



**Performance Report for Cooperative Agreement No: NA16SEC4810007
for the Period from September 1, 2017 to February 28, 2018**

University of Maryland Eastern Shore

Living Marine Resources Cooperative Science Center

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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.

- DSU: We advertised online for fisheries/aquaculture students. Also, we requested that former student Nivette Perez-Perez (MS degree, DSU) help advertise LMRCSC at DSU in Puerto Rico.
- HU: Handed out LMRCSC brochures, spoke to individual students with the required GPA, and facilitated summer internship applications at UMES and SSU
- OSU: Distributed opportunities for fall 2018 at SACNAS and AFS meetings. Also met with Columbia River Inter-Tribal Fish Commission and talked with education coordinator for the Samish Nation about student recruitment; interviewed several candidates
- RSMAS: We invited potential Ph.D. students to the RSMAS student recruitment event on February 9, 2018. Students visited the campus and met with potential advisors and current graduate students.
- SSU: Hosted campus visits from 6 potential students (4 M.S., 2 B.S), updated website, and recruited former LMRCSC undergraduate intern to M.S. program; hosted GIS Day competition, regional science fair and GA-SC National Ocean Science Bowl (NOSB) competition
- UMES: UMES staff represented the center at the recruitment events listed in Table 1.

Table 1: Recruitment events that took place from September 1, 2017 to February 28, 2018

Event	Date
UMES SANS Research Roundtable	September 12, 2017
National Technical Association, Morgan State University	September 20-22, 2017
Jr. MANRRS Leadership Institute, UMES	September 29, 2017
UMES Open House	October 20, 2017
Wor-Wic Community College, MD Transfer Fair	October 24, 2017
UMES DNS Research Roundtable	October 31, 2017
UMES Upward Bound	November 4, 2017
UMES Honors Day	December 1, 2017
Prince George's Community College	December 5, 2017 & Jan 23, 2018
Eastern Shore Community College Visit	December 6, 2017 & Jan 24, 2018
Northern Virginia Community College	December 12, 2017 & January 30, 2018
Chesapeake Community College	December 13, 2017
Science In Society Conference, River Hill High School, Clarksville, MD	December 19, 2017
Somerset County, Maryland Board of Education	December 33, 2017
Northern Virginia Community College HBCU Fair	February 21, 2018
Worcester County, Maryland Board of Education	February 1, 2018

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

The Center used this reporting period to plan for workshops that will be offered to students including the “Literacy in NOAA mission related disciplines: A cohort experience” workshop that will be offered for one week in March 2018, and Data Management workshop that was offered to students in fall 2017. Graduate students in the program have begun to take classes including courses offered at the Center to enable them to acquire core competencies in marine and fisheries science. Additional specific examples include:

- HU: The curriculum at HU is in preparation for careers in marine science. Students are also engaged in research during the semester.
- OSU: Weekly lab and one-on-one meetings with Angelika Munguia (M.S. student, OSU) about data analysis, interpretation, and writing.
- RSMAS: LMRCSC students are encouraged to participate in stock assessment working groups and other training.

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 LMRCSC 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. Stephanie Martinez-Rivera (Ph.D. student, UMES) is the Scott B. Gudes Public Service Scholar in Marine Resource Conservation.

Research Goal:

Eight collaborative research proposals funded during the previous reporting period are ongoing; 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. Six of the lead PIs of the projects are located at LMRCSC MSIs, hence the projects are helping to build sustainable capacities at the Center MSIs; three of the lead PIs are graduate students.

Table 2. TAB projects funded for FY 2016 to 2017 (*Students)

Project #	Lead PI	Project Title	Research Thematic Area	Students	NOAA Scientists
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	Assessment	1 PhD	1
17-02	Bradley Stevens (UMES)	Biological baseline data for Jonah Crab Management	Assessment	1 UG, 1 MS	1
17-03	Stephanie Martinez-Rivera* (UMES) and Shadaesha Green* (UMCES)	Reproductive Biology of red deepsea crabs, <i>Chaceon quinquedens</i> .	Assessment	2 PhD	2
17-04	Tara Cox (SSU)	Refining stock structure of common bottlenose dolphins (<i>Tursiops truncatus</i>) through photo-identification and genetic analysis	Assessment	1 UG, 1 MS	2
17-05	Shari Wiley (HU)	The Impact of Increasing Sea Surface Temperatures on Piscivore and Planktivore Species Dynamics: An Ecosystem-Based Modeling Approach	Climate & Ecosystems		
17-06	Joseph Pitula (UMES)	Ecosystem impact of a harmful algal bloom species (<i>Dinophysis acuminata</i>) on aquaculture shellfish	Healthy Habitats	1 PhD	1
17-07	Jessica Miller (OSU)	Migration and foraging ecology of at-risk species: Columbia River Chinook salmon and Atlantic weakfish	Assessment	1 UG, 1 MS	1
17-08	Ammar Hanif* (UMCES-IMET)	Comparing the diet and microbiome of Atlantic menhaden and Eastern oyster using DNA barcoding	Assessment	1 UG, 1 PhD	1

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 held in Fall 2017.

Ethical Conduct of Research Training for Students and Faculty:

RSMAS: Research Ethics (RSM 700) is offered every fall, and required for RSMAS graduate students

SSU: Advised students of CITI training available on website

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 2018 have been subcontracted to LMRCSC institutions
- b) The Center advertised vacant personnel positions, including the Postdoctoral Research Fellows, Assistant Professor at Hampton University (HU), and the Education Lead at Savannah State University (SSU).
 - a. Dr. Chris Heckscher is now a participating Center scientist at HU;
 - b. Dr. Dan Cullen has been selected as the Postdoctoral Research Fellow at UMES and will begin work in March 2018;
 - c. Dr. Victoria Young of SSU was hired as the LMRCSC Education Expert
- c) The Communication Specialist of the LMRCSC, Ms. Anne Dudley, resigned to pursue another opportunity. Preparations are underway to advertise the vacancy.
- 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-one (21) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 6 Ph.D., 6 M.S., and 9 B.S. Additionally, twelve (12) students have been identified/recruited as members of Cohort 2 (2017-2018) including 5 Ph.D., 4 M.S., and 3 B.S. students.

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

Consistent with our goal specified in the Implementation Plan, five rising sophomores participated in 2017 summer programs, and all were recruited into Cohort 2. At least three of the five students submitted applications to the NOAA EPP Undergraduate and Hollings Scholarships. The Center has begun recruitment of students for the summer 2018 program.

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

Ms. Stephanie Martinez-Rivera (Ph.D. student, UMES) is the Scott B. Gudes Public Service Scholar in Marine Resource Conservation. The center is in the process of selecting a student for the 2018 scholarship award.

Building of a Strong Center Cohort Community: Plans for building a strong cohort community at the LMRCSC have been discussed at the LMRCSC Executive Committee meeting and will be fostered via a) Cohort Building Workshop in Spring 2018; lesson design and logistical planning for the workshop took place during this period, while the workshop itself was scheduled for the first week of March 2018 which falls within the next reporting period; b) Student Seminar Series that continued in Fall 2017 and spring 2018; c) Data Management course that was taught in Fall 2017; and d) Professional Development workshop at UMES offered by Dr. Maggie Sexton biweekly for undergraduate students and monthly for graduate students in Fall 2017, Spring 2018.

Research Goals:

Eight collaborative proposals were funded by the LMRCSC after reviews by the Technical Advisory Board (TAB) in the previous reporting period. These projects (Table 2) continued during this period. Other research projects supported with leveraged funds from agencies such as NOAA, NSF, USDA, are on-going at the LMRCSC.

Administration Goals:

- a) Dr. Dan Cullen has been selected for the Post-doctoral Position at UMES and will begin work in March 2018.
- b) At SSU, the Education Expert position has been filled by Dr. Victoria Young.
- c) The Center held its monthly Executive Committee meetings during which plans to execute student development and professional activities were discussed.
- d) The Center plans to hold its Science meeting at the NOAA EPP Forum at Howard University during the next reporting period, March 2018.

4. Key outcomes or other achievements:

- a) A total of 33 students (21 in Cohort 1, 12 in Cohort 2) have been recruited to the Center
- b) Plans for more rigorous evaluations of the LMRCSC have commenced.
- 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 took in the Data Management for Scientists course that was offered in fall 2017.

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

- HU: 5 of the 6 HU funded students attended ASLO or other conferences. Two students are working on a review paper with their mentor.
- OSU: Presentations were made by Angelika Munguia (M.S. student, OSU) and Jessica Miller (OSU) at the Coastal and Estuarine Research Federation (CERF) 2017.
- RSMAS: Faculty and students presented research results at meetings and working groups
- SSU: Presentations were made at state and national conferences, community launch of community resilience film
- UMES: Presentations were made at CERF November 2017 and Geological Society of America (GSA) annual meeting in October 2017.

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 12 students have been recruited into Cohort 2, including 5 Ph.D., 4 M.S. and 3 B.S.
- b) Offer to students a workshop on Literacy in NOAA related sciences in spring 2018
- c) Work with sophomores supported during the Summer 2018, as well as any other sophomores recruited during Fall 2018 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.

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

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: Tyrae Freeman (DSU) completed her M.B.A. degree in December 2017.

Publications in Journals:

The following tables contain manuscripts published during this period and those currently under review. A justification of how each manuscript is associated with the LMRCS is included to the right of the citation.

21 publications (2 student authors identified by asterisk*); LMRCSC scientists are in bold

Publications in journals	Justification
Barker BD, AZ Horodysky , DW Kerstetter. (In press). Hot, or not? Comparative behavioral thermoregulation, critical temperature regimes, and thermal tolerances of the invasive lionfish <i>Pterois</i> sp. versus native western North Atlantic reef fishes. <i>Biological Invasions</i> . 00:000-000.	LMRCSC TAB recipient
Bembe, B., Williams, E., Place, A., Liang, D., & J. Sook Chung (2018) Effects of temperature and photoperiod on hemolymph vitellogenin levels during spawning events of the blue crab, <i>Callinectes sapidus</i> , in captivity (2018). <i>Aquaculture Res</i> ,	leveraged
Bonin CA , Lewallen EA, van Wijnen AJ, Cremer MJ, Simões Lopes PC: Habitat preference and behavior of the Guiana dolphin (<i>Sotalia guianensis</i>) in a well preserved estuary off Southern Brazil. <i>P. J. Zoology</i> 49(6): 2235-2242.	LMRCSC supported faculty
Carlton, J.T., Chapman, J.W., Geller, J.G., Miller, J.A. , Carlton, D.A., McCuller, M.I., Treneman, N., Steves, B. P., Ruiz, G.M. 2017. Tsunami-driven rafting: Transoceanic species dispersal and implications for marine biogeography. <i>Science</i> . 357:1402-1406.	LMRCSC PI at OSU
Carlton, J.T., Chapman, J.W., Geller, J.G., Miller, J.A. , Ruiz, G.M., Carlton, D.A., McCuller, M.I., Treneman, N., Lewis, R., Bilderback, D., Harris, L. In press. Biological and ecological studies of Japanese Tsunami Marine Debris (JTMD). <i>Aquatic Invasions</i> .	LMRCSC PI at OSU
Cooke SJ, RJ Lennox, SD Bower, AZ Horodysky , MK Treml, E Stoddard, LA Donaldson & AJ Danylchuk. 2017. Fishing in the dark – the science and management of recreational fisheries at night. <i>Bulletin of Marine Science</i> . 93(2): 519-538.	LMRCSC TAB recipient
Fields, A.T., Fischer, G. A., Shea, S. K. H., Zhang, H., Abercrombie, D. L., Feldheim, K. A., Babcock, E. A. & Chapman, D. D. (2018) Species composition of the international shark fin trade assessed through a retail-market survey in Hong Kong. <i>Conservation Biology</i> doi:10.1111/cobi.13043	Leveraged by LMRCSC PI at RSMAS
Goes, M., Babcock, E. A. , Bringas, F., Ortnier, P., & Goni, G. (2017) The impact of improved thermistor calibration on the expendable bathythermograph profile data. <i>Journal of Atmospheric and Oceanic Technology</i> 9:1947-1961. doi:10.1175/JTECH-D-17-0024.1	Leveraged by LMRCSC PI at RSMAS
Grüss, A., Chagaris, D. D., Babcock, E. A. & Tarnecki, J. H. (2018) Assisting ecosystem-based fisheries management efforts using a comprehensive survey database, a large environmental database, and generalized additive models. <i>Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science</i> 10:40–70. doi: 10.1002/mcf2.10002	Leveraged by LMRCSC PI at RSMAS
Haq, S, Bachvaroff, TR, and Place, AR. (2017) Characterization of Acetyl-CoA Carboxylases in the Basal Dinoflagellate <i>Amphidinium carterae</i> . <i>Marine Drugs</i> 15:149; doi: 10.3390/md15060149.	Leveraged by LMRCSC scientist at IMET

Hurst, T. P., Miller, J. A. , Ferm, N., Heintz, R. A., and 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> .	Leveraged by LMRCS PI at OSU
Lennox RJ, J Alos, SJ Cooke, AZ Horodysky , T Klefoth, C Monk, R Arlinghaus. 2017. What makes fish vulnerable to capture by hooks? A conceptual framework and a review of key determinants. <i>Fish and Fisheries</i> .18: 986-1010.	LMRCSC TAB recipient
Liu, CL, Place, AR & Jagus, R. (2017). Use of antibiotics for maintenance of axenic cultures of <i>Amphidinium carterae</i> for the analysis of translation, <i>Marine Drugs: Advances and New Perspectives in Marine Biotechnology II</i> , 15(8): E242. doi: 10.3390/md15080242.	Leveraged by LMRCS PI at IMET
Lycett*, K., J. Sook Chung, & Pitula J. (2018). The relationship of blue crab (<i>Callinectes sapidus</i>) size class and molt stage to disease acquisition and intensity of <i>Hematodinium perezii</i> infections. <i>PloS One</i> 13: e192237.	Leveraged by LMRCS scientists at IMET and UMES
Matta, M. E., Miller, J. A. , Short, J., Helser, T., Hurst, T. P. Rand, K., Ormseth, O. 2017. Spatial and temporal variation in otolith elemental signatures of age-0 Pacific cod (<i>Gadus macrocephalus</i>) in the Gulf of Alaska. <i>Deep Sea Research Part II: Topical Studies in Oceanography</i> .	Leveraged by LMRCS PI at OSU
Miller, J. A. , *Gillman, R., Carlton, J.T., Clarke-Murray, C., Nelson, J. C., Otani, M., and Ruiz, G. M. 2018. Trait-based characterization of species transported on JTMD: Effect of prior invasion history on trait distribution. <i>Marine Pollution Bulletin</i> .	Leveraged by LMRCS PI at OSU
Miller, J. A. , Carlton, J.T., Chapman, J.W., Geller, J. B., Ruiz, G.M. 2018. Transoceanic dispersal of the mussel <i>Mytilus galloprovincialis</i> on Japanese tsunami marine debris: A model for evaluating rafting of a coastal species at sea. <i>Marine Pollution Bulletin</i> .	Leveraged by LMRCS PI at OSU
Roy, S, Jagus, R , Morse, D. (2018) Translation and translational control in dinoflagellates. <i>Microorganisms</i> , ahead of print.	Leveraged by LMRCS PI at IMET
Ta, N., Miller, J. A. , Chapman, J. C., Pleus, A. E., Calvanese, T., Miller-Morgan, T., Burke, J., and Carlton, J. T. C. 2018. The Western Pacific barred knifejaw, <i>Oplegnathus fasciatus</i> (Temminck & Schlegel, 1844) (Pisces: Oplegnathidae) arriving with tsunami debris on the Pacific coast of North America. <i>Aquatic Invasions</i> .	Leveraged by LMRCS PI at OSU
Tewfik, A., Babcock, E. A. , Gibson, J., Burns-Perez, V. R. & Strindberg, S. (2017) Benefits of a replenishment zone revealed through trends in focal species at Glover's Atoll, Belize. <i>Marine Ecology Progress Series</i> 580: 37–56, 2017. doi:10.3354/meps12290	Leveraged by LMRCS PI at RSMAS
Williams, EP, Place, AR & Bachvaroff, T R (2017). Transcriptome Analysis of Core Dinoflagellates Reveals a Universal Bias Towards "GC" Rich Codons. <i>Mar. Drugs</i> , 15:125; doi:10.3390/md15050125B.	Leveraged by LMRCS scientist at IMET
Wilson, M. T., Dougherty, A., Matta, M. E., Mier, K. L., and Miller, J. A. 2018. Geographic variation in otolith chemistry of age-0 juvenile walleye pollock (<i>Gadus chalcogrammus</i>) in relation to regional hydrography. <i>Marine Ecology Progress Series</i> .	Leveraged by LMRCS PI at OSU

4 publications under review or accepted (2 student authors identified by *)

Manuscripts under review or accepted	Justification
Bembe, B., Williams, E., Place, A., Liang, D., & J. Sook Chung (2018). Effects of temperature and photoperiod on hemolymph vitellogenin levels during spawning events of the blue crab, <i>Callinectes sapidus</i> , in captivity (2018). Aquaculture Res, available electronically ahead of print.	Leveraged by LMRCS scientist at IMET
Lewis, N. Achenbach. , Ellis, L, Pitula, J. , Rafuse, C., Rosales*, D., and Wolny., J.,(2018) Morphometric, Phylogenetic, Growth and Toxicity Assessment of <i>Coolia monotis</i> Meunier (Dinophyceae) from Nova Scotia, Canada. Harmful Algae, In Review.	LMRCSC Cohort 1 student*
Roy, S, Jagus, R , Morse, D. (2018) Translation and translational control in dinoflagellates. Microorganisms, available electronically ahead of print.	Leveraged by LMRCS PI at IMET
Schweitzer, C. C.*, Lipcius, R. N., Stevens, B. G. (2018). Impacts of fish traps on benthic habitat. ICES J. Mar. Sci. UNDER REVIEW.	LMRCSC Cohort 2 student*

Books: 1 book; LMRCS scientists are in bold

Books	Justification
Cuker, B. E., Crawford, M.K. , and R. Chambers. 2017. Renewable Energy and Environmental Sustainability, D. Gosselin, Ed., InTeGrate's Earth-focused Modules and Courses Peer Reviewed Collection, https://serc.carleton.edu/163286	Leveraged

Book Chapters: 1 book chapter; LMRCS scientists are in bold

Book chapters	Justification
Rosenberger, A., C. Zimmerman, D. Noakes, R. Taylor, E. Keeley, J. Musick, R. Phillips, A. Horodysky , M. Neilson, T. Ray, & J. Neilson. Salmonidae. In: Diversity of North American Freshwater Fishes: Natural History, Ecology, and Conservation, Volume II.	Leveraged by LMRCS scientist at HU

Thesis/Dissertations: None

Conference Papers, Posters and Presentations:

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

11 oral presentations (7 student presenter)

Oral presentations at professional meetings	Justification
Almodóvar*, Laura. (2017). Juvenile black sea bass in the Chesapeake Bay. Presented at the MEES Colloquium 3 Minute Thesis. Cambridge, MD. September, 2018. Oral Presentation.	LMRCSC Cohort 2 Student
Dorsey*, K., et.al. (2018) Effect of Ocean Acidification on Auditory Neurobiology in a tropical Marine Fish. Presented at Ocean Sciences Meeting, Portland, OR. February 2018.	LMRCSC Cohort 2 student
Fenwick*, I., Price, A. *, and Stevens, B. (2018). Assessing the Condition Index of Black Sea Bass Using Fat/Oil Content and BMI. Presented at Ocean Sciences Meeting, Portland, OR. February 2018.	LMRCSC Cohort 1 (Fenwick) & Cohort 2

	(Price) students
Gonsior, M, Leanne Powers, Philippe Schmitt-Kopplin, Mourad Harir, Feng Chen, Ernest Williams, & Allen R. Place Disinfection by-products arising from <i>Microcystis aeruginosa</i> algal DOM. 9th U.S. Conference on Harmful Algae. Baltimore, MD. 2017.	Leveraged
Jagus, R. 2017. Dinoflagellates: Eukaryotes that are not plants, fungi or metazoa. EMBL Conference on Translational Control, Heidelberg, Germany.	Leveraged by LMRCS C PI at IMET
Miller, J. A. , Morgan, C. A., Beckman, B. R., Burke, B. J., Van Doornik, D. M., and Weitkamp, L. A. Reconstructing patterns of migration and estuarine residence in Columbia River Chinook salmon: the potential role of otolith barium in large river systems. CERF 2017, Providence, RI	LMRCS C PI & TAB project
Place, AR , Ernest Williams, Saddef Haq and Tsvetan R. Bachvaroff. Some Assembly Required - Beyond the type I, II and III polyketide synthase paradigms in dinoflagellates. 9th U.S. Conference on Harmful Algae, Baltimore, MD, Sept 6-9, 2017.	Leveraged
Rosales* D. , S. Parveen, G. Ozbay, J. Pitula: Detection of <i>Vibrio parahaemolyticus</i> and harmful algal species in <i>Crassostrea virginica</i> in the Delaware Inland Bays. 9th Symposium on Harmful Algae in the US. Baltimore, MD November 2017.	LMRCS C Cohort 1 student & TAB project
Schweitzer*, C. C., Stevens, B. G. , (2017). The Use of Sea Whips (<i>Leptogorgia spp.</i>) as an Indicator Species (IS) for Habitat Quality Assessment within the Mid-Atlantic Bight (MAB). Presented at national AFS. August 2017	LMRCS C Cohort 2 student
Schweitzer*, C. C., Horodysky, A. Z., Price, A. L., Stevens, B.G. (2018). Evaluating the effectiveness of reflex action mortality predictor (RAMP) in black sea bass, <i>Centropristis striata</i> , bycatch within the commercial trap fishery. Presented at AFS Tidewater, North Carolina. Jan 2018	LMRCS C Cohort 2 student
Wenker*, R.P. 2017. Cold-water corals in the Mid-Atlantic Bight: Age, growth, and recovery. Presented at Marine Estuarine and Environmental Science (MEES) Colloquium, Horn Point Laboratory, Cambridge, MD, September, 2017. Oral Presentation.	LMRCS C Cohort 1 student

Posters: 14 (*6 student presenters)

Poster presentations at professional meetings	Justification
Broensen, L, Daniel D. Kepple, Allen R. Place and Matthew W. Parrow. 2017. Image Cytometry (ICM) as a method for cell cycle analysis of mixotrophic cultures and field bloom samples of <i>Karlodinium veneticum</i> . 9th U.S. Conference on Harmful Algae. Baltimore, MD. 2017	Leveraged
Galvez, B.* , Neilan, B., Greco, M., Oliver, D.* , Ozbay, G., Smith, S. (2017) Stable Isotope Analysis of Juvenile Weakfish (<i>Cynoscion regalis</i>) from the Delaware Bay. Presented at the Mid-Atlantic Fisheries meeting, Dover, DE, October 2017.	LMRCS C Cohort 1 student

Galvez, B.*, Oliver, D.*, Neilan, B., Greco, M., Ozbay, G., Smith, S. (2018) Estimating Diet of Juvenile Weakfish (<i>Cynoscion regalis</i>) from the Delaware Bay Using Stable Isotope Analysis Presented at the Ocean Sciences meeting, Portland, OR, February 2018.	LMRCSC Cohort 1 student
Griffin*, E., Wong Z., Perrtree R., Rosel P., Cox T. Using photo-identification and genetic data to identify fine-scale stock structure. The Society for Marine Mammalogy (SMMS) 22 nd Biennial Conference, Halifax, Nova Scotia, Canada, October 24, 2017	LMRCSC cohort 1
Griffin*, E., Wong Z., Perrtree R., Rosel P., Cox T. Using photo-identification and genetic data to identify fine-scale stock structure. Savannah State University GIS Day, November 15, 2017 Award: Second Place Graduate Level	LMRCSC cohort 1
Haq, S, & Bachvaroff, TR, Oyler, BL, & Place, AR (2017) ACETYL-COA CARBOXYLASES IN DINOFLAGELLATES: FUELING THE POLYKETIDE SYNTHASE PATHWAYS 9th U.S. Conference on Harmful Algae. Baltimore, MD. 2017.	Leveraged
Haq, S, Place, AR & Bachvaroff, TR. Oyler, BL, & Place, AR (2017) Phylogenetic analysis of acetyl CoA carboxylases in dinoflagellates. 17th ICHA Proceedings, Florianópolis, Brazil.	Leveraged
Mayes*, C., et al. (2018). Ecosystem Based Approaches to Modeling Fish Species Distribution in Chesapeake Bay Area. Presented at VA Sea Grant Symposium, WA, DC., February 2018.	LMRCSC Cohort 1 student
Milton*, I. (2018) Frequency of <i>Vibrio parahaemolyticus</i> and <i>Vibrio vulnificus</i> in Blue Crabs and Seawater of the Maryland Coastal Bays. Presented at Ocean Sciences Meeting, Portland, OR. February 2018.	LMRCSC Cohort 1 student
Munguia*, A., Miller, J. A. , Weitkamp, L. A. and Van Doornik, D. Potential indicators of habitat use: diet and stable isotope composition during juvenile salmonid emigration. CERF 2017, Providence, RI.	LMRCSC Student (Cohort 1) and TAB
Noland, K, Liu, CL, & Jagus, R. 2017. Dramatic changes in eIF4E-1a phosphorylation accompany the striking diel changes in protein synthetic rate of axenic <i>Amphidinium carterae</i> . EMBL Conference on Translational Control, Heidelberg, Germany.	Leveraged
Oyler, BL, Donald F. Smith, Saddef Haq, David R. Goodlett, Allen R. Place , Primary structure elucidation of hemolytic toxins from dinoflagellates responsible for fish kills by accurate tandem mass spectrometry. 9th U.S. Conference on Harmful Algae, Baltimore, MD, Sept 6-9, 2017	Leveraged
Smith*, N., et al. (2018). Macroalgal predictability, quantity, and species assemblage affect estimates of herbivory rate and herbivore selectivity on coral reefs. Presented at Ocean Sciences Meeting, Portland, OR. February 2018.	LMRCSC Cohort 1 student
Williams, EP, Bachvaroff, T, Place, AR : Phosphopantetheinyl transferases in dinoflagellates: toxin versus fat synthesis 9th U.S. Conference on Harmful Algae. Baltimore, MD. 2017.	Leveraged

Other Publications:

Technologies or Techniques: None

Patents: None

Inventions: None

Websites: 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 ($9 \times 0.25 = 2.25$).*

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
Stacy	Smith	DSU	Principal Investigator	90
Christopher	Heckscher	DSU	Participating	10
Gulni	Ozbay	DSU	Participating	3
Deidre	Gibson	HU	PI	40
Carolina	Lewallen	HU	Faculty	80
Jessica	Miller	OSU	PI	35
Elizabeth	Babcock	RSMAS	Principal Investigator	7
David	Die	RSMAS	Faculty	3.5
Dionne	Hoskins-Brown	SSU	Principal Investigator	60
Tara	Cox	SSU	Faculty Advisor	40
Chris	Hintz	SSU	Faculty Advisor	20
Sue	Ebanks	SSU	M.S. Committee Member	5
Paulinus	Chigbu	UMES	Center Director and Principal Investigator	80

Anne	Dudley	UMES	Data, Information, and Communication Manager	124
Onjale	Scott	UMES	Operations Professional Program Coordinator	160
Margaret	Sexton	UMES	Assistant Center Director	160
Bradley	Stevens	UMES	Distinguished Research Professor	160
Ida	Tilghman	UMES	Administrative Assistant	160
Rosemary	Jagus	UMCES	PI	80
J. Sook	Chung	UMCES	mentor	40
Tsvetsan	Bachvaroff	UMCES	bioinformatics resource	20
Russell	Hill	UMCES	fundraiser	20
Allen	Place	UMCES	mentor	10
Dave	Secor	UMCES	mentor	10

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	DNREC	Dover, DE	Helped students collect samples
State government	NJ DEP	Galloway Township, NJ	Helped students collect samples (BG)
State government	DNREC	Dover, DE	Helped students collect samples(BG)
Non profit	Chesapeake Bay Foundation	Richmond, VA	Helped students with oyster restoration project
Regional Fishery Management Organization	International Commission for the Conservation of Atlantic Tunas		PhD student participated in ICCAT stock assessment of mako sharks
Federal Commission	Gullah Geechee Cultural Heritage Corridor Commission	Charleston, SC	Connected researchers to coastal Gullah communities
State government	GaDNR	Brunswick, GA	Provided access to field sites and datasets

Have other collaborators or contacts been involved? Yes

If Yes, describe involvement and time spent.

Last name	First name	Title/Affiliation	Description of involvement
Crawford	Maurice	Associate professor, UMES	Committee member for Brian Galvez
North	Heather	Oyster tech, CBF	Helped students with oyster restoration project
Chapman	Demian	Marine Science Professor, FL Int. Univ.	Provided shark data
George	Albert	Director of Conservation/SC Aquarium	Hosted debut of the film Savannah Climate Change: A Global Reality with SCETV
Pitula	Joe	Associate Professor, UMES	Collaborator on TAB project

Have NOAA collaborators or contacts been involved? Yes

If Yes, describe involvement and time spent.

Last name	First name	Title/Affiliation	Description of involvement
Townsend	Howard	NEFSC	M.S. committee member/mentor for Brian Galvez
Zamon	Jen	NWFSC	M.S. committee/mentor for Nicole Kleponis
Fogarty	Michael	NEFSC	NERTO advisor for Cristin Mayes (HU)
Weitkamp	Laurie	NWFSC	MS Committee member for A. Munguia
Cortes	Enric	SEFSC	Ph.D. committee member and NERTO supervisor for Halie O'Farrell
Walter	John	SEFSC	Collaborator
Thorson	Jim	NWFSC	Collaborator
Rosel	Patricia	Lafayette laboratory	M.S. committee member for Emily Griffin (SSU)
Smith	Vernon	NMS Silver Spring	Developing more internships for LMRCSC students
Roberson	Kimberly	NOAA Grays Reef National Marine Sanctuary	M.S. committee member for Hannah Schroeder (SSU)
Deshpande	Ashok	NEFSC	M.S. committee member for Enid Munoz (UMES)
Jacobs	John	Fishery Research Biologist, COL	Technical advisor and Ph.D. committee member for Detbra Rosales (UMES)
van Dolah	Francis	NOS/NCCOS, Hollins Marine Lab	Collaborator on dinoflagellate research
Friedland	Kevin	NMFS, NEFSC, Woods Hole, MA	PhD committee member for Amar Hanif; Collaborator on TAB project
Leight	A.K.	NOS/NCCOS.Oxford	Collaborator on TAB project
Messick	Gretchen	NOS/NCCOS, Oxford MD	Collaborator on blue crab health and disease project

Morton	Steve	NMFS, Center for Coastal Fisheries and Habitat Research	Collaborator on blue crab research
Poach	Mathew	NMFS J.J. Howard Marine Sciences Lab, Sandy Hook	Collaborator on red crab research
Richards	Anne	NEFSC	Collaborator on TAB project
Rivera	Jose	NMFS Habitat Conservation Division, Puerto Rico	Collaborator on sponge research
Shank	Burton	NEFC, Woodshole	Collaborator on Jonah crab reproductive status
Skelley	Suzanne	COL/NOS	Collaborator on TAB project
Weinberg	James	NMFS/NEFSC Resource Evaluation & Assessment Division	Ph.D. committee member for Shadaesha Green & Amanda Lawrence

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-one (21) students have been identified as members of Cohort 1 of which 19 belong to underrepresented minority groups. Twelve (12) students have been identified as members of Cohort 2; eleven (11) 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.

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

None to report during this period.

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 these students in Cohort 1 has attracted other interested students to ask about NOAA careers.

DSU: 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.

HU: Students and faculty are receiving the financial support needed to stay in school, to be trained in research, and to be gainfully employed to conduct NOAA fisheries related research.

RSMAS: The award is supporting one Ph.D. student per cohort to be trained in NOAA relevant science

SSU: The award provides higher quality and more frequent training than students would experience in the degree program alone.

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 2016 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? To whom and how is this information and the Center accomplishments communicated?

SSU: Two long-term datasets are being supported through the center research. The information is shared with the scientific community through regional and professional meetings and through consultations with policy makers (particularly the marine mammal work).

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

SSU: Of the projects operating at this time. Dr. Hintz's laboratory has developed a pCO₂-controlled experimental culture system that is inexpensive and portable and can be used to conduct climate change studies on research vessels.

UMCES: Graduate student Amar Hanif is assisting NOAA-COL scientists, A.K. Leight & S. 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 Lake mussels; he is seeking training from Dr. Ashok Deshpande at NOAA Sandy Hook Lab.

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

DSU: One of the societal impacts is that more minorities are being hired in fisheries positions. The students who do research are informing others about their research activities through outreach in schools.

HU: Student outreach activities.

SSU: Center research is communicated to the public in leadership training organizations and conferences like the Institute for Georgia Environmental Leadership and the Choosing to Lead Conference as well as in non-technical regional periodicals.

UMCES: Nick Hammond presents "Startup CEO Training" for interested members of the public. In collaboration with the Baltimore Underground Science Space (BUGSS) iGEM program IMET presented an evening on using biology to degrade plastics and microplastics for cleaning up our water and environment. This was followed by a screening of 'A Plastic Ocean' and a Q&A session with Dr. Michael Gonsior (UMCES-CBL), one of the featured researchers from the film. This event is open to all of IMET and

the general public

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:

- SSU: It has been difficult to recruit students at the upper class level who meet all of the program targets and who have demonstrated the ability to meet the program's extracurricular requirements. To address this challenge, one freshman was recruited for cohort 3. Additionally, a nomination process was created to identify strong undergraduate students in the existing student corps.
- UMCES: Loss of LMRCSC support of UMCES IMET's summer undergraduate internship program due to budgetary constraints has negatively impacted our recruitment of graduate students and reduced mentoring opportunities for current graduate students. \$60,000 Elkins award to Rose Jagus will support undergraduate internship program for summer 2018. Matching funds for this are being sought from foundations.

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

- SSU: The postdoctoral fellowship was advertised in spring 2017. The human resources office advertised the position incorrectly, yielding several applicants, but few that met all center requirements. Those who were most appropriate were screened but none were competitive. It was during the screening that the advertising error was detected. The ad was reposted in September 2017.
- UMCES: Loss of LMRCSC support of IMET's summer undergraduate internship program has created a challenge with our recruitment of graduate students and reduced mentoring opportunities for current graduate students. \$60,000 Elkins award to Jagus will support undergraduate internship program for summer 2018. Matching funds of \$20,000 have been secured from the Bunting Foundation.

Changes that have a significant impact on expenditures:

- DSU: One of our master's students (TyRae Freeman) graduated with an MBA degree without completing the NERTO internship and cohort experience workshop requirements. This has impacted the percentage of funding applied to direct student support. Currently we are searching for funds to replace those funds used by the student.
- SSU: Having the postdoctoral position unfilled leaves a surplus in salaries. We will assess whether the surplus funds can be used to cover the minimum expenses required for full support of a new student to be added to cohort 1 for two years.

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.

Direct Student Support – 21 students were recruited to Cohort 1; 12 students have so far been recruited to Cohort 2.

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
TyRae	Freeman*	1	M.B.A.	DSU	\$3,615	\$6,000			
Brian	Galvez*	1	M.S.	DSU	\$10,856	\$11,308	\$2,925		
Ileana	Fenwick*	1	B.S.	HU		\$3,600			
Isaiah	Milton*	1	B.S.	HU		\$3,600			
Nefertiti	Smith*	1	B.S.	HU	\$4,000	\$3,750			
Cristin	Mayes*	1	M.S.	HU	\$10,670	\$9,000	\$225		
Angie	Munguia*	1	M.S.	OSU	\$5,858	\$10,343	\$1,485		
Halie	O’Farrell*	1	Ph.D.	RSMAS	\$10,653	\$14,862			
Darius	Sanford*	1	B.S.	SSU	\$0	\$3,648	\$0	\$0	\$0
Emily	Griffin	1	M.S.	SSU	\$4,519	\$12,230	\$834	\$0	\$0
Shadaesha	Green*	1	Ph.D.	UMCES	\$3,861	\$13,452			
Ammar	Hanif*	1	Ph.D.	UMCES	\$2,495	\$19,895			
Amanda	Lawrence*	1	Ph.D.	UMCES		\$1,977			

Nakia	Coit*	1	B.S.	UMES	\$3,871	\$2,611	\$1,829		
Nylah	McClain*	1	B.S.	UMES	\$4,021	\$1,774	\$1,551		
India	Oliver*	1	B.S.	UMES	\$4,046	\$1,489			
Malisa	Smith*	1	B.S.	UMES	\$3,962	\$62	\$1,978		
Chryston	Otubu*	1	B.S.	UMES	\$4,046	\$2,659	\$1,551		
Rebecca	Wenker	1	M.S.	UMES	\$1,914	\$10,474			
Stephanie	Martinez-Rivera*	1	Ph.D.	UMES		\$19,270			
Detbra	Rosales*	1	Ph.D.	UMES	\$1,612	\$16,145		\$2,337	\$3,958
Kleponis	Nicole	2	M.S.	DSU	\$6,811	\$2,423			
Kendra	Dorsey*	2	B.S.	HU	\$4,000	\$3,750			
Janelle	Layton*	2	B.S.	HU		\$4,850			
Brittany	King*	2	Ph.D.	OSU	\$4,630	\$11,403	\$1,704		
Adrienne	Wilson*	2	PhD.	RSMAS	\$22,413	\$14,862			
Desmond	Love*	2	B.S.	UMES	\$4,046				
Andre	Price*	2	M.S.	UMES	\$638	\$13,079			
Enid	Munoz-Ruiz*	2	M.S.	UMES	\$3,589	\$10,888			
Jorge	Rodriguez*	2	M.S.	UMES	\$1,914	\$14,863			
Laura	Almodovar-Acevedo*	2	Ph.D.	UMES		\$7,995	\$865		
Cara	Schweitzer*	2	Ph.D.	UMES		\$12,181			
Kasondra	Rubalcava*	2	Ph.D.	UMES	\$2,885	\$11,986			

Milestones for Meeting Requirements of the Award: Presented below are timelines for students in cohort 1 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 synopsis, and are preparing to fulfill the NERTO requirement.

First	Last	Cohort #	Degree	Partner	Cohort Experience	NERTO	Ethical Conduct of Research Training	Data Management Course	NOAA Mentor
TyRae	Freeman*	1	M.S.	DSU			Fall 17	Fall 17	
Brian	Galvez*	1	M.S.	DSU	Spr. 18	Sum. 18	Fall 17	Fall 17	Fall 17
Ileana	Fenwick*	1	B.S.	HU	n/a	n/a	Fall 18	n/a	n/a
Isaiah	Milton*	1	B.S.	HU	n/a	n/a	Fall 18	n/a	n/a
Nefertiti	Smith*	1	B.S.	HU	n/a	n/a	Fall 18	n/a	n/a
Cristin	Mayes*	1	M.S.	HU	Spr. 18	Sum. 18	Fall 18	Fall 17	Fall 17
Angie	Munguia*	1	M.S.	OSU	Spr. 18	Sum. 17	Fall 17	Fall 17	Fall 17
Halie	O'Farrell*	1	Ph.D.	RSMAS	Spr. 18	Sum. 18	Fall 16	Fall 17	Fall 16
Darius	Sanford*	1	B.S.	SSU	n/a	Sum. 19	Sum. 18	Fall 19	Sum. 19
Emily	Griffin	1	M.S.	SSU	Spr. 18	Fall 17	Fall 17	Fall 17	Fall 17
Shadaesha	Green*	1	Ph.D.	UMCES	Spr. 18	Fall 18	Fall 17	Fall 17	Fall 17
Ammar	Hanif*	1	Ph.D.	UMCES	Spr. 18	Fall 17	Fall 17	Fall 17	Fall 17
Amanda	Lawrence	1	Ph.D.	UMCES	Spr. 18	Sum. 19	Fall 17	Fall 18	Fall 17

Nakia	Coit*	1	B.S.	UMES	n/a	n/a	Sum. 17	n/a	n/a
Nylah	McClain*	1	B.S.	UMES	n/a	n/a	Sum. 17	n/a	n/a
India	Oliver*	1	B.S.	UMES	n/a	n/a	Sum. 17	n/a	n/a
Malisa	Smith*	1	B.S.	UMES	n/a	n/a	Spr. 18	n/a	n/a
Chryston	Otubu*	1	B.S.	UMES	n/a	n/a	Sum. 17	n/a	n/a
Rebecca	Wenker	1	M.S.	UMES	Spr. 18	Sum. 18	Fall 16	Fall 17	Fall 18
Stephanie	Martinez-Rivera*	1	Ph.D.	UMES	Spr. 18	Fall 2018	Fall 15	Fall 18	Fall 17
Detbra	Rosales*	1	Ph.D.	UMES	Spr. 18	Spr. 18	Fall 15	Fall 17	Fall 17
Kleponis	Nicole	2	M.S.	DSU	Spr. 19	Sum. 19	Spr. 18	Fall 18	Spr. 18
Kendra	Dorsey*	2	B.S.	HU	n/a	n/a	Fall 18	n/a	Fall 17
Janelle	Layton*	2	B.S.	HU	n/a	n/a	Fall 18	n/a	n/a
Brittany	King*	2	Ph.D.	OSU	Spr. 18	TBD	Fall 18	Fall 18	Fall 18
Adrienne	Wilson*	2	Ph.D.	RSMAS	Spr. 18	Fall 18	Fall 17	Fall 18	Fall 18
Desmond	Love*	2	B.S.	UMES	n/a	n/a	Spr. 18	n/a	n/a
Andre	Price*	2	M.S.	UMES	Spr. 18	Fall 18	Spr. 18	Fall 17	Fall 17
Enid	Munoz-Ruiz*	2	M.S.	UMES	Spr. 18	Sum. 18	Fall 18	Fall 18	Fall 17
Jorge	Rodriguez*	2	M.S.	UMES	Spr. 18	Sum. 18	Fall 17	Fall 17	Fall 17
Laura	Almodovar-Acevedo*	2	Ph.D.	UMES	Spr. 18	Fall 17	Fall 17	Fall 17	Fall 17
Cara	Schweitzer*	2	Ph.D.	UMES	Spr. 18	Fall 18	Fall 17	Fall 18	Fall 17
Kasondra	Rubalcava*	2	Ph.D.	UMES	Spr. 18	Sum. 19	Fall 18	Fall 18	Spr. 18

*Underrepresented minorities

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.

Recruiting for this activity began during this period. Five students will participate in the rising sophomore experiential training program at the LMRCSC in summer 2018. 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 and SSU.

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, dates completed, participants, outcomes for Center measures of success.

Student name(s)	Activity name and/or description
Adrienne Wilson	RSMAS Ethical conduct in research training
Amanda Lawrence	UMES/NOAA Data Base Management Course
Amanda Lawrence	Webinar, Interviewing for Federal Jobs
Amanda Lawrence	Webinar, How to give an oral presentation
Ammar Hanif	UMES/NOAA Data Base Management Course
Cristin Mayes	M.S. thesis Ecosystem modeling
Detbra Rosales	Workshop on detection and quantification of marine toxins, Baltimore, MD, November 11, 2017
Ileana Fenwick	Research training in oyster restoration
Isaiah Milton	Research training in marine mammal genetics
Janelle Layton	Research training in marine mammal genetics
Kendra Dorsey	Research training in OA impacts on fish vision and hearing
Nefertiti Smith	Research training in marine mammal genetics
Shadaesha Green	UMES/NOAA Data Base Management Course,
Shadaesha Green	Webinar, Interviewing for Federal Jobs
Stephanie Martinez-Rivera	AFS webinar: Using Bayesian clustering algorithms to discover population genetic structure, January 10, 2018
Stephanie Martinez-Rivera	AFS webinar: Policy overview: and 2018 engagement outlook, November 4, 2017
Stephanie Martinez-Rivera, Enid Munoz-Ruiz	ERN Webinar: How to deliver an excellent oral presentation, January 26, 2018

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

SSU: The postdoc position was mis-advertised by the SSU HR office in 2017. The applicants were reviewed, but those that were eligible did not have fisheries research skills or had graduated earlier than 2 years prior. The position has been re-advertised.

UMES: Dr. Dan Cullen has been selected for this position. Work will begin in March 2018.

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	3	Summer 2018
DSU Students	1	Fall 2018
HU Faculty	3	Fall 2018
HU Students	2	Fall 2018

OSU Faculty	0	
OSU Students	1	Summer 2018
RSMAS Faculty	2	Summer 2018
RSMAS Students	1	Fall 2018
SSU Faculty	2	Spring 2018
SSU Students	2	Spring 2018
UMCES Faculty		
UMCES Students		
UMES Faculty	2	Summer 2018
UMES Students	2	Summer 2018

Papers currently in review:

Manuscripts under review or accepted	Justification
Bembe, B., Williams, E., Place, A., Liang, D., & J. Sook Chung (2018). Effects of temperature and photoperiod on hemolymph vitellogenin levels during spawning events of the blue crab, <i>Callinectes sapidus</i> , in captivity (2018). Aquaculture Res, available electronically ahead of print.	leveraged
Lewis, N. Achenbach. , Ellis, L, Pitula, J. , Rafuse, C., Rosales*, D., and Wolny., J.,(2018). Morphometric, Phylogenetic, Growth and Toxicity Assessment of <i>Coolia monotis</i> Meunier (Dinophyceae) from Nova Scotia, Canada. Harmful Algae, In Review.	LMRCSC Cohort 1 student*
Roy, S, Jagus, R , Morse, D. (2018). Translation and translational control in dinoflagellates. Microorganisms, available electronically ahead of print.	leveraged
Schweitzer, C. C.*, Lipcius, R. N., Stevens, B. G. (2018). Impacts of fish traps on benthic habitat. ICES J. Mar. Sci. UNDER REVIEW.	LMRCSC Cohort 2 student*

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	Institution	Cohort #	Start date	Role	Time Commitment	Line Office	Project Title
Howard Townsend	Brian Galvez	DSU	1	Jan-17	Committee member		NOAA NEFSC	Red-throated loon fish diet and distribution in the Delaware Bay as an indicator of ecosystem health
Mike Fogarty	Cristin Mayes	HU	1	17-Sep	TAB collaborator, committee member	1 year	NOAA CB	The Impact of Increasing Sea Surface Temperature on Piscivore and Planktivore Species Dynamics: An Ecosystem-Based Modeling Approach

AK Leight	Ammar Hanif	UMCES	1	1-Jun-17	collaborator		NCCOS	
Kevin Friedland	Ammar Hanif	UMCES	1	1-Dec-13	committee member and TAB collaborator		NMFS	Diet and microbiome of Atlantic menhaden
John Jacobs	Ammar Hanif	UMCES	1	1-Jun-17	TAB collaborator		NCCOS	Comparing the diet and microbiome of Atlantic menhaden and Eastern oyster using DNA barcoding
James Weinberg	Shadaesha Green	UMCES	1	17-Sep-16	NERTO mentor and committee member		NMFS	size and maturity of male red crabs
Laurie Weitkamp	Angie Munguia	OSU	1	1-Sep-17		~1.5 month/yr	NOAA NWFSC	Characterizing feeding ecology and food web linkages of yearling chinook salmon (<i>Onchorhynchus tshawytscha</i>) emigrating through the lower Columbia River and Estuary
Enric Cortes	Halie O'Farrell	RSMAS	1	2015	Committee member		NOAA SEFSC	Evaluation of the effect of size and sex-based spatial segregation on shortfin mako and bull shark fishery sustainability
Patricia Rosel	Emily Griffin	SSU	1	1-Sep-17	Committee member, communicating collaborator		NOAA NMFS Lafayette	Refining stock structure of common bottlenose dolphins (<i>Tursiops truncatus</i>) through photo-identification and genetic analysis
John Jacobs	Detbra Rosales	UMES	1	1/15/2018	Committee member, technical advisor		NOAA COL	Assessing the impacts of harmful algal species and <i>Vibrio</i> spp. on oysters
Chris Long	Stephanie Martinez Rivera	UMES	1	Fall 17	Committee member, technical advisor		NOAA	Reproductive biology of Jonah Crab
Jen Zamon	Nicole Kleponis	DSU	2	Jan-18	Committee member		NOAA NWFSC	Diet analysis of Delaware Bay weakfish (<i>Cynoscion regalis</i>) using stable isotope and stomach content analyses
Rich Brill	Kendra Dorsey	HU	2	1-May-17	Research collaborator	3 years	NOAA NEFSC	Effects of Ocean Acidification on Auditory

								Neurobiology in a Tropical Marine Fish
Rich McBride	Andre Price	UMES	2	Sum. 18	NERTO mentor		NOAA NEFSC	Diet of Black Sea Bass
Tod Kellison	Cara Schweitzer	UMES	2	Fall 18	NERTO mentor		NOAA SEFSC	By-catch mortality of Black Sea Bass
Howard Townsend	Laura Almodovar-Acevedo	UMES	2	Fall 17	Committee member		NOAA COL	Habitat suitability model for Black Sea Bass

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 **29** and graduated **1** in NOAA- mission sciences.
2. **Total number of EPP-funded post-secondary students** who are trained **33** 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) = \$1,098,277

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-one (21) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 6 Ph.D., 6 M.S., and 9 B.S. Twelve (12) students have been recruited to Cohort 2 (2017-2018) including 5 Ph.D., 4 M.S., and 3 B.S. students.

Outputs:

(a) Increase 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 2017, 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 first week of the next reporting period.

(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 2017 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-one (21) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 6 Ph.D., 6 M.S., and 9 B.S. Twelve (12) students have been recruited to Cohort 2 (2017-2018) including 5 Ph.D., 4 M.S., and 3 B.S. students.

(a) **Number of degrees earned annually in NOAA mission-related disciplines** – One student graduated with an M.B.A 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:** Four students, all 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
Angie Munguia*	Juvenile salmon long-term habitat monitoring and field collections for action effectiveness in the Lower Columbia River and Estuary	Laurie Weitkamp, primary	Hammond, OR
Detbra Rosales*	Assessing the impacts of harmful algal species and <i>Vibrio</i> spp. on oysters	John Jacobs	Oxford, MD
Laura Almodovar-Acevedo*	Habitat suitability model for Black sea bass in Chesapeake Bay	Howard Townsend	Oxford, MD
Ammar Hanif*	Comparing the diet and microbiome of Atlantic menhaden and Eastern oyster using DNA barcoding	John Jacobs	NOS/COL
Ammar Hanif*	Microbial community analysis of the Tred Avon, Choptank River tributary, using high-throughput sequencing	A.K. Leight & Suzanne Skelley	NOS/COL

*URM

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

The grant has made it possible for 8 collaborative research projects to be funded for the period of 2016 – 2017, which will enable more Center scientists to be available to mentor and advise undergraduate and graduate students. In addition, 16 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 LMRCSC and degrees awarded that reflect the changing demographics of the nation.

Outputs	# During this Reporting Period
Seminars	3
New courses offered	1
New programs developed	0
New degrees offered	0
# of students supported by the LMRCSC	33
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 = **28** URMs at the LMRCSC took part in student development activities.

(b) Increased number of URM students who select to pursue higher education in NOAA mission fields = **17** URMs at the LMRCSC 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 is in the process of completing search for the two post-doctoral positions at two MSIs (UMES and SSU) which will help increase research capacity 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 LMRCS faculty, staff and students:** Each of the eight LMRCS TAB projects has a NOAA scientist as a collaborator.
- (b) **Number of NOAA scientists serving as mentors and advisors for student research:** 23 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 = 5**
- (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.

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

Eight collaborative research projects were funded by the LMRCS for the period of 2016 – 2017. 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:

	# From Projects Directly Supported with FY 16 Funds	# from Leveraged Projects
# of peer reviewed publications	12	11
# of presentations	16	9
# Tools developed	8	0
Use of LMRCS research results and tools by NOAA & other stakeholders	2	1
# of instances LMRCS publications are cited	Not available	Not available
# of LMRCS students, staff or faculty recognized nationally for LMRCS research	2	3

TAB Funded Research Projects in 2016-2017

In 2016-2017, the LMRCS funded eight small research projects approved by the Technical Advisory Board (TAB). Some of these were continuations of projects funded in previous years. Three of these were awarded to lead investigators at UMES, one each at HU, SSU, and UMCS-IMET, and two were joint projects between UMES/UMCS-IMET, and OSU/DSU, respectively. Numerous other scientists and students at LMRCS institutions were involved, as well as many NOAA investigators. Topics included bycatch and discard mortality, reproduction and maturity, genetic stock structure, climate change impacts, harmful algal blooms, fish migration, and trophic ecology. These projects involved a total of five PhD students, three MS students, four undergraduate students, and nine NOAA collaborators. Abstracts of the projects are presented below; more detailed reports can be found in Appendix I.

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, discarded (sublegal) BSB were assessed using a condition index involving the presence or absence of impairments (dorsal fin movement, mouth movement, gag reflex, and operculum movement) and occurrence of barotrauma (floating and stomach eversion). Fish were assessed from two sites, and in two different seasons, and held in sea cages after assessment for up to 10 d. Barotrauma (floating) was observed in 81% of discarded fish, and stomach eversion in 27%. Overall delayed mortality was 44% (n=384) in 2016 and 40% (n=237) in 2017. Mortality was significantly related to the total number of impaired reflexes, but specific combinations of reflexes were better predictors of mortality.

Thematic Area Addressed: Stock Assessment Support

Lead Scientist(s): Bradley G. Stevens

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

Project Number: 17-02

Project Title: Biological baseline data for Jonah Crab Management

Project Abstract: Jonah crab (*Cancer borealis*) are caught almost exclusively as bycatch in the Southern New England lobster fishery, but as that fishery has declined since 2002, Jonah crab landings have increased 5-fold. Jonah crab is a data-poor species, and lack of information on abundance, biology, growth, age, or reproduction, prohibits adequate management. A 2016 Fishery Management Plan includes a minimum legal size (4.75") based on scant information. This project has updated fundamental biological and reproductive information of Jonah crab in the Mid-Atlantic Bight necessary to manage this species. Morphometric analyses were conducted to estimate size at 50% sexual maturity (SM_{50}), and a gonadosomatic index was used to determine the female crab reproductive cycles. This information is critical for defining size limits and management areas for the Jonah crab fishery in the Mid-Atlantic Bight.

Thematic Area Addressed: Stock Assessment Support

Lead Scientist(s): Bradley G. Stevens (University of Maryland Eastern Shore)

NOAA Collaborator(s): Burton Shank (NOAA/NMFS)

LMRCSC Collaborator(s):

LMRCSC Research Student(s): Noelle A. Olsen (MS, UMES), Melati Tarrant (UG REU, University of Rhode Island).

Project Number: 17-03

Project Title: Reproductive biology of the red deepsea crab, *Chaceon quinquegens*.

Project Abstract: Biennial reproductive cycles are common among crabs living at extremely low temperatures. It is unusual, however that red deepsea crabs (*Chaceon quinquegens*), found at 5-8

°C temperatures, have a biennial reproductive cycle. Red crabs have sustained a federally-managed fishery in the Mid-Atlantic since the 1970's. However, they are still considered a data-poor fishery raising major concerns about the status of the stock. This study aimed to determine the size at 50% sexual maturity (SM50), estimate the size-specific fecundity and timing of reproduction of the females. Samples were collected in the Mid-Atlantic Bight at depths >300 m aboard NOAA research vessels and commercial vessels. Gross morphology was recorded including carapace length and width, abdomen width, size and color of ovaries, presence of external eggs and vulvae condition. Histological analysis was used to determine five stages of ovarian development. Estimates of SM50 range between 64-72 mm in carapace length. Preliminary estimates of size-specific fecundity range between 34,000 and 188,000. Timing of reproduction was determined using the ovarian maturation stages, ratio of ovigerous and non-ovigerous females, and shell condition across collections and years. This information will help define management strategies for red crabs and other deepsea crab fisheries with multi-year reproductive cycles in other parts of the world. The presence of crustacean hyperglycemic hormone 1 and 2 (CHH) and molt-inhibiting hormone (MIH) in the eyestalk ganglia of adult females was confirmed using whole mount immunohistochemistry and RP-HPLC. Using a degenerate PCR and 5' and 3' RACE cloning strategy, a full-length cDNA sequence encoding CHH and MIH was cloned. Ovarian stage 1 and 3 hepatopancreas tissues were used for transcriptome sequencing. Over 142 million sequencing reads were obtained, and 50,088 transcripts were assembled. An additional 100 primer sets have been tested for selection of potential genetic markers to examine the population structure of this species in the United States. This project is committed to NOAA's mission of providing scientific data to improve, supplement, and enhance management of deep-sea red crabs and other deep-sea crab fisheries with multi-year reproductive cycles.

Thematic Area Addressed: Stock Assessment Support

Lead Scientist(s): Stephanie Martinez Rivera (PI, UMES), Shadaesha Green (Co-PI, IMET), Bradley G. Stevens (Co-PI, UMES), Sook Chung (Co-PI, IMET)

NOAA Collaborator(s): Burton Shank (NEFSC, Woods Hole), Chris Long (AFSC, Kodiak, AK), James Weinberg (NEFSC, Woods Hole, MA)

LMRCSC Collaborator(s): Bradley G. Stevens (Co-PI, UMES), Sook Chung (Co-PI, IMET)

LMRCSC Research Student(s): Stephanie Martinez-Rivera (PhD, UMES), Shadaesha Green (PhD, IMET).

Project Number: 17-04

Project Title: Examining stock structure of common bottlenose dolphins (*Tursiops truncatus*) through photo-identification and genetic analyses

Project Abstract: Cetaceans range over large distances resulting in complex patterns of population structure. The coastal ecotype of common bottlenose dolphin (*Tursiops truncatus*) populations usually consists of distinct groups that exhibit localized adaptations on small spatial scales that result in fine-scale genetic structuring. The purpose of this study was to couple long-term photo-identification data with genetics to examine stock structure of common bottlenose dolphins in the estuarine waters around Savannah, GA. The study area was categorized into three segments: a) a northern region, b) a buffer region, and c) a southern region. Remote biopsy sampling was conducted in September 2015 and February and March 2017. Nucleotide and haplotype frequency was estimated from the sample population based on sample location and long term sighting data. Haplotype diversity (Fst) was found to be significantly different between the northern region and buffer region and between the northern and southern region with the addition of photo-ID data ($p=0.0018$ and $p=0.016$) but not between the buffer and southern region. Nucleotide diversity (Φst) was not significantly different in any of the pairwise comparisons. With the addition of sighting history data, the results showed stronger subdivision between populations.

The addition of supplemental data, such as photo-ID to a genetic analysis, may provide a closer look at stock structure. Methods used in this study could be utilized by future studies to improve understanding of the complex stock structure of common bottlenose dolphins in coastal waters.

Thematic Area Addressed: Assessment

Lead Scientist(s): Tara Cox (Savannah State University)

NOAA Collaborator(s): Patricia Rosel (NOAA/NMFS)

LMRCSC Collaborator(s): Joseph Pitula (University of Maryland, Eastern Shore)

LMRCSC Research Student(s): Emily Griffin (MS, Savannah State University) Debra Baskerville (UG, University of Maryland, Eastern Shore)

Project Number: 17-06

Project Title: Ecosystem impact of a harmful algal bloom species (*Dinophysis acuminata*) on aquaculture shellfish

Project Abstract: Land development within the Maryland Coastal Bay watershed induces a suite of environmental stressors that negatively impact aquatic animal health, such as eutrophication leading to the development of harmful algal blooms (HABs). The proposed study seeks to monitor an ongoing bloom event, which has led to increased numbers of the potential toxin-producing species *Dinophysis acuminata*. The impact of this organism on animals within the MCB remains undetermined. It is vital to understand its impact on resident shellfish that act as the primary filter feeders during bloom events, as these species will serve as the first level of bioaccumulation of toxin in the food chain. Indirectly, reduced fitness in these organisms may also lead to reduced ability to clear blooms during HAB events.

Thematic Area Addressed: Safe Seafood and Aquaculture

Lead Scientist(s): Joe Pitula, UMES

NOAA Collaborator(s): John Jacobs, NOAA Cooperative Oxford Laboratory

LMRCSC Collaborator(s): Gulnihal Ozbay, DSU

LMRCSC Research Student(s): Detbra Rosales (PhD, UMES)

Project Number: 17-07

Project Title: Migration and foraging ecology of at-risk species: Columbia River Chinook salmon and Atlantic weakfish

Project Abstract: Quantifying habitat use for migratory fish is challenging yet important for the development of sound management and recovery plans. Given that migratory fish are highly mobile and often have short, habitat-specific residence times, research approaches that can shed light on diet, growth, or condition during migration continue to be developed and refined. Longitudinal studies, or those that follow specific cohorts of fish during their migration, can quantify spatial variation in foraging, growth, and sometimes mortality, thus providing information on habitat use. Interior Columbia River Chinook salmon (*Oncorhynchus tshawytscha*) and Weakfish (*Cynoscion regalis*) are two migratory species of concern. Interior Columbia River Chinook salmon have been listed under the Endangered Species Act since 2005, and habitat restoration within the lower Columbia River and Estuary is a key element of their recovery plan. The Atlantic weakfish stock has been depleted since around 2002, and recent assessments indicated that natural mortality may be the cause for the stock's inability to rebound despite fishing mortality decreases since 2011. Therefore, we implemented a longitudinal study design to quantify foraging and growth using traditional diet, stable isotope, and otolith chemical analyses during migration for these two, commercially important migratory species.

Thematic Area Addressed: Healthy Habitats

Lead Scientist(s): Jessica Miller, OSU
NOAA Collaborator(s): Laurie Weitkamp, OSU
LMRCSC Collaborator(s): Stacy Smith DSU
LMRCSC Research Student(s): Angelica Munguia (MS, OSU); Brian Galvez (MS, DSU);
Sawyer Finley, NSF REU Summer student at OSU (leveraged)

Project Number: 17-08

Project Title: Comparing the diet and microbiome of Atlantic menhaden and Eastern oyster using DNA barcoding

Project Abstract: Atlantic menhaden (*Brevortia tyrannus*) and Eastern oysters (*Crassostrea virginica*) diets derive from filtration of the water columns, consuming planktonic organisms. Both are very powerful filtering organisms however, exactly what items are being filtered still remains largely unknown. This comparison will help to assign trophic levels and develop more accurate food web models and assess ecosystem health. Overall these stomach contents could reflect the ability for each organism to function as an environmental sampler. Identification of stomach contents is difficult due to items being largely unrecognizable by conventional methods, therefore contents will be investigated using primers that target the hypervariable regions of the 16S and 18S ribosomal DNA (rDNA) using Illumina's MiSeq high-throughput sequencing technology. To our knowledge this has yet to be done between two filtering species. The results from this study could help to restore the Choptank River, a large tributary of the Chesapeake Bay, which is a project focus of the NOAA-Cooperative Oxford Lab and also help train minority students in the field of marine biology.

Thematic Area Addressed: Quantitative Fisheries & Healthy Habitat

Lead Scientist(s): Ammar Hanif, UMCES-IMET

NOAA Collaborator(s): Dr. John Jacobs (NOAA-COL, Oxford, MD)

LMRCSC Collaborator(s): Dr. Bradley Stevens, UMES

LMRCSC Research Student(s): Ammar Hanif, MS; Malisa Smith (UG), UMES

Start Date: 1 Sept 2016

End Date: 31 December 2017

5.3 CSC Administration

Outcome 1. Increased CSC capacity to support and sustain education and research in NOAA mission areas.

Outputs:

- (a) Funds leveraged with CSC award to support NOAA mission in education and research amount to **\$1,098,277**. Additional details can be found in Section VII of this report.

Outcome 2. Increased engagement by CSCs with the URM communities to enhance the mission workforce pipeline.

Output:

- (a) *Number of structured activities to recruit and retain students, particularly from URM communities:* The Center participated in several recruitment events aimed at recruiting URM students into LMRCSC institutions.
- (b) *Number of MSI inter-institutional collaborative partnerships established and maintained in support of NOAA's mission:* 6.

Outcome 3. To increase communication of CSC accomplishments and capacity

Outputs: (a) *Number of LMRCSC products used by stakeholders*, (b) *Number of featured articles in print or digital media referencing the NOAA LMRCSC*:

The LMRCSC Communication Specialist prepared a newsletter that was released in Fall 2017, and modified and updated the LMRCSC website.

Outcome 4. Increased use of post-secondary education evaluation methodologies

Outputs: (a) Number of best practices that are measurable, scalable and transferrable, (b) Consistent use of established evaluation practices, including higher education practices, to measure effectiveness of each component of the award:

Internally, methodologies are being developed by the Education Expert.

The College of Exploration that serves as External Evaluator of the LMRCSC has developed, as part of the Center's Comprehensive Evaluation Plan, surveys that incorporate post-secondary education evaluation methodologies that will be used to collect data and evaluate the Center. An Evaluation report for FY16 conducted by the College of Exploration has been submitted to the LMRCSC.

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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:	\$130,925.44
Stipend:	\$276,431.53
Travel:	\$14,945.73
NERTO:	\$2,337.00
<u>One-time Research:</u>	<u>\$3,957.71</u>

Total: **\$428,597.41**

Collaborative Research:

Eight collaborative projects in the amount of \$321,279 in direct cost were funded during the previous 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
NSF	Grant	Oct. 16-Sep. 2021	\$5,000,000	\$500,000	P. Chigbu	NSF CREST-CISCEP	Funds are used to support students and conduct research
Bunting Foundation	Grant	07/01/17-TBD	\$20,000	\$20,000	Rose Jagus	Support IMET Summer Internship	Funding supports IMET Summer Internship, 2018
Elkins Professorship	Endowment Income	02/01/18-TBD	\$60,000	\$60,000	Rose Jagus	Support IMET Summer Internship	Funding supports IMET Summer

							Internship, 2018
NIST	Grant	9/1/2017 - 8/31/2018	\$112,050	\$37,355	J. Sook Chung	New method development for measuring low concentration of protein/peptide	Funds are used to support Amanda Lawrence for stipend, tuition, travel and research
Ratcliffe Foundation	award	07/01/14-06/30/20	\$800,000	\$67,000	Russell Hill/Nick Hammond	Award to cultivate the leadership & 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

Collaborative Research:

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
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 LMRCS cohort 2 student tuition.
	Grant	8/1/13-7/31/18	\$900,000	\$180,000	Cuker, B	Multicultural Diversity in the	

NSF	Grant	2/1/15-1/31/18	\$200,000	\$30,000	Gibson, D.	Cryptic Diet of the Doliolid...	Funds are used to support Research Associate and LMRCSC graduate A. Salcedo.
Sea of Change	gift	Mar-Dec 2018	\$15,056	0	Dionne Hoskins-Brown	Faux habitat or foe food: How prevalent are microplastic fragments in oyster reefs and muddy estuarine sediments?	Support a stipend for a high school student to work in the lab. March to May after school and in a full-time internship in the summer.
NSF	Grant	12/1/2012 - 1/31/19	\$686,888	\$65,273	Rose Jagus	Translation regulation of gene expression in toxic dinoflagellates	Funds support PIs salary
NIH	Grant	9/24/2012 - 7/31/2018	\$368,382	\$13,742	Rose Jagus	Translation regulation of gene expression in toxic dinoflagellates	Funds support PIs salary
NSF	Grant	5/1/12 - 4/30/18	\$627,489	\$4,021	J. Sook Chung	Functional Roles of a Novel Crustacean Female Sex Hormone in Sex Differentiation and Developing Secondary Sex Features of Crustaceans	Funds support PIs salary and Green research
NIST	Grant	1/1/16 - 12/31/17	\$135,788	\$53,578	J. Sook Chung	New method development for measuring low concentration of protein/peptide hormones of commercially important crustacean species in US	Funds support PIs salary
NSF	Grant	10/1/2017 - 9/30/2018	\$36,285	\$8,340	J. Sook Chung	NSF CREST-CISCEP	Funds support PIs salary

EPICORE	Grant	8/1/2017 - 4/30/2018	\$10,921	\$7,896	Eric Schott	In vivo challenge assay of the effect of bacterial probiotics against AHPND shrimp pathogens for Epicore Bionetworks, Inc.	Funds support PIs salary
Sea Grant	Grant	11/1/2017 - 9/30/2018	\$9,370	\$2,788	Eric Schott	Opening the door for research on a pathogenic virus of the soft clam <i>Mya arenaria</i>	Funds support PIs salary
NOAA	Grant	6/1/2015 - 5/31/2018	\$299,381	\$12,500	Eric Schott	Disease and Discard Mortality in the Blue Crab Fishery: using New information about an old virus to improve management of the resource	Funds support PIs salary
DPW	Grant	7/12/2016 - 7/13/2018	\$12,988	\$1,003	Eric Schott	DPW- Microbial Source Tracking as a Tool for Assessing and Managing Fecal Contamination through UB	Funds support PIs salary
USDA	Grant	9/1/2015 - 8/31/2018	\$ 12,513	\$1,117	Eric Schott	Testing and Application of Novel Probiotic Bacteria	Funds support PIs salary
NSF	Grant	7/1/2017 - 6/30/2018	\$136,610	\$23,664	Eric Schott	Determining how Variation in life history & connectivity drive pathogen-host dynamics	Funds support PIs salary

Appendices

Appendix I: TAB Funded Research Projects in 2016-2017

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, discarded (sublegal) BSB were assessed using a condition index involving the presence or absence of impairments (dorsal fin movement, mouth movement, gag reflex, and operculum movement) and occurrence of barotrauma (floating and stomach eversion). Fish were assessed from two sites, and in two different seasons, and held in sea cages after assessment for up to 10 d. Barotrauma (floating) was observed in 81% of discarded fish, and stomach eversion in 27%. Overall delayed mortality was 44% (n=384) in 2016 and 40% (n=237) in 2017. Mortality was significantly related to the total number of impaired reflexes, but specific combinations of reflexes were better predictors of mortality.

Thematic Area Addressed: Stock Assessment Support

Lead Scientist(s): Bradley G. Stevens

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 Sept 2016

End Date: 31 December 2017

Scientific Merit: Sampling was conducted in in 2016 and 2017 at two sites in 25 m to 30 m depth, approximately 25 km off the coasts of Delaware and Maryland. Series 1 was completed in August 2017 and Series 2 from late October to early November 2017. The mean air temperature for Series 1 and Series 2 was 26.7 °C and 19.6 °C, respectively. Traps were hauled and fish were sorted by commercial fishermen. Approximately 388 s (6.5 min) were required to retrieve a complete trap-line, for an average 19 s between each trap, and approximately 632 s (10.5 min) for sorting and discarding to be completed. Experimental trap-lines were left to soak for 4 to 10 days. After trap retrieval, sublegal fish were discarded into a container filled with 150 L of seawater. Fish were recorded as floating or not, measured (cm), placed on a wet towel, and tagged with anchor T-bar Floy® tags (Seattle, Washington) in the muscle beneath the dorsal fin. Fish were assessed for signs of barotrauma (i.e. floating and stomach eversion) and the present or absence of behaviors and reflexes. After assessment fish were placed in a 950 L holding vat filled with 2/3 of seawater until processing for all fish caught at that site was complete. To determine delayed mortality rate, up to 25 fish were held in sea cages (1.2 x 1.2 x 0.6 m with 9.7 cm² wire mesh) near the fishing sites for 4 to 10 days. Sea cages were retrieved at a reduced speed to prevent barotrauma, and tag numbers of live fish were recorded; Fish not present were presumed dead.

Size range of bycatch was 19–29 cm due to presence of escape vents; minimum legal size is 30 cm. There was no difference in fish length distribution between mortalities and survivors (K-S test, $p = 0.63$). Barotrauma was observed in 81% of fish. During series 1 and 2 a total of 621 black sea

bass discards were assessed and estimated discard mortality was 47.0% (317/674). Discard mortality for Series 1 was 50.9% (221/434), which included both immediate and delayed mortality. Estimated delayed mortality rate was 44.2% (170/384) for Series 1, and 39.6% (94/237) for Series 2. There was no difference in delayed mortality between sampling series ($p = 0.26$). A short-term immediate mortality (i.e. less than 30 min) was observed for black sea bass during Series 1. Of the 170 bycatch mortalities in Series 1, 109 occurred before sea-cage placement. Immediate mortality was not observed in Series 2. Overall, proportional mortality increased with the impairment score, from no impairment (i.e. score = 0.0, mortality 0.08) to total impairment (i.e. score of 1.0, mortality 0.83). There was a significant difference between the mean impairment score of survivors ($\bar{x} = 0.35$) compared to mortalities ($\bar{x} = 0.55$; t-test, $p < 0.001$). The most frequently observed impairments were barotrauma, i.e. expansion of the swim bladder resulting in the fish floating (81% of fish), and the absence of the gag reflex (61% of fish). Severe barotrauma (i.e. stomach eversion) was only detected in 27% of black sea bass. Logistic regression showed that the best model for predicting mortality in black sea bass bycatch included barotrauma and reflexes (Table 1). A conditional inference tree was constructed to determine which individual combinations of barotrauma and reflex impairments affected mortality. Fish without barotrauma had only 10% probable mortality rate. The highest probable mortality (~80 %) occurred among fish that were 1) floating, with impaired mouth and dorsal fin movement, and 2) floating, with impaired mouth movement and gag reflex. Hazardous ocean conditions and sea cage confinement for a 10 day duration could have contributed to mortality during Series 2. However, mortality during cooler months is usually considerably lower. The preliminary experiment conducted in 2016 showed a delayed mortality rate of 13.7% during cooler months with a 5 day sea cage confinement during calm conditions compared to 39.6% observed in cooler months post-hazardous conditions during Series 2 in 2017.

Products:

Presentations:

Schweitzer, C.C., Horodysky, A.Z., and Stevens, B.G. Evaluating the effectiveness of reflex action mortality predictor (RAMP) in black sea bass, *Centropristis striata*, bycatch within the commercial trap fishery. NOAA EPP. Washington, D.C. March 2018

Schweitzer, C.C., Horodysky, A.Z., and Stevens, B.G. Evaluating the effectiveness of reflex action mortality predictor (RAMP) in black sea bass, *Centropristis striata*, bycatch within the commercial trap fishery. American Fisheries Society: Tidewater Chapter. Beaufort, NC. January 2018.

Manuscript prepared for submission:

Schweitzer, C. C., A. Z. Horodysky, A. L. Price, and B. G. Stevens. Impairment indicators for delayed mortality in black sea bass (*Centropristis striata*) bycatch in the commercial trap fishery using a condition index. 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. There are also no published data validating RAMP assessments for BSB, which could improve future mortality assessments. 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 LMRCSC website, and at the annual UMES Research Symposium. Results were presented at the 2018 American Fisheries Society Tidewater Chapter meeting in January 2018, and the NOAA-EPP Education and Science Forum in March, 2018. This project will engage graduate and undergraduate students from underrepresented communities in NOAA mission-relevant STEM research. The results of this project will contribute to the Ph.D. Dissertation of a minority graduate student (Cara Schweitzer, Hispanic-American).

Project Number: 17-02

Project Title: Biological baseline data for Jonah Crab Management

Project Abstract: Jonah crab (*Cancer borealis*) are caught almost exclusively as bycatch in the Southern New England lobster fishery, but as that fishery has declined since 2002, Jonah crab landings have increased 5-fold. Jonah crab is a data-poor species, and lack of information on abundance, biology, growth, age, or reproduction, prohibits adequate management. A 2016 Fishery Management Plan includes a minimum legal size (4.75") based on scant information. This project has updated fundamental biological and reproductive information of Jonah crab in the Mid-Atlantic Bight necessary to manage this species. Morphometric analyses were conducted to estimate size at 50% sexual maturity (SM_{50}), and a gonadosomatic index was used to determine the female crab reproductive cycles. This information is critical for defining size limits and management areas for the Jonah crab fishery in the Mid-Atlantic Bight.

Thematic Area Addressed: Stock Assessment Support

Lead Scientist(s): Bradley G. Stevens (University of Maryland Eastern Shore)

NOAA Collaborator(s): Burton Shank (NOAA/NMFS)

LMRCSC Collaborator(s):

LMRCSC Research Student(s): Noelle A. Olsen (MS, UMES), Melati Tarrant (UG REU, University of Rhode Island).

Start Date: 1 Sept 2016

End Date: 31 December 2017

Scientific Merit: From December 2015 to September 2017, 1,473 Jonah crabs were collected from the Mid-Atlantic Bight (MAB) between 37 and 39°N. Collections were made using commercial black sea bass or lobster traps, and from the VIMS scallop dredge survey. Morphometric analyses were conducted to estimate size at 50% sexual maturity (SM_{50}) based on a modified version of Somerton's (1980) computer technique. Using log-transformed data on chela height and chela length versus CW in male Jonah crabs, SM_{50} was found to be 98.44 mm CW and 100.6 mm CW (n=564), respectively—both being below the minimum legal size. For female crabs, a broken-stick model was applied to the regression of abdomen width vs. CW, and the breakpoint was estimated to occur at 88.2 mm CW (n=716). A gonadosomatic index was calculated for female crabs to estimate reproductive cycles. Mean GSI was highest in September, and declined through March, indicating that the ovary builds up in late winter and spring, and oviposition occurs in the Fall. September was also the month during which the greatest number of females were found with sperm plugs, indicating that fertilization had occurred. Most of those had new shells but five crabs with sperm plugs had hard shells, evidence that females can mate in the hard-shell condition, without molting. This is the first study to estimate size at maturity of both male and female crabs in the MAB, and the first to demonstrate hard-shell mating. This information is critical for defining size limits and management areas for the Jonah crab fishery in the Mid-Atlantic Bight. The results from this project will be shared with both NOAA and the Atlantic States Marine Fisheries Commission (ASMFC) to improve federal and state management for Jonah crabs in the Mid-Atlantic Bight. The R code used to estimate SM_{50} will be made available and has the potential to be applied to other crustacean fisheries management.

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

Olsen, N.A.* and B.G. Stevens (2017). Reproductive biology and size at maturity and of Jonah crabs, *Cancer borealis*, in the Mid-Atlantic Bight. Presented at the National Organization of Gay and Lesbian Scientists & Technical Professionals 4th Biennial Out to Innovate Career Summit, Danvers, MA. March 4-5, 2017.

Olsen, N.A.* and B.G. Stevens (2017). Reproductive biology of Jonah crabs, *Cancer borealis*, in the Mid-Atlantic Bight. Presented at the American Fisheries Society Tidewater Chapter 31st Annual Meeting, Virginia Beach, VA, March 9-11, 2017.

Olsen, N.A.* and B.G. Stevens (2017). From pest to plate: Using morphometry to help improve management of Jonah crabs, *Cancer borealis*, in the Mid-Atlantic Bight. Presented at the American Fisheries Society 147th Annual Meeting, Tampa, FL, August 20-24, 2017.

Relevance: Our results will support NOAA's mission to "conserve and manage coastal and marine ecosystems and resources". Estimates of size at sexual maturity will support accurate and appropriate selection of minimum legal sizes and help to minimize discard mortality. Knowledge of the female reproductive cycle and changes in gonadosomatic index (GSI) over time will increase understanding of stock reproductive capacity, and help to set fishing seasons. This information will help to improve management and long-term sustainability for the Jonah crab fishery.

Broader Impacts: This project supported MS student Noelle Olsen, who is expected to graduate in May 2018 with a Master of Science in Marine Estuarine and Environmental Science from UMES. The research will comprise a portion Noelle's MS thesis. This project provided her an opportunity to collaboratively work with academia (UMES and the Virginia Institute of Marine Science), NOAA scientists, state management, and commercial lobstermen. In summer of 2017, Noelle mentored Melati Tarrant, an undergraduate intern in the NSF-funded Research Experience for Undergraduates (NSF REU) program. Funds from this TAB grant were able to supplement the training received and experience gained by the REU student as they worked with Noelle. In 2018, Noelle was accepted into the NOAA Knauss Marine Policy Fellowship Program, and she is now (March 2018) working with the Fishery Observer Program at NOAA headquarters in Silver Spring, MD.

Project Number: 17-03

Project Title: Reproductive biology of the red deepsea crab, *Chaceon quinque-dens*.

Project Abstract: Biennial reproductive cycles are common among crabs living at extremely low temperatures. It is unusual, however that red deepsea crabs (*Chaceon quinque-dens*), found at 5-8 °C temperatures, have a biennial reproductive cycle. Red crabs have sustained a federally-managed fishery in the Mid-Atlantic since the 1970's. However, they are still considered a data-poor fishery raising major concerns about the status of the stock. This study aimed to determine the size at 50% sexual maturity (SM50), estimate the size-specific fecundity and timing of reproduction of the females. Samples were collected in the Mid-Atlantic Bight at depths >300 m aboard NOAA research vessels and commercial vessels. Gross morphology was recorded including carapace length and width, abdomen width, size and color of ovaries, presence of external eggs and vulvae condition. Histological analysis was used to determine five stages of ovarian development. Estimates of SM50 range between 64-72 mm in carapace length. Preliminary estimates of size-specific fecundity range between 34,000 to 188,000. Timing of reproduction was determined using the ovarian maturation stages, ratio of ovigerous and non-ovigerous females, and shell condition across collections and years. This information will help define management strategies for red crabs and other deepsea crab fisheries with multi-year reproductive cycles in other parts of the world. The presence of crustacean hyperglycemic hormone 1 and 2 (CHH) and molt-inhibiting hormone (MIH) in the eyestalk ganglia of adult females was confirmed using whole mount immunohistochemistry and RP-HPLC. Using a degenerate PCR

and 5' and 3' RACE cloning strategy, a full-length cDNA sequence encoding CHH and MIH was cloned. Ovarian stage 1 and 3 hepatopancreas tissues were used for transcriptome sequencing. Over 142 million sequencing reads were obtained, and 50,088 transcripts were assembled. An additional 100 primer sets have been tested for selection of potential genetic markers to examine the population structure of this species in the United States. This project is committed to NOAA's mission of providing scientific data to improve, supplement, and enhance management of deep-sea red crabs and other deep-sea crab fisheries with multi-year reproductive cycles.

Thematic Area Addressed: Stock Assessment Support

Lead Scientist(s): Stephanie Martinez Rivera (PI, UMES), Shadaesha Green (Co-PI, IMET), Bradley G. Stevens (Co-PI, UMES), Sook Chung (Co-PI, IMET)

NOAA Collaborator(s): Burton Shank (NEFSC, Woods Hole), Chris Long (AFSC, Kodiak, AK), James Weinberg (NEFSC, Woods Hole, MA)

LMRCSC Collaborator(s): Bradley G. Stevens (Co-PI, UMES), Sook Chung (Co-PI, IMET)

LMRCSC Research Student(s): Stephanie Martinez-Rivera (PhD, UMES), Shadaesha Green (PhD, IMET).

Start Date: 1 Sept 2016

End Date: 26 March 2018

Scientific Merit: Preliminary results of this study suggest that deep-sea red crabs have a biennial reproductive cycle. Red crabs presented five ovarian developmental stages that were determined using histology. We estimated the size at 50% sexual maturity (SM50) using the ovary stages and gonopore data. Estimates of SM50 range between 64-72 mm in carapace length and were calculated by non-linear logistic regression, and variance was estimated by bootstrapping. Histology and Image j processing was finished for all sample collections. Preliminary estimates of size-specific fecundity range between 34,000 to 188,000 and were calculated by linear regression. Sample processing for fecundity will be finished in one month.

To elucidate the presence of putative reproductive regulators in adult female deep-sea red crabs, the CHH levels of females at different ovarian stages were estimated. The amounts of CHH 1 and 2 are found in the SG with a ratio of CHH1:CHH2 isoforms ranging from 1:4 in this species. To confirm the identity of these peptides a dot blot assay was conducted and revealed that all peaks were indeed CHH and MIH. Levels of the CHH protein present in the SG of adult females (ovarian stages 2 and 3) and adult males were as follows: CHH1 as a minor form were similar between females at both ovarian stages 2 and 3 (56.0 ± 2.9 pmol/SGE $n=6$, and 42.8 ± 2.8 pmol/SG, $n=3$, respectively) and males 50.6 ± 5.5 pmol/SGE ($n=11$). CHH2 (major form) content of males and females at stage 3 was similar (161.3 ± 20.1 pmol/SGE, $n=11$ and 174.0 ± 21.9 pmol/SGE, $n=3$, respectively). However, CHH2 differed significantly between that of males and females at ovarian stage 2 (161.3 ± 20.1 pmol/SGE, $n=11$ and 250.1 ± 24.9 pmol/SGE, $n=6$).

The full-length cDNA sequences of MIH and CHH were isolated using a degenerate PCR and 5' and 3' RACE cloning method. cDNAs were used to determine CHH expression in adult male and female red crabs of similar sizes. CHH expression levels were slightly higher in females (4.5×10^6 copies/ μ g eyestalk total RNA, $n=9$) than in males (4.0×10^6 copies/ μ g eyestalk total RNA, $n=9$). Analysis of transcriptome sequencing data revealed over 142 million reads. Processed reads were assembled, and a total of 50,088 contigs produced. This assembly will be used to map stage 1 and 3 samples to examine differential gene expression (DGE) of genes related reproduction. Selection of potential microsatellite markers is currently underway, with an additional 100 primer sets generated. Microsatellite markers (10-13) will be used to delineate the genetic distribution of the deep-sea red crab within the United States.

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

Martínez-Rivera, S., and B.G. Stevens. (2017, April). Reproductive biology of female red deep-sea crabs (*Chaceon quinquegens*) in the Mid-Atlantic Bight. American Fisheries Society: DelMarVa's Aquatic Resources & Ecosystems Research Symposium, Berlin, MD.

Relevance: This project is committed to NOAA's mission of providing scientific data to improve, supplement, and enhance management of deep-sea red crabs. In addition, given current uncertainties about red crab biology and their potentially low productivity and longevity, the data collected may help prevent long term ecosystem damage. This project will collect the critical information that was identified by the NOAA Red Crab Working Group. Understanding the fecundity, size at maturity, and spawning frequency will allow for more accurate estimates of spawning stock reproductive potential. Estimates of size at maturity are necessary to set appropriate fishing mortality levels, and prevent recruitment overfishing. Development and expansion of the fishery including new markets and product forms will be difficult without the information we propose to collect. Although our research takes place primarily in the Mid-Atlantic Bight, interpretation of crab reproductive patterns relative to temperature and depth will have implications for other deep-sea crab fisheries including those of Alaskan king and snow crabs. Results will help define management strategies for crabs with multi-year reproductive cycles in other parts of the world.

Broader Impacts: The results of this research will form part of the PhD dissertations for graduate students Stephanie Martinez-Rivera, and Shadaesha Green. Both students have spent time aboard NOAA research vessels and commercial fishing vessels. Both students have completed their comprehensive exams, and have matriculated to the status of PhD Candidacy in 2017. Our work will help create direct interactions between students, scientists, and fishermen that will benefit all by enabling better understanding of goals, perceptions, and needs for red crab management.

Project Number: 17-04

Project Title: Examining stock structure of common bottlenose dolphins (*Tursiops truncatus*) through photo-identification and genetic analyses

Project Abstract: Cetaceans range over large distances resulting in complex patterns of population structure. The coastal ecotype of common bottlenose dolphin (*Tursiops truncatus*) populations usually consists of distinct groups that exhibit localized adaptations on small spatial scales that result in fine-scale genetic structuring. The purpose of this study was to couple long-term photo-identification data with genetics to examine stock structure of common bottlenose dolphins in the estuarine waters around Savannah, GA. The study area was categorized into three segments: a) a northern region, b) a buffer region, and c) a southern region. Remote biopsy sampling was conducted in September 2015 and February and March 2017. Nucleotide and haplotype frequency was estimated from the sample population based on sample location and long term sighting data. Haplotype diversity (Fst) was found to be significantly different between the northern region and buffer region and between the northern and southern region with the addition of photo-ID data ($p=0.0018$ and $p=0.016$) but not between the buffer and southern region. Nucleotide diversity (Φst) was not significantly different in any of the pairwise comparisons. With the addition of sighting history data, the results showed stronger subdivision between populations. The addition of supplemental data, such as photo-ID to a genetic analysis, may provide a closer look at stock structure. Methods used in this study could be utilized by future studies to improve understanding of the complex stock structure of common bottlenose dolphins in coastal waters.

Thematic Area Addressed: Assessment

Lead Scientist(s): Tara Cox (Savannah State University)

NOAA Collaborator(s): Patricia Rosel (NOAA/NMFS)

LMRCSC Collaborator(s): Joseph Pitula (University of Maryland, Eastern Shore)

LMRCSC Research Student(s): Emily Griffin (MS, Savannah State University) Debra Baskerville (UG, University of Maryland, Eastern Shore)

Start Date: 1 January 2017

End Date: 3 May 2018

Scientific Merit: As of mid-March 2018, we have used photo-identification (Photo-ID) data to examine stock structure of the Northern Georgia/Southern South Carolina Estuarine System (NGSSCES) stock of common bottlenose dolphins (*Tursiops truncatus*). Emily Griffin, our MS LMRCSC research student conducted remote biopsy sampling in the estuarine waters of Savannah, Georgia in February and March 2017. Photo-ID data were collected from the Savannah area between April 2009 and June 2015. The sighting history collected through photo-ID was used in conjunction with genetic data to examine stock structure. Remote biopsy samples were collected and taken to the National Marine Fisheries Service laboratory by Emily Griffin for genetic analyses. Emily Griffin worked with Dr. Rosel in extracting DNA, sequencing DNA, determining haplotypes, and identifying sex of individual common bottlenose dolphins. Genetic differences between locations within the Savannah study area were examined using ARLEQUIN 3.5. Our work suggests that the addition of photo-ID can aid genetics in identifying differences within a population. The combination of methods such as photo-ID and genetics are necessary for the proper management of marine mammal stocks.

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

Griffin, E., R. Perrtree, D. Hardwick, A.M. Gorgone, A.A. Hohn, and T. Cox. 2016. Understanding movement of common bottlenose dolphins in the Northern/Georgia Southern South Carolina Estuarine System. Southeast and Mid-Atlantic Marine Mammal Symposium, Savannah, GA. April 2, 2016. Poster

Griffin, E., Z. Wong, R. Perrtree, and T. Cox. 2017. Evaluation of the Northern Georgia/Southern South Carolina Estuarine System stock of common bottlenose dolphins (*Tursiops truncatus*) in the waters around Savannah, GA. Savannah State University 7th Annual Research Conference, Savannah, GA. April 11, 2017. Poster.

Griffin, E., Z. Wong, R. Pertree, B. Balmer, P. Rosel, and T. Cox. 2017. Evaluation of the Northern Georgia/Southern South Carolina Estuarine System stock of common bottlenose dolphins (*Tursiops truncatus*) in the waters around Savannah, GA. Southeast and Mid-Atlantic Marine Mammal Symposium, Beaufort, NC. April 8, 2017. Oral.

Griffin, E., Z. Wong, R. Pertree, B. Balmer, P. Rosel, and T. Cox. 2017. Using photo-identification and genetic data to identify fine-scale stock structure. Society for Marine Mammalogy 22nd Biennial Conference, Halifax, NS. October 24, 2017. Poster.

Griffin, E., Z. Wong, R. Pertree, B. Balmer, P. Rosel, and T. Cox. 2017. Using photo-identification and genetic data to identify fine-scale stock structure. Savannah GIS Day, Savannah, GA. November 15, 2017. Poster.

Griffin, E., R. Perrtree, B. Balmer, P. Rosel, and T. Cox. 2018. Using photo-identification and genetic data to identify fine-scale stock structure. Southeast and Mid-Atlantic Marine Mammal Symposium, Conway, SC. March 23, 2018. Oral.

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 re-examining the southern stock boundary of the NGSSCES stock of common bottlenose dolphins. Thus, this research will contribute to the Southeast Fisheries Science Center's efforts to "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." 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. Both the Northern Georgia/Southern South Carolina Estuarine System Stock and the Central Georgia Estuarine System Stock are considered strategic stocks under the Marine Mammal Protection Act.

Broader Impacts: This project provided opportunities for both graduate (Griffin) and

undergraduate (Baskerville) students to participate in collaborative research, working with NOAA mentors and SSU faculty and researchers. Griffin's analyses combining both long-term habitat use and genetics are the basis of her Master's thesis in Marine Sciences at Savannah State University, which she will defend on April 11, 2018, with an anticipated graduation in May 2018. Griffin then intends to continue on to a Ph.D. program in marine science. This opportunity was Baskerville's first exposure to research, especially field research. Although she is planning to attend dental school, not graduate work in marine sciences, her exposure to marine science at SSU has broadened her exposure to and awareness of marine life and conservation issues.

Project Number: 17-06

Project Title: Ecosystem impact of a harmful algal bloom species (*Dinophysis acuminata*) on aquaculture shellfish

Project Abstract: Land development within the Maryland Coastal Bay watershed induces a suite of environmental stressors that negatively impact aquatic animal health, such as eutrophication leading to the development of harmful algal blooms (HABs). The proposed study seeks to monitor an ongoing bloom event, which has led to increased numbers of the potential toxin-producing species *Dinophysis acuminata*. The impact of this organism on animals within the MCB remains undetermined. It is vital to understand its impact on resident shellfish that act as the primary filter feeders during bloom events, as these species will serve as the first level of bioaccumulation of toxin in the food chain. Indirectly, reduced fitness in these organisms may also lead to reduced ability to clear blooms during HAB events.

Thematic Area Addressed: Safe Seafood and Aquaculture

Lead Scientist(s): Joe Pitula, UMES

NOAA Collaborator(s): John Jacobs, NOAA Cooperative Oxford Laboratory

LMRCSC Collaborator(s): Gulnihal Ozbay, DSU

LMRCSC Research Student(s): Detbra Rosales (PhD, UMES)

Start Date: 1 Sept 2016

End Date: 31 August 2017

Scientific Merit: The presence of *V. parahaemolyticus* and several harmful algal bloom (HAB) species causes concerns for the proposed aquaculture sites due to environmental and human health risks associated with these organisms. We are examining the 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 and PCR-based screening methodologies, we are comparing the HAB and bacteria communities residing inside the oyster, *Crassostrea virginica*, to environmental water samples. A number of HAB species, such as *Karlodinium veneficum*, *Dinophysis spp.*, *Heterosigma akashiwo* and *Chattonella subsalsa*, were found in the Delaware Inland Bays (DIBs) during year one of the study. *V. parahaemolyticus* was detected both in the water samples and *C. virginica* gut content samples. We will present data on HAB and pathogenic bacteria species from both water and oyster samples that analyzes potential human health risks at the proposed DIB oyster aquaculture sites.

Products: Detbra presented her work at the 2017 Harmful Algal Bloom Symposium in Baltimore, MD in November:

D. Rosales and J. Pitula, "Detection of *Vibrio Parahaemolyticus* and Harmful Algal Species in *Crassostrea Virginica* In The Delaware Inland Bays"

She also will be presenting her work at the 2018 Atlantic Estuarine Research Symposium Meeting in Rehoboth Beach: "Assessing the impacts of harmful algal species and *Vibrio spp.* on aquaculture in the Delaware Inland Bays"

Relevance: This proposal addresses multiple objectives within NOAA's Next Generation Strategic

Plan, including the need for developing sustainable aquaculture. This effort also contributes actions in direct support of guidelines of the President's Chesapeake Bay Executive Order²⁶ which calls for NOAA to use sound ecosystem science to protect habitat and produce science that informs the management process. In addition, this project promotes the development of rapid and informative bioindicators of ecosystem health. The results from this study will be reported to NOAA, published in a peer-reviewed journal and presented at scientific conferences.

Broader Impacts: This study will be used to develop the PhD degree requirements for Detbra Rosales. By its nature, it also will initiate many future graduate student projects, as ultimately long-term monitoring and ecosystem models will need to be generated. This project will provide students with in-depth training in multiple facets of traditional fisheries science along with hands-on training in biomolecular techniques and ecological examinations. The student will receive direct training from both NOAA and DNR scientists during the course of this study, which includes a NERTO fellowship that she is currently performing under the supervision of Dr. John Jacobs at the NOAA Cooperative Oxford Laboratory.

Project Number: 17-07

Project Title: Migration and foraging ecology of at-risk species: Columbia River Chinook salmon and Atlantic weakfish

Project Abstract: Quantifying habitat use for migratory fish is challenging yet important for the development of sound management and recovery plans. Given that migratory fish are highly mobile and often have short, habitat-specific residence times, research approaches that can shed light on diet, growth, or condition during migration continue to be developed and refined. Longitudinal studies, or those that follow specific cohorts of fish during their migration, can quantify spatial variation in foraging, growth, and sometimes mortality, thus providing information on habitat use. Interior Columbia River Chinook salmon (*Oncorhynchus tshawytscha*) and Weakfish (*Cynoscion regalis*) are two migratory species of concern. Interior Columbia River Chinook salmon have been listed under the Endangered Species Act since 2005, and habitat restoration within the lower Columbia River and Estuary is a key element of their recovery plan. The Atlantic weakfish stock has been depleted since around 2002, and recent assessments indicated that natural mortality may be the cause for the stock's inability to rebound despite fishing mortality decreases since 2011. Therefore, we implemented a longitudinal study design to quantify foraging and growth using traditional diet, stable isotope, and otolith chemical analyses during migration for these two, commercially important migratory species.

Thematic Area Addressed: Healthy Habitats

Lead Scientist(s): Jessica Miller, OSU

NOAA Collaborator(s): Laurie Weitkamp, OSU

LMRCSC Collaborator(s): Stacy Smith DSU

LMRCSC Research Student(s): Angelica Munguia (MS, OSU); Brian Galvez (MS, DSU); Sawyer Finley, NSF REU Summer student at OSU (leveraged)

Start Date: 1 Sept 2016

End Date: 31 December 2017

Scientific Merit: Fish, primarily young-of-the-year, were collected along the estuarine gradient, including the lower Columbia River and estuary from the head of tide to the mouth of the estuary and the upper, middle, and lower portions of Delaware Bay to better understand food web support during migration. For the lower Columbia River, we focused on Chinook salmon and used genetic stock identification to identify the stock group of greatest management concern (Snake River spring/summer Chinook salmon). Diet analyses of yearling salmon were combined with stable isotope analysis ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) of tissues with different turnover rates, including muscle (weeks to a month) and fin (7-10 d). The goals were to evaluate the spatial and temporal variation in food

web support and determine the relative importance of wetland habitats, which have been the focus of extensive restoration efforts, in supporting yearling migrants. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of dominant prey (*Americorophium* and Dipterans) from the juvenile salmon diets were also measured along the estuarine gradient to evaluate spatial variation in food web support. Otolith structural and chemical analyses provided estimates of residence time and growth rates during migration. Stable isotope data for Chinook salmon and their prey indicate a clear shift in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in yearlings as they migrate through the lower river and estuary, supporting the hypothesis that rapidly migrating individuals do feed and reside in these habitats long enough to alter their carbon and nitrogen isotopic composition. Diet analyses indicate that insects, primarily from marshes, comprised 25% to 60% of the diet during migration, providing a direct link with the estuarine habitat restoration efforts. For Weakfish, collections along the estuarine gradient were used to quantify carbon sources supporting the fish and the trophic levels of fish and their prey (e.g., anchovy, mysid shrimp, gammarid amphipods and isopods) as they migrate. Weakfish have been collected from the upper, middle, and lower portions of Delaware Bay, including 12 trawl stations in the western Delaware Bay and 11 stations from the eastern Delaware Bay. For Weakfish, smaller individuals (<60 mm) were depleted in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ compared to larger individuals (>60 mm). Most of the weakfish collected in the Delaware Bay are less than age 3. Weakfish diets were analyzed using frequency of occurrence (%F). Stomach contents were compared between size classes: small (<60 mm), medium (61-100 mm), large (101-138 mm) and adults (> 138 mm) and by bay location and season (lower, middle and upper). The dominant prey item among all size classes was the mysid shrimp despite past studies indicating adult fish switch to a diet of small fish. Eighty percent of the adult stomachs sampled contained mysids, whereas only 18% had small identifiable fish in their guts. Seasonally, weakfish fed on mysids in spring and autumn in all bay locations; however, gammarid amphipods and small fish occurred more frequently in weakfish stomachs in mid-summer in the middle bay. The most 'nutritious' food for juvenile weakfish is mysid shrimp.

Products:

- *Munguia, A., Miller, J. A, and Weitkamp, L. A. 2017. Feeding ecology of juvenile Chinook salmon through the lower Columbia River and estuary. Oral Presentation at Lower Columbia River Partnership Workshop, Portland, OR
- *Munguia, A., Miller, J. A, and Weitkamp, L. A. 2017. Characterizing feeding ecology and food web linkages of yearling Chinook salmon in the lower Columbia River and estuary. Poster Presentation at Salmon Ocean Ecology Meeting, Seattle, WA
- *Munguia, A., Miller, J. A., Weitkamp, L. A. and Van Doornik, D. 2017. Potential indicators of habitat use: diet and stable isotope composition during juvenile salmonid emigration. Poster presentation at the Coastal and Estuarine Research Federation, Providence, RI.
- *Munguia, A., Miller, J. A., Weitkamp, L. A. and Van Doornik, D. 2017. Making Connections to Habitats: feeding ecology of juvenile Chinook salmon during emigration. Salmon Ocean Ecology Meeting. Newport, OR
- *Munguia, A., Miller, J. A., Weitkamp, L. A. and Van Doornik, D. 2018. Making Connections to Habitats: feeding ecology of juvenile Chinook salmon during emigration. LMRCSC Student Seminar Series.
- *Galvez, B., Neilan, B., Ozbay, G., Smith, S. 2017. Stable Isotope Ratios of Weakfish from the Eastern Delaware Bay – Preliminary Data. April 2017. UMES AFS Student Subunit Meeting, Berlin, MD.
- *Galvez, B., Neilan, B., Greco, M., Oliver, D.*, Ozbay, G., Smith, S. 2017. Stable Isotope Analysis of Juvenile Weakfish (*Cynoscion regalis*) from the Delaware Bay. Poster Presentation at the Mid-Atlantic Chapter of the American Fisheries Society Meeting, Dover, DE

*Galvez, B., Smith, S. 2017. Diet examination of weakfish (*Cynoscion regalis*) from the Delaware Bay using stomach content and stable isotope analysis. Oral Presentation as part of the LMRCS Webinars Series

Galvez, B., Oliver, D., Neilan, B., Greco, M., Ozbay, G., Smith, S. 2018. Estimating Diet of Juvenile Weakfish (*Cynoscion regalis*) from the Delaware Bay Using Stable Isotope Analysis. Poster Presentation at the Ocean Sciences Meeting, Portland, OR

Relevance: Recovery plans rely on understanding of the factors limiting population growth. For migratory coastal species, such as Chinook salmon and Weakfish, a more complete understanding of foraging and growth during their migration contributes to: 1) evaluations of habitat restoration efforts; 2) determination of factors influencing mortality, i.e., low prey quality; and 3) identification of habitat areas with relatively high (or low) foraging and growth potential. For Chinook salmon, this research addresses information needs identified in NOAA's Biological Opinion and will provide information relevant to the conservation and management of ESA-listed, federally managed Chinook salmon populations. For Weakfish, this research aligns with Atlantic States Marine Fisheries Commission (ASMFC) goal to conduct new biological studies monitoring diets spatially, "particularly in estuaries". The ASMFC receives most of its federal funding from NOAA fisheries to carry out the Atlantic Coastal Fisheries Management Act.

Broader Impacts: NOAA LMRCS student education and research goals met include the following: undergraduate and graduate student research is preparing future workforce for marine and fisheries sciences, and linking student to professional networks and employment opportunities in marine and fisheries sciences (Delaware Department of Natural Resources and Environmental Control, New Jersey Department of Environmental Protection, NOAA Oxford Lab, MD and NWFSC's Hammond Lab, OR), and fostering collaborative research (DU and OSU). Angie Munguia also gained valuable mentoring experience serving as a mentor to summer NSF REU intern Sawyer Finley in 2017. Brian Galvez gained mentoring experience working with DSU undergraduate Diondre Oliver.

Project Number: 17-08

Project Title: Comparing the diet and microbiome of Atlantic menhaden and Eastern oyster using DNA barcoding

Project Abstract: Atlantic menhaden (*Brevortia tyrannus*) and Eastern oysters (*Crassostrea virginica*) diets derive from filtration of the water columns, consuming planktonic organisms. Both are very powerful filtering organisms however, exactly what items are being filtered still remains largely unknown. This comparison will help to assign trophic levels and develop more accurate food web models and assess ecosystem health. Overall these stomach contents could reflect the ability for each organism to function as an environmental sampler. Identification of stomach contents is difficult due to items being largely unrecognizable by conventional methods, therefore contents will be investigated using primers that target the hypervariable regions of the 16S and 18S ribosomal DNA (rDNA) using Illumina's MiSeq high-throughput sequencing technology. To our knowledge this has yet to be done between two filtering species. The results from this study could help to restore the Choptank River, a large tributary of the Chesapeake Bay, which is a project focus of the NOAA-Cooperative Oxford Lab and also help train minority students in the field of marine biology.

Thematic Area Addressed: Quantitative Fisheries & Healthy Habitat

Lead Scientist(s): Ammar Hanif, UMCES-IMET

NOAA Collaborator(s): Dr. John Jacobs (NOAA-COL, Oxford, MD)

LMRCSC Collaborator(s): Dr. Bradley Stevens, UMES

LMRCSC Research Student(s): Ammar Hanif, MS; Malisa Smith (UG), UMES

Start Date: 1 Sept 2016

End Date: 31 December 2017

Scientific Merit: Due to not being able to collect menhaden in the Choptank during the designated collection times, the initial scope of the project was amended to include the assessment of the microbial community in the Tred Avon, a tributary of the Choptank River. The goal of this project is to assess the microbial community of water samples collected from 8 sites in the Tred Avon tributary on two different dates. This information will support the Ecological Assessment project in the Tred Avon River being conducted as part of NOAA's efforts in the Choptank Habitat Focus Area. The overall microbial community will be assessed looking at the bacterial and eukaryotic groups that are in the tributary. Furthermore we will assess the bacterial community at the sites for relative abundance of dominant taxa as well as various marine pathogens of interest such as *Vibrio* spp., *Enterococcus* spp., *Legionella* spp., *Mycobacterium* spp., *Escherichia* spp., *Giardia* spp., and *Cryptosporidium* spp. Existing data from the HFA project on total bacterial abundance, salinity, water temperature, and nutrient levels will be compared to the microbial community data to test for trends in dominant species as well as specific pathogens. To date we have successfully extracted DNA, submitted and received high-throughput data from the 8 samples. All sites produced high quality reads and are in the process of being analyzed.

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

Relevance: The Choptank River is one of the largest tributaries of the Chesapeake Bay. It is also the focus of a large restoration project closely monitored by NOAA-Cooperative Oxford Lab. One focus of this restoration is to increase water clarity by the establishment of oyster reefs. Atlantic menhaden also occupy this tributary as it facilitates an important nursery. Though Atlantic menhaden stocks aren't federally managed, many of the fish that rely on menhaden as a primary food source are. Collectively oysters and menhaden help to filter the water of the overgrowth of phytoplankton due to eutrophication. Our findings will help provide a better understanding of food web dynamics in the Chesapeake Bay and the gut contents of menhaden and oysters could be used in ecosystem health assessments serving to improve ecosystem based management policies.

Broader Impacts: The project also affords student involvement and training: the training of both a minority undergraduate and minority graduate student, Ammar Hanif, whose ambition is to become a NOAA scientist. The UMES undergraduate student worked at UMCES-IMET as part of the LMRCSC-IMET summer intern program and participated in this project by PCR verification of the results found by the MiSeq high throughput sequencing, acquiring skills in handling DNA, PCR, gel electrophoresis. These training accomplishments reflect NOAA's emphasis on human capital, training, education, and future recruitment to NOAA. Dr. Pitula and Mr. Hanif will organize a half-day workshop at UMES on potentially useful applications of DNA barcoding to wider questions in marine systems and the ability of this technique to augment traditional analyses of both benthic and planktonic organisms. This workshop will be available by videoconferencing to other LMRCSC and CSC partners.