenza, S.E., Rincon-Diaz, M.P. & <b>Heppell, S.S.</b> (2019). A global synthesis of sea turtle life history data for demographic studies: a case study in the loggerhead sea turtle. International Symposium on Sea Turtle Biology and Conservation, Charleston, SC. Poster Presentation	LMRCSC Cohort 2 student
<b>Young, V.</b> , Hoskins-Brown, D., Chigbu, P., Sexton, M., Gibson, D., Jagus, R., Babcock, E., Miller, J., Smith, S.L., & Stevens, B. (2019). The NOAA LMRCSC and its multifaceted approaches to facilitate student development and diversity in the marine sciences. American Meteorological Society meeting, Phoenix, AZ, January 6-10, 2019.	LMRCSC PIs
Morales, A. & <b>Chigbu, P.</b> (2019). The community structure of soft-bottom macrobenthic fauna in dead-end canals in the Maryland Coastal Bays, USA. ASLO, Puerto Rico, Feb. 24 to March 1, 2019.	LMRCSC Scientists
Elfadul, R., Jesien, R., Elnabawi, A., <b>Chigbu, P.</b> & <b>Ishaque, A.</b> (2019). Analysis of emerging contaminants in Maryland Coastal Bays using <i>in vitro</i> bioassays as biological screening tools. ASLO, Puerto Rico, Feb. 24 to March 1, 2019.	LMRCSC Scientists

**Other Publications:** None

**Technologies or Techniques:** None

**Patents:** None

**Inventions:** None

**Websites:** [www.umes.edu/lmrcsc](http://www.umes.edu/lmrcsc)

**Products:** None

### III. Participants in Award Performance

There are no limits on the number of participants listed for this section; however, the Center is required to list all participants who have worked one-person month or more for the project reporting period. *NOTE: Conversion of percentage of effort to person months is as follows. To calculate person months, multiply the percentage of effort associated with the project times the number of months of the appointment. For example: 25% of a 9 month academic year appointment equals 2.25 (AY) person months (9 x 0.25= 2.25).*

**For the reporting period, specific questions are listed below. For award participants, recipient must provide information for:**

1. What individuals have worked on the project?
2. What organizations have been involved as partners?
3. What other collaborators have been involved?

**1. What individuals have worked on the project?**

First name	Last Name	Partner Institution	Most Senior Project Role	Project Hours Worked per Month
Christopher	Heckscher	DSU	Participating	10
Dennis	McIntosh	DSU	Participating	10
Gulni	Ozbay	DSU	Participating	10
Stacy	Smith	DSU	Principal Investigator (PI)	80
Deidre	Gibson	HU	PI	40
Carolina	Lewallen	HU	Faculty	80
Jessica	Miller	OSU	PI	80
Elizabeth	Babcock	RSMAS	PI	7
David	Die	RSMAS	Faculty	3.5
Tara	Cox	SSU	Faculty	20
Sue	Ebanks	SSU	Faculty	10
Dionne	Hoskins-Brown	SSU	PI	40
Victoria	Young	SSU	Education Expert	160
Paulinus	Chigbu	UMES	LMRCSC PI	80
Tanesha	Hankerson	UMES	Communications & Outreach Specialist	124
Alexander	Kessie	UMES	Coordinator for Budget & Data Management	160
Judith	Rose	UMES	Program Coordinator	76
Cy'Anna	Scott	UMES	Recruiter/Geoscience Coordinator	80
Margaret	Sexton	UMES	Interim Assistant Director	160
Bradley	Stevens	UMES	DRS	160
Ida	Tilghman	UMES	Administrative Assistant	160



## 2. What organizations have been involved as partners?

Provide additional information such as:

1. Type of Partner Organization:
2. Name:
3. Location:
4. Partner's Contribution to the Project:

Type of partner organization	Name	Location	Partners contribution to the project
State government	NJDEP	Ocean County, NJ	Helped students collect samples
Non profit	Chesapeake Bay Foundation	Richmond, VA	Helped students with oyster restoration project
Tribal government	Columbia River Inter-tribal Fish Commission	Portland OR	Intellectual investment, samples, collaborative research
Federal government	NEFSC	Milford, CT	JSAN Training for students
Federal government	NEFSC	Sandy Hook, NJ	NERTO

Have other collaborators or contacts been involved? Yes

If Yes, describe involvement and time spent.

Last name	First name	Title/Affiliation	Description of involvement
Coyne	Kathy	DE Sea Grant head/Prof UD	Helping student with DNA analysis/lab space
North	Heather	Oyster tech, CBF	Helped students with oyster restoration project
Hess	Jon	Columbia River Intertribal Fish Commission	Working with Pelekai on thesis research
Parveen	Salina	Food & Environmental Microbiology Professor, UMES	Helped with students' graduate research
Straub	Peter	Professor, Stockton University	Collaborated with students using a scientific freeze-dryer
McGillis	Wade	Professor, Lamont-Doherty earth Observatory, Columbia University	Collaborated with students using their particle counter coupled with a Raman Spectrometer
Seethapathy	Suresh	Scientist, Thermo Fisher	Advised on Thermo Scientific Trace 1310 Gas Chromatograph - TWQ 8000 Evo Triple Quadrupole Mass Spectrometer
Gallanger	Scott	Woods Hole Oceanographic Institution	Consulted on microplastic polymer identification.

**Have NOAA collaborators or contacts been involved?** Yes

If Yes, describe involvement and time spent.

Last name	First name	Title/Affiliation	Description of involvement
Avens	Larisa	NEFSC	Committee member for M. Ramirez (LMRCSC OSU Graduate student)
Baker-Yeboah	Sheekela	NOAA EPP/MSI	Mentor for India Oliver (LMRCSC UMES Undergraduate student)
Caldwell	Phil	SEFSC	Serves on an internal committee to collaborate of the use of UAS for habitat monitoring in the South Atlantic, Gulf, and Caribbean
Cortes	Enric	SEFSC	Ph.D. committee member and NERTO mentor for Halie O'Farrell (LMRCSC RSMAS Graduate student)
Croxton	April	NOAA, OAR	Mentor for Jorge Rodriquez (LMRCSC UMES Graduate Student)
Deshpande	Ashok	NEFSC	M.S. committee member of Davielle Drayton (LMRCSC SSU student); Mentor for Enid Munoz Ruiz (LMRCSC UMES Graduate student)
Fogarty	Michael	NEFSC	NERTO advisor for Cristin Mayes (LMRCSC HU Graduate student)
Guida	Vince	NOAA, NMFS	NERTO mentor for Rebecca Wenker (LMRCSC UMES Graduate student), and mentor for Daniel Cullen (LMRCSC UMES Post-doctoral Research Associate)
Hill	Ron	SEFSC	Serves on an internal committee to collaborate on the use of UAS for habitat monitoring in the South Atlantic, Gulf, and Caribbean
Laurel	Ben	AFSC	Committee member for Pelekai (LMRCSC OSU Graduate student)
Merino	Joy	SEFSC	Serves on an internal committee to collaborate of the use of UAS for habitat monitoring in the South Atlantic, Gulf, and Caribbean
Burton	Mike	NOAA Beaufort, NC Lab	Mentor for Cara Schweitzer (LMRCSC UMES Graduate student)
Moore	Jeffery	SWFSC	NERTO mentor for M. Ramirez (LMRCSC OSU Graduate student)
Sharack	Beth	NOAA, Sandy Hook	NERTO mentor for Enid Munoz Ruiz (LMRCSC UMES Graduate student)
Sharma	Rishi	NWFSC	Collaborator
Tellison	Todd	NMFS	Mentor for Cara Schweitzer (LMRCSC UMES Graduate student)
Thorson	James	AFSC	NERTO mentor for LaTreeese Denson (LMRCSC RSMAS Graduate student)

Townsend	Howard	NEFSC	M.S. committee member; mentor for Kasondra Rubalcava (LMRCSC UMES Graduate student)
Walter	John	SEFSC	Collaborator
Weitkamp	Laurie	NWFSC	Committee member for Pelekai (LMRCSC OSU Graduate student)
Wikfors	Gary	NOAA, NMFS	NERTO mentor for Jorge Rodriguez (LMRCSC UMES Graduate student)
Zamon	Jen	NWFSC	M.S. committee member

## IV. Impacts of Award

### What is the impact on the development of future workforce candidates for the principal discipline(s) of the award and NOAA mission-aligned support of the project?

Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 11 B.S. Twenty (20) students have been recruited to Cohort 2 (2017-2018) including 9 Ph.D., 4 M.S., and 7 B.S. students. So far, Fourteen (14) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 3 M.S. and 8 B.S. students; at least 10 of them belong to underrepresented minority groups. LMRCSC activities focus on training programs that are preparing students for work on essential fish habitat, marine protected species and ecosystems. The future workforce candidates, our students, are gaining valuable experiences via the cohort experience so they will have colleagues after they graduate. Developing these relationships early will help them in the future. The NOAA mentor experience will prepare students for their first NOAA 'job' experience. Under the tutelage of a mentor, the students will develop work skills, such as co-worker interactions, proper workplace etiquette, etc.

### What is the impact on other disciplines and Program Level Outputs and Outcomes aligned with the 2016 FFO?

Nothing to report.

### What is the impact on the development of candidates for the NOAA mission future workforce?

The LMRCSC, through its Student Development Plan, will produce a cadre of more prepared students for careers in marine and fisheries science. The presence of the LMRCSC and its support for students has attracted other interested students to ask about NOAA careers.

Angie Munguia (LMRCSC student at OSU) who is scheduled to graduate in Spring 2019, has secured employment at the Oregon Health Sciences University in Portland, OR.

### **What is the impact of the Center activities to building institutional capacity in support of the objectives of the NOAA FY16 CSC award?**

The project is helping the Center to build capacity at Center Institutions through hiring of postdoctoral fellows, new staff, and support of scientists in NOAA related science disciplines, and enhanced collaboration with NOAA scientists. Funds leveraged from external sources by Center scientists are being used to train additional students and to build infrastructure for research and education. The Center is establishing federal guidelines as an expectation of minimal student support. These are unprecedented and are communicating a standard for what is needed to guide a student through a degree. The LMRCSC award supports student research to a degree that allows students to explore more sophisticated approaches with distant collaborators - something that would not be possible without the one-time \$10,000 in research support.

### **What is the impact of the NOAA award on the Center's data and information resources?**

The NOAA award has enabled the LMRCSC to acquire fisheries and environmental data from research activities that have been or are being used for publications and presentations at professional meetings. Additionally, data on student enrollment, graduation and participation in professional development activities are being collected and are being used together with results from the assessments and evaluations of the Center by LMRCSC external evaluators to improve on the Center's performance, and to determine the extent to which the Center is accomplishing its goals and objectives.

### **To whom and how is this information and the Center accomplishments communicated?**

Research results have been published, and presented at scientific meetings and stock assessment working groups.

### **How has the Center successfully conducted transfer of research results and new technologies in support of NOAA mission-aligned R2X?**

- DSU: Students and PIs attend meetings, present poster and talks, and are thereby informing others of the research results from the center.
- RSMAS: Research results have been published, and presented at scientific meetings and stock assessment working groups.
- UMCES: Grad student Hanif assisting NOAA-COL scientists, Leight and Skelley with microbial community analysis of the Tred Avon, Choptank River tributary, using high-throughput sequencing. Hanif is also helping NCCOS Monitoring & Assessment Branch to characterize microplastics in Great Lakes mussels (seeking training from Dr. Ashok Deshpande, Sandy Hook).

### **What were the societal impacts of the Center research activities? How were or are the impact results communicated to the general public.**

- HU Faculty and students are being invited to give talks, serve on panels, and work with K-12 students on Center related research.
- RSMAS PhD students participated in outreach activities for elementary and high school students, and helped organize an event on diversity and inclusion at RSMAS
- UMES Enid-Munoz-Ruiz mentored an undergraduate at UMES on microplastic research with Oysters from the Chesapeake Bay. Rebecca Wenker, Enid Munoz-Ruiz, and Kasandra

Rubalcava aided in organizing, planning, and running the 33rd annual meeting of the American Fisheries Society (AFS) Tidewater Chapter (February 7-9, 2019) that was held at Salisbury University, Salisbury, MD. Students and professionals presented their research on fisheries and related topics. Wilmelie Cruz Marrero was a graduate mentor for underrepresented students at the University of Puerto Rico. She guided and trained four students from the university in underwater video systems. She also evaluated their development during the sampling survey, helped them improve their skills during the process, and carried out outreach events informing students about the application process for graduate school. Kasondra Rubalcava as part of the AFS student subunit, attended multiple outreach events: 10/13/2018- Manning educational booth at the Fall 3K fun walk and run event at UMES to educate and inform the over 100 participants using live fish, microscopes, flash cards, etc. 11/7/2018 - Manning educational booth on Fisheries and Environmental Science at the STEM Festival at UMES. 300-400 participants were present. Semaj Fielding volunteered at the freshman convocation, gave several tours and spoke to potential UMES students about the LMRCSC program. Nafia Coit mentored a freshman female at UMES. Enid Munoz-Ruiz participated at the chemistry table at SUBMERGE! NYC Marine Science Festival, NYC September 29, 2018.

## V. Changes/Challenges

If not previously reported in writing to NOAA through other mechanisms, provide the following additional information or state, "Nothing to Report", if applicable.

### **Changes in performance of the award objectives - approach and reason(s) for change:**

Two candidates for the SSU postdoc position were interviewed in January 2019. The federal government shutdown shifted this activity to March.

### **Actual or anticipated problems or delays and actions or plans to resolve them:**

- SSU Accommodating the candidate's and the committee's schedules is extending the process. Revisions have been made to the hiring process regarding postdocs as faculty and not staff (as they had been hired before) and require several more steps for evaluation and selection.
- UMES During the government shutdown students deployed for NERTO remained in place for the remainder of their 3 months and waited for the government to reopen. In the future, students and NOAA mentors will be asked to include a back-up plan in their NERTO plans in order to avoid lost productivity in the event of a shutdown during the internship.

### **Changes that have a significant impact on expenditures:**

Nothing to report.

## VI. Special Award Conditions

This report section is intended to provide information on progress under each special award condition for the specific reporting period. This is not cumulative reporting.

Accomplishments (provide evidence) in implementing of:  
**Center Evaluation – activities completed for the Evaluation Plan that assess program progress and measures, the impact of activities related to intended education, and training, research and outcomes of the CSC.**

The report of the year 3 External Evaluations of the LMRCSC conducted during this reporting period by a team from the College of Explorations (COE) is presented in Appendix I.

**Direct Student Support** – Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 11 B.S. Twenty (20) students have been recruited to Cohort 2 (2017-2018) including 9 Ph.D., 4 M.S., and 7 B.S. students. So far, fourteen (14) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 3 M.S. and 8 B.S. students.

### Participant Beneficiaries

Increase in the number of undergraduate and graduate students who gain NOAA mission-relevant STEM discipline-specific knowledge and skills that are the primary focus of the Center Type award (i.e. Atmospheric Sciences and Meteorology, Coastal and Marine Ecosystems, Earth System Sciences and Remote Sensing Technologies, and Living Marine Resources), enroll and complete degrees, and are prepared to enter NOAA mission-aligned STEM careers or pursue advanced education.

**EPP CSC Award Postsecondary Student Cohort(s) Supported (provide for each student by name):**

1. Tuition, 2. Stipend, 3. Travel, 4. NERTO, 5. One-time Research:

First	Last	Cohort #	Degree	Partner	Tuition	Stipend	Travel	NERTO	One-time Research Support	Professional Development
Ileana	Fenwick*	1	B.S.	HU		\$5,250				
Isaiah	Milton*	1	B.S.	HU		\$5,000				
Nefertiti	Smith*	1	B.S.	HU	\$10,000					
Dante	Freeman*	1	B.S.	SSU	\$12,000			NA	NA	
Nakia	Coit*	1	B.S.	UMES	\$4,151	\$770				
Nylah	McClain*	1	B.S.	UMES	\$4,151	\$1,202				\$2,025
India	Oliver*	1	B.S.	UMES		\$0				
Malisa	Smith*	1	B.S.	UMES						
Chryston	Otubu*	1	B.S.	UMES	\$4,151	\$1,889				
Brian	Galvez*	1	M.S.	DSU	\$3,760	\$9,692	\$2,980			
Amanda	Pappas*	1	M.S.	DSU	\$11,376	\$9,692				
Cristin	Mayes*	1	M.S.	HU	\$10,942	\$9,000				

Angie	Munguia*	1	M.S.	OSU	\$0	\$0	\$0	\$0	\$0	
Hillary	Thalman	1	M.S.	OSU	\$9,160	\$9,250	0			
Rebecca	Wenker	1	M.S.	UMES	\$2,124	\$9,688		\$5,056		
Halie	O'Farrell*	1	Ph.D.	RSMAS	\$3,920	\$7,431		\$11,592		
Stephanie	Martinez-Rivera*	1	Ph.D.	UMES	\$1,742	\$10,620		\$2,903	\$419	
Detbra	Rosales*	1	Ph.D.	UMES	\$876	\$10,647		\$240	\$11,666	
Kendra	Dorsey*	2	B.S.	HU	\$10,000					
Janelle	Layton*	2	B.S.	HU		\$5,000				
Aris-Aja	Horsey*	2	B.S.	UMES	\$4,151	\$424				
Desmond	Love*	2	B.S.	UMES		\$0				
DaQuan	Davis*	2	B.S.	UMES	\$4,151	\$1,162	\$223			
Joe	Day*	2	BS	SSU	\$12,000			NA	NA	
Sena	Tay*	2	BS	SSU	\$6,994			NA	NA	
Nicole	Kleponis	2	M.S.	DSU	\$8,304	\$9,692	\$1,290			
Davielle	Drayton*	2	M.S.	SSU	\$1,339	\$12,600		\$0	\$331	
Andre	Price*	2	M.S.	UMES	\$823	\$9,300		\$3,447	\$1,471	
Enid	Munoz-Ruiz*	2	M.S.	UMES	\$2,075	\$12,865		\$969	\$2,907	
Jorge	Rodriguez*	2	M.S.	UMES	\$1,255	\$14,723		\$2,500		
Brittany	King*	2	Ph.D.	OSU	\$9,160	\$9,900	\$710	\$0	\$0	
Matthew	Ramirez*	2	Ph.D.	OSU	4580	6200		9950		
LaTreeese	Denson*	2	Ph.D.	RSMAS	\$15,309	\$22,293		\$6,266		
Adrienne	Wilson*	2	Ph.D.	RSMAS	\$11,216	\$14,862		\$11,587		
Laura	Almodovar-Acevedo*	2	Ph.D.	UMES			\$454			
Cara	Schweitzer*	2	Ph.D.	UMES	\$2,072	\$14,749		\$7,500	\$4,800	
Kasondra	Rubalcava*	2	Ph.D.	UMES	\$7,111	\$11,533	\$894			
Kathryn	Cruz	3	B.S.	HU		\$5,000				
Alexandria	Ambrose*	3	B.S.	SSU				NA	NA	
Erianna	Hammond*	3	B.S.	SSU	\$12,000			NA	NA	
Michael	Williams	3	B.S.	SSU	\$12,000			NA	NA	
Semaj	Fielding*	3	B.S.	UMES	\$10,852					
Rhyan	Knight*	3	B.S.	UMES	\$4,151	\$263				
Teemer	Barry*	3	B.S.	UMES	\$4,151	\$1,333				
Keala	Pelekai*	3	M.S.	OSU	9160	\$9,250	\$0			
Shaneese	Mackey*	3	M.S.	SSU	\$2,936	\$0	\$2,424	\$0	\$99	
Anya	Byrd*	3	Ph.D.	RSMAS	\$23,396	\$14,862				
Wilmelie	Cruz-Marrero*	3	Ph.D.	UMES	\$355	\$10,008	\$247			
Shanelle	Houghton*	3	Ph.D.	UMES	\$720	\$7,697				
Marci-Ann	Smith*	none	B.S.	UMES						\$4,555
Tyler	Washington*	none	B.S.	UMES						\$4,151
Khari	Crommarty*	RSTP	B.S.	UMES						\$219
Colby	Boomer*	RSTP	B.S.	UMES						\$208

*RSTP – Rising Sophomore Training Program participant*

**Milestones for Meeting Requirements of the Award:** Presented below are timelines for students to meet major award requirements. During this reporting period, NOAA mentors have been identified for most of the graduate students. The students have developed or are in the process of developing their research proposals, and are preparing to fulfill the NERTO requirement.



First	Last	Cohort #	Degree	Partner	Cohort Experience	NERTO	One-time Research	Ethical Conduct of Research Training	Data Management Course	NOAA Mentor
Ileana	Fenwick*	1	B.S.	HU	n/a	n/a	n/a	Fall 18	n/a	n/a
Isaiah	Milton*	1	B.S.	HU	n/a	n/a	n/a	Fall 18	n/a	n/a
Nefertiti	Smith*	1	B.S.	HU	n/a	n/a	n/a	Fall 18	n/a	n/a
Dante	Freeman*	1	B.S.	SSU	n/a	n/a	n/a	Fall 18	n/a	n/a
Nakia	Coit*	1	B.S.	UMES	n/a	n/a	n/a	Sum 17	n/a	n/a
Nylah	McClain*	1	B.S.	UMES	n/a	n/a	n/a	Sum 17	n/a	n/a
India	Oliver*	1	B.S.	UMES	n/a	n/a	n/a	Sum 17	n/a	n/a
Malisa	Smith*	1	B.S.	UMES	n/a	n/a	n/a	n/a	n/a	n/a
Chryston	Otubu*	1	B.S.	UMES	n/a	n/a	n/a	Sum 17	n/a	n/a
Brian	Galvez*	1	M.S.	DSU	Spr. 18	Sum 18	Sum 18	Fall 17	Fall 17	Y
Amanda	Pappas*	1	M.S.	DSU	Spr. 19	Fall 19	Sum 19	Fall 18	Fall 19	Y
Cristin	Mayes*	1	M.S.	HU	Spr. 18	Sum 18	Sum 18	Fall 18	Fall 17	Y
Angie	Munguia*	1	M.S.	OSU	Spr. 18	Sum 17	Fall 17	Fall 17	Wint. 17	Y
Hillary	Thalmann	1	M.S.	OSU	Spr. 19	TBD	Sum 19	Fall 18	TBD	Y
Rebecca	Wenker	1	M.S.	UMES	Spr. 18	Fall 18	Sum 18	Fall 17	Fall 17	Y
Halie	O'Farrell*	1	Ph.D.	RSMAS	Spr. 18	Sum 18	Spr. 19	Fall 16	Fall 17	Y
Stephanie	Martinez-Rivera*	1	Ph.D.	UMES	Spr. 18	Sum 18	Spr. 18	Spr. 14	Fall 17	Y
Detbra	Rosales*	1	Ph.D.	UMES	Spr. 18	Sum 18	Fall 17	Fall 17	Fall 17	Y
Kendra	Dorsey*	2	B.S.	n/a	n/a	n/a	n/a	Fall 18	n/a	Y
Janelle	Layton*	2	B.S.	n/a	n/a	n/a	n/a	Fall 18	n/a	n/a
Aris-Aja	Horsey*	2	B.S.	UMES	n/a	n/a	n/a	Spr. 19	n/a	n/a
Desmond	Love*	2	B.S.	UMES	n/a	n/a	n/a	n/a	n/a	n/a
DaQuan	Davis*	2	B.S.	UMES	n/a	n/a	n/a	Sum 18	n/a	n/a
Joe	Day*	2	BS	SSU	n/a	n/a	n/a	Fall 18	n/a	n/a
Sena	Tay*	2	BS	SSU	n/a	n/a	n/a	n/a	n/a	n/a
Nicole	Kleponis	2	M.S.	DSU	Spr. 19	Sum 19	Sum 19	Spr. 18	Fall 18	Y
Davielle	Drayton*	2	M.S.	SSU	Spr. 19	Sum 18	n/a	Fall 19	Fall 19	Y
Andre	Price*	2	M.S.	UMES	Spr. 18	Fall 18	Spring 18	Fall 17	Fall 17	Y
Enid	Munoz-Ruiz*	2	M.S.	UMES	Spr. 18	Fall 18	Spring 18	Spr. 18	Fall 2018	Y
Jorge	Rodriguez*	2	M.S.	UMES	Spr. 18	Fall 18	Sum 18	Spr. 18	Fall 17	Y
Brittany	King*	2	Ph.D.	OSU	Spr. 18	TBD	n/a	Fall 18*	TBD	TBD
Matthew	Ramirez*	2	Ph.D.	OSU	Spr. 18	Fall 2018	Fall 2018	Fall 17	Spr. 17	Y
LaTreese	Denson*	2	Ph.D.	RSMAS	Spr. 19	Fall 18	Sum 19	Fall 15	Fall 18	Y
Adrienne	Wilson*	2	Ph.D.	RSMAS	Spr. 18	Sum 18	Sum 19	Fall 17	Fall 18	Y
Laura	Almodovar-Acevedo*	2	Ph.D.	UMES	Spr. 18	Sum 17	Sum 17	Spr. 18	Fall 17	Y
Cara	Schweitzer*	2	Ph.D.	UMES	Spr. 18	Winter 19	Fall 2017	Spr. 18	Fall 18	Y
Kasondra	Rubalcava*	2	Ph.D.	UMES	Spr. 18	Sum 19	Sum 19	Fall 18	Fall 18	Y
Kathryn	Cruz	3	B.S.	HU	n/a	n/a	n/a	Fall 18	n/a	n/a
Alexandria	Ambrose*	3	B.S.	SSU	n/a	n/a	n/a	Fall 18	n/a	Sum 19
Erianna	Hammond*	3	B.S.	SSU	n/a	n/a	n/a	Fall 18	n/a	n/a

Michael	Williams	3	B.S.	SSU	n/a	n/a	n/a	Fall 18	n/a	n/a
Semaj	Fielding*	3	B.S.	UMES	n/a	n/a	n/a	Spr. 19	n/a	n/a
Rhyan	Knight*	3	B.S.	UMES	n/a	n/a	n/a	Spr. 19	n/a	n/a
Teemer	Barry*	3	B.S.	UMES	n/a	n/a	n/a	Fall 18	n/a	n/a
Keala	Pelekai*	3	M.S.	OSU	Spr. 19	TBD	Sum 19	Fall 18	TBD	Y
Shaneese	Mackey*	3	M.S.	SSU	Spr. 19	Sum 19	TBD	Fall 18	Fall 19	Spr. 19
Anya	Byrd*	3	Ph.D.	RSMAS	Spr. 19	Sum 19	Sum 19	Fall 18	Fall 19	Y
Wilmelie	Cruz-Marrero*	3	Ph.D.	UMES	Spr. 19	Sum 19	Sum 19	Fall 18	Fall 19	Y
Shanelle	Haughton*	3	Ph.D.	UMES	Spr. 19	Sum 19	Sum 19	Spr. 19	Fall 19	Y
Marci-Ann	Smith*	none	B.S.	UMES	n/a	n/a	n/a	Fall 18	n/a	n/a
Tyler	Washington*	none	B.S.	UMES	n/a	n/a	n/a	Sum 18	n/a	n/a
Khari	Crommarty*	RSETP	B.S.	UMES	n/a	n/a	n/a	Sum 18	n/a	n/a
Colby	Boomer*	RSETP	B.S.	UMES	n/a	n/a	n/a	Sum 18	n/a	n/a

\*Underrepresented minorities; RSTP – Rising Sophomore Training Program participant

### Professional Development - Award Recipient Must Report Activities Accomplished for

1. [Rising Sophomore Experiential Training Program](#). Provide activities completed for IV., B., 8.1.2 (i) 1. thru 3. (FFO pg. 39). Students must be identified by name, home academic institution, academic year and major.

The Rising Sophomore Experiential Training Program (RSETP) occurs in the summer. During this period, we began recruiting for the 2019 RSETP interns. These students will participate in NOAA-mission aligned summer research projects and other activities designed for students in the NSF Research Experiences for Undergraduates in marine and estuarine science at UMES.

### Individual Student Development Plan. Center activities to ensure completion, monitoring and student success.

All students are required to complete the student development plan with their advisors upon recruitment into the program. These plans are currently being completed and collated.

2. [Student Preparation for Success in the Career Path Relevant to the Center Award](#). Provide Center activities with activity titles, participants, outcomes for Center measures of success.

Student Preparation of Success in the Career Path Relevant to the Center Award	
Student name(s)	Activity name and/or description
Nefertiti Smith	Research training in marine mammal genetics, and interviewing for PhD programs
Cristin Mayes	M.S. thesis Ecosystem modeling, applying to PhD programs
Isaiah Milton	Research training in genetics, and applying to summer internships
Ileana Fenwick	Research training in oyster restoration, accepted to summer internships
Kendra Dorsey	Research training in Ocean Acidification impacts on fish vision and hearing, applying to MS programs
Janelle Layton	Research training in marine mammal genetics, EPP scholar
Kathryn Cruz	Research training in marine mammal genetics, accepted to summer internship

Matthew Ramirez	2018 workshop participant in Introduction to Bayesian Statistics for Stable Isotope Ecologist, Chile,
Matthew Ramirez	Co-developed educational materials and activities for "Discovering the Scientist Within, OSU Pre-college Program"
Matthew Ramirez	2018 STEM Academy - Wild About Wildlife, co-coordinator and curriculum developer for week-long summer program for middle schoolers.
Matthew Ramirez	Program Coordinator, Fisheries and Wildlife Mentorship Program
Matthew Ramirez	Member Graduate Student Advisory Committee, advises OSU graduate school on student matters
Halie O'Farrell	CAPAM Technical Workshop on Spatial Stock Assessment Models
Adrienne Wilson	CAPAM Technical Workshop on Spatial Stock Assessment Models
Halie O'Farrell, Adrienne Wilson	Inclusivity Workshop at University of Miami RSMAS October 12 2018
LaTrese Denson	North Pacific Fisheries Management Council Groundfish Plan Team Meetings at the Alaska Fisheries Science Center
Shaneese Mackey	UAS online course and exam
Dante Freeman	ASLO Student Workshop – "I need the degree and the money!" San Juan, Puerto Rico, February 25, 2019
Dante Freeman	2019 ASLO Early Career Workshop – How to successfully write proposals and receive funding
Shaneese Mackey	Weekly mentoring meetings with advisor
Erianna Hammond	Weekly mentoring meetings with advisor
Jorge Rodriguez	JSAN training at the NOAA NEFSC in Milford, CT
Wilmelie Cruz-Marrero	American Fisheries Society Sutton Scholar mentor of Puerto Rican student.

### Post-Doctoral Program -

Center Process to Recruit and Select Postdoctoral Fellows

For each Fellow provide: Approved Postdoctoral Plan including anticipated number and proposed dates for publication submissions; activities; NOAA-facility tenure; and, anticipated products in support of Center priorities for education and training

UMES: In February 2019, Dr. Cullen completed his six months' residency at NOAA NEFSC, J.J. Howard Sandy Hook Lab, New Jersey. He is currently analyzing data and preparing manuscripts for publication in journals.

SSU: The postdoc position was misadvertised by the SSU HR office in 2017. The position has been re-advertised, but the interview and selection process was delayed by the government shutdown of December 2018 to January 2019.

### Pre-Publication Manuscript Submission -

Provide anticipated number and proposed dates for Center submissions for both faculty and students

	Target # of manuscripts	Proposed date of submission
DSU Faculty	2	Aug-19
DSU Students	1	Jun-19
HU Faculty	8	Fall 2019
HU Students	0	
OSU Faculty		
OSU Students		
RSMAS Faculty	1	Mar-19
RSMAS Students	3	Jul-19
SSU Faculty	2	Dec-19
SSU Students	1	Dec-19
UMCES Faculty		
UMCES students		
UMES Faculty	2	Dec - 19
UMES Students	2	Dec - 19

### Papers currently in review or in press: \*Students. LMR CSC scientists in bold

Publications in journals	Justification	Status
Cruz-Marrero*, W., <b>Cullen, D., Stevens, B.G.</b> , & Gay, N.C. (2019). <i>In situ</i> habitat characterization of Maryland offshore wind sites; Developing sampling techniques for image data sets. Revision process for PloS One.	Leveraged	Under Review
Cruz-Marrero*, W., Touhy, C., <b>Stevens, B.G.</b> , & Appeldoorn, R.A. (2019). Comparing divers and camera sled surveys: an improvement for fisheries independent data for queen conch in Puerto Rico. Revision process for Proceedings	Leveraged	Under Review
Schweitzer*, C. C., <b>Horodysky, A. Z.</b> , Price*, A. L. & <b>Stevens, B. G.</b> (2019). Impairment indicators for delayed mortality in black sea bass ( <i>Centropristis striata</i> ) discards in the commercial trap fishery. under review: Conservation Physiology	TAB Project	Under Review
Schweitzer*, C.C., <b>Stevens B. G.</b> (2019). The importance of soft coral sea whips ( <i>Leptogorgia</i> sp.) to fish abundance on artificial reefs in the mid-Atlantic Bight. under review: PeerJ	TAB Project	Under Review
Oghenekaro, E.U. & <b>Chigbu, P.</b> (2019). Population dynamics and life history of marine Cladocera in the Maryland Coastal Bays. Journal of Coastal Research.	Leveraged; LMR CSC PI	Under Review

<b>Chigbu, P.</b> , Malinis, L., Malagon, H.* & Doctor, S. (2019). Influence of temperature on the occurrence and distribution of sand shrimp ( <i>Crangon septemspinosa</i> ) in mid-Atlantic Coastal Lagoons. Journal of Crustacean Biology.	Leveraged; LMRCSC PI	Under Review
--	-------------------------	--------------

### NOAA Substantial Involvement and Collaborative Engagement

Identify NOAA mentors and collaborators, including: mentor and aligned student mentored; start date and time mentorship; time commitment; Line Office affiliation; and, project title.

Mentor	LMRCSC Student	Start date	Role	Time Commitment	Line Office	Project Title
Eric Cortes	Brian Galvez	Jan-17	Committee member		NOAA NEFSC	Trophic ecology of Atlantic Weakfish in the Delaware Bay using stomach content and stable isotope analyses
Patricia Rosel	Amanda Pappas	Jun-18	Collaborator		NOAA NEFSC	Ecology of a toxic harmful algal bloom species ( <i>Dinophysis acuminata</i> ) in the Delaware Inland Bays
Laurie Weitkamp	Nicole Kleponis	Jan-18	Committee member		NOAA NWFSC	Assessing the relative abundance of the wintering red-throated loon in the Delaware Bay
Mike Fogarty	Cristin Mayes	17-Sep	TAB collaborator, committee member	2 years	NEFSC	The Impact of Increasing Sea Surface Temperature on Piscivore and Planktivore Species Dynamics: An Ecosystem-Based Modeling Approach
Larisa Avens	Matt Ramirez	1-Sep-18	committee member		NOAA NEFSC	Influence of trophic ecology, habitat use, and population density on Kemp's ridley sea turtles ( <i>Caretta caretta</i> )
Jeffrey Moore	Matt Ramirez	1-Sep-18	NERTO mentor		SWFSC	Integration of habitat-specific growth variation in assessment models: a case study in the Kemp's ridley sea turtle
Laurie Weitkamp	Angie Munguia	1-Sep-17	NERTO mentor; committee member	~1.5 month/year	NOAA NWFSC	Characterizing feeding ecology and food web linkages of yearling chinook salmon ( <i>Onchorhynchus</i>

						<i>tshawytscha</i> ) emigrating through the lower Columbia River and Estuary
Ben Laurel	Hillary Thalman	9/1/18	committee member		AFSC	Thermal impacts on juvenile Pacific Cod ( <i>Gadus macrocephalus</i> ) foraging and growth in Gulf of Alaska nursery habitats
Eric Cortes	Halie O'Farrell	2015	Committee member, NERTO mentor	3 month NERTO	NOAA SEFSC	Evaluation of the effect of size and sex-based spatial segregation on shortfin mako and bull shark fishery sustainability
Robert Allman	Adrienne Wilson	2017	NERTO mentor	3 month NERTO	NOAA SEFSC	Ageing methods for lane snapper, a data poor species
James Thorson	LaTreese Denson	10-Jul- 05	NERTO mentor	3 month NERTO	NOAA AFSC	Environmental influences on indices of abundance for King Mackerel in the Gulf of Mexico examined through spatiotemporal geostatistical models
Patricia Rosel	Emily Griffin	1-Sep- 17	Committee member, communicatin g collaborator		NOAA NMFS Lafayette	Refining stock structure of common bottlenose dolphins ( <i>Tursiops truncatus</i> ) through photo- identification and genetic analysis
Ashok Deshpande	Davielle Drayton	1-Jan- 18	Committee member, communicatin g collaborator	~4 mo (including NERTO)	NOAA NEFSC	Evaluation of microplastic consumption by the eastern oyster, <i>Crassostrea virginica</i> , in Savannah GA
Ashok Deshpande	Dante Freeman	1-Jan- 18	Committee member, communicatin g collaborator	10 weeks	NOAA NEFSC	Comparing two methods to analyze the chemical components of marine plastic debris
Ashok Deshpande	Enid Munoz Ruiz	9/1/17	NOAA NERTO mentor		NOAA, NMFS	Assessment of Microplastics and Polybrominated Diphenyl Ethers (PBDEs) in Scallops as Possible Indicators of Plastic Pollution

Vince Guida	Rebecca Wenker	8/1/17	NOAA NERTO mentor		NOAA, NMFS	Development of alternative search strategy for assessing densities of clumped distribution species within a comprehensive image database.
April Croxton	Jorge Rodriquez	1/1/15	NOAA/NERT O mentor		NOAA, OAR	Separation by density gradient centrifugation of blue mussel hemocytes; Flow cytometry analysis of fluorescently-labeled lectin stained blue mussel hemocytes; Trypsinization of cell surface glycoconjugates of blue mussel hemocytes; Observation of i-situ glycan-based molecular interactions between blue mussel hemocytes and its parasitic trematodes.
Gary Wikfors	Jorge Rodriquez	1/1/15	NOAA NERTO mentor		NOAA, NMFS	<i>Mytilus edulis</i> hemocytes: Studies on hemocyte glycoconjugates and their possible role in host-pathogen interactions
Sheekela Baker-Yeboah	India Oliver	9/1/16	NOAA mentor		NOAA EPP/MSI	Exploring Ocean Optical Properties using Satellite and <i>in situ</i> Data.
Howard Townsend	Kasondra Rubalcava	9/1/17	NOAA mentor		NOAA, NMFS	Development of an Ecosystem Model for the Maryland Coastal Bays.
Mike Burton	Cara Schweitzer	9/1/18	NOAA NERTO mentor		NOAA SEFSC	The effectiveness of an alternative whole video-reading protocol on detecting the presence of sharks.
Todd Kellison	Cara Schweitzer		NOAA mentor		NMFS	Mortality of Black Sea Bass discarded by the commercial fishery



## CSC Programmatic Special Award Conditions

Recipient must provide accomplishments for Programmatic Special Award Conditions that address the education and training, scientific research and administrative functions in the award including, for example, outcomes from Advisory Board Meetings, effective management for all key personnel positions, early engagement with NOAA in performance of award, outcomes of Center meetings, integration of human dimensions in all award activities, implementing longitudinal outcomes tracking, and overall Program-level metrics for the EPP/MSI CSC postsecondary awards as a Federal STEM Education Agency-mission Future Workforce, for reporting period (NOT cumulative).

### A. Provide FY16 Center award information for:

1. **Number of EPP-funded post-secondary students from underrepresented minority communities** who are trained **48** and graduated **1** in NOAA- mission sciences.
2. **Total number of EPP-funded post-secondary students** who are trained **53** and graduate **1** in NOAA-mission fields relevant to this announcement.
3. **Number of EPP-funded graduates who enter the NOAA mission workforce as hires** by NOAA **0**, NOAA contractors **0**, NOAA partners **0**, resource management agencies **0**, NGO community **0**, academia **0** or as entrepreneurs **0**.
4. **Number of EPP-funded graduates who participate in and complete NOAA agency mission-related postdoctoral level programs** **0**.
5. **Total new funds leveraged with NOAA EPP award** (including post-secondary student support) = **\$953,958**

### B. Provide FY16 Center award information to demonstrate contribution to supporting CSC Desired Program level Outcomes and Outputs defined in FFO p. 7 - 10, for this reporting period.

#### 5. CSC Desired Program Level Outcomes and Outputs

##### 5.1 Education and Training

#### **Outcome 1. Increased number, annually, of CSC post-secondary students, trained.**

Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 11 B.S. Twenty (20) students have been recruited to Cohort 2 (2017-2018) including 9 Ph.D., 4 M.S., and 7 B.S. students. So far, fourteen (14) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 3 M.S. and 8 B.S. students.

#### **Outputs:**

(a) Increased quantitative and analytical skills – Students are acquiring quantitative and analytical skills by taking courses such as Data Management for scientists that was offered in fall 2018, and by participating in internships and REU programs.

(b) Increased competence in applying STEM to decision making, policy and management – This will be addressed by the Cohort Experience Workshop. Planning for the workshop took place during this time period. The workshop is scheduled for the next reporting period in spring 2019.

(c) Increased skills to use large data sets, geographical information systems (GIS) and statistical analysis, computer modeling, and algorithm development – An online course was offered covering Data Management in Fall 2018 and will be offered every subsequent Fall. All graduate students are required to complete the course prior to graduation.

**Outcome 2. Increased number of CSC post-secondary students educated and graduated annually.**

Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 11 B.S. Twenty (20) students have been recruited to Cohort 2 (2017-2018) including 9 Ph.D., 4 M.S., and 7 B.S. students. So far, fourteen (14) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 3 M.S. and 8 B.S. students.

(a) **Number of degrees earned annually in NOAA mission-related disciplines** – One student graduated with a Ph.D. during this period.

(b) **Number of students (total and URM) who participated in professional development opportunities, to include at least one on-site experiential research and training opportunity at a NOAA Lab, office, or facility with tangible training and research:** Eight students, seven of whom belong to URM groups, participated in on-site experiential research and training opportunities at a NOAA Lab, office or facility during this reporting period.

Student Name	Activity/project title	NOAA personnel involved	Location
Halie O'Farrell*	Fisheries independent data collection and harvest control rules for sharks	Enric Cortes	SEFSC, Panama City
Adrienne Wilson*	Age and growth of Lane Snapper, a data poor species	Robert Allman	SEFSC, Panama City
LaTreese Denson*	Environmental influences on indices of abundance for King Mackerel in the Gulf of Mexico examined through spatiotemporal geostatistical models	James Thorson	AFSC Seattle
Shaneese Mackey*	UAS pilot training class	LT Jacob G. Barbaro	La Jolla, CA
Rebecca Wenker	Development of alternative search strategy for assessing densities of clumped distribution species within a comprehensive image database.	Vince Guida	NOAA Sandy Hook, NJ Lab
Enid Munoz-Ruiz*	Assessment of Microplastics and Polybrominated Diphenyl Ethers (PBDEs) in Scallops as possible indicators of Plastic Pollution	Ashok Deshpande	NOAA Sandy Hook, NJ Lab

Jorge Rodriguez*	<i>Mytilus edulia</i> hemocytes: Studies on hemocyte glycoconjugates and their possible role in host-pathogen interactions	April Croxton	Northeast Fisheries Science Center, Milford, CT.
Cara Schweitzer*	The effectiveness of an alternative whole video-reading protocol on detecting the presence of sharks.	Mike Burton	NOAA Beaufort, NC Lab

\*Underrepresented minorities (URM)

### Outcome 3. Increased CSC capacity to train and graduate students.

The grant has made it possible for 11 collaborative research projects to be funded/selected for funding during the period of 2018 – 2019, which will enable more Center scientists to be available to mentor and advise undergraduate and graduate students. In addition, 22 NOAA scientists have been identified to serve as mentors of the students during the NERTO program or as collaborators in the TAB funded projects. The NERTO has increased exposure to NOAA training and encouraged faculty to increase their flexibility in scheduling graduate students' field work and academic schedules.

**Outputs:** (a) Number of seminars, new courses, new programs, and new degrees offered to develop working skills and functional competencies to support the NOAA mission and workforce, (b) Total numbers of students supported by the LMRCS and degrees awarded that reflect the changing demographics of the nation.

Outputs	# During this Reporting Period
Seminars	15
New courses offered	0
New programs developed	1
New degrees offered	0
# of students supported by the LMRCS	53
Total degrees awarded	1
Degrees awarded to URMs	1

### Outcome 4. Reduce the attainment gap for URMs in NOAA mission-relevant fields

The recruitment of new URMs (graduate and undergraduate students) during this reporting period is an important first step needed for preparing the students for careers in NOAA mission-relevant fields. This will ultimately help to reduce the attainment gap for the URMs in the fields.

#### Outputs:

(a) Increased number of URM students in student development activities that will lead them to the attainment of degrees and/or employment in NOAA mission fields = **16** URMs at the LMRCS took part in student development activities.

(b) Increased number of URM students who select to pursue higher education in NOAA mission fields = **48** URMs at the LMRCS are pursuing higher education in NOAA mission fields during this reporting period.

## 5.2 Scientific Research

### Outcome 1. Increased NOAA mission-relevant research capacity at MSIs.

NOAA scientists are already collaborating with Center scientists as well as working with some of the graduate students; suitable mentors are being identified for the remaining students. The Center has a post-doctoral research associate at UMES, and is in the process of completing search for another post-doctoral position at SSU which will help increase research capacity at the Center. Additionally, research funds provided to scientists at the Center are enabling them to purchase equipment and supplies for their research in addition to Graduate Research Assistantship provided to support research endeavors.

#### Outputs:

- (a) **Number of research collaborations with NOAA and LMRCSC faculty, staff and students:** Each of the eleven (11) LMRCSC TAB projects has a NOAA scientist as a collaborator.
- (b) **Number of NOAA scientists serving as mentors and advisors for student research:** 26 NOAA scientists and collaborators are working with the Center.
- (c) **Number of intra-institutional collaborative partnerships established and maintained in support of NOAA's mission = 11**
- (d) **Number of uses of NOAA data in research and tool development = 1.** Halie O'Farrell (Ph.D. student at RSMAS) is using the U.S. pelagic longline observer data for her dissertation research. In addition, Kasondra Rubalcava (Ph.D. student at UMES) is using the long term fish dataset collected by the Maryland Department of Natural Resources for her dissertation research aimed at developing an ecosystem model for the Maryland Coastal Bays.

### Outcome 2. CSC-supported faculty, staff and students' research directly aligned with NOAA's mission and strategic priorities.

Eleven (11) collaborative research projects were funded by the LMRCSC for the period of 2017 – 2018. These projects were funded after they had been reviewed by the Technical Advisory Board (TAB) based on a number of criteria one of which is their alignment with NOAA's mission and strategic priorities.

#### Outputs:

	<u># from Projects Directly Supported with FY 16 Funds</u>	<u># from Leveraged Projects</u>
# of peer reviewed publications	3	10
# of presentations	34	3
# Tools developed	0	0
Use of LMRCSC research results and tools by NOAA & other stakeholders	1	0
# of instances LMRCSC publications are cited	116	216
# of LMRCSC students, staff or faculty recognized nationally for LMRCSC research	8	0

## LMRCSC TAB-funded Projects

Since 2016, the LMRCSC has funded nineteen (19) TAB projects, in the areas of Stock Assessment (15), Healthy Habitats (3), and Climate and Ecosystems (1). Species under study have included: Atlantic menhaden *Brevoortia tyrannus*, Atlantic weakfish *Cynoscion regalis*, black sea bass *Centropristis striata*, chinook salmon, *Oncorhynchus tshawytscha*, king mackerel *Scomberomorus cavalla*, Pacific lamprey *Entosphenus tridentatus*, jonah crab *Cancer borealis*, red deep-sea crab *Chaceon quinqueedens*, dinoflagellates *Dinophysis acuminata*, sea whips *Leptogorgia virgulata*, Atlantic sea scallop *Pecten caurinus*, common bottlenose dolphin *Tursiops truncatus*, and humans *Homo sapiens*.

Topics of research projects have included: impacts of diversity and social identity on career choice; crab fisheries, reproduction, molting, morphometrics, maturity, and management; Fish population dynamics, matrix models catchability, migration, geostatistics, diet, otoliths, stable isotopes, and trace elements; contaminants, persistent organic pollutants, and microplastics; photo-identification, spatial analyses, and skeletochronology; HABs, molecular biology, *Vibrio* spp., and oyster aquaculture; use of benthic habitats by fish; age and growth of corals; fish bycatch, discard mortality, and reflex assessment (RAMP); and many other topics.

NOAA scientists who have been involved with these projects include scientists from the NOAA Northeast Fisheries Science Center (Richard Brill, Mike Fogarty, Vincent Guida, Richard McBride, Burton Shank, Beth Sharack), the Southeast Fishery Science Center (Patricia Rosel), the Southwest Fishery Science Center (Jeffrey Moore), the Alaska Fisheries Science Center (Chris Long), the Northwest Fisheries Science Center (Linda Park, Laurie Weitkamp, Kevin Werner, Gina Ylitalo), and the NOS NCCOS (John Jacobs, Howard Townsend).

In the tables below, projects that were begun in each fiscal year are identified, along with their research themes: Stock Assessment (SA), Healthy Habitats (HH), Climate and Ecosystems (C&E), or Seafood Safety (SS). Status of each project is listed as Open if currently ongoing, Final if the final report is included in this document, and Complete if the final report was provided previously. Abstracts and full reports are included for projects listed as Open and Final.

## LMRCSC TAB Project Titles FY2017-2019

Project No.	P.I. Name	Project Title	Theme	Status
18-01	Brittany King (Ph.D. Student, OSU)	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	SA	Open
18-02	J. Sook Chung (UMCES/IMET)	Baseline Data of Male Reproductive Status for Jonah Crab Management	SA	Open
18-03	LaTreease Denson (Ph.D. Student, UM/RSMAS)	Indices of abundance for King Mackerel in the Gulf of Mexico and South Atlantic improved by incorporating spatiotemporal and environmental variability	SA	Open
18-04	Tara Cox (SSU)	Examining ecosystem health through contaminant analysis of common bottlenose dolphins ( <i>Tursiops truncatus</i> )	SA	Open
18-05	Matthew Ramirez (Ph.D. Student, OSU)	Integration of habitat-specific growth variation into assessment models: a case study in the Kemp's Ridley sea turtle	SA	Open

18-06	Detbra Rosales (Ph.D. Student, UMES) Assessing the Impacts of Harmful Dinoflagellates and <i>Vibrio</i> spp. on Oyster Aquaculture in the Delaware Inland Bays	HH	Open
18-07	Rebecca Wenker (M.S. Student, UMES) Cold-water corals in the Mid-Atlantic Bight: Age, colony complexity, and growth	SA	Final
18-08	Eric Lewallen (Hampton U.) Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys	SA	Open
18-09	Brian Galvez (M.S. Student, DSU) Diet analysis of juvenile weakfish in the Delaware Bay using stomach content and stable isotope analysis	SA	Final
18-10	Andre Price (M.S. Student, UMES) Feeding Ecology of Black Sea Bass at Selected Reef Sites using Gut Content and Stable Isotope Analyses	SA	Final
18-11	Enid Munoz (M.S. Student, UMES) Assessment of Microplastics and Polybrominated Diphenyl Ethers (PBDEs) in Scallops as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic, Southern New England, and Gulf of Maine Stock Fisheries	HH	Open
17-01	Cara Schweitzer (Ph.D. Student, UMES) Discard mortality of sub-legal black sea bass in the commercial trap fishery: Impacts of air exposure and acute temperature changes.	SA	Final
17-02	Bradley Stevens (UMES) Biological baseline data for Jonah Crab Management	SA	Complete
17-03	Stephanie Martinez-Rivera (Ph.D. Student, UMES) Reproductive Biology of red deepsea crabs, <i>Chaceon quinquegens</i> .	SA	Complete
17-04	Tara Cox (SSU) Refining stock structure of common bottlenose dolphins ( <i>Tursiops truncatus</i> ) through photo-identification and genetic analysis	SA	Complete
17-05	Shari Wiley (Hampton U.) The Impact of Increasing Sea Surface Temperatures on Piscivore and Planktivore Species Dynamics: An Ecosystem-Based Modeling Approach	C&E	Open
17-06	Joe Pitula (UMES) Ecosystem impact of a harmful algal bloom species ( <i>Dinophysis acuminata</i> ) on aquacultured shellfish	HH	Complete
17-07	Jessica Miller (OSU) Migration and foraging ecology of at-risk species: Columbia River Chinook salmon and Atlantic weakfish	SA	Complete
17-08	Ammar Hanif (Ph.D. Student, UMCES/IMET) Comparing the diet and microbiome of Atlantic menhaden and Eastern oyster using DNA barcoding	SA	Complete

## LMRCSC TAB Project Abstracts

### Project Number: 18-01

**Project Title:** Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce

**Project Abstract:** NOAA Fisheries has a responsibility to provide the best available science for the management of living marine resources. Research has shown the value of diversified thinking and approaches in science and that diverse perspectives can improve our collective ability to solve problems. However, African American, Latino, and Native American populations face the issue of being underrepresented in marine and fisheries science professions, resulting in a workforce that does not reflect the diversity of the United States. This study focuses on the underrepresentation of racial and ethnic groups in marine and fisheries related science professions and aims to provide an analysis of how life experiences and identity shape marine and fisheries science related career decisions of individuals across different racial and ethnic groups and career levels (undergraduates, graduates and professionals). This study uses in-depth interviews and a qualitative data analysis approach to analyze the effects of life experiences and identity on career decisions. In February 2019, we conducted 9 in-depth semi-structured interviews with participants across different racial and ethnic groups, including individuals that identify with the three racial and ethnic groups mentioned above, and career levels (undergraduate and graduate) at the ASLO Aquatic Sciences meeting. The majority of the participants interviewed were at the undergraduate career level (77%). Data obtained from these interviews has yet to be analyzed.

**Keywords:** Diversity, Underrepresentation, Race, Ethnicity, Identity, Social Identity, Life Experiences, Career Decisions

**Thematic Area Addressed:** Assessment

**Species studied:** *Homo sapiens*      **Common name:** Humans

**Lead Scientist(s):** Brittany King (OSU, PhD Student), Kelly Biedenweg, PhD (OSU)

**NOAA Collaborator(s):** Kevin Werner (NOAA/NWFSC)

**LMRCSC Collaborator(s):** Benjamin Cuker, PhD (Hampton University)

**LMRCSC Research Student(s):**

**Start Date:** 1 September 2018

**End Date:** 31 March 2020

### Project Number: 18-02

**Project Title:** Baseline Data of Male Reproductive Status for Jonah Crab Management

**Project Abstract:** The fishery for Jonah crab (*Cancer borealis*) has been rapidly increasing in the Northeast United States since 2002. As a data-poor species, it still lacks in the information on age, growth or reproduction. In 2016, the Fishery Management Plan stated a minimum legal size (4.75") based on limited information, despite that the life history and the size at the onset of sexual maturity are unknown, and that animals over the legal size would experience another molt to become larger. The goals of this project are to: 1) establish a relationship between the size of males and reproductive status (onset of sexual maturity; physiological and functional maturity) by studying the primary male sex hormone, insulin-like androgenic gland hormone; and 2) determine if the largest size group of adults undergoes another molt cycle. This information is critical for setting size limits and managing crab fisheries in the Mid-Atlantic Bight.

**Keywords:** Crabs, Fisheries, Reproduction, Molting, Management

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Cancer borealis*      **Common name:** Jonah crab

**Lead Scientist(s):** J. Sook Chung (UMCES-IMET)



**NOAA Collaborator(s):** Burton Shank (NOAA/NMFS), Paul McElhany (NOAA/NWFSC)  
**LMRCSC Collaborator(s):** B. Stevens (UMES), R. Jagus (UMCES-IMET)  
**LMRCSC Research Student(s):** Amanda Lawrence (Master Student, UMCES-IMET)  
**Start Date:** 1 September 2018                      **End Date:** 31 August 2019

**Project Number: 18-03**

**Project Title:** Indices of abundance for King Mackerel in the Gulf of Mexico and South Atlantic improved by incorporating spatiotemporal and environmental variability

**Project Abstract:** The assessment of King mackerel in the Gulf of Mexico uses an index for estimating spawning stock biomass; this index is developed using a statistical model that is parameterized by fitting to larval count data from annual plankton surveys. The model used to make the index does not explicitly consider spatiotemporal variation, which is inherent to the larval count data and can influence local population density. Biomass trends can be misrepresented by a model that does not explicitly consider changes in spatial distributions (e.g., migration or ontogenetic shifts). This misrepresentation of estimated trends has been shown to lead to incorrect and uncertain estimates of stock status in the stock assessments, which are used to set management regulations which help to achieve NOAA's sustainable fisheries goals. King mackerel spatial distributions vary over time as adults migrate seasonally and change their distribution based on the quality of their environment. Migrations cause shifts in their spawning locations from year to year, and this then impacts the larval stage as their distribution is dependent on the location of spawning, and the local oceanography. So far we have used geostatistical models to answer the following question: Will accounting for spatiotemporal variation reduce the uncertainty in the estimates of the index, or indicate new biomass trends? Incorporating spatiotemporal variability indicates a slight decrease in abundance in various years. Additional model exploration and validation is needed.

**Keywords:** larval surveys, spatiotemporal modeling, biomass indices, King mackerel, Gulf of Mexico

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Scomberomus cavalla*    **Common name:** King Mackerel

**Lead Scientist(s):** LaTreese Denson, University of Miami RSMAS, Elizabeth Babcock, University of Miami RSMAS

**NOAA Collaborator(s):** John Walter, NOAA Southeast Fisheries Science Center; James Thorson, Alaska Fisheries Science Center

**LMRCSC Collaborator(s):** Dionne Hoskins-Brown, Savannah State University

**LMRCSC Research Student(s):** LaTreese Denson, University of Miami RSMAS (PhD);  
Alexandria Ambrose Savannah State University (UG)

**Start Date:** 12 September 2018                      **End Date:** 31 August 2019

**Project Number: 18-04**

**Project Title:** Examining ecosystem health through contaminant analysis of common bottlenose dolphins (*Tursiops truncatus*)

**Project Abstract:** As apex predators, common bottlenose dolphins (*Tursiops truncatus*) are an indicator species for ecosystem health. Persistent organic pollutants (POPs) accumulate in the blubber of bottlenose dolphins, making this species an indicator for ecosystem POP exposure. Spatial differences in bottlenose dolphin POP levels have been identified throughout the southeastern U.S. including the highest recorded PCB concentrations worldwide reported in estuaries around Brunswick, GA. This project aims to (1) identify baseline POP levels for the

Northern Georgia Southern South Carolina Estuarine System (NGSSCES) Stock, (2) determine if the NGSSCES Stock has been exposed to the same point-source contaminants as the two other estuarine stocks in Georgia, and (3) use POP exposure as an additional tool in combination with genetics, photo-identification, and spatial analyses to assess stock structure. A total of 24 genetic samples and 20 POP samples were collected in February 2019. The genetic samples have been sent to NOAA for sexing of the individuals. The POP samples will be analyzed by LMRCSC student Sena Tay in summer 2019 in G. Ylitalo's lab at the Northwest Fisheries Science Center. Additional fieldwork will be conducted in March 2019 to obtain more samples

**Keywords:** contaminants, persistent organic pollutants, photo-identification, spatial analyses, genetics, bottlenose dolphins

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Tursiops truncatus*      **Common name:** Common bottlenose dolphin

**Lead Scientist(s):** Tara M. Cox, Savannah State University

**NOAA Collaborator(s):** Gina Ylitalo, NOAA, Northwest Fisheries Science Center

**LMRCSC Collaborator(s):** Carolina Bonin Lewallen, Hampton University

**LMRCSC Research Student(s):** Sena Tay (UG; SSU)

**Start Date:** 1 August 2018

**End Date:** 31 July 2019

### **Project Number: 18-05**

**Project Title:** Integration of habitat-specific growth variation into assessment models: a case study in the Kemp's Ridley sea turtle.

**Project Abstract:** Spatiotemporal variation in demographic parameters can strongly influence a species' population dynamics but is generally not included in sea turtle population due in part to lack of sufficient data. For example, Kemp's ridley sea turtles that inhabit the U.S. Atlantic Coast grow slower than conspecifics that inhabit the U.S. Gulf of Mexico (GoM) Coast, which may lead to differences in age at maturation for individuals or whole cohorts. To evaluate the influence of this variation on Kemp's ridley population dynamics, we are developing an improved age-structured population model that incorporates habitat-specific vital rate estimates (growth, survival). Using a ~30 year dataset of somatic growth rates obtained through skeletochronology, we have developed habitat-specific (Atlantic, GoM) maturation schedules for this species. In addition, ongoing analyses are using 20 years of stranding length frequency data collected through the Sea Turtle Stranding and Salvage Network to estimate habitat-specific survival rates that will be included in the model. On-going analyses will examine model sensitivity to changes in stage-and habitat-specific model parameters. This project will help answer critical question about the contribution of somatic growth variation, habitat use, and Atlantic turtles, which have been excluded from all existing population models, to Kemp's ridley population dynamics.

**Keywords:** population dynamics, stage-structured models, matrix models, migration, age and growth, maturity, skeletochronology

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Lepidochelys kempii*      **Common name:** Kemp's ridley sea turtle

**Lead Scientist(s):** Matthew Ramirez (OSU), Selina Heppell (OSU)

**NOAA Collaborator(s):** Jeffrey Moore (NOAA/NMFS), Larisa Avens (NOAA/NMFS)

**LMRCSC Collaborator(s):** Elizabeth Babcock (RSMAS)

**LMRCSC Research Student(s):** Matthew Ramirez (PhD, OSU), Tamara Popovska (UG, RSMAS)

**Start Date:** 1 September 2018

**End Date:** 31 August 2019

**Project Number: 18-06**

**Project Title:** Assessing the Impacts of Harmful Dinoflagellates and *Vibrio* spp. on Oyster Aquaculture in the Delaware Inland Bays.

**Project Abstract:** The Delaware Inland Bays (DIBs) are a collection of salt marshes, saltwater creeks, and shallow open waters. Over the years, the ecological health of certain areas in the DIBs has deteriorated because of poor water quality. In 2013, the Delaware State Legislature instructed the Delaware Department of Natural Resources and Environmental Control to create an oyster aquaculture industry. We are examining areas near proposed aquaculture sites to determine the impacts of water quality and proliferation of pathogenic bacteria on oyster aquaculture. Using a combination of microscopy, PCR, MPNQPCR, and bioinformatics, we are comparing the HAB community, bacterial community and *Vibrio* spp. in the water column and in *Crassostrea virginica*. In 2017 and 2018 we were able to identify the presence of many bloom forming algal species such as *Karlodinium veneficum*, *Dinophysis* sp., *Heterosigma akashiwo* and *Chattonella subsalsa* in the DIBs. *Vibrio parahaemolyticus* and *V. vulnificus* were also detected in both environmental samples and *C. virginica*. However, *Vibrio* spp. abundance varied between sites and was positively correlated with temperature. On average, nutrient levels were relatively higher at Torquay canal, DE in comparison to other areas in the DIBs. Additionally, we are working on determining the bacterial communities in water and oyster and identifying the impacts that okadaic acid (dinoflagellate toxin) has on oyster's health. By evaluating the impacts of HABs and *Vibrio* spp. on oysters, we are fulfilling NOAA's mission of understanding and predicting changes in oceans and coasts, as HAB species are proliferating due to anthropogenic forces.

**Keywords:** HAB, molecular biology, *Vibrio* spp., oysters, aquaculture.

**Species studied:** *Vibrio* spp. **Common name:** Vibrio

**Thematic Area Addressed:** Healthy Habitats

**Lead Scientist(s):** Detbra Rosales (UMES)

**NOAA Collaborator(s):** John Jacobs (NOAA/NCCOS)

**LMRCSC Collaborator(s):** Joseph Pitula (UMES)

**LMRCSC Research Student(s):** Detbra Rosales (PhD, UMES) and Reuel Danquah (UG, UMES).

**Start Date:** 1 May 2018

**End Date:** 30 May 2019

**Project Number: 18-07**

**Project Title:** Cold-water corals in the Mid-Atlantic Bight: Age, colony complexity, and growth

**Project Abstract:** Sea whips (*Leptogorgia virgulata*) are a common structural component of benthic habitats found in the DelMarVa region of the Mid-Atlantic Bight, and may serve as essential fish habitat for commercially valuable species. However, they are slow-growing, easily damaged, and especially vulnerable to damage by passive fishing gear. Despite their potential importance, sea whips are generally understudied in this region. Therefore, we proposed to examine the age, colony complexity, and growth of sea whips from 4 sites in the DelMarVa. There were no significant differences in the bifurcation ( $R_b$ ) and tributary to source (T/S) ratios between sites, with the  $R_b \approx 3$  for all sites. Estimated age of sea whips ranged from 2 to 15 y, with 50% in the range of 6 to 8 y. Coral growth was determined by relating age estimates to total coral length in a von Bertalanffy growth model, and the model parameters were calculated to be:  $L_\infty = 86.1$  cm,  $K = 0.14$  yr<sup>-1</sup>, and  $t_0 = 1.44$  years. A total of 67 corals were tagged and total length measured, to measure growth over time. Five of these corals were damaged to measure the regrowth after damage. Data provided by this project will help fill the large knowledge gap concerning coral habitats that exists in the coastal DelMarVa region, and the baseline created will be a useful reference to study changes over time. This also relates to NOAA's goal to improve our understanding of ecosystems to inform resource management decisions, especially if sea whips were to become a managed species.

**Keywords:** age, growth, corals, benthic habitats, von Bertalanffy  
**Thematic Area Addressed:** Stock Assessment Support  
**Species studied:** *Leptogorgia virgulata*      **Common name:** Sea whip  
**Lead Scientist(s):** Rebecca Wenker, (MS, UMES)  
**NOAA Collaborator(s):** Vince Guida (NOAA, NMFS)  
**LMRCSC Collaborator(s):** Bradley Stevens (UMES), Daniel Cullen (LMRCSC Postdoctoral Fellow, UMES)  
**LMRCSC Research Student(s):** Rebecca Wenker, (MS, UMES)  
**Start Date:** 1 May 2018      **End Date:** 30 April 2019

**Project Number: 18-08**

**Project Title:** Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys

**Project Abstract:** The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous species that occurs throughout the Northern Pacific Ocean and is important to humans for at least two key reasons: 1) Indigenous peoples near the Columbia River have a cultural value for them as a ceremonial food item, and 2) during their marine phase, lampreys parasitize many fish species and may reduce commercial harvests (e.g., Pacific hake, walleye pollock). Although culturally important, vulnerable (freshwater modifications reduce larval habitats), and ecologically interesting (parasites can exhibit dramatic fluctuations in abundance), the basic biology of Pacific lamprey in marine waters has not been well documented. The goal of this study is to identify prey items of Pacific lampreys and characterize their feeding ecology in the Northeastern Pacific Ocean in, particularly where they overlap with commercially-targeted species (e.g., Pacific hake, shrimps).

**Keywords:** Pacific lamprey, feeding ecology, parasitism, predation, culture  
**Thematic Area Addressed:** Assessment  
**Species studied:** *Entosphenus tridentatus*      **Common name:** Pacific lamprey  
**Lead Scientist(s):** Eric Lewallen (Hampton University)  
**NOAA Collaborator(s):** Laurie Weitkamp (NOAA/NMFS); Linda Park (NOAA/NMFS)  
**LMRCSC Collaborator(s):** Carolina Bonin Lewallen (Hampton University)  
**LMRCSC Research Student(s):** Janelle Layton (UG, Hampton University), Patricia S Montalvo-Rodriguez (MS, Hampton University, expected to start 1 June 2019)  
**Start Date:** 1 Sept 2018      **End Date:** 31 August 2020

**Project Number: 18-09**

**Project Title:** Diet analysis of juvenile weakfish in the Delaware Bay using stomach content and stable isotope analysis

**Project Abstract:** The weakfish (*Cynoscion regalis*) is a commercially and recreationally valuable fish species that inhabits the Atlantic Coast of North America. The fishery is depleted and has yet to rebound and its failure to recover is attributed to unknown causes of elevated natural mortality rates. We studied the diet of juvenile weakfish in two of their spawning and nursery habitats, the Delaware Bay and the Maryland Coastal Bays. Using stable isotope analysis, mixing models, and stomach content analysis, we sought to answer questions regarding organic matter cycling, prey availability, and prey preference of juvenile weakfish in 2017 and 2018 throughout their estuarine residency, on both coasts of the Delaware Bay, and along the salinity gradient. In the Maryland Coastal Bays, juvenile weakfish diet was analyzed during the summer. Using generalized linear models (GLM) of stable isotope values of Delaware Bay weakfish, we found that  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values were mediated via bottom-up effects from basal primary production that differed over time

and space. In contrast to previous studies, mixing models and stomach content analysis (SCA) revealed that gammarid amphipods contributed significantly to juvenile weakfish diet, especially during the summer. The mixing model and SCA results provide necessary updated information of juvenile weakfish diet in the Delaware Bay as prioritized by the ASMFC 2016 Weakfish Stock Assessment. The GLM results revealed that element cycling within the Delaware Bay occurs at small spatial scales, suggesting that EBFM decisions should consider small spatial scales when implementing ecosystem-wide management applications.

**Keywords:** Food habits, stable isotopes, mixing models, MixSIAR, nursery habitats, Delaware Bay

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Cynoscion regalis*      **Common name:** Weakfish

**Lead Scientist(s):** Dr. Stacy Smith, DSU

**NOAA Collaborator(s):** Dr. Howard Townsend, NOAA

**LMRCSC Collaborator(s):** Dr. Maurice Crawford, UMES

**LMRCSC Research Student(s):** Brian Galvez (MS)

**Start Date:** 1 May 2018

**End Date:** 30 April 2019

**Project Number:** 18-10

**Project Title:** Feeding Ecology of Black Sea Bass Using Gut Content and Stable Isotope Analyses

**Project Abstract:** Food habits of black sea bass (BSB, *Centropristis striata*) have been studied from trawl surveys in the Mid-Atlantic Bight, but no studies have compared food choices between specific habitats or locations. We sampled BSB at selected natural and artificial reefs near Ocean City, MD using hook-and-line angling to determine how habitat preferences influenced length frequencies, sex ratio, dietary preferences, and stable isotope ratios of  $\delta^{12}\text{C}/\delta^{13}\text{C}$  and  $\delta^{14}\text{N}/\delta^{15}\text{N}$ . Stomach content analysis, and stable isotope analyses of muscle, liver, and mucus were used to determine whether diets varied significantly between sampling locations. Results indicate that crustaceans dominate diets of BSB by frequency of occurrence. This data will help to understand how BSB utilize different habitat types, and the contribution of reef habitats to BSB populations in the Mid-Atlantic Bight.

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Centropristis striata*      **Common name:** black sea bass

**Lead Scientist(s):** Dr. Brad Stevens, Andre Price. UMES.

**NOAA Collaborator(s):** Dr. Richard McBride, NOAA NEFSC.

**LMRCSC Collaborator(s):** Dr. Maurice Crawford. Graduate committee member, UMES

**LMRCSC Research Student(s):** Andre Price, MS

**Start Date:** 1 March 2018

**End Date:** 30 September 2018

**Project Number:** 18-11

**Project Title:** Assessment of Microplastics and Polybrominated Diphenyl Ethers (PBDEs) in *Placopecten magellanicus* as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic Stock Fisheries

**Project Abstract:** Plastic fragments, pellets, fibers and cosmetic beads less than 5 mm in size are termed as microplastics. These are emerging contaminants that in recent years have been found in tap water samples all over the world and in a vast array of aquatic organisms with the possibility of toxic effects in them. The focus of this research will seek to determine if there are microplastics present in the Atlantic sea scallop stock banks across the east coast of the United States. Multiple studies have implied that polybrominated diphenyl ethers (PBDEs), persistent bioaccumulative

fire-retardant pollutants, in fish tissues display positive correlations with geographic plastic debris densities. We will examine if this linear relationship also exists in a benthic environment using sea scallops as model organism. Briefly, micropolymer assays will be conducted using an efficient extraction method in which scallop tissues will be divided into muscle, respiratory system and gastrointestinal tract before digestion and visual quantification of microplastics. Scallop and bottom water column samples will be collected from multiples regions across Georges Bank and Mid-Atlantic Bight. Tissues will be tested for PBDEs while plastic debris will be examined in the water samples. Since sea scallops are important commercial organisms with fisheries dredging over 50 million pounds annually for seafood consumption, our research directly contributes to NOAA's goal to conserve and manage coastal and marine ecosystems and resources by providing the scientific foundation for understanding many future studies of the dangers microplastics can have on important ecological and commercial species.

**Keywords:** Microplastics, scallops, Pollution, Georges Bank

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Placopecten magellanicus*

**Common name:** Atlantic sea scallop

**Lead Scientist(s):** Enid C. Muñoz Ruiz (MS, University of Maryland Eastern Shore)

**NOAA Collaborator(s):** Ashok Deshpande (NOAA/NEFSC); Beth Sharack (NOAA/NEFSC)

**LMRCSC Collaborator(s):** Ali Ishaque (University of Maryland Eastern Shore)

**LMRCSC Research Student(s):** Enid C. Muñoz Ruiz (MS, UMES)

**Start Date:** 1 June 2018

**End Date:** 30 December 2019

#### **Project Number: 17-01**

**Project Title:** Discard mortality of sub-legal black sea bass in the commercial trap fishery: Impacts of air exposure and acute temperature changes.

**Project Abstract:** Bycatch within the commercial fisheries industry is of growing concern with regards to sustainability. Discarded bycatch can succumb to either immediate or delayed mortality. Delayed mortality can be difficult to assess and is poorly understood in black sea bass (BSB, *Centropristis striata*), however is estimated at 21% by the Atlantic States Marine Fisheries Commission (ASMFC). Underestimation of bycatch mortality can lead to overfishing and render stock assessment models ineffective. To obtain better estimates of mortality within the commercial trap fishery, a release condition index (RCI) score was used on BSB to assess for the presence of reflexes (operculum, mouth, gag, and dorsal fin) and occurrence of barotrauma (floating and stomach protrusion). Fish were assessed from several commercial fishing locations during standard commercial trap fishing. Sampling was conducted in May, August, and November to determine the effects that a change in temperature ( $\Delta T$ ) between ocean floor and air have on mortality rates. BSB discards had significantly lower RCI score and low probability for mortality during the month of May ( $\chi^2$ :  $p < 0.001$ ) compared to fish caught in August and November. However, there was no significant difference in RCI scores of discards during August and November. A general linear model (GLM) showed that  $\Delta T$  had a significant effect on RCI scores ( $p = 0.01$ )

**Keywords:** Discard mortality, bycatch, RAMP, RCI

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Centropristis striata*

**Common name:** Black sea bass

**Lead Scientist(s):** Cara Schweitzer, UMES

**NOAA Collaborator(s):** Richard Brill, Ecosystems and Aquaculture Division, Behavioral Ecology Branch, NMFS/NEFSC, and Virginia Institute of Marine Science

**LMRCSC Collaborator(s):** Andrij Z. Horodysky, Hampton University.

**LMRCSC Research Student(s):** Cara Schweitzer, Ph.D. candidate

**Start Date:** 1 May 2018

**End Date:** 30 May 2019

**Project Number: 17-05**

**Project Title:** The Impact of Increasing Sea Surface Temperatures on Piscivore and Planktivore Species Dynamics: An Ecosystem-Based Modeling Approach

**Project Abstract:** Ecosystem-based fishery management has rapidly become the standard approach for assessing the viability of commercial fishery stocks. Species interaction and seasonal fluctuations play key roles in understanding the impact that harvesting has on species sustainability. However, as the effect of climate change on weather conditions and average temperatures become exceedingly dramatic, immediate action must be taken to include mechanisms into population models that account for climate change to avoid deleterious effects that could lead to the collapse of important commercial fisheries. We conducted a quantitative analysis that incorporates such mechanisms to demonstrate the impacts of increasing sea temperatures on fish production in several key species in the Chesapeake Bay ecosystem.

**Thematic Areas Addressed:** Assessment; Climate and Ecosystems

**Lead Scientist(s):** Shari Wiley (former HU faculty); Eric Lewallen (current HU faculty)

**NOAA Collaborator(s):** Michael Fogarty (NOAA/NEFSC)

**LMRCSC Collaborator(s):** Andrij Horodysky (current HU faculty)

**LMRCSC Research Student(s):** Cristin Mayes (current HU graduate student)

**Start Date:** 1 August 2017

**End Date:** 1 May 2019

INTENTIONAL BLANK PAGE

**NOTE: INSERT BLANK PAGE BEFORE NEXT SECTION OF REPORT**



## VII. Financial Information

### 1. Total NOAA funding breakout

FY 16 Award Center base funds: Indicate how funds were used for the reporting period, using award budget categories to provide detailed information for reporting period. Unobligated balances will be compared with SF 425 reporting.

#### Postsecondary Direct Student Support:

Tuition:	\$258,514.00
Stipend:	\$283,846.21
Travel:	\$9,221.27
NERTO:	\$62,010.75
One-time Research:	\$21,692.33
Professional Development:	\$11,158.70

**Total: \$646,543.36**

#### Collaborative Research:

Eleven (11) collaborative projects funded in the amount of **\$473,563.25** in direct costs are continuing during this reporting period.

### 2. Total leverage funding breakout

Indicate funding source, type (grant or contract), amount, Center PI, project title; and, how funding contributed to the FY 16 Center award for:

#### Postsecondary Student Support:

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
NIST	Grant	9/1/2017 - 8/31/2019	112,050	48,052	J. S. Chung	New method dev. for measuring low concentration of protein/peptide	Funds are used to support Amanda Lawrence for 1-year stipend, tuition, travel and research
NSF	Grant	07/1/16-06/30/19	\$300,000	\$10,000	Horodysky, A.	Linking environment to form and function by quantifying the effects of ocean acidification on visual and auditory neurobiology in marine fishes	Funds are used to support Horodysky and 1 LMRCSC cohort 2 student tuition

NSF	Grant	8/1/13-7/31/18	\$900,000	\$180,000	Cuker, B	Multicultural Diversity in the Aquatic Sciences	Funds are used to support students to ASLO conference.
NSF	Grant	7/1/16-6/30/19	300,000	10,000	Horodysky, A.	Linking environment to form and function by quantifying the effects of ocean acidification on visual and auditory neurobiology in marine fishes	Funds are used to support Horodysky and 1 LMRCSC cohort 2 student tuition.
NSF	Grant	5/1/12 - 4/30/19	627,489	3,199	J. Sook Chung	Functional Roles of a Novel Crustacean Female Sex Hormone in Sex Differentiation and Dev. Secondary Sex Features of Crustaceans	Funds support PIs salary and S. Green's research
Ratcliffe Foundation	award	07/01/14-06/30/20	800,000	66,667	Russell Hill/Nick Hammond	Award to cultivate the leadership and business skills necessary to bring their research into commercial markets and to provide students with an enhanced appreciation of the potential business implications of their research.	Funds support graduate student stipends while training in entrepreneurial skills
Sea of Change Foundation	Grant	March 1-December 31, 2018	\$15,856	not reported	Dionne Hoskins-Brown	Faux habitat or foe food: How prevalent are microplastic fragments in oyster reefs and muddy estuarine sediments?	Support a high school intern for team research project with S. Mackey and D. Drayton (LMRCSC students)

**Collaborative Research:**

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
Bonneville Power Administration	Grant	1/1/2019	\$35,000	\$42,000	J. Miller	Growth and residence of Interior Columbia River Chinook salmon in coastal waters	Funds support research associated with Munguia MS and Miller
DPW	Grant	7/12/16 - 7/13/19	12,988	\$841	E. Schott	DPW-Microbial Source Tracking as a Tool for Assessing and Managing Fecal Contamination through UB	Funds support PIs salary
NOAA/NMFS	MOU	Jan. 2000 - continuing	\$100,000	\$50,000	D. Hoskins	NOAA CMER	Support a NMFS FTE for a CMER program
NSF	Grant	12/1/12 - 1/31/19	\$686,888	\$65,273	R. Jagus	Translation regulation of gene expression in toxic dinoflagellates	Funds support PIs salary & intern research
NSF	Grant	7/1/17 - 6/30/20	\$359,437	\$44,593	E. Schott	Determining how Variation in life history & connectivity drive pathogen-host dynamics	Funds support PIs salary, intern stipend and intern research
NSF	Grant	9/1/16 – 8/31/21	\$5 million	\$500,000	P. Chigbu; M. Sexton; A. Ishaque; S. Parveen	CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics	Funds support PIs salaries, students, research

# Appendices

## Appendix I: External Evaluations Report of the LMRCSC

### Living Marine Resources Cooperative Science Center External Evaluation Report for Year 3 (2018-2019)

#### Background and Introduction

The Living Marine Resources Cooperative Science Center (LMRCSC) was “established in October 2001 as a cooperative agreement between NOAA’s Educational Partnership Program (EPP), and a collective of universities “to address environmental, natural resources management and STEM workforce challenges...” The mission of the Center “is to prepare a diverse student body for careers in marine and fisheries science through exemplary academic and research collaborations” (all quotes from the Project Narrative). The LMRCSC received an additional five years of funding, which began in Fall 2016. The project leadership contracted with The College of Exploration’s (TCOE) Dr. Tina Bishop, Dr. Peter Tuddenham, and Dr. Howard Walters to develop and implement an external evaluation of the project. This evaluation plan was reviewed and approved by internal project leadership, and also was submitted with the project proposal for review and approval by NOAA EPP. This current report has been written by Drs. Bishop and Walters and submitted to the Project Leadership.

#### *Evaluation Plan*

The revised CSC evaluation framework is based on a set of three over-arching questions, focused on the CSC impact on students and graduates, NOAA mission-aligned research, and CSC management and administrative processes. The guiding questions for this framework are:

- 1. How has the Center award implementation activities increased the number of students and graduates trained in the competencies and skills that align with employability and graduate studies in NOAA mission-aligned areas to advance the effectiveness and impacts of the NOAA Educational Partnership Program with Minority Serving Institutions (EPP/MSI) postsecondary NOAA mission STEM future workforce program?*
- 2. What is the evidence that the Center award implementation activities enhanced the capacity for NOAA mission-aligned research at partner institutions and other MSI’s?*
- 3. What is the evidence that the CSC management team and administrative processes enhanced the capacity of lead and partner institutions to meet the goals and objectives of the Center award in advancing the effectiveness and impacts of the NOAA EPP/MSI STEM future workforce program?* □

The emphasis on *evidence claims* in these guiding questions is consistent with the external evaluation planned and underway for the LMRCSC as implemented by Bishop and Walters. Annually, the external evaluators are implementing data collection to obtain evidence that the project is meeting these overarching goals. Given the comprehensive span of the project, the external evaluation annually identifies and targets select stakeholders related to the project, and select programming efforts within the LMRCSC to collect evidence that supports the overarching questions and the project goals and objectives.

#### *Year Three Data Collection and Evaluation Focus*

For year three of the external evaluation, evidence collection focused on current graduate students, NOAA Scientists who are working with these students or with the LMRCSC in a support position, and project co-PIs. In the fall of 2018, surveys were developed and disseminated to the LMRCSC funded students in the NERTO projects and the TAB projects, as well as to the NOAA and university scientists who were working with these students.

Additionally, in January of 2019, the evaluators visited the University of Miami, Rosenstiel School of Marine and Atmospheric Science, to interview one of the LMRCS co-PIs, Dr. Beth Babcock, and two of the graduate students at that location who are funded by LMRCS.

The data from the NERTO and TAB surveys, as well as the interviews at the University of Miami, are currently being analyzed. The remainder of this report below includes only the scientists and students who participated in NERTO projects this past year. The remaining analyses, as well as additional evaluation activities undertaken during the remainder of this fiscal year, will be presented in a report scheduled for Summer 2019.

### ***NERTO Student Survey Data and Summaries***

A group of five students provided extensive response data to describe their NERTO projects and other, related information regarding their participation in LMRCS. Student projects included research on or in: fisheries related to striped bass and menhaden; fisheries related to black sea bass and NOAA HabCam system; flow cytometry training; PBDE extractions training and related work; and oyster health. All of these projects clearly extend NOAA's mission science as required under the overarching questions noted above. When asked to sort their projects based on NOAA priorities, most students selected seafood safety and aquaculture, followed by ecosystem science, living resource management, and fisheries health. Three of the five were required to manage, analyze or manipulate large datasets during their NERTO experience, and three of the five also considered the social science implications of their research during the NERTO.

Items five through ten on the survey drilled down to the relationships between the students and the NERTO mentors. An important observation was the duration of the relationships between the scientists and students. While one student reported working with the mentor for only one semester, the remaining students reported extensively longer working relationships: from a full academic year (two more students) to multiple years (the additional two students). The durability of these working relationships suggests a strong commitment to this element of LMRCS by the NOAA scientists, but also the strong possibility that these mentoring relationships have become more than one dimensional academic projects, and likely are authentic mentorships. Response data (item 6) shows an average of over 20 hours weeks of work time with the mentor directly on these projects—again contributing to the evaluator conclusion that these are authentic mentorship relationships. Students further reported multimodal communications strategies from in person to a variety of distance communications technologies involved in the project. Every student reported that the mentor had provided positive support for their academic work, with most skewing toward significant support. The same was observed regarding support for the students' professional careers: students perceived strong, positive support for their professional development from these NOAA scientists. And finally, narrative response data is consistently found to strengthen the value of selected response or ranked response items. These students provided rich affirmations of the role of their mentors/NOAA scientists:

- My mentor has supported my career development by serving as a recommender for both a PhD opportunity involving fisheries analysis as well as a NOAA job opportunity;
- He introduced me to and integrated me into a federal science career environment. He involved me in weekly meetings, introduced me to colleagues in the lab, helped me make connections with people involved in research similar to mine, and was always available to support or to answer questions I had;
- Provided excellent information on the process of conducting research for the federal government.
- He proof reads all of my work and offers constructive criticism. Keeps me up to date with workshops and conferences;
- He has communicated with me about post-doctoral fellowship and other agencies I should apply for jobs with.

Items eleven and twelve asked about primary benefits and career skills that were obtained from the NERTO project. Students provided a range of technical and laboratory related skills, but more interestingly, described the social benefits of networking, working in a NOAA lab, and making connections in that environment as it related to their life and career choices. This was true in item twelve as well. There were skills listed: working in R, lab skills, image analysis skills, lab skills, record keeping. But responding students also pointed to networking, working on teams and collaboratively, and working in a multidisciplinary environment as well.

Items thirteen through eighteen were a series of selected response or ranking items related to careers and academic success. All of the students strongly agreed or agreed that NERTO was a positive influence on career decisions. Four of the five agreed that NERTO helped with other academic work. Each student suggested that NERTO had inspired them toward a career choice—using language like encouragement, collaboration, providing insight, and helping me realize. Four of the five respondents were highly positive that NERTO had given them good insight into NOAA organizational culture (in the context of eventual career choices) and four of the five perceived that NERTO had created a network for the student that was related to future success in the workforce. From other items in the survey, it seems that the fifth student in the above response sets who seems not to have had such a positive perception or outcome had developed concerns about employability in NOAA with federal budget issues and job openings. These concerns may not be unwarranted and should be considered in the broader challenge of recruiting underrepresented populations into the federal workforce at a time when the federal workforce is experiencing serious stresses.

Item nineteen asked to what extent the mentor introduced the students to other colleagues (an opportunity that was mentioned briefly above by a couple of respondents). Each of the five reported some instance of this occurring, with three stating “quite a bit” and one reporting “significantly.”

Item twenty asked about any challenges he students experienced scheduling or completing their NERTO projects. There were no actionable clusters of responses to this item. Two students described difficulty obtaining housing. One described difficulty obtaining information and forms, but clarified that it was obvious the website had been updated and improved, and that Dr. Chigbu (the LMRCS data) was accessible to students and able to help. This student was the only substantive respondent to item twenty-one (what other types of support would have improved the experience) and described a need for better access to the forms. A single student response should not be considered actionable in this case, as the issue was not recognized by the other students.

Item twenty-two asked respondents “what have you learned about the social implications of your science during your NERTO experience?” This item is directly attached to previous interested expressed by NOAA EPP. The responses were, overall, weak to this item, suggesting that students were not attuned to these social implications. This may be considered in reviewing the programming for the graduate student workshops and webinars moving forward.

Item twenty-three asked respondents, “As a result of my NERTO experience, I feel a sense of belonging to NOAA mission science fields.” Again, this item emerged directly from NOAA EPP stated interests for the Centers. Each of these five respondents Strongly Agreed or Agreed that this was a true statement.

Item twenty-four solicited any additional career support information that LMRCS might provide, and elicited only one substantive response: the respondent had encountered George Liles’ presentation regarding NOAA employment and suggested that other LMRCS students be made aware of this content and presentation.

Item twenty-five asked for suggestions “to improve the NERTO process” that students would like to suggest to the LMRCS administration. While there was no single cluster of similar responses, individually, four of the responses seemed substantive (note: the evaluators are only passing these on to the LMRCS leadership; we make no judgment as to the relevance nor credibility of the responses). These responses included:

- Some of the information on the process for establishing and completing the NERTO seem very ambiguous. It would help to establish clearer and more precise instructions;
- I believe it's unnecessary and redundant to develop a project with your NOAA mentor, and then have to go through the whole SSIO application process like there's a possibility you're not going to get the internship;
- More involvement in the NERTO setup to diminish setbacks and speed the process;
- Have the university not take so long with the paperwork.

### ***NERTO Scientist/Mentor Survey***

An electronic survey was created and disseminated to the NOAA scientists who developed and/or supervised the student projects to obtain their perspectives on the projects, with four of these individuals providing responses. The reader should note that these projects include the same ones to which the students responded in the previous section, but from the scientist's perspectives. For the projects represented by these individuals, two were focused on ecosystem science and two on stock assessment. Two of the respondents also included living resource management, and physiology and immunology as topic areas. Of interest, none of the scientists report social impacts of these NERTO projects—suggesting some disconnect in the use of this language between the NOAA EPP indicator language and the NOAA field scientists. This should be reviewed by LMRCSC leadership personnel.

Item four asked respondents to “describe any opportunities your NERTO intern(s) had to practice large data set management or analysis during the project.” The responses mirrored the students substantively: learning new modeling and programming techniques; preparing aging structures for lane snapper by, in part, querying a life history database, entering and extracting records; statistical modeling procedures; and managing large flow-cytometric data sets emerging from the project. These seem to support and model NOAA EPPs stated interest in conveying these skills to the LMRCSC graduate students.

Items five through eleven were a series of short or selected response items regarding discrete aspects of the mentoring role. Respondents each worked with a single student (item five), with three of the respondents working up to five hours weekly, and one working up to ten hours weekly. Each of the respondents perceived the time allocated for project work was appropriate. With respect to mentoring aspects of the work, one respondent reviewed online materials and one referenced forms that were required, but none described or offered that they were offered or provided support to guide the mentoring aspects of the work with graduate students. Nevertheless, all of the scientists perceived they were sufficiently prepared for this mentoring role, and each perceived that they were matched well with the students with whom they worked, and that their students were well prepared for the work requirements.

The scientists were asked to describe the types of work and skills-practice they required of their interns. These responses included:

- He had to practice new modeling and computer programming methods, such as how to develop his own likelihood formulae and estimate parameters to maximize the likelihood in the computer coding software R;
- The intern learned how to age land snapper, constructed growth curves and tested for differences between male and female growth curves;
- Field work—collecting fish, inverts, and water quality data. Lab work—preparing samples for stable isotope analysis. Analytical work—statistical modeling stable isotope ratios;
- Collecting hemolymph samples from mussels and conducting flow-cytometric analysis of hemocytes probed with fluorescent indicators of specific physiologies.

These skills correlate substantially with expectations for NOAA mission science content

areas, and support a conclusion the NERTO projects were well developed for both NOAA EPP goals, and to support the graduate students learning and development for the NOAA science career pipeline.

The remaining survey questions probed additional aspects of the NERTO, the mentorship, NOAA alignment concerns, and the broader goals and objectives of the LMRCS. For each of the respondents, these were new relationships with new students, with little if any prior contact between the scientist and student. Three of the scientists further described how the project had also afforded “social and emotional support to the students” as a component of the mentoring experience. This included helping obtain housing for a student, involving the student in social activities with other colleagues and lab staff, career discussions, and assistance with research writing and presentation skills. The scientists not only helped students develop technical skills, but discussed the relationship of the project to potential dissertation topics, career plans, and future research. Three of the respondents further described explicit opportunities and experiences that further linked the student to the NOAA specific research field. These included opportunities to work with several other, related research programs in the same lab, meeting personnel, providing papers to the student that supported the work, and inviting the student to participate in other field survey programs. Three of the four also intentionally introduced the students to other colleagues in the research field—which would be invaluable for expanding the students’ networks of potential mentors, advisors, and potential employment opportunities.

Item eighteen asked “what do you perceive to be the benefits of the NERTO to students?” The responses were varied and worth duplicating here, as again, these seem to support the overarching NOAA EPP mission and LMRCS goals and objectives for graduate students:

- Opportunities for networking and being mentored on expertise not available at their local institution.
- The intern was able to experience several research programs conducted by a NOAA laboratory and interact with federal scientists. This experience would be helpful in determining if a career as a federal scientist would be a good fit.
- It opens up other doors/avenues for students to learn about research in other organizations. It provides an opportunity for students to network with other scientists outside of their university.
- The student had access to sophisticated technology and a group of scientists and technicians familiar with their operation and usefulness.

Item nineteen reversed the previous question’s focus, and asked “what were the benefits of the NERTO to you as a researcher?” for the scientists to consider. The responses included networking and capacity building, and the opportunity to get important work completed with student help. Interestingly, one scientist commented on the enthusiasm of the intern as a help to the scientists, causing them to remember the reason why they were doing their work. One respondent reported he/she advanced her own knowledge because the internship prompted him/her to study an area of science that wasn’t familiar prior to launching the project. A second scientist also reported personal learning from the results of the student’s project.

Item twenty sought to capture any specific challenges to undertaking the NERTO, but given the sample size of responses, no theme emerged in the data. One respondent, however, pointed to the difficulty in finding housing for the student—an issue that emerged in conversation with another scientist with the evaluation team at a site visit to one of the project co-PI facilities.

Each of the respondents perceived that the NERTO projects were related, or significantly related to NOAA mission science. The respondents further perceived that all of these graduate students were good candidates for future NOAA mission workforce employment—which is a primary goal of NOAA EPP for the LMRCS.

In the closing survey items, when given the opportunity to advise the LMRCS regarding additional support for interns, no substantive responses emerged. The scientists did offer that



they wished personally that they had obtained additional training in analytical programming, statistical analysis, and support developing a generalized ability to continue learning, as employment skills will change over time from graduate school.

In the main, when comparing the responses of the NERTO supervising NOAA scientists and the NERTO graduate students, there is a singular focus from both audiences that the projects were highly positive, related to NOAA mission science, were heavily skills-driven and developmental for the students (and in some cases also for the scientists). While this response number is low, the consistent data suggest that LMRCSC is also serving an important professional development function with the NOAA scientists themselves. This should be considered part of support for NOAA science under the overarching questions provided by NOAA EPP, and as further evidence that the LMRCSC is strong, and accomplishing—with supportive evidence—its goals and objectives for students and for NOAA science and scientists.

### **Conclusions**

These surveys were undertaken to consider the overarching NOAA EPP objectives and questions, as these are further sustained in the LMRCSC work with scientists and students. The survey data provide evidence that the LMRCSC is directly supporting scientists to work with diverse students, in ways that positively support NOAA mission science, NOAA's future mission workforce, and the individual needs of these students for meaningful career mentoring, science content and skills development, and recruitment into the career pipeline through social support, mentoring, networking, and introduction to the discipline by meaningful scientists and faculty members.

The students are obtaining opportunities, through LMRCSC fiscal support, training, and linkages to scientists (university and NOAA), to meaningfully expand their capacity to engage NOAA mission science, to use large dataset management and analytic skills, and to enhance their connections to NOAA's workforce and an expansive and diverse network of scientists and peers who are at various stages in the career pipeline. These students and their scientist mentors perceive the value and benefits of the NERTO experiences—and clearly these experiences also benefit the scientists themselves.

Concerns over paperwork, fiscal constraints, work and project timetables all seem within the typical concerns expressed by these professionals, and are deemed insufficient to elicit responses. Large systems work efforts, through required standardization of work flow and management, typically raise such concerns.

The leadership of LMRCSC is encouraged to consider the expressions of need for enhanced communications among the entire community of stakeholders, and to continue, and highlight, its ongoing efforts in support of NOAA EPP and NOAA mission science evidenced in these NERTO experiences. It seems clear there are numerous examples of high impact, social impact, and student impact projects among these NERTO experiences that serve as evidence of the strong, positive impacts of LMRCSC overall. The broader science community and public could only benefit from enhanced awareness of these accomplishments.

## Appendix II: TAB Funded Research Projects in 2017-2019

### LMRCSC TAB Project Titles FY2017-2019

Project No.	P.I. Name	Project Title	Theme	Status
18-01	Brittany King (OSU)	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	SA	Open
18-02	J. Sook Chung (UMCES/IMET)	Baseline Data of Male Reproductive Status for Jonah Crab Management	SA	Open
18-03	LaTrese Denson (UM/RSMAS)	Indices of abundance for King Mackerel in the Gulf of Mexico and South Atlantic improved by incorporating spatiotemporal and environmental variability	SA	Open
18-04	Tara Cox (SSU)	Examining ecosystem health through contaminant analysis of common bottlenose dolphins ( <i>Tursiops truncatus</i> )	SA	Open
18-05	Matthew Ramirez (OSU)	Integration of habitat-specific growth variation into assessment models: a case study in the Kemp's ridley sea turtle	SA	Open
18-06	Detbra Rosales (UMES)	Assessing the Impacts of Harmful Dinoflagellates and <i>Vibrio</i> spp. on Oyster Aquaculture in the Delaware Inland Bays	HH	Open
18-07	Rebecca Wenker (UMES)	Cold-water corals in the Mid-Atlantic Bight: Age, colony complexity, and growth	SA	Final
18-08	Eric Lewallen (Hampton U.)	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys	SA	Open
18-09	Brian Galvez (DSU)	Diet analysis of juvenile weakfish in the Delaware Bay using stomach content and stable isotope analysis	SA	Final
18-10	Andre Price (UMES)	Feeding Ecology of Black Sea Bass at Selected Reef Sites using Gut Content and Stable Isotope Analyses	SA	Final
18-11	Enid Munoz (UMES)	Assessment of Microplastics and Polybrominated Diphenyl Ethers (PBDEs) in Scallops as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic, Southern New England, and Gulf of Maine Stock Fisheries	HH	Open
17-01	Cara Schweitzer (UMES)	Discard mortality of sub-legal black sea bass in the commercial trap fishery: Impacts of air exposure and acute temperature changes.	SA	Final
17-02	Bradley Stevens (UMES)		SA	Complete

	Biological baseline data for Jonah Crab Management		
17-03	Stephanie Martinez-Rivera (UMES) Reproductive Biology of red deepsea crabs, <i>Chaceon quinquegens</i> .	SA	Complete
17-04	Tara Cox (SSU) Refining stock structure of common bottlenose dolphins ( <i>Tursiops truncatus</i> ) through photo-identification and genetic analysis	SA	Complete
17-05	Shari Wiley (Hampton U.) The Impact of Increasing Sea Surface Temperatures on Piscivore and Planktivore Species Dynamics: An Ecosystem-Based Modeling Approach	C&E	Complete
17-06	Joe Pitula (UMES) Ecosystem impact of a harmful algal bloom species ( <i>Dinophysis acuminata</i> ) on aquaculture shellfish	HH	Complete
17-07	Jessica Miller (OSU) Migration and foraging ecology of at-risk species: Columbia River Chinook salmon and Atlantic weakfish	SA	Complete
17-08	Ammar Hanif (UMCES/IMET) Comparing the diet and microbiome of Atlantic menhaden and Eastern oyster using DNA barcoding	SA	Complete

**Project Number: 18-01**

**Project Title:** Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce

**Project Abstract:** NOAA Fisheries has a responsibility to provide the best available science for the management of living marine resources. Research has shown the value of diversified thinking and approaches in science and that diverse perspectives can improve our collective ability to solve problems. However, African American, Latino, and Native American populations face the issue of being underrepresented in marine and fisheries science professions, resulting in a workforce that does not reflect the diversity of the United States. This study focuses on the underrepresentation of racial and ethnic groups in marine and fisheries related science professions and aims to provide an analysis of how life experiences and identity shape marine and fisheries science related career decisions of individuals across different racial and ethnic groups and career levels (undergraduates, graduates and professionals). This study uses in-depth interviews and a qualitative data analysis approach to analyze the effects of life experiences and identity on career decisions. In February 2019, we conducted 9 in-depth semi-structured interviews with participants across different racial and ethnic groups, including individuals that identify with the three racial and ethnic groups mentioned above, and career levels (undergraduate and graduate) at the ASLO Aquatic Sciences meeting. The majority of the participants interviewed were at the undergraduate career level (77%). Data obtained from these interviews has yet to be analyzed.

**Keywords:** Diversity, Underrepresentation, Race, Ethnicity, Identity, Social Identity, Life Experiences, Career Decisions

**Thematic Area Addressed:** Assessment

**Species studied:** *Homo sapiens*      **Common name:** Humans

**Lead Scientist(s):** Brittany King (OSU, PhD Student), Kelly Biedenweg, PhD (OSU)

**NOAA Collaborator(s):** Kevin Werner (NOAA/NWFSC)

**LMRCSC Collaborator(s):** Benjamin Cuker, Ph.D. (Hampton University)

**LMRCSC Research Student(s):**

**Start Date:** 1 September 2018

**End Date:** 31 March 2020

**Project Results:** This research project received final approval from Oregon State University's Institutional Review Board (IRB) in January 2019. Once IRB was obtained, we began outreach and recruitment of individuals to participate in in-depth semi-structured interviews. Brittany reached out to Dr. Cuker and he shared the project's IRB approved recruitment letter with the 2019 ASLOMP participants. After initial recruitment, 14 participants opted-in to being contacted for an interview at the 2019 Association for the Science of Limnology and Oceanography (ASLO) Aquatic Sciences meeting. In February 2019, Brittany attended the ASLO Aquatic Sciences meeting and conducted 9 in-depth semi-structured interviews with ASLOMP participants across different racial and ethnic groups and career levels (undergraduate and graduate). The majority of the participants interviewed were at the undergraduate career level (77%). Data obtained from these interviews has yet to be analyzed. Brittany is scheduled to attend this year's LMRCSC cohort meeting in April where she plans to continue interviews with LMRCSC graduate fellows. The following week she will be in the Washington, DC area interviewing individuals at the professional career level. Data analysis is expected to begin this summer.

**Products:** Publications or presentations at regional, national, or international meetings?

King, Brittany. 2018. Underrepresentation of racial and ethnic groups in marine and fisheries science professions. Presented at International Symposium on Society and Resource Management. Snow Bird, UT. June 19, 2018

**Relevance:** NOAA has acknowledged that in order to continue to meet its mission, a commitment to strengthening diversity and inclusion is critical. As a part of their strategic plan, multiple NMFS science centers have highlighted the importance of diversity and the need to recruit highly skilled and motivated employment candidates that reflect the diversity of the nation as one of their goals. This project will contribute to science by examining the drivers that influence individuals from underrepresented communities pursuing fisheries science careers and contribute to NOAA by providing a better understanding of how to recruit and retain individuals from underrepresented communities.

**Broader Impacts:** This project explores a social science and human dimensions aspect of marine and fisheries science that is often overlooked. It aligns well with LMRCSC missions to prepare a diverse student body for careers in marine and fisheries sciences through exemplary academic and research collaborations, by examining drivers that influence a diverse marine/fisheries science workforce. The project provides the LMRCSC student researcher, Brittany King, the opportunity to integrate social science research into the LMRCSC program to help better understand underrepresentation in marine and fisheries science professions. The results of this study will be used to inform other components of Brittany's dissertation research that test more specific hypotheses about life experience and identity, including research on the development of career identities amongst youth.

**Project Number:** 18-02

**Project Title:** Baseline Data of Male Reproductive Status for Jonah Crab Management

**Project Abstract:** The fishery for Jonah crab (*Cancer borealis*) has been rapidly increasing in the Northeast United States since 2002. As a data-poor species, it still lacks in the information on age, growth or reproduction. In 2016, the Fishery Management Plan stated a minimum legal size (4.75")

based on limited information, despite that the life history and the size at the onset of sexual maturity are unknown, and that animals over the legal size would experience another molt to become larger. The goals of this project are to 1) establish a relationship between the size of males and reproductive status (onset of sexual maturity; physiological and functional maturity) by studying the primary male sex hormone, insulin-like androgenic gland hormone; and 2) determine if the largest size group of adults undergoes another molt cycle. This information is critical for setting size limits and managing crab fisheries in the Mid-Atlantic Bight.

Keywords: Crabs, Fisheries, Reproduction, Molting, Management

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Cancer borealis* **Common name:** Jonah crab

**Lead Scientist(s):** J. Sook Chung (UMCES-IMET)

**NOAA Collaborator(s):** Burton Shank (NOAA/NMFS), Paul McElhany (NOAA/NWFSC)

**LMRCSC Collaborator(s):** B. Stevens (UMES), R. Jagus (UMCES-IMET)

**LMRCSC Research Student(s):** Amanda Lawrence (Master Student, UMCES-IMET)

**Start Date:** 1 September 2018

**End Date:** 31 August 2019

**Project Results:** A method has been established to quantify spermatophore content in *C. borealis*, which is an important primary sexual characteristic. Fifty (50) males were measured and tissue samples were dissected for analysis of insulin-like androgenic gland hormone cloning and expression. Forty (40) of the 50 were synthesized cDNAs and another 40 samples for RNA extraction are stored in 70% ethanol. Challenges that have occurred throughout this process were waiting for the proper permits to be processed for vent-less traps which took over 2 months before we could request crabs. Other challenges that arose were that the androgenic glands of these crabs were small and delicate, compared to other crab species, which made them hard to dissect, and required more time per dissection. The gonads this time of year (fall/winter) were ripe and would readily burst when touched. This was an issue for GSI measurements, which also added time per dissection to allow for accurate extraction. The graduate student (Amanda Lawrence) is currently doing her NERTO Experience (February 25 – May 17, 2019) with Dr. Paul McElhany at the Northwest Fisheries Science Center in Mukilteo, WA. She will be learning about physiology of the Dungeness crab *Cancer magister* as she studies the effects of ocean acidification on larval development of these crabs. She will become skilled at rearing Dungeness crab larvae and using a respirometer to study the energetic costs of maintaining pH balance at lower pH conditions than that of the current ocean.

**Products:**

Chung, J. S., Huang, X., Bachvaroff, T. R., Lawrence\*, A., Pitula, J. S. and Jagus, R. (2019) Infection by *Callinectes sapidus* reovirus increases transcript levels of eukaryotic translation initiation factor 4E(eIF4E) family members and eIF4E binding protein (4E-BP) in the hemocytes and eyestalk ganglia of the blue crab, *C. sapidus* [In press for *Journal of Shellfish Research*]

**Relevance:** Research on the Jonah crab is critical due to the fact that a major fishery exists for the males, yet we do not have a clear understanding behind the timing or mechanisms of sexual maturation. This process can be better understood with information about how size relates to the neuropeptides involved in this process and to sexual maturity itself.

**Broader Impacts:** This research can impact the management of the Jonah crab by providing important biological information regarding the size of the males and different aspects of sexual maturity. The NERTO Experience was mandated by NOAA's LMRCSC as Amanda is a recipient of the LMRCSC-fellowship. This required internship provides a training opportunity to further her skills in rearing larval and juvenile crabs while also learning new techniques.

**Project Number: 18-03**

**Project Title:** Indices of abundance for King Mackerel in the Gulf of Mexico and South Atlantic improved by incorporating spatiotemporal and environmental variability

**Project Abstract:** The assessment of King mackerel in the Gulf of Mexico uses an index for estimating spawning stock biomass; this index is developed using a statistical model that is parameterized by fitting to larval count data from annual plankton surveys. The model used to make the index does not explicitly consider spatiotemporal variation, which is inherent to the larval count data and can influence local population density. Biomass trends can be misrepresented by a model that does not explicitly consider changes in spatial distributions (e.g., migration or ontogenetic shifts). This misrepresentation of estimated trends has been shown to lead to incorrect and uncertain estimates of stock status in the stock assessments, which are used to set management regulations which help to achieve NOAA's sustainable fisheries goals. King mackerel spatial distributions vary over time as adults migrate seasonally and change their distribution based on the quality of their environment. Migrations cause shifts in their spawning locations from year to year, and this then impacts the larval stage as their distribution is dependent on the location of spawning, and the local oceanography. So far we have used geostatistical models to answer the following question: Will accounting for spatiotemporal variation reduce the uncertainty in the estimates of the index, or indicate new biomass trends? Incorporating spatiotemporal variability indicates a slight decrease in abundance in various years. Additional model exploration and validation is needed.

**Keywords:** larval surveys, spatiotemporal modeling, biomass indices, King mackerel, Gulf of Mexico

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Scomberomus cavalla*      **Common name:** King Mackerel

**Lead Scientist(s):** LaTreese Denson, University of Miami RSMAS, Elizabeth Babcock, University of Miami RSMAS

**NOAA Collaborator(s):** John Walter, NOAA Southeast Fisheries Science Center; James Thorson, Alaska Fisheries Science Center

**LMRCSC Collaborator(s):** Dionne Hoskins-Brown, Savannah State University

**LMRCSC Research Student(s):** LaTreese Denson, University of Miami RSMAS (PhD); Alexandria Ambrose Savannah State University (UG)

**Start Date:** 12 September 2018

**End Date:** 31 August 2019

**Project Results:** To date we have found that both of the indices, the non-spatiotemporal and the spatiotemporal model identify most of the same trends in the early years but in the later years 1999 and beyond, there is a slightly lower estimate from the spatiotemporal index. There are possibly some redundancies in the model factors which need to be explored further. To date spatial variation has been more informative than spatiotemporal variation to the development of the index of abundance.

**Products:** Denson, L.S., Babcock E.A. & Walter J.F. (2018). The effect of spatial and temporal variation on larval indices used for King mackerel in the Northern Gulf of Mexico. ICES Annual Science Conference in Hamburg, Germany.

**Relevance:** To date these results are relevant to NOAA's fisheries operations by supporting the use of a more complex model to account for how King mackerel larval counts change over time and space. This allows us to have a better idea of fisheries population dynamics to better manage such fisheries.

**Broader Impacts:** The NERTO experience completed in December 2019 at the Alaska Fishery Science Center allowed PhD candidate, LaTreese Denson the opportunity to learn a new skill. It also allowed her to build a network of possible collaborators across the country in Seattle,

Washington. This training also allowed Denson to bring these skills to the Gulf of Mexico where these type of models are only recently being explored.

**Project Number: 18-04**

**Project Title:** Examining ecosystem health through contaminant analysis of common bottlenose dolphins (*Tursiops truncatus*)

**Project Abstract:** As apex predators, common bottlenose dolphins (*Tursiops truncatus*) are an indicator species for ecosystem health. Persistent organic pollutants (POPs) accumulate in the blubber of bottlenose dolphins, making this species an indicator for ecosystem POP exposure. Spatial differences in bottlenose dolphin POP levels have been identified throughout the southeastern U.S. including the highest recorded PCB concentrations worldwide reported in estuaries around Brunswick, GA. This project aims to (1) identify baseline POP levels for the Northern Georgia Southern South Carolina Estuarine System (NGSSCES) Stock, (2) determine if the NGSSCES Stock has been exposed to the same point-source contaminants as the two other estuarine stocks in Georgia, and (3) use POP exposure as an additional tool in combination with genetics, photo-identification, and spatial analyses to assess stock structure. A total of 24 genetic samples and 20 POP samples were collected in February 2019. The genetic samples have been sent to NOAA for sexing of the individuals. The POP samples will be analyzed by LMRCS student Sena Tay in summer 2019 in G. Ylitalo's lab at the Northwest Fisheries Science Center. Additional fieldwork will be conducted in March 2019 to obtain more samples

**Keywords:** contaminants, persistent organic pollutants, photo-identification, spatial analyses, genetics, bottlenose dolphins

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Tursiops truncatus*      **Common name:** Common bottlenose dolphin

**Lead Scientist(s):** Tara M. Cox, Savannah State University

**NOAA Collaborator(s):** Gina Ylitalo, NOAA, Northwest Fisheries Science Center

**LMRCSC Collaborator(s):** Carolina Bonin Lewallen, Hampton University

**LMRCSC Research Student(s):** Sena Tay (UG; SSU)

**Start Date:** 1 August 2018

**End Date:** 31 July 2019

**Project Results:** A total of 24 genetic samples and 20 POP samples were collected last month. The genetic samples have been sent to NOAA for sexing of the individuals. The POP samples will be analyzed by LMRCS student Sena Tay in summer 2019 at the Northwest Fisheries Science Center in Seattle, Washington.

**Products:** Sena Tay's abstract was accepted to the Southeast and Mid-Atlantic Marine Mammal Symposium (SEAMAMMS). She will present a poster at SEAMAMMS at Georgetown University Mar 29-31, 2019. Our next report will have the citation for that presentation.

**Relevance:** This project directly addresses several of NOAA's research priorities and thematic areas. This project contributes to NOAA's mandate to manage protected resources by examining habitat health as well as stock assessment. The proposal covers two research themes of the Living Marine Resources Cooperative Science Center: Healthy Habitats: Relationships with Populations and Assessment: Support and Information. This research will contribute to the Southeast Fisheries Science Center's efforts to "describe and assess the role of habitat in supporting healthy marine ecosystems and populations of exploited and protected species" and "monitor and assess fisheries and marine ecosystems, including populations of exploited and protected species, their habitats, and the associated human communities that rely on marine resources" (NOAA 2013). Monitoring protected species, such as common bottlenose dolphins, is part of the "core" activities that the SEFSC must continue even when budgets are minimal. Assigning marine mammals to stocks is necessary for effective management of these protected

species. The three estuarine system stocks in Georgia (Northern Georgia/Southern South Carolina Estuarine System Stock, Central Georgia Estuarine System Stock, and Southern Georgia Estuarine Stock) are all considered strategic stocks under the Marine Mammal Protection Act (Hayes et al. 2017).

Previous samples (n=20) from 20 male common bottlenose dolphins were analyzed by G. Ylitalo and found to have the lowest mean concentrations of PCBs (31.1 µg/g) compared to 14 other locations in the Southeastern U.S. (Kucklick et al. 2011). The additional 20 samples that were collected last month will be analyzed for contaminants in G. Ylitalo's lab in summer 2019 by LMRCSC student Sena Tay. This will provide a robust baseline POP contaminant level for the Northern Georgia Southern South Carolina Estuarine System (NGSSCES) Stock and allow for comparison to the other two Georgia stocks of common bottlenose dolphins.

**Broader Impacts:** This study addresses the need for more technical training for students and increased representation of women and minorities in marine science. The under-represented students will learn concepts of marine ecology, marine mammal biology and management, and spatial ecology while gaining skills in photo-identification, contaminant analyses, and GIS. In addition to these methodological skills, students will learn critical science communication skills through dissemination of the study's results and writing a manuscript for a peer-reviewed journal.

### **Literature Cited**

Hayes, S.A., E. Josephson, K. Maze-Foley, and P. Rosel, eds. 2017. U.S. and Gulf of Mexico marine mammal stock assessments – 2016. NOAA Technical Memorandum NMFS-NE-241. 282pp.

Kucklick J., L. Schwacke, R. Wells, A. Hohn, A. Guichard, J. Yordy, L. Hansen, E. Zolman, R. Wilon, J. Litz, D. Nowacek, T. Rowles, R. Pugh, B. Balmer, C. Sinclair, and P. Rosel. 2011. Bottlenose dolphins as indicators of persistent organic pollutants in waters along the US East and Gulf of Mexico coasts. *Environ Sci Technol* 45(10): 4270-4277.

National Oceanic and Atmospheric Administration. 2013. Southeast Fisheries Science Center Science Plan 2013-2018. National Oceanic and Atmospheric Administration, Sept. 2013, 25 pp. Web. 7 January 2018.

### **Project Number: 18-05**

**Project Title:** Integration of habitat-specific growth variation into assessment models: a case study in the Kemp's ridley sea turtle.

**Project Abstract:** Spatiotemporal variation in demographic parameters can strongly influence a species' population dynamics but is generally not included in sea turtle population due in part to lack of sufficient data. For example, Kemp's ridley sea turtles that inhabit the U.S. Atlantic Coast grow slower than conspecifics that inhabit the U.S. Gulf of Mexico (GoM) Coast, which may lead to differences in age at maturation for individuals or whole cohorts. To evaluate the influence of this variation on Kemp's ridley population dynamics, we are developing an improved age-structured population model that incorporates habitat-specific vital rate estimates (growth, survival). Using a ~30 year dataset of somatic growth rates obtained through skeletochronology, we have developed habitat-specific (Atlantic, GoM) maturation schedules for this species. In addition, ongoing analyses are using 20 years of stranding length frequency data collected through the Sea Turtle Stranding and Salvage Network to estimate habitat-specific survival rates that will be included in the model. Ongoing analyses will examine model sensitivity to changes in stage-and habitat-specific model parameters. This project will help answer critical question about the contribution of somatic growth variation, habitat use, and Atlantic turtles, which have been excluded from all



existing population models, to Kemp's ridley population dynamics.

**Keywords:** population dynamics, stage-structured models, matrix models, migration, age and growth, maturity, skeletochronology

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Lepidochelys kempii*      **Common name:** Kemp's ridley sea turtle

**Lead Scientist(s):** Matthew Ramirez (OSU), Selina Heppell (OSU)

**NOAA Collaborator(s):** Jeffrey Moore (NOAA/NMFS), Larisa Avens (NOAA/NMFS)

**LMRCSC Collaborator(s):** Elizabeth Babcock (RSMAS)

**LMRCSC Research Student(s):** Matthew Ramirez (PhD, OSU), Tamara Popovska (UG, RSMAS)

**Start Date:** 1 September 2018

**End Date:** 31 August 2019

**Project Results:** As the model is still in development, there are no major project results to report at this time. Matthew completed his NERTO experience in Fall 2018 with Dr. Moore at the NOAA Southwest Fisheries Science Center. While there Matthew coded the majority of the age-structured model in R that includes habitat-specific life stages and maturation schedules (Fig. 1). However, there has been an unexpected delay in obtaining the stranding length frequency data necessary to proceed with estimation and parameterization of survival rates via catch curve analysis and transition probabilities for turtles moving from Atlantic to GoM habitats. We have been assured these data will become available by April at which point we will proceed with finalizing configuration of the model. Model testing and analysis will begin in the Spring 2019 and conclude in Summer 2019.

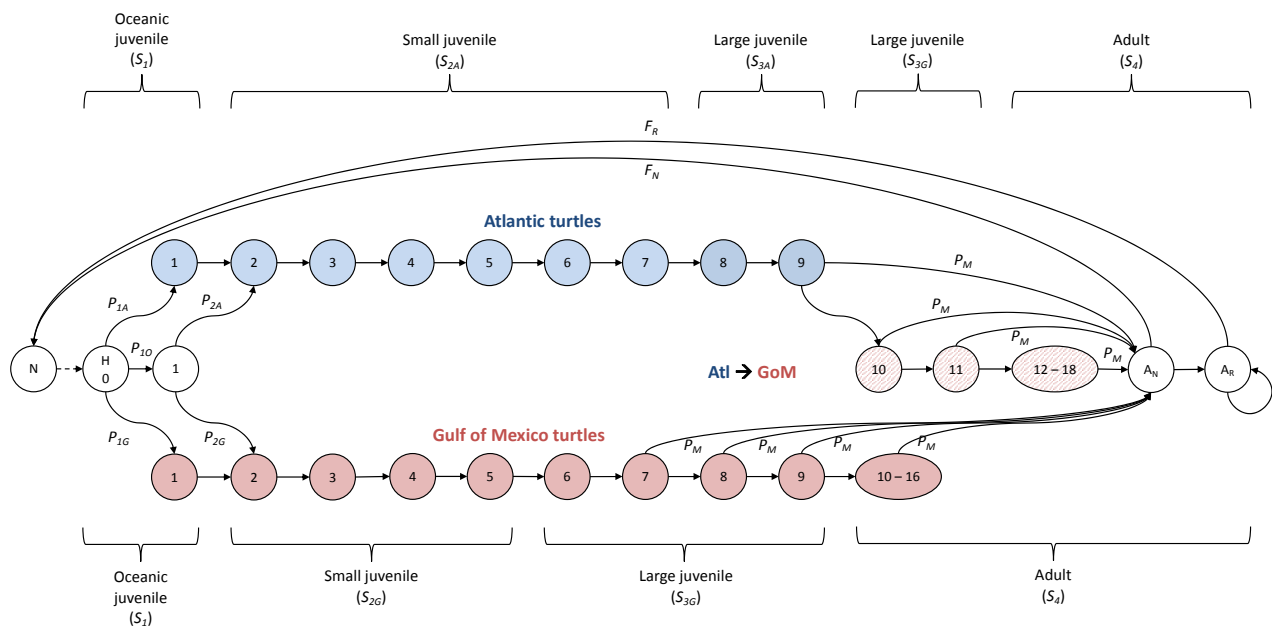


Fig. 1. Conceptual diagram of the model in development. Major modifications from the most recent Kemp's ridley population model used for status assessment include (1) separation of Atlantic and GoM juvenile life stages, (2) incorporation of habitat-specific maturation schedules and survival rates, (3) incorporation of variable recruitment from oceanic to neritic life stages (based on stable isotope analyses conducted by MDR), and (4) incorporation of variable recruitment from Atlantic to GoM neritic life stages (based on strand length frequency data).

**Products:** Both Matthew and Tamara attended and presented at the International Sea Turtle Symposium in February 2019.

- **Ramirez, MD**, L Avens, LR Goshe, ML Snover, and SS Heppell. 2019. Density-independent decline in Kemp's ridley somatic growth rates following the Deepwater horizon oil spill. International Symposium on Sea Turtle Biology and Conservation, Charleston, SC.
- Popovska, T, E Babcock, and **MD Ramirez**, L Avens, LR Goshe, and SS Heppell. 2019. A meta-analysis of somatic growth in sea turtles. International Symposium on Sea Turtle Biology and Conservation, Charleston, SC.

**Relevance:** We expect our results will support NOAA's mission "to conserve and manage coastal and marine ecosystems and resources" by achieving the following objectives: (1) update an assessment model for the endangered Kemp's ridley sea turtle to inform and improve management efforts, (2) evaluate the contribution of Atlantic Kemp's ridley sea turtles to overall species population dynamics, and (3) evaluate alternative hypotheses for the recent reduction in the recovery rate for the species.

**Broader Impacts:** This study addresses the need for more quantitative training for students and increased representation of minority students in fisheries science. Both Matthew and Tamara have learned a variety of quantitative methods used for population and statistical modeling, including catch curve analysis, model fitting, sensitivity analysis. This project also provided Matthew an opportunity to collaborate with NOAA scientists from multiple science centers.

**Project Number: 18-06**

**Project Title:** Assessing the Impacts of Harmful Dinoflagellates and *Vibrio* spp. on Oyster Aquaculture in the Delaware Inland Bays.

**Project Abstract:** The Delaware Inland Bays (DIBs) are a collection of salt marshes, saltwater creeks, and shallow open waters. Over the years, the ecological health of certain areas in the DIBs has deteriorated because of poor water quality. In 2013, the Delaware State Legislature instructed the Delaware Department of Natural Resources and Environmental Control to create an oyster aquaculture industry. We are examining areas near proposed aquaculture sites to determine the impacts of water quality and proliferation of pathogenic bacteria on oyster aquaculture. Using a combination of microscopy, PCR, MPN/PCR, and bioinformatics, we are comparing the HAB community, bacterial community and *Vibrio* spp. in the water column and in *Crassostrea virginica*. In 2017 and 2018 we were able to identify the presence of many bloom forming algal species such as *Karlodinium veneficum*, *Dinophysis* sp., *Heterosigma akashiwo* and *Chattonella subsalsa* in the DIBs. *Vibrio parahaemolyticus* and *V. vulnificus* were also detected in both environmental samples and *C. virginica*. However, *Vibrio* spp. abundance varied between sites and was positively correlated with temperature. On average nutrient levels were relatively higher at Torquay canal, DE in comparison to other areas in the DIBs. Additionally we are working on determining the bacterial communities in water and oyster and identifying the impacts that okadaic acid (dinoflagellate toxin) has on oyster's health. By evaluating the impacts of HABs and *Vibrio* spp. on oysters, we are fulfilling NOAA's mission of understanding and predicting changes in oceans and coasts, as HAB species are proliferating due to anthropogenic forces.

**Keywords:** HAB, molecular biology, *Vibrio* spp., oysters, aquaculture.

**Species studied:** *Vibrio* spp. **Common name:** *Vibrio*

**Thematic Area Addressed:** Healthy Habitats

**Lead Scientist(s):** Detbra Rosales (UMES)

**NOAA Collaborator(s):** John Jacobs (NOAA/NCCOS)

**LMRCSC Collaborator(s):** Joseph Pitula (UMES)

**LMRCSC Research Student(s):** Detbra Rosales (PhD, UMES) and Reuel Danquah (UG, UMES).

**Start Date:** 1 May 2018

**End Date:** 30 May 2019

**Project Results:** From April-October 2018 we have collected water and oyster samples from the

Delaware Inland bays. We have worked with John Jacobs to identify the impacts okadaic acid has on oyster health. Detbra Rosales, our Ph.D. LMRCSC research assistant has processed water and oyster samples for the identification and enumeration of harmful algae and pathogenic *Vibrio* spp. She was able to identify the presence of many harmful algal species such as *Karlodinium veneficum*, *Dinophysis* spp., *Heterosigma akashiwo* and *Chattonella subsalsa* in the DIBs. *V. parahaemolyticus* and *V. vulnificus* were also detected in both environmental samples and *C. virginica*. She is currently screening these samples for the presence of *V. parahaemolyticus* and *V. vulnificus* virulent genes. She has also exposed oysters to Okadaic acid and *V. parahaemolyticus* to understand the influence of okadaic acid on gene expression and bacterial susceptibility. As of now okadaic acid has no effect on *V. parahaemolyticus* growth within oysters, however okadaic acid has decreased *V. parahaemolyticus* growth in media. We are currently in the process of extracting RNA from oysters that were exposed to Okadaic acid and running RT-QPCR for Hsp 70 (Heat shock protein 70) and GADPH (house-keeping gene) to understand the impacts of Okadaic acid on oyster health. We were able to create the standard curves for both Hsp 70 and GADPH and the next step is to convert RNA to CDNA. Reuel Danquah, our LMRCSC undergraduate research assistant has been testing 2018 oysters and water samples for the presence of bacteria and Dinoflagellates. These samples were sent out for metagenomics to determine the eukaryotic and microbial community in the Delaware Inland Bays oysters. We are currently processing the large dataset using the software Mothur to help us remove duplicated sequences and align sequences to known sequences in the Silva database.

**Products:**

Rosales, D., Parveen S., Ozbay, G., Jacobs, J., and Pitula, J., (2018). Harmful Algal Succession and *Vibrio* association in the Delaware Inland Bays. World Aquaculture 2019 meeting Oral presentation.

**Relevance:** Oysters are harvested for human consumption, and studies have shown that dinoflagellate (HABs) can increase bacterial loads in oysters. HABs can also produce toxins that accumulate in our shellfish and cause human sickness. Therefore, understanding the relationship between the factors that promote both HAB development and pathogenic bacterial proliferation is imperative. Our results will support NOAA's long-term goal of "healthy habitats" by 1) Evaluating the community structure of harmful dinoflagellates and *Vibrio* spp. in the Delaware Inland Bays; 2) Comparing the seasonal succession of harmful dinoflagellates and microbial community in the water to the community in oysters gut contents; and 3) Determining the impacts of okadaic acid on oysters health and *Vibrio* spp. growth. We are fulfilling NOAA's mission of understanding and predicting changes in oceans and coasts, as HAB species are increasing due to anthropogenic forces.

**Broader Impacts:** A major component of completing our project is to provide both our Graduate (Detbra) and Undergraduate (Reuel) students with an opportunity to collaborate with NOAA mentors, UMES and DSU faculty, DNREC, and stakeholders. With our findings we will be able to better inform local government, stakeholders, and scientists on the areas in the Delaware inland Bays that are safe for oyster aquaculture and how we, as a community, can decrease factors that lead to the presence of HABs. We expect Detbra Rosales to complete her Ph.D. degree in August 2019. Reuel has gained research experience that motivated him to pursue a graduate degree in Marine Science. Reuel has completed his undergraduate degree in Biology and is currently, a LSAMP graduate student in the Toxicology program at UMES.

**Project Number: 18-07**

**Project Title:** Cold-water corals in the Mid-Atlantic Bight: Age, colony complexity, and growth

**Project Abstract:** Sea whips (*Leptogorgia virgulata*) are a common structural component of benthic habitats found in the DelMarVa region of the Mid-Atlantic Bight, and may serve as

essential fish habitat for commercially valuable species. However, they are slow-growing, easily damaged, and especially vulnerable to damage by passive fishing gear. Despite their potential importance, sea whips are generally understudied in this region. Therefore, we proposed to examine the age, colony complexity, and growth of sea whips from 4 sites in the DelMarVa. There were no significant differences in the bifurcation ( $R_b$ ) and tributary to source (T/S) ratios between sites, with the  $R_b \approx 3$  for all sites. Estimated age of sea whips ranged from 2 to 15 y, with 50% in the range of 6 to 8 y. Coral growth was determined by relating age estimates to total coral length in a von Bertalanffy growth model, and the model parameters were calculated to be:  $L_\infty = 86.1$  cm,  $K = 0.14$  yr<sup>-1</sup>, and  $t_0 = 1.44$  years. A total of 67 corals were tagged and total length measured, to measure growth over time. Five of these corals were damaged to measure the regrowth after damage. Data provided by this project will help fill the large knowledge gap concerning coral habitats that exists in the coastal DelMarVa region, and the baseline created will be a useful reference to study changes over time. This also relates to NOAA's goal to improve our understanding of ecosystems to inform resource management decisions, especially if sea whips were to become a managed species.

**Keywords:** age, growth, corals, benthic habitats, von Bertalanffy

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Leptogorgia virgulata*      **Common name:** Sea whip

**Lead Scientist(s):** Rebecca Wenker, (MS, UMES)

**NOAA Collaborator(s):** Vince Guida (NOAA, NMFS)

**LMRCSC Collaborator(s):** Bradley Stevens (UMES), Daniel Cullen (LMRCSC Postdoctoral Fellow, UMES)

**LMRCSC Research Student(s):** Rebecca Wenker, (MS, UMES)

**Start Date:** 1 May 2018

**End Date:** 30 April 2019

**Final Results:** Total length distributions were not significantly different between sites (KS test,  $P > 0.008$ ). Total length ranged from 8.3 cm to 85.3 cm, with 50% of corals residing in the 34.2-56.4 cm range. No significant differences in the bifurcation ( $R_b$ ) and (T/S) ratios of *L. virgulata* were found between sites (ANOVA,  $P > 0.05$ ). The average  $R_b$  ratios of approximately 3 for all sites indicated that for each branch of a given order, there are approximately three branches in the next lower order. Neither mean age nor age distribution differed significantly between sites (ANOVA,  $P > 0.05$ ; KS test,  $P > 0.08$ ). Estimated age of sea whips ranged from 2 to 15 y, with 50% in the range of 6 to 8 y. Mean age and distributions were not significantly different between sites (ANOVA,  $P > 0.05$ ; KS test,  $P > 0.08$ ). Age-length keys generated from the pooled coral data show the trend of age increasing with total coral length. Coral growth was determined by relating age estimates to total coral length in a von Bertalanffy growth model. The model parameters were calculated to be:  $L_\infty = 86.1$  cm,  $K = 0.14$  yr<sup>-1</sup>, and  $t_0 = 1.44$  years. A total of 67 corals were tagged, and their total length measured in cm. 5 of these corals were also damaged to measure regrowth after damage.

**Products:**

Wenker, R.P. and B.G. Stevens. 2019. Sea whip coral (*Leptogorgia virgulata*) in the Mid-Atlantic Bight: Age, colony complexity, and distribution. ASLO 2019 Aquatic Sciences Meeting. February 23-March 2. San Juan, Puerto Rico. (Oral)

Wenker, R.P. 2019. Sea whip coral (*Leptogorgia virgulata*) in the Mid-Atlantic Bight: Age, colony complexity, and growth. 33<sup>rd</sup> Annual Meeting of the AFS Tidewater Chapter. February 7-9, 2019. Salisbury, MD (Oral)

**Relevance:** Data provided by this project will help fill the large knowledge gap concerning coral habitats that exist in the coastal DelMarVa region. While Alcyonacean corals are not Federally managed species, they may be critical components of essential fish habitat for black sea bass (*Centropristis striata*), tautog (*Tautoga onitis*), and lobster (*Homarus americanus*). Increasing our

knowledge about their growth and resilience could benefit the managed species they already support. This aligns with NOAA's goal of assessing and defining the essential characteristics of marine habitats, understanding the potential impacts of fishing on sensitive coral habitats, and improving long-term sustainability of fisheries. Additionally, at present the distribution and extent of nearshore hard-bottom habitat is poorly documented, which prohibits the ability to characterize and map important fish habitat. Such information will be highly useful to help define and manage essential fish habitat that cannot be sampled with fish trawls. Socio-economic benefits include knowledge of the biology of habitats that support fisheries, and impacts of habitat damage on the economies/communities that depend on them. Results of this study should result in at least one peer-reviewed publication, and will help develop a baseline of information about Alcyonacean corals in this region.

**Broader Impacts:** This project will facilitate direct interaction and collaboration between students from the University of Maryland Eastern Shore, scientists (NOAA mentor and UMES faculty), and industry collaborators (dive boat operators). This work will also serve as the basis for Rebecca Wenker's Master's Thesis, which she will defend in April 2019. Ultimately, this project will also result in at least one peer-reviewed publication, and the development of maps and a potential model predicting the distribution of alcyonacean corals in the Mid-Atlantic region.

### **Project Number: 18-08**

**Project Title:** Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys

**Project Abstract:** The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous species that occurs throughout the Northern Pacific Ocean and is important to humans for at least two key reasons: 1) Indigenous peoples near the Columbia River have a cultural value for them as a ceremonial food item, and 2) during their marine phase, lampreys parasitize many fish species and may reduce commercial harvests (e.g., Pacific hake, walleye pollock). Although culturally important, vulnerable (freshwater modifications reduce larval habitats), and ecologically interesting (parasites can exhibit dramatic fluctuations in abundance), the basic biology of Pacific lamprey in marine waters has not been well documented. The goal of this study is to identify prey items of Pacific lampreys and characterize their feeding ecology in the Northeastern Pacific Ocean in, particularly where they overlap with commercially-targeted species (e.g., Pacific hake, shrimps).

**Keywords:** Pacific lamprey, feeding ecology, parasitism, predation, culture

**Thematic Area Addressed:** Assessment

**Species studied:** *Entosphenus tridentatus* **Common name:** Pacific lamprey

**Lead Scientist(s):** Eric Lewallen (Hampton University)

**NOAA Collaborator(s):** Laurie Weitkamp (NOAA/NMFS); Linda Park (NOAA/NMFS)

**LMRCSC Collaborator(s):** Carolina Bonin Lewallen (Hampton University)

**LMRCSC Research Student(s):** Janelle Layton (UG, Hampton University), Patricia S Montalvo-Rodriguez (MS, Hampton University, expected to start 1 June 2019)

**Start Date:** 1 Sept 2018

**End Date:** 31 August 2020

**Project Results:** The Pacific lamprey (*Entosphenus tridentatus*) is an ancient (>100 million years), parasitic species with a complex anadromous life cycle. Reproductive adults migrate into freshwater during spring months, and spawn a year later. The larvae develop in freshwater and are consumed by a variety of predators including fishes inhabiting coastal tributaries. After developing in freshwater, young Pacific lampreys migrate to sea where they spend 3-4 years feeding primarily on fishes, before re-entering freshwater to spawn. Surprisingly, very little is known about the Pacific lamprey feeding ecology; including diet composition and prey preferences. Although lamprey parasitism has been known to fishermen and indigenous

communities for centuries, its impact on commercial fisheries has never been formally assessed. This information is a crucial component to accurate modeling of ecosystem-based fishery management in the North Pacific Ocean. In addition to their ecological impacts on North Pacific Ocean fisheries, Pacific lampreys have unique cultural value to humans. Indigenous tribes of the mid-Columbia River Plateau traditionally harvest these animals, which formulate an important cultural identification icon. Indigenous peoples were the first to highlight Pacific lamprey conservation issues that were later corroborated by risk assessment analyses. Due to their value to indigenous cultures across the Pacific Northwest and critical ecological role in marine ecosystems, the conservation and management of Pacific lampreys has received special attention from the U.S. Fish & Wildlife Service, which established the Pacific Lamprey Conservation Initiative. This initiative includes the participation of multiple stake-holders who are signatory parties for the Pacific Lamprey Conservation Agreement in effect since 2012. Pacific lampreys are commonly caught in marine waters during fishery-independent surveys conducted by NOAA Fisheries' Northwest and Alaska Fisheries Science Centers and by commercial fisheries that NOAA Fisheries regulates. However, it is unclear how lamprey's role as parasitic predators affects marine ecosystems. NOAA researchers also regularly catch Pacific and Western River lampreys in the Columbia River estuary, including the collection of lamprey-wounded fish specimens. Documented fish species with lamprey wounds include: non-native American shad, sub-yearling Chinook salmon, shiner perch, and Pacific herring. However, the species or types (i.e., pelagic vs. demersal) of fish parasitized by lamprey in marine waters, or their impacts to commercial species is poorly known. Our goal is to use genetic methods to investigate prey items from the gut contents of Pacific lampreys collected in marine habitats, providing a complete characterization of their diets and feeding ecology.

To date, we have obtained >250 Pacific lamprey specimens from NWFSC collaborator Dr. Weitkamp, 20 of which have been processed at Hampton University by dissection, gut fullness measurement and genetic analysis. Using independent funds for another project, basic dissection equipment (e.g., scale, calipers, dissecting scissors) and forensic DNA sampling kits have been purchased. A senior thesis project has resulted from the advisement. Preliminary data indicate comparatively high gut fullness indices among juvenile lampreys collected as bycatch alongside the Pacific Hake fishery, and early DNA data suggest further fine-tuning of our molecular methods will be necessary for high-quality sequencing reads.

**Products:** Publications or presentations at regional, national, or international meetings?

Layton JM, Bonin CA, Pressley N, Park LK, Weitkamp LA, Lewallen EA. Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys. American Society of Limnology and Oceanography, San Juan, PR, February 23 - March 1st, 2019 (podium).

Layton JM, Bonin CA, Pressley N, Park LK, Weitkamp LA, Lewallen EA. Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys. Emory University, Atlanta, GA, September 30 - October 2, 2018 (poster).

Layton JM, Bonin CA, Pressley N, Park LK, Weitkamp LA, Lewallen EA. Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys. 23rd Annual School of Science Research Symposium, Hampton University, Hampton, VA April 11-12, 2018 (poster).

Layton JM, Bonin CA, Pressley N, Park LK, Weitkamp LA, Lewallen EA. Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys, 9th Biennial NOAA EPP Science and Education Forum. Howard University, Washington, DC, March 18-21, 2018 (poster).

**Relevance:** As stated in the RFP for this funding mechanism: "The LMRCS will conduct research that supports stock assessment of fish, invertebrates, and marine mammals, by describing and

understanding population abundance, migration and distribution patterns, predator-prey relationships, habitat use, age structure, growth, mortality, reproductive biology and behavior, and responses to environmental variability.” We will specifically provide fundamental data for the direct assessment of Pacific lampreys by analyzing predator-prey relationships and habitat use, as well as distribution patterns. As a research program, we have the ability to perform large-scale training in laboratory-based genetics, gut content analysis, and forensics for students at Hampton University. In addition, we will provide students with opportunities for field-based research in marine and freshwater habitats.

**Broader Impacts:** During the first year of this project we will finalize specimen collections and sample processing (e.g., voucher preservation, gut dissection, gut content preservation). The master’s student included (Patricia S Montalvo-Rodriguez) is expected to join the research team in June of 2019, and will carry out genetic analyses. Ms. Montalvo-Rodriguez will complete a 3 month internship at the NOAA Northwest Fisheries Science Center during the summer of 2020. The second year of this project will be focused on collecting any remaining data, analysis of genetic and geospatial data, preparation of manuscripts, and presenting the results of our work at a national fisheries research conference (e.g., AFS). The master’s student will be expected to graduate in May 2021 from the Department of Marine and Environmental Science at Hampton University.

**Project Number: 18-09**

**Project Title:** Diet analysis of juvenile weakfish in the Delaware Bay using stomach content and stable isotope analysis

**Project Abstract:** The weakfish (*Cynoscion regalis*) is a commercially and recreationally valuable fish species that inhabits the Atlantic Coast of North America. The fishery is depleted and has yet to rebound and its failure to recover is attributed to unknown causes of elevated natural mortality rates. We studied the diet of juvenile weakfish in two of their spawning and nursery habitats, the Delaware Bay and the Maryland Coastal Bays. Using stable isotope analysis, mixing models, and stomach content analysis, we sought to answer questions regarding organic matter cycling, prey availability, and prey preference of juvenile weakfish in 2017 and 2018 throughout their estuarine residency, on both coasts of the Delaware Bay, and along the salinity gradient. In the Maryland Coastal Bays, juvenile weakfish diet was analyzed during the summer. Using generalized linear models (GLM) of stable isotope values of Delaware Bay weakfish, we found that  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values were mediated via bottom-up effects from basal primary production that differed over time and space. In contrast to previous studies, mixing models and stomach content analysis (SCA) revealed that gammarid amphipods contributed significantly to juvenile weakfish diet, especially during the summer. The mixing model and SCA results provide necessary updated information of juvenile weakfish diet in the Delaware Bay as prioritized by the ASMFC 2016 Weakfish Stock Assessment. The GLM results revealed that element cycling within the Delaware Bay occurs at small spatial scales, suggesting that EBFM decisions should consider small spatial scales when implementing ecosystem-wide management applications.

**Keywords:** Food habits, stable isotopes, mixing models, MixSIAR, nursery habitats, Delaware Bay

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Cynoscion regalis*                      **Common name:** Weakfish

**Lead Scientist(s):** Dr. Stacy Smith, DSU

**NOAA Collaborator(s):** Dr. Howard Townsend, NOAA

**LMRCSC Collaborator(s):** Dr. Maurice Crawford, UMES

**LMRCSC Research Student(s):** Brian Galvez (MS)

**Start Date:** 1 May 2018

**End Date:** 30 April 2019

**Final Results:**

***Generalized Linear Models – Delaware Bay Weakfish 2017 & 2018  
2017 & 2018 Weakfish Muscle***

The results of the GLMs revealed that the isotopic values of juvenile weakfish are influenced by multiple variables. The nested model terms elucidated that individual stations within certain bay locations and individual months within certain seasons contributed to differences in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . GLM results showed within-location variability between states for individual size classes, indicating that weakfish from opposite sides of the bay exhibit differing delta values, possibly pointing towards differential basal food webs between states or different feeding strategies, as weakfish in NJ were reliably more enriched in  $\delta^{13}\text{C}$ , indicative of a more benthic based food web. Of the four models run for every size class, tissue, and isotope, models 2 and 4 consistently had the best fit to the data as determined by the AICc values. The dichotomy between these models suggests that there are two differing mechanisms that best explain  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of juvenile weakfish – state/location/station, season, and weight (model 2), and the state\*season interaction plus location/station (model 4).

**Stomach Content Analysis Delaware Bay Weakfish** In total, 1,028 juvenile weakfish (with non-empty stomachs; SL = 21-137 mm) from 36 stations were analyzed for stomach contents during the 2-year study period. A notable shift in diet from crustacean to fish prey was observed with increased predator length. Although an increase in the frequency of fish prey was observed with an increase in size class, the frequency of crustacean prey remained high in the larger size classes in 2017 and 2018. Mysid shrimp and gammarid amphipods were the dominant prey items (found in up to 100% of the small and medium size classes), whereas individuals in the large size class had more diverse diets with higher %F observed for UID fish (likely bay anchovy), sand shrimp, and other arthropod species (e.g. small blue crabs, larval horseshoe crabs). The %F of all prey items remained relatively stable over both years, but mysid shrimp occurred in 79% for pooled size classes in 2017 (n = 348) and 91% in 2018 (n = 680). Overall, the contributions of individual prey species varied by season and state; however, a consistent decrease in gammarid amphipod consumption (mainly *Ampelisca* sp.) was noted from the summer to fall in 2017 and 2018 for both Delaware and New Jersey. This decrease in amphipod consumption was consistently related to an increase in mysid consumption over the same time period, in what was called the “seasonal mysid-gammarid relationship”. Additionally, all size class weakfish caught from the middle bay consistently showed higher frequencies of prey items in their stomachs compared to weakfish caught from the lower and upper bays.

**Maryland Coastal Bays** Twenty juvenile weakfish from the MCBs were caught and analyzed for SCA using the %F method. No prey preferences were observed, however, gammarid amphipods showed the highest %F values at 59%, followed by mysids (53%), polychaete worms (47%), UID fish (41%), sand shrimp (29%), other arthropod species (29%), isopod spp. (18%), and UID (18%). The highest three prey items observed in the MCB weakfish conformed to the prey preferences of Delaware Bay weakfish, suggesting that juvenile weakfish feed on select types of invertebrates throughout their estuarine nursery habitats in the Mid-Atlantic region. However, the MCB weakfish showed higher %F values of UID fish than those caught in Delaware Bay.

### **Stable isotope mixing models – Delaware Bay Weakfish 2018**

Using the stable isotope mixing model package MixSIAR in R (Stock and Semmens 2016), 46 mixing models were run for the different size classes, tissue types, and season-bay location-state combinations. The Bayesian framework of this model allowed the use of SCA data to be incorporated as priors (Table 1). Using this feature of the model, the most notable results over all size classes, bay locations, seasons, and states was the reliance/preference that juvenile weakfish showed for gammarid amphipods. Similarly, as observed in past studies, juvenile weakfish also relied heavily on mysid shrimp throughout their estuarine residency. Unexpectedly, however, larger juveniles, known to increase their reliance on forage fish, did not appear to incorporate the isotope values of known forage fish into their tissues, suggesting that these prey types had little importance to growth of juvenile weakfish during their estuarine residency.



**Products:\***

Galvez, B., Townsend, H. (2019). Trophic ecology of weakfish from the Delaware Bay using stable isotope and stomach content analyses. Presented at the Association for the Sciences of Limnology and Oceanography Aquatic Sciences Meeting. San Juan, Puerto Rico, March 2019. Oral Presentation

\* Does not include three other presentations listed in semi-annual report.

**Relevance:** This study provides the first simultaneous analysis of juvenile weakfish diet throughout the entire Delaware Bay (both DE and NJ nearshore zones) and over the course of their estuarine residency. The findings presented here directly answer the question posed in the 2016 Weakfish Stock Assessment to monitor weakfish diets over broad regional and spatial scales. GLM results of carbon and nitrogen stable isotopes revealed two primary aspects regarding juvenile weakfish movement and food web controls: 1) juvenile weakfish exhibit a certain degree of site fidelity within individual size classes, and 2) their isotopic values are mediated by bottom-up controls via spatiotemporal primary productivity, conservative mixing, and possible anthropogenic nitrogen. The variability in delta values of the two stable isotopes could potentially be used as indicators of the local variability of nursery habitats described in Beck et al. (2001). These findings could have implications on future management decisions as the data show that juvenile weakfish are affected by locally available organic matter and prey sources, suggesting that EBFM approaches should consider fine-scale variability when applying ecosystem-wide management decisions. Stomach content analysis and mixing model results also found variability in the diet of juvenile weakfish for different prey items. The seasonal, state, and locational differences in their diet are further evidence of the local availability of various prey items. The results of this diet analysis show that the diet of juvenile weakfish cannot be generalized throughout the Delaware Bay and over the course of their estuarine residency. Rather, more emphasis should be put on the locational and seasonal aspects of diet. Finally, one of the most important findings of this study was the apparent importance of gammarid amphipods to the weakfish diet. Contrary to previous studies, this conclusion highlights a marked shift in the diet of juvenile weakfish from mysids to gammarids in the Delaware Bay.

**Broader Impacts:** The results from this project are a product of collaborative effort with a NOAA scientist and an LMRCSC partner institution collaborator. Brian's role in this project has met the LMRCSC's research and education goals through his hands-on field experience such as boat operation and sampling gear deployment, laboratory experience using stomach content and stable isotope analysis, and statistical analysis mentorship. Brian has developed relationships from both NOAA and LMRCSC partner institutions that have given him the experience in project collaboration for work that addresses NOAA's NGSP by improving the understanding of ecosystems to better inform resource managers. Brian is currently working on a manuscript to publish the results of this study in Transactions of the American Fisheries Society.

**Project Number: 18-10****Project Title: Feeding Ecology of Black Sea Bass Using Gut Content and Stable Isotope Analyses**

**Project Abstract:** Food habits of black sea bass (BSB, *Centropristis striata*) have been studied from trawl surveys in the Mid-Atlantic Bight, but no studies have compared food choices between specific habitats or locations. We sampled BSB at selected natural and artificial reefs near Ocean City, MD using hook-and-line angling to determine how habitat preferences influenced length frequencies, sex ratio, dietary preferences, and stable isotope ratios of  $\delta^{12}\text{C}/\delta^{13}\text{C}$  and  $\delta^{14}\text{N}/\delta^{15}\text{N}$ . Stomach content analysis, and stable isotope analyses of muscle, liver, and mucus were used to determine whether diets varied significantly between sampling locations. Results indicate that crustaceans dominate diets of BSB by frequency of occurrence. This data will help to understand

how BSB utilize different habitat types, and the contribution of reef habitats to BSB populations in the Mid-Atlantic Bight.

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Centropristis striata*

**Common name:** black sea bass

**Lead Scientist(s):** Dr. Brad Stevens, Andre Price. UMES.

**NOAA Collaborator(s):** Dr. Richard McBride, NOAA NEFSC.

**LMRCSC Collaborator(s):** Dr. Maurice Crawford. Graduate committee member, UMES

**LMRCSC Research Student(s):** Andre Price, MS

**Start Date:** 1 March 2018

**End Date:** 30 September 2018

**Final Project Results:** We sampled BSB (n=407) at selected natural and artificial reefs near Ocean City, MD in 2016 and 2018, using hook-and-line angling to determine how reef type influenced length frequencies, sex ratios, dietary preferences, age, and stable isotope ratios of  $\delta^{12}\text{C}/\delta^{13}\text{C}$  and  $\delta^{14}\text{N}/\delta^{15}\text{N}$ . Sample size analysis showed that the number of preliminary samples were too small to detect differences  $>0.3\text{‰}$  and a minimum sample size of 100 fish is required. BSB stomach content analysis, and stable isotope analyses of muscle, liver, and mucus were used to determine whether diets varied significantly between artificial and natural sites. BSB caught in this study were compared to a NOAA dataset (n=1304) for trawl-caught BSB spanning from 2000-2016. Stomach content analyses indicate that crustaceans dominate diets of BSB at artificial and natural sites by proportion and by frequency of occurrence. Otoliths were removed and aged at the NOAA Northeast Fishery Science Center. There were no significant differences in age composition between fish at natural and artificial habitats, indicating that the sorting of age by location type did not occur. ANOVA tests determined that location type had a significant effect on stable isotopes values in all tissues except for  $\delta^{15}\text{N}$  in mucus. Our study shows that natural and artificial reefs are ecologically equivalent for Black Sea Bass caught near Ocean City, MD.

**Products:**

Andre L. Price, Cara Schweitzer, Bradley G. Stevens. Comparing Localized Feeding Ecology of Black Sea Bass (*Centropristis striata*) at Selected Reefs Using Gut Content and Stable Isotope Analyses. National Oceanographic and Atmospheric Administration Educational Partnership Program (NOAA EPP) Education and Science Forum 2018. Washington, DC.

**Relevance:** This research is relevant to NOAA Fisheries' goal to maintain healthy oceans and habitats as well as sustainable fisheries. Specifically, this research will provide local age data from two reef locations in the Ocean City, Maryland area. These reefs are not directly sampled by NOAA trawl surveys due to site bathymetry; this project will provide size, sex, and age (in 2018) of fish directly sampled from the reef sites. In addition, this work may help detect differences in diet between natural and artificial habitats, and whether those diets change with ontogeny, sex, or location.

**Broader Impacts:** The broader impacts of this project included direct and regular engagement with commercial fishermen, as well as with undergraduate students supported by NOAA's LMRCSC. Two undergraduate students worked directly with Andre and received training on dermal mucus sampling. Andre completed his NERTO internship during the months of September through December, 2018, under the mentorship of Dr. Richard McBride, during which he acquired additional skills in otolith age analysis, and statistical analysis of trophic data. Andre will defend his thesis in April and graduate in May, 2019.

**Project Number:** 18-11

**Project Title:** Assessment of Microplastics and Polybrominated Diphenyl Ethers (PBDEs) in *Placopecten magellanicus* as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic Stock Fisheries

**Project Abstract:** Plastic fragments, pellets, fibers and cosmetic beads less than 5 mm in size are termed as microplastics. These are emerging contaminants that in recent years have been found in tap water samples all over the world and in a vast array of aquatic organisms with the possibility of toxic effects in them. The focus of this research will seek to determine if there are microplastics present in the Atlantic sea scallop stock banks across the east coast of the United States. Multiple studies have implied that polybrominated diphenyl ethers (PBDEs), persistent bioaccumulative fire-retardant pollutants, in fish tissues display positive correlations with geographic plastic debris densities. We will examine if this linear relationship also exists in a benthic environment using sea scallops as model organism. Briefly, micropolymer assays will be conducted using an efficient extraction method in which scallop tissues will be divided into muscle, respiratory system and gastrointestinal tract before digestion and visual quantification of microplastics. Scallop and bottom water column samples will be collected from multiples regions across Georges Bank and Mid-Atlantic Bight. Tissues will be tested for PBDEs while plastic debris will be examined in the water samples. Since sea scallops are important commercial organisms with fisheries dredging over 50 million pounds annually for seafood consumption, our research directly contributes to NOAA's goal to conserve and manage coastal and marine ecosystems and resources by providing the scientific foundation for understanding many future studies of the dangers microplastics can have on important ecological and commercial species.

**Keywords:** Microplastics, scallops, Pollution, Georges Bank

**Thematic Area Addressed:** Healthy Habitats

**Species studied:** *Placopecten magellanicus*

**Common name:** Atlantic sea scallop

**Lead Scientist(s):** Enid C. Muñoz Ruiz (MS, University of Maryland Eastern Shore)

**NOAA Collaborator(s):** Ashok Deshpande (NOAA/NEFSC); Beth Sharack (NOAA/NEFSC)

**LMRCSC Collaborator(s):** Ali Ishaque (University of Maryland Eastern Shore)

**LMRCSC Research Student(s):** Enid C. Muñoz Ruiz (MS,UMES)

**Start Date:** 1 June 2018

**End Date:** 30 December 2019

**Project Results:** Enid completed her NERTO internship in mid-March 2019. During that experience, she determined the optimum extraction method to yield the optimum quantification of hydrophobic bioaccumulative compounds in the Atlantic Sea Scallop, *Placopecten magellanicus*, using modern solid phase extraction "quick, easy, cheap, effective, rugged, and safe" (QUECHERS). Microscope dissections and filter fiber analysis have begun at the University of Maryland Eastern Shore. Although filters have been found to contain some fibers, it is yet too early to generate inferences as fiber analysis is still underway. The microscope project is moving at a promising pace.

**Products:**

E. Munoz-Ruiz. Rethink Plastics. Princess Anne Chamber of Commerce February Luncheon. (2019). Washington Inn, Princess Anne, MD. Key Speaker. Oral Presentation.

**Relevance:** It is NOAA's mission to "provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems—all backed by a sound science and an ecosystem-based approach to the management". This research supports NOAA's Fisheries mission, because it looks into the potential of these emerging contaminants to carry toxicants that can have effects on organisms and ecosystems. Specifically, the objectives are to: (1) Determine if Atlantic sea scallops, a very important commercial species, are contaminated with microplastics, (2) if plastics are present, would they be potentially available for trophic transfer or consumption by humans, (3) if weathering of plastics causes PBDEs to leach off of them and bioaccumulate in the fatty tissues of sea scallops, and (3) determine PBDE concentrations, potential human carcinogens, in Atlantic sea scallops.

**Broader Impacts:** With this extensive and arduous research, we hope that Enid Muñoz-Ruiz will

obtain the experience, knowledge and requirements to fulfill her Master's degree in Aquatic Toxicology at the University of Maryland Eastern Shore and furthermore, open many doors in her career. The course work, field and research experience, in addition to the many meetings and collaborations will instill in her a sense of networking and interdisciplinary approach in the scientific community when it comes to developing ideas for projects she will pursue in the future. Enid hopes to complete this project and graduate in spring 2020.

**Project Number: 17-01**

**Project Title:** Discard mortality of sub-legal black sea bass in the commercial trap fishery: Impacts of air exposure and acute temperature changes.

**Project Abstract:** Bycatch within the commercial fisheries industry is of growing concern with regards to sustainability. Discarded bycatch can succumb to either immediate or delayed mortality. Delayed mortality can be difficult to assess and is poorly understood in black sea bass (BSB, *Centropristis striata*), however is estimated at 21% by the Atlantic States Marine Fisheries Commission (ASMFC). Underestimation of bycatch mortality can lead to overfishing and render stock assessment models ineffective. To obtain better estimates of mortality within the commercial trap fishery, a release condition index (RCI) score was used on BSB to assess for the presence of reflexes (operculum, mouth, gag, and dorsal fin) and occurrence of barotrauma (floating and stomach protrusion). Fish were assessed from several commercial fishing locations during standard commercial trap fishing. Sampling was conducted in May, August, and November to determine the effects that a change in temperature ( $\Delta T$ ) between ocean floor and air have on mortality rates. BSB discards had significantly lower RCI score and low probability for mortality during the month of May ( $\chi^2$ :  $p < 0.001$ ) compared to fish caught in August and November. However, there was no significant difference in RCI scores of discards during August and November. A general linear model (GLM) showed that  $\Delta T$  had a significant effect on RCI scores ( $p = 0.01$ )

**Keywords:** Discard mortality, bycatch, RAMP, RCI

**Thematic Area Addressed:** Stock Assessment Support

**Species studied:** *Centropristis striata*

**Common name:** Black sea bass

**Lead Scientist(s):** Cara Schweitzer, UMES

**NOAA Collaborator(s):** Richard Brill, Ecosystems and Aquaculture Division, Behavioral Ecology Branch, NMFS/NEFSC, and Virginia Institute of Marine Science

**LMRCSC Collaborator(s):** Andrij Z. Horodysky, Hampton University.

**LMRCSC Research Student(s):** Cara Schweitzer, PhD candidate

**Start Date:** 1 May 2018

**End Date:** 30 May 2019

**Project Results:** The mean RCI score for Black Sea Bass (BSB) discards caught in different seasons was: May 0.35; August: 0.50; and November: 0.46. BSB discards had significantly lower RCI score and low probability for mortality during the month of May ( $\chi^2$ :  $p < 0.001$ ) compared to fish caught in August and November. There was no significant difference between RCI score of fish caught in August and November ( $\chi^2$ ;  $p = 0.38$ ). This indicates that the probability for mortality is lowest in spring, highest in summer, and slightly but not significantly lower in fall.

**Products:**

Schweitzer, C. C., and **B. G. Stevens**. "The effectiveness of increasing connectivity between two patch reefs for increasing site fish abundance in the Mid-Atlantic". Presented at Ecological Society of America, New Orleans, LA August 2018.

Schweitzer, C. C., A. Z. Horodysky, A. L. Price, and **B. G. Stevens**. In press. Impairment indicators for predicting delayed mortality in black sea bass (*Centropristis striata*) discards within the commercial trap fishery. Submitted to Fisheries Research.

**Relevance:** There is currently little published data or information regarding discard rate and post-release mortality within the BSB commercial fishing industry. Published values are poorly documented and may not accurately depict current practices. Results of this research should also produce recommendations for alternative fishing practices to reduce post-release mortality and improve the sustainability of the BSB fishery. The NMFS Strategic Research Plan for 2013-2018 includes the specific priority of “Studies on impacts of bycatch on non-target species.” The Northeast Fishery Science Center research priorities include “fishery-independent data on commercial and recreational fisheries catch and bycatch,” and this priority is also included by several other NOAA Fishery Science Centers.

**Broader Impacts:** Our results will be communicated at several scientific conferences and meetings, on the LMRCS website, and at the annual UMES Research Symposium. Cara has presented this work at the Ecological Society of America, New Orleans, LA, in August 2018, and has submitted a manuscript for publication. This project engaged both graduate and undergraduate students from underrepresented communities in NOAA mission-relevant STEM research. The results of this project will comprise a portion of the Ph.D. Dissertation of a minority graduate student (Cara Schweitzer, Hispanic-American). Cara is planning to graduate in May, 2019.

**Project Number: 17-05**

**Project Title:** The Impact of Increasing Sea Surface Temperatures on Piscivore and Planktivore Species Dynamics: An Ecosystem-Based Modeling Approach

**Project Abstract:** Ecosystem-based fishery management has rapidly become the standard approach for assessing the viability of commercial fishery stocks. Species interaction and seasonal fluctuations play key roles in understanding the impact that harvesting has on species sustainability. However, as the effect of climate change on weather conditions and average temperatures becomes exceedingly dramatic, immediate action must be taken to include mechanisms into population models that account for climate change to avoid deleterious effects that could lead to the collapse of important commercial fisheries. We conducted a quantitative analysis that incorporates such mechanisms to demonstrate the impacts of increasing sea temperatures on fish production in several key species in the Chesapeake Bay ecosystem.

**Thematic Areas Addressed:** Assessment; Climate and Ecosystems

**Lead Scientist(s):** Shari Wiley (former HU faculty); Eric Lewallen (current HU faculty)

**NOAA Collaborator(s):** Michael Fogarty (NOAA/NEFSC)

**LMRCSC Collaborator(s):** Andrij Horodysky (current HU faculty)

**LMRCSC Research Student(s):** Cristin Mayes (current HU graduate student)

**Start Date:** 1 August 2017

**End Date:** 1 May 2019

**Project Results:** Ecosystem-based fisheries management approaches attempt to address ecological processes and typical environmental fluctuations to lessen their impact on fish stocks. This concept that multi-species interactions can better illuminate fishery stock dynamics is not new to fisheries science. During the 1970s and 1980s, several single-species population models were extended to include multiple species and the implied ecological interactions (Andersen & Ursin, 1977; Kerr & Ryder, 1989; May, Beddington, Clark, Holt, & Laws, 1979; Mercer, 1982). The sophistication of multi-species models has increased significantly with the advancement of technology and the availability of necessary data to determine key parameters. Thus, the insight these models provide to management has become instrumental in influencing policy. Particularly in the Chesapeake Bay, ecosystem-based fisheries management is necessary to capture the diversity of species and complex interactions that occur in North America’s largest estuary, and are critical to maintaining a flourishing and robust ecosystem that provided economic stability for

many. Predation interaction has been extensively examined in the Chesapeake Bay, particularly among striped bass or bluefish as the predator and menhaden as the prey (Brandt, Gerken, Hartman, & Demers, 2009; Buckel, Steinberg, & Conover, 1995; Harfmar & Brandt, 1995; Hartman & Brandt, 1995; Ludsin et al., 2009; Uphoff, 2003). Although several of these studies address the effects of climate change and anthropogenic stressors, there are yet to be predation-interaction models specifically designed to account for the negative effects of increasing sea surface temperatures on fish production in the Chesapeake Bay estuary. Therefore, the purpose of this proposal is to create mechanisms to incorporate into well-established fishery stock assessment models that will accurately portray how the ecosystem is currently functioning and how it is likely to function in the future given changes in habitat and stock management.

To date, funds from this project have been dispersed to Ms. Cristin Mayes (MS candidate) to complete her graduate course work at HU, conduct a NERTO fellowship at the NEFSC, as well as allow for attendance at an ArcGIS workshop. Dr. Lewallen also utilized funds to visit the NEFSC during the summer of 2018. Funds remaining in the category of summer salary for Dr. Horodysky will be utilized in May or June 2019 for the purpose of completing remaining research objectives. Ms. Mayes is currently scheduled to defend her thesis at the end of March 2019, although the logistics of this event are yet to be resolved.

**Products:**

Mayes C, Horodysky A, Bonin C, Fogarty M, Gibson D, Wiley S, Lewallen EA. Ecosystem Based Approaches to Modeling Fish Species Distributions in the Atlantic. 90th Annual National Technical Association Conference, Hampton University, Hampton, VA, September 28-29, 2018.

Mayes C, Horodysky A, Bonin CA, Fogarty M, Gibson D, Wiley S, Lewallen EA. Ecosystem Based Approaches to Modeling Fish Species Distributions in Chesapeake Bay. 23rd Annual School of Science Research Symposium, Hampton University, Hampton, VA April 11-12, 2018.

Mayes C, Horodysky A, Bonin CA, Wiley S, Gibson D, Lewallen EA. Ecosystem Based Approaches to Modeling Fish Species Distributions in Chesapeake Bay. Virginia Sea Grant Graduate Symposium. Virginia Crossings, VA. February 9th, 2018.

**Relevance:** Results from our research will contribute to the body of research in quantitative fisheries in several ways. In particular, through estimating the impact of climate changes on species abundance in the Chesapeake Bay, we will be able to provide recommendations on whether current harvest rates should be adjusted to account for possible decreases in biomass of commercial fishery stocks. This project will examine trophic levels from phytoplankton to top piscivores, linking the end members through planktivorous forage fishes; this project is thus complementary to EBFM initiatives. Additionally, these results will provide insight on the impacts of rising sea surface temperatures on the Chesapeake Bay food-web structure, and help determine if fishing exacerbates structural changes in food webs, or possibly, acts as a stabilizing mechanism.

**Broader Impacts:** By recruiting a mathematics graduate student from an under-represented minority (Ms. Cristin Mayes) to the program, we have provided an excellent opportunity for academic growth and career progression. Utilizing the professional network and expertise of Dr. Wiley, Ms. Mayes has been exposed to the problem-solving tactics of a prominent research group at the NEFSC. Dr. Lewallen has facilitated the crossover of mathematical principles into biological systems by facilitating the attendance to a 5-day ArcGIS workshop held at Hampton University in June 2018. As expected, Ms. Mayes has presented the results of this work at multiple conferences (listed above). Participation in this project has given Ms. Mayes an opportunity to apply her mathematical background to solving real-world problems in marine ecology, and spur collaborative interest in pursuing future projects in quantitative fisheries.