

## Supplemental Text to the LMRCSC Semiannual Report

Text and tables are arranged using the same numbering system in the RPPR form:

### 25. What was accomplished under these goals?

#### a. Major Activities:

##### i. Education Activities:

**Student Recruitment Activities:** During this period, recruitment activities focused on recruiting qualified graduate students through an online recruitment webinar. Forty-nine (49) prospective students registered for the event. Attendees received an introduction to the LMRCSC through a video presentation followed by an opportunity to ask questions of LMRCSC Faculty and Staff. Additionally, we recruited undergraduate students from the pool of existing undergraduates at partner institutions and solicited applications to our leveraged training programs, which often feed into our undergraduate and graduate programs. A selection of activities that took place during this period include:

**HU:** Due to COVID restrictions, no students were on campus during this period, therefore, we reached out to individual students with the required GPA.

**OSU:** Interviews and discussions with potential NOAA Mentors occurred during this period.

**RSMAS:** We are currently seeking an M.S. student.

**SSU:** Hosted four campus visits and guest visits to lab meetings and participated in Virtual Open Campus Day

**UMES:** Solicited applications from undergraduate students to the Geoscience Bridge Program and Rising Sophomore Experiential Training Program. Both programs are currently projected to be held in person, but are preparing to shift to an online format if conditions and university policy requires it.

**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. During this period, most facilities were closed due to COVID-19. Several NERTO internships were conducted remotely with the assistance of the students' NOAA mentors. We are currently recruiting for the Rising Sophomore Experiential Training Program for summer 2021. Current guidance from the university is to prepare for an in-person program, but we are also making contingency plans for a virtual program if conditions change.

- ii. Research Activities – In 2020-2021, 15 active TAB projects were investigated by students and scientists at LMRCSC partner institutions. Two of these began in 2018, two in 2019, and 10 in 2020. Ten new projects were proposed and funded in Fall 2020. The following table describes only those projects that were active in the last year.

**Table 25.1: TAB Projects During this Reporting Period\***

<b>Project Number</b>	<b>Principal Investigator</b>	<b>Title</b>	<b>Thematic Research Area</b>
<b>18-01</b>	Brittany King	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	FESS
<b>18-08</b>	Eric Alexander Lewallen	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys	SASI
<b>19-04</b>	David Secor	Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts	SASI
<b>19-06</b>	Hillary Thalmann	Thermal impacts on juvenile Pacific Cod ( <i>Gadus macrocephalus</i> ) foraging and growth in Gulf of Alaska nursery habitats	CLIME
<b>20-01</b>	Savannah M. Geiger	An analysis of distribution and abundance of microplastics in selected commercially important species in Northern Georgia coastal waters	HaBS
<b>20-02</b>	Sierra Hildebrandt	Investigating the Impacts of Adult-Oyster-Conditioned-Water on <i>Crassostrea virginica</i> Larval Setting Efficiency Utilizing Direct Setting in the Hampton River, Virginia	HaBS
<b>20-03</b>	Kyarii Ramarui	Proteomic analysis of two <i>Haematococcus pluvialis</i> strains as aquaculture feedstock	SNAP
<b>20-04</b>	Eric Schott	Life history and disease ecology of the blue crab, a key benthic-pelagic link in tropical and temperate American estuaries	SASI
<b>20-05</b>	Matt Kenworthy	Evaluating the effects of landscape scale habitat variability on white shrimp ( <i>Litopenaeus setiferus</i> ) population dynamics in Georgia estuaries	HaBS
<b>20-06</b>	Janelle Layton	Investigating the effects of climate change on heat shock proteins and development in the early life history stages of Nassau grouper	CLIME
<b>20-07</b>	Dennis McIntosh	Assessment of New Technologies for Post-Harvest Oyster Purification	SNAP
<b>20-08</b>	Shanelle Haughton	Evaluating physiological and immune responses of snow crabs ( <i>Chionoecetes</i> sp.) to <i>Hematodinium</i> infection	SASI

<b>20-09</b>	Victoria Williams	Understanding Adaptive Capacity: An Analysis of Community Perceptions and Policy Responses to Ocean Acidification and other marine stressors on the West Coast	CLIME
<b>20-10</b>	Imani Wilburn	The Occurrence of Microplastics in Maryland Coastal Bay Fishes	HaBS

\*Only currently active projects are included. CLIME: Climate Impacts on Marine Ecosystems; HaBS: Habitats and Biological Systems; SASI: Stock Assessment Support and Information; SNAP: Seafood, Nutrition, Aquaculture, and Pathology; FESS: Fishery Economics and Social Sciences

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 funding agencies.

**Data Management and QA/QC:** The Data Management course was offered in Fall 2020. Twelve (12) students enrolled in it.

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

All center students are required at a minimum to complete online CITI Responsible Conduct of Research courses. The certificate of completion is submitted with the Student Development Form. In addition, graduate students at RSMAS, UMES, and UMCES are required to take a course in scientific ethics.

iii. Administrative activities:

1. The Center conducted its monthly Executive Committee, Education Committee, and Science Committee meetings.
2. The Center participated in and responded to the Independent External Review, and submitted the response to NOAA EPP.
3. The Center is organizing its annual science meeting in collaboration with NOAA NEFSC to be held April 6-7, 2021.
4. It is also collaborating with NOAA NEFSC to develop and plan for a new summer internship program, named IN FISH that will be offered beginning in summer 2021

b. Specific Objectives

- i. **Education Goal 1.** Prepare the future workforce for marine and fisheries sciences
  1. Objective 1.1: Recruit students from under-represented groups into marine and fisheries science disciplines
  2. Objective 1.2: Increase retention and degree completion rates for students in marine and fisheries sciences programs
  3. Objective 1.3: Assess the value-added outcomes of degree programs in marine and fisheries sciences at the partner institutions
- ii. **Education Goal 2.** Strengthen collaborations across universities and professional networks to enhance academic programs in marine and fisheries sciences
  1. Objective 2.1: Use relevant research-based curricula to provide students with the highest quality education in marine and fisheries sciences

2. 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
  3. Objective 2.3: Ensure that curricula of degree programs at partner institutions address current challenges and emergent needs within the profession
  4. Objective 2.4: Link students to professional networks and employment opportunities in marine and fisheries sciences
- iii. **Scientific Research Goal 3.** Develop an exemplary capacity for scientific collaborations among partner institutions in the NOAA relevant fields of marine and fisheries sciences
1. 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
  2. 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
  3. 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
- iv. **Administration Goal 4.** Organizational excellence for effective and efficient management of the programs and activities of the Center
1. 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
  2. Objective 4.2: Monitor and ensure compliance with Center Award Conditions
- v. **Administration Goal 5.** Effectively communicate the activities and accomplishments of the center
1. Objective 5.1: Develop infrastructure for effective and efficient internal and external communication
  2. 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
- vi. **Administration Goal 6.** Assess and evaluate the center's goals and objectives
1. Objective 6.1: Assess and evaluate center educational programs
  2. Objective 6.2: Assess and evaluate center research
  3. Objective 6.3: Assess and evaluate center administration
- c. Significant results:
- i. Education goals:
    1. Students Recruited and trained: Twenty-five (25) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 13 B.S. Of these Cohort 1 students, eighteen (18) have graduated, including 4 Ph.D., 6 M.S., and 8 B.S.

students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 5 M.S., and 5 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty-two (22) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 7 M.S. and 11 B.S. students. Two students from Cohort 3 have graduated so far including 1 Ph.D. and 1 B.S. So far, sixteen (16) students including 3 Ph.D., 8 M.S., and 5 B.S. students have been recruited into Cohort 4. Eight (8) students have been recruited into Cohort 5 including 2 Ph.D., 1 M.S., and 5 B.S. students. Recruitment for this cohort is ongoing. A complete list of the students trained during this period and the financial support provided to them is available in Appendix I.

2. Fifty-four percent (54%) of those who received B.S. degrees have enrolled in graduate or professional schools. Two students completed their NERTO virtually during this reporting period. Two of the Center students received NSF Graduate Research Fellowships. One Center Ph.D. student received NOAA Sea Grant Knauss Fellowship, and the LMRCSC former Post-doctoral Fellow received a CINAR Fellowship that has enabled him to transition to a Research Assistant Professor at UMES. One recent LMRCSC Ph.D. recipient received an NSF CREST Post-doctoral fellowship
3. Recruitment of Rising Sophomores for Summer Experiential Training (RSET) at the LMRCSC: Consistent with our goal specified in the Implementation Plan, planning and recruitment took place during this period for the 2021 RSET interns. Selection of interns will take place during the beginning of the next reporting period. We are currently planning for an in-person internship experience at UMES, but we are also making contingency plans for a remote internship in the event that conditions or policies change.
4. Building a Strong Center Cohort Community:
  - a. Data Management course was taught in Fall 2020
  - b. Two installments of the Graduate Student Seminar Series took place during this period (November 2020 and February 2021). Planning is underway for additional seminars to be held during the next reporting period.
  - c. During this period of covid-19 pandemic, it became clear that an in-person Cohort Experience Workshop would not be possible in Spring 2021. The Education Committee has worked to create an asynchronous experience that is engaging for the students. This workshop will take place in the next reporting period.
  - d. Professional Development workshop was offered by Dr. Maggie Sexton biweekly for undergraduate students and monthly for graduate students during the academic year at UMES.
  - e. PIs at HU, OSU, SSU, and UMCES report holding regular lab meetings with Center students.
- ii. Research goals: 14 collaborative research projects (Table 25.1) were underway after selection for funding by the LMRCSC after reviews by the Technical Advisory Board (TAB). Reports on the TAB projects are included in Appendix II. Other research projects supported with leveraged funds

from agencies such as NOAA, NSF, USDA, are on-going at the LMRCS. A list of leveraged funds can be found in Appendix III.

- iii. Administrative goals:
  1. The Center held its monthly Executive Committee meetings during which plans to execute student development and professional activities were discussed.
  2. The Center held its annual Board of Visitors Meeting virtually using Google Meet on October 30, 2020.
  3. The LMRCS External Evaluators submitted to the Center their findings from assessment activities during this period. The report is available in Appendix IV.
- d. Key outcomes or other achievements:
  - i. A total of 95 students (25 in Cohort 1, 24 in Cohort 2, 22 in Cohort 3, 16 in Cohort 4, and 8 in Cohort 5) have been recruited to the Center
  - ii. One LMRCS received a Knauss Fellowship, and another Center graduate received an NSF CREST Post-doctoral Fellowship.
  - iii. A former LMRCS post-doctoral Research Associate received the Cooperative Institute for the North Atlantic Region (CINAR) Fellowship, which made it possible for him to transition to a Research Assistant Professor position in Fisheries Science at the LMRCS-UMES.
  - iv. External Evaluation of the LMRCS is continuing.
  - v. New proposals have been submitted to various agencies to leverage funding in order to support additional students.

## 26. What opportunities for training and professional development has the project provided?

The project has provided students several training and professional development opportunities including the cohort experience workshop, NERTO, and training in Ethical Conduct of Research and Data Management (Table 26.1, 26.2).

**Table 26.1:** Supported students, training opportunities and milestones.

First	Last	URM (y or n)	Cohort #	Degree	Partner	Cohort Experience	NERTO	Ethical Conduct of Research Training	Data Management Course	NOAA Mentor
Amanda	Pappas	N	1	M.S.	DSU	Spr 19	Fall 19	Fall 18	Fall 19	Y
Marcus	Teat	Y	2	B.S.	DSU	NA	NA	Fall 20	NA	NA
Caitlyn	Czajkowski	N	3	M.S.	DSU	Spr 21	TBD	Spr 21	TBD	TBD
Luis	Rodriguez-Sanoguet	Y	3	M.S.	DSU			Spr. 20		
Maria	Henson	Y	1	B.S.	HU	NA	NA	Spr. 21	Spr 21	NA
Sierra	Hildebrandt	N	2	M.S.	HU	Spr. 21	Sum 20	Spr. 20	Fall 19	Y
Josette	McLean	Y	2	M.S.	HU	Spr. 21	Sum 20	Spr. 20	Fall 19	Y
Amani	Tolin	Y	3	B.S.	HU	NA	NA	Spr. 20	Spr 21	NA
Arona	Bender	Y	3	M.S.	HU	Spr. 21	Sum 21	Spr. 20	Fall 20	Y

PaShun	Hawkins	Y	4	B.S.	HU	NA	NA	Spr. 21	Spr 21	NA
Jaelyn	Leslie	Y	4	M.S.	HU	Spr. 21	Sum 21	Fall 20	Fall 20	Y
Jonathan	Nash	Y	5	B.S.	HU	NA	NA	Spr. 21	Spr 21	NA
T'Kiyah	Reeves	Y	5	B.S.	HU	NA	NA	Spr. 21	Spr 21	NA
Derrick	Richardson	Y	5	B.S.	HU	NA	NA	Spr. 21	Spr 21	NA
Brittany	King	Y	2	Ph.D.	OSU	Mar-18	Fall 20	Spr. 19	Spr 20	Y
Keala	Pelekai	Y	3	M.S.	OSU	Apr-19	Fall 20	Fall 18	Fall 19	Y
Janelle	Layton	Y	4	M.S.	OSU	Apr-21	TBD	Fall 20	TBD	TBD
Victoria	Williams	Y	4	M.S.	OSU	Apr-21	Spr. 21	TBD	TBD	Y
Halie	O'Farrell	Y	1	Ph.D.	RSMAS	Spr 18	Sum 18	Fall 16	Fall 17	Y
Latreese	Denson	Y	2	Ph.D.	RSMAS	Spr 18	Sum 18	Fall 17	Fall 18	Y
Adrienne	Wilson	Y	2	Ph.D.	RSMAS	Spr 19	Fall 18	Fall 15	Fall 18	Y
Juan	Cervera	Y	3	M.S.	RSMAS	Spr 21	Sum 20	Fall 19	Fall 19	Y
Cristin	Mayes	Y	4	Ph.D.	RSMAS	NA	Sum 21	Fall 19	NA	Y
Chryston	Best-Otubu	Y	5	Ph.D.	RSMAS	Spr 21	Sum 21	Fall 20	Fall 20	Fall 21
Joe	Day	Y	2	B.S.	SSU	NA	NA	Spr. 20	NA	NA
Davielle	Drayton*	Y	2	M.S.	SSU	Sum 18	Fall 19	Sum.18	Fall 18	Y
Ambrose	Alexandria	Y	3	B.S.	SSU	NA	NA	Spr. 19	Spr. 16	NA
Mackey	Shaneese	Y	3	M.S.	SSU	Sum 19	Fall 18	Fall 19	Spr 19	Y
Chelsea	Spaulding	Y	4	B.S.	SSU	NA	NA	Spr. 21	Sum 20	NA
Savannah	Geiger	N	4	M.S.	SSU	Spr 21	Sum 21	Fall 20	Sum 19	Y
Sena	Tay	Y	4	M.S.	SSU	Spr 21	TBD	Spr. 21	Fall 21	NA
William	Burns	Y	5	B.S.	SSU	NA	NA	Spr. 21	NA	NA
Savannah	Clax	Y	5	B.S.	SSU	NA	NA	Spr. 21	NA	Y
Kristafer	Howard	Y	5	M.S.	SSU	Spr 21	Spr 21	Spr. 21	Fall 20	Y
Dante	Freeman	Y	2	B.S.	SSU	NA	Fall 18	NA	NA	NA
Erianna	Hammond	Y	2	B.S.	SSU	NA	Fall 18	NA	NA	NA
Michael	Williams	Y	2	B.S.	SSU	NA	Fall 18	NA	NA	NA
Shadaesha	Green	Y	1	Ph.D.	UMCES	Spr. 18	Sum 19	Fall 17	Fall 17	Y
Nicholas	Coleman	Y	2	M.S.	UMCES	TBD	TBD	TBD	Fall 21	Y
Benjamin	Frey	Y	3	M.S.	UMCES	Spr. 19	Spr. 19	Fall 19	Fall 19	Y
Kyarii	Ramarui	Y	4	Ph.D.	UMCES	Spr. 21	Spr. 21	Fall 19	Fall 20	Y
Olivia	Pares	Y	5	Ph.D.	UMCES	TBD	TBD	TBD	Fall 20	Y
Detbra	Rosales	Y	1	Ph.D.	UMES	Spr. 18	Sum. 18	Fall 15	Fall 17	Y
Kasondra	Rubalcava	Y	2	Ph.D.	UMES	Spr. 18	Sum. 19	Fall 19	Fall 19	Y
Teemer	Barry	Y	3	B.S.	UMES	N/A	N/A	Fall 18	Spr. 21	N/A
DaQuan	Davis	Y	3	B.S.	UMES	N/A	N/A	Sum. 18	Spr. 21	N/A
Semaj	Fielding	Y	3	B.S.	UMES	N/A	N/A	Spr. 21	Spr. 21	N/A
Tyler	Washington	Y	3	B.S.	UMES	N/A	N/A	Sum. 18	Spr. 21	N/A
Shanelle	Haughton	Y	3	Ph.D.	UMES	Spr. 19	Sum. 19	Fall 19	Fall 19	Y
Ashley	Silver	Y	3	Ph.D.	UMES	Spr. 21	Sum. 21	Fall 20	Fall 20	Y

Glen	Colins	Y	4	B.S.	UMES	N/A	N/A	Spr. 21	Spr. 21	N/A
Mya	Rufus	Y	4	B.S.	UMES	N/A	N/A	Sum. 18	Spr. 21	N/A
Shakira	Goffe	Y	4	M.S.	UMES	Spr. 21	Sum. 21	Fall 19	Fall 20	Y
Tahirah	Johnson	Y	4	M.S.	UMES	Spr. 21	Sum. 21	Spr. 21	Fall 20	Y
Imani	Wilburn	Y	4	M.S.	UMES	Spr. 21	Sum. 21	Spr. 20	Fall 20	Y
Jaymeelita	Colbert-Williams	Y		No Degree	UMES	N/A	N/A	N/A	N/A	N/A
Destiny	Coleman	Y		No Degree	UMES	N/A	N/A	N/A	N/A	N/A
Glen	Colins	Y		No Degree	UMES	N/A	N/A	N/A	N/A	N/A
Reem	Dafalla	Y		No Degree	UMES	N/A	N/A	N/A	N/A	N/A
Miyae	Felder	Y		No Degree	UMES	N/A	N/A	N/A	N/A	N/A
Nyla	Jeanpierre	Y		No Degree	UMES	N/A	N/A	N/A	N/A	N/A
Joel	Williams	Y		No Degree	UMES	N/A	N/A	N/A	N/A	N/A

Table 26.2: NERTO internships completed during this reporting period.

Student Name	Activity/Project Title	NOAA Personnel Involved	Location
Sierra Hildebrandt	Assessing the Effectiveness of utilizing Oyster Condition Water on the Direct Setting of Oyster Spat on Shell	Jason Spires and Shawn McLaughlin	Virtual
Juan Cervera	NERTO: Inland Essential Fishery Habitat Mapper Application	Jennifer Leo	Virtual, NOAA SEFSC Galveston

## 29. Publications, conference papers, and presentations

**Table 29.1:** LMRCSC Publications in peer reviewed journals. Center students are identified with asterisk (\*). Center scientists' names appear in bold.

Citation	Type
Cruz-Marrero* W, Harms-Tuohy CA, Appeldoorn RS, <b>Stevens BG</b> . 2020. Comparison of video camera sled with diver surveys for queen conch <i>Lobatus gigas</i> density estimates in the west coast of Puerto Rico. <i>Bulletin of Marine Science</i> . 96(4):641-654.	Direct
<b>Cullen DW</b> , Guida V. 2021. Use of geographically weighted regression to investigate spatial non-stationary environmental effects on the distributions of black sea bass ( <i>Centropristis striata</i> ) and scup ( <i>Stenotomus chrysops</i> ) in the Mid-Atlantic Bight, USA. <i>Fisheries Research</i> . 234.	Direct
Huang X, Green* S, <b>Chung JS</b> . 2021. The presence of an insulin-like peptide-binding protein (ILPBP) in the ovary and its involvement in the ovarian development of the red deep-sea crab, <i>Chaceon quinquegens</i> . <i>General and Comparative Endocrinology</i> . 301.	Direct, Cohort 1 Student
Ramirez* MD, Popovska T, <b>Babcock EA</b> . 2021. Global synthesis of sea turtle von Bertalanffy growth parameters through Bayesian hierarchical modeling. <i>Marine Ecology Progress Series</i> . 657:191-207.	Direct, Cohort 2 Student



Schweitzer* CC, <b>Horodysky AZ</b> , Price* AL, <b>Stevens BG</b> . 2020. Impairment indicators for predicting delayed mortality in black sea bass ( <i>Centropristis striata</i> ) discards within the commercial trap fishery. <i>Conservation Physiology</i> . 8.	Direct, Cohort 2 Student
Olsen* NA, <b>Stevens BG</b> . 2020. Size at maturity, shell conditions, and morphometric relationships of male and female Jonah crabs in the Middle Atlantic Bight. <i>North American Journal of Fisheries Management</i> . 40(6):1472-1485.	Direct, TAB
Aquino GAG, Cabaitan PC, <b>Secor DH</b> . 2021. Locomotor activity and growth response of glass eel <i>Anguilla marmorata</i> exposed to different salinity levels. <i>Fisheries Science</i> . 87(2):253-262.	Leveraged
Bangley CW, Curtis TH, <b>Secor DH</b> , Latour RJ, Ogburn MB. 2020. Identifying important juvenile dusky shark habitat in the northwest Atlantic Ocean using acoustic telemetry and spatial modeling. <i>Marine and Coastal Fisheries</i> . 12(5):348-363.	Leveraged
Cartolano MC, <b>Babcock EA</b> , McDonald MD. 2020. Evidence that gulf toadfish use pulsatile urea excretion to communicate social status. <i>Physiology &amp; Behavior</i> . 227.	Leveraged
<b>Chung JS</b> , Christie A, Flynn E. 2020. Molecular cloning of crustacean hyperglycemic hormone (CHH) family members (CHH, molt-inhibiting hormone and mandibular organ-inhibiting hormone) and their expression levels in the Jonah crab, <i>Cancer borealis</i> . <i>General and Comparative Endocrinology</i> . 295.	Leveraged
<b>Curran MC</b> , Robertson A. 2020. Chemistry made easy: Teaching students about the link between marine chemistry and coral reef biodiversity. <i>Current: The Journal of Marine Education</i> . p. 1-11.	Leveraged
<b>Curran MC</b> , Wiggins JJ, Wilber DH. Flatfish habitat use of a small southeastern US tidal creek: Long- and short-term occupancy patterns. <i>Estuaries and Coasts</i> .	Leveraged
Edge BO, <b>Chigbu P</b> . 2021. Carbon and nitrogen stable isotopes of copepods in a tidal estuarine system in Maryland, USA. <i>Regional Studies in Marine Science</i> . 42:101620.	Leveraged
Edge BO, <b>Ishaque AB</b> , <b>Chigbu P</b> . 2020. Spatial and temporal patterns of delta C-13 and delta N-15 of suspended particulate organic matter in Maryland Coastal Bays, USA. <i>Water</i> . 12(9).	Leveraged
Enchelmaier AC, <b>Babcock EA</b> , Hammerschlag N. 2020. Survey of fishes within a restored mangrove habitat of a subtropical bay. <i>Estuarine Coastal and Shelf Science</i> . 244.	Leveraged
Fandel AD, Garrod A, Hoover AL, Wingfield JE, Lyubchich V, <b>Secor DH</b> , Hodge KB, Rice AN, Bailey H. 2020. Effects of intense storm events on dolphin occurrence and foraging behavior. <i>Scientific Reports</i> . 10(1).	Leveraged
Fucich D, <b>Chen F</b> . 2020. Presence of toxin-antitoxin systems in picocyanobacteria and their ecological implications. <i>ISME Journal</i> . 14(11):2843-2850.	Leveraged
Fucich D, Xu Y, Sosa A, Jia Y, Zhang R, Jiao N, <b>Chen F</b> . 2021. Complete genome sequences of Chesapeake Bay	Leveraged

<i>Synechococcus</i> strains CBW1002 and CBW1006 isolated in winter. <i>Genome Biology and Evolution</i> . 13(2).	
Hutchison ZL, <b>Secor DH</b> , Gill AB. 2020. The interaction between resource species and electromagnetic fields associated with electricity production by offshore wind farms. <i>Oceanography</i> . 33(4):96-107.	Leveraged
Itakura H, O'Brien MHP, <b>Secor D</b> . 2021. Tracking oxy-thermal habitat compression encountered by Chesapeake Bay striped bass through acoustic telemetry. <i>ICES Journal of Marine Science</i> .	Leveraged
Jung H, Ventura T, <b>Chung JS</b> , Kim WJ, Nam BH, Kong HJ, Kim YO, Jeon MS, Eyun SI. 2020. Twelve quick steps for genome assembly and annotation in the classroom. <i>PLOS Computational Biology</i> . 16(11).	Leveraged
Kerr LA, Whitener ZT, Cadrin SX, Morse MR, <b>Secor DH</b> , Golet W. 2020. Mixed stock origin of Atlantic bluefin tuna in the us rod and reel fishery (Gulf of Maine) and implications for fisheries management. <i>Fisheries Research</i> . 224.	Leveraged
Lycett KA, Shields JD, Chung JS, <b>Pitula JS</b> . 2020. Population structure of the blue crab <i>Callinectes sapidus</i> in the Maryland Coastal Bays. <i>Journal of Shellfish Research</i> . 39(3):699-713.	Leveraged
O'Brien MHP, <b>Secor DH</b> . 2021. Influence of thermal stratification and storms on acoustic telemetry detection efficiency: A year-long test in the us southern Mid-Atlantic Bight. <i>Animal Biotelemetry</i> . 9(1):8.	Leveraged
<b>Parveen S</b> , Jacobs J, <b>Ozbay G</b> , Chintapenta LK, Almuhaideb E, Meredith J, Ossai S, Abbott A, Grant A, Brohawn K, <b>Chigbu P</b> , Richards GP. 2020. Seasonal and geographical differences in total and pathogenic <i>Vibrio parahaemolyticus</i> and <i>Vibrio vulnificus</i> levels in seawater and oysters from the Delaware and Chesapeake Bays determined using several methods. <i>Applied and Environmental Microbiology</i> . 86(23).	Leveraged
Redding SG, Cooper LW, Castonguay M, Wiernicki C, <b>Secor DH</b> . 2020. Northwest Atlantic mackerel population structure evaluated using otolith delta O-18 composition. <i>ICES Journal of Marine Science</i> . 77(7-8):2582-2589.	Leveraged
<b>Secor DH</b> , O'Brien MHP, Gahagan BI, Fox DA, Higgs AL, Best JE. 2020. Multiple spawning run contingents and population consequences in migratory striped bass <i>Morone saxatilis</i> . <i>PloS One</i> . 15(11).	Leveraged
Vinagre AS, Model JFA, Vogt EL, Manara LM, Trapp M, Da Silva RSM, <b>Chung JS</b> . 2020. Diet composition and long-term starvation do not affect crustacean hyperglycemic hormone (CHH) transcription in the burrowing crab <i>Neohelice granulata</i> (Dana, 1851). <i>Comparative Biochemistry and Physiology a-Molecular &amp; Integrative Physiology</i> . 247.	Leveraged
Wang HL, Bier R, Zgleszewski L, Peipoch M, Omondi E, Mukherjee A, <b>Chen F</b> , Zhang CL, Kan JJ. 2020. Distinct distribution of archaea from soil to freshwater to estuary:	Leveraged

Implications of archaeal composition and function in different environments. <i>Frontiers in Microbiology</i> . 11.	
Wiernicki CJ, Liang D, Bailey H, <b>Secor DH</b> . 2020. The effect of swim bladder presence and morphology on sound frequency detection for fishes. <i>Reviews in Fisheries Science &amp; Aquaculture</i> . 28(4):459-477.	Leveraged
Wiernicki CJ, O'Brien MHP, Zhang F, Lyubchich V, Li M, <b>Secor DH</b> . 2020. The recurring impact of storm disturbance on black sea bass ( <i>Centropristis striata</i> ) movement behaviors in the Mid-Atlantic Bight. <i>PLoS One</i> . 15(12).	Leveraged
Zhang ZF, Qin F, <b>Chen F</b> , Chu X, Luo HW, Zhang R, Du S, Tian Z, Zhao YL. 2021. Culturing novel and abundant pelagiphages in the ocean. <i>Environmental Microbiology</i> . 23(2):1145-1161.	Leveraged
Zhao M, Flowers EM, <b>Schott EJ</b> . 2021. Near-complete sequence of a highly divergent reovirus genome recovered from <i>Callinectes sapidus</i> . <i>Microbiology Resource Announcements</i> . 10(1):e01278-01220.	Leveraged
Zheng Q, Wang Y, Lu JY, Lin WX, <b>Chen F</b> , Jiao NZ. 2020. Metagenomic and metaproteomic insights into photoautotrophic and heterotrophic interactions in a <i>Synechococcus</i> culture. <i>Mbio</i> . 11(1).	Leveraged

**Table 29.2:** Publications that were in press or under review at the end of the reporting period. Center students are identified by asterisk (\*). Center scientists' names appear in bold.

Publications in Preparation	Justification	Status
Frischer, Marc. E. et al., <b>Gibson, D.M.</b> Selective feeding and linkages to the microbial food web by the Doliolid <i>Dolioletta gegenbauri</i> in the South Atlantic Bight. <i>Limnology and Oceanography</i> . Accepted	Leveraged	Accepted
Clementi, G.M., <b>E. A. Babcock</b> , J. Valentin-Albanese, M. E. Bond, K.I. Flowers, M. R. Heithaus, E. R. Whitman, M. P. M. Van Zinnicq Bergmann, T. L. Guttridge, O. R. O'Shea, O. N. Shipley, E. J. Brooks, S. T. Kessel, and D. D. Chapman. 2021. Anthropogenic pressures on reef-associated sharks in jurisdictions with and without directed shark fishing. <i>Marine Ecology Progress Series</i> 661:175-18. doi:10.3354/meps13607	Leveraged	In press
<b>Curran, M.C.</b> , A.L. Ramsey, and A.S. Bower. 2021. Learning about ocean currents one track at a time. <i>Science Activities</i> . DOI: 10.1080/00368121.2021.1885333	Leveraged	In press
Griffin*, E.K., P. E. Rosel, B. C. Balmer, R. M. Perrtree, and <b>T.M. Cox</b> . <i>In Press</i> . Using Photo-Identification and Genetic Data to Examine Fine-Scale Population Structure of Common Bottlenose Dolphins ( <i>Tursiops truncatus</i> ) in the Estuarine Waters Surrounding Savannah, Georgia. <i>Aquatic Mammals</i> .	Leveraged	In Press

Ali Pervaiz, Aamer Ali Shah, Fariha Hassan, Norbert Hertkorn, Michael Consior, <b>Feng Chen</b> . 2019. Production, optimization and partial characterization of exopolysaccharide extracted from psychrotrophic <i>Pseudomonas</i> sp. BGI-2 isolated from the ice of Batura glacier, Pakistan. <i>Frontiers in Microbiology</i> .		in press
<b>Secor, D.H.</b> , M.H.P. O'Brien, N. Coleman, A. Horne, I. Park, D.C. Kazyak, D.G. Bruce, C. Stence. Atlantic sturgeon status and movement ecology in an extremely small spawning habitat: The Nanticoke-Marshyhope Creek Estuary, Chesapeake Bay. <i>Reviews in Fisheries Science and Aquaculture</i> .	Leveraged	in review
Da Silva, L.V., Ossai, S., <b>Chigbu, P. &amp; Parveen, S.</b> (2021). Antimicrobial and genetic profiles of <i>Vibrio vulnificus</i> and <i>Vibrio parahaemolyticus</i> isolated from Maryland Coastal Bays, USA. <i>Frontiers of Microbiology</i> .	Leveraged; LMRCSC PI	Under review
Morales-Nunez, A. & <b>Chigbu, P.</b> (2021). <i>Carinacuma umesi</i> , a new cumacean genus and species (Crustacea: Peracarida: Bodotriidae) from shallow-waters of Maryland Coastal Bays, USA, Mid-Atlantic region. <i>PeerJ</i> .	Leveraged; LMRCSC PI	Under review

**Table 29.3:** Oral presentations at virtual professional meetings. Center students are identified by asterisk (\*). Center scientists' names appear in bold.

Oral Presentations at Professional Meetings	Justification
Arai, K., M. Castonguay, <b>D.H. Secor</b> . 2020. Decadal trends in stock mixing of Northwest Atlantic mackerel from otolith oxygen and carbon stable isotopes. American Fisheries Society Tidewater Chapter meeting. Zoom.	Leveraged
Dahlenburg, C., Alavi, M., Bachvaroff, T., Burkett, T., Frederick, A., Gash, L., Jaffe, M., Johnston, A., Khan, S., Lim, Y-B., Scheifele, L., Tefferri, S., Vonderhaar, M., <b>Schott, E.</b> 2020. Community science can help fill knowledge gaps about the ecology of urban estuaries. Maryland Water Monitoring Conference, December 4, 2020.	Leveraged
<b>Ebanks, S.</b> 2021. From Back Page to Reoccurring Theme: A Scientist's Systematic Approach to Elevating the Science. NRT Program on Climate Resilience, Auburn University. February 26, 2021.	Leveraged
<b>Ebanks, S.</b> 2021. The Next Generation of Geoscience Leaders: Strategies for Excellence in Diversity and Inclusion. Presented at the Pardee Symposium 27 Oct., 2020, 1:30–5:30 pm	Leveraged
<b>Eric Schott</b> . 2021. Community Science Census of Biodiversity in an Urban Estuary. Johns Hopkins University Whiting School of Engineering. Department of Environmental Health and Engineering. February 2, 2021.	
King, B*, Fonner, R. 2020. Ecological & Social Predictors of Salmon Habitat Restoration Effort in Puget Sound. LMRCSC Student Seminar Series. December, 2020 (Virtual Presentation)	Cohort 2 Student
King, B*, Fonner, R. 2020. Ecological & Social Predictors of Salmon Habitat Restoration Effort in Puget Sound. Puget Sound Partnership Social Science Advisory Committee Meeting. November, 2020 (Virtual Presentation)	Cohort 2 Student

King, B*, Fonner, R. (2020). Ecological & Social Predictors of Salmon Habitat Restoration Effort in Puget Sound. NOAA Northwest Fisheries Science Center Ecosystem Science Division Meeting. December, 2020 (Virtual Presentation)	Cohort 2 Student
<b>Pride, C.</b> Connecting HBCU Students and Coastal Communities to Georgia's Barrier Island. Geoheritage Distinguished Speaker Series (Invited). U.S. National Committee for Geoscience, Oct. 20, 2020.	Leveraged
<b>Secor, D.H.</b> 2020. Assessing migration "flyways" of migratory fishes in the MD Wind Energy Area. Electric Power Research Institute Sturgeon Interest Group. Zoom.	Leveraged

### 32. Other Products

**Table 32.1:** Book chapters produced by the Center during the current funding period. Center students are identified by asterisk (\*). Center scientists' names appear in bold.

Book Chapters	Justification
Cuker, B., <b>Gibson, D.</b> Preparing a Workforce for the New Blue Economy: Chapter "Building an inclusive and equitable new blue economy", Elsevier.	Leveraged
<b>Cuker, B.</b> , et al. Diet for a sustainable ecosystem: The science for recovering the health of the Chesapeake Bay and its People; Chapter The Chesapeake Bay Oyster: Cobblestone to Keystone Kimberly S. Reece, Eugene M. Burreson, Deidre M. Gibson, Sierra S. Hildebrandt, Ileana Fenwick Pages 127-153 Springer Nature.	Leveraged
<b>Hoskins-Brown.</b> Protein from Pluff Mud: Oysters, Shrimp and Crab. In: Social Roots: Reconnecting Low country Foodways with the Landscape (editor Sarah Ross) in review.	Leveraged
<b>Bonin, C.A.</b> The Genetic consequences of philopatry, dispersal and reproductive behaviors. In: Ethology and Behavioral Ecology of Otariids and the Odobenid. C. Campagna & R. Harcourt. Springer, 2020. ISBN 978-3-030-59183-0.	Leveraged

**Table 32.2:** Theses and Dissertations produced by Center students during the current reporting period.

Theses/Dissertations	Justification
O'Farrell*, Halie (2021). Modeling Shark Bycatch Mitigation Strategies in Longline Fisheries. Doctoral Dissertation. <a href="https://scholarship.miami.edu/esploro/outputs/doctoral/Modeling-Shark-Bycatch-Mitigation-Strategies-in-Longline-Fisheries/991031547888702976">https://scholarship.miami.edu/esploro/outputs/doctoral/Modeling-Shark-Bycatch-Mitigation-Strategies-in-Longline-Fisheries/991031547888702976</a>	LMRCSC Cohort 1 student
Pappas, Amanda (2020). Winter bloom dynamics and molecular analysis of benthic sediments for the toxic dinoflagellate, <i>Dinophysis acuminata</i> , at Torquay Canal, Rehoboth Bay, Delaware, USA (Master's thesis) Proquest	LMRCSC Cohort 1 student

**Table 32.3:** Other products.

Other Products	Justification
<a href="https://datadryad.org/stash/dataset/doi:10.5061/dryad.6hdr7sqxt">https://datadryad.org/stash/dataset/doi:10.5061/dryad.6hdr7sqxt</a> (Secor et al. 2020: Hudson River striped bass telemetry)	Leveraged
<a href="https://datadryad.org/stash/dataset/doi:10.5061/dryad.1zcrjdfnw">https://datadryad.org/stash/dataset/doi:10.5061/dryad.1zcrjdfnw</a> (Secor et al. 2020: Chesapeake Bay striped bass telemetry)	Leveraged
<a href="https://datadryad.org/stash/landing/show?id=doi%3A10.5061%2Fdryad.66t1g1jzz">https://datadryad.org/stash/landing/show?id=doi%3A10.5061%2Fdryad.66t1g1jzz</a> (Wiernicki et al. 2020: MD Wind Energy Area black sea bass telemetry and ocean modeling output)	Leveraged
<a href="https://datadryad.org/stash/dataset/doi:10.5061/dryad.6hdr7sqx3">https://datadryad.org/stash/dataset/doi:10.5061/dryad.6hdr7sqx3</a> (Rothermel et al. 2020: MD Wind Energy Area striped bass and Atlantic sturgeon telemetry data)	Leveraged
Sarah Fortner, Melisa Diaz, Sue Ebanks, Cynthia Fadem, Jennifer Latimer, Kim Landsbergen, Carmen Nezat, Kenneth Brown. 2020? The Metal Redlining Network: science, education, & advocacy. Earth & Space Science Open Archive	Leveraged
Amanda Pappas Blog for DNREC/Delaware Wetlands: <a href="https://wmap.blogs.delaware.gov/2020/09/17/dinophysis-acuminata-a-dinoflagellate-you-should-know/">https://wmap.blogs.delaware.gov/2020/09/17/dinophysis-acuminata-a-dinoflagellate-you-should-know/</a>	Cohort 1 Student

### 33. What individuals worked on this project?

Last name	First Name	Total number of months worked during this time period	Project Role	Contribution to project (briefly describe)	State, U.S. territory, and/or country of residence	Collaborated with individual in a foreign country	Country(ies) of foreign collaborator	Travelled to foreign country	if traveled to foreign country(ies), duration of stay
Smith	Stacy	6	PD/PI	Worked with students/did research	Delaware, USA	no		no	
Pappas	Amanda	6	Graduate Student (research assistant)	HAB research	Delaware, USA	no		no	
Czajkowski	Caitlyn	6	Graduate Student (research assistant)	Aquaculture research	Delaware, USA	no		no	
Rodriguez	Luis	6	Graduate Student (research assistant)	Protected species research	Delaware, USA	no		no	
Teat	Marcus	6	Undergraduate Student	Oyster aquaculture research	Delaware, USA	no		no	
Gibson	Deidre	6	PD/PI	Project director of the program and advised Sierra Hildebrand, Derrick Richardson, Jonathan Nash, and co-advised Amani Tolin	Virginia, USA	no		no	

Lewallen	Carolina	6	Faculty	Advised Arona Bender, Jaelyn Leslie, and co-advised Josette McLean	Virginia, USA	no		no	
Lewallen	Eric	6	Faculty	Advised Josette McLean	Virginia, USA	no		no	
Cuker	Benjamin	6	Faculty	Advised Amani Tolin	Virginia, USA	no		no	
Dash	Shawn	6	Faculty	Advised Amani Tolin	Virginia, USA	no		no	
Sharma	Indu	6	Faculty	Advised PaShun Hawkins and T'kiyah Reeves	Virginia, USA	no		no	
Horodysky	Andrij	2	Faculty	Advised Maria Henson	Virginia, USA	no		no	
Adebola	Tunde	2	Faculty	A research faculty working with graduate students on GIS training	Virginia, USA	no		no	
Hildebrandt	Sierra	6	Graduate Student (research assistant)	Conducted research	Virginia, USA	no		no	
McLean	Josette	6	Graduate Student (research assistant)	Conducted research	Virginia, USA	no		no	
Bender	Arona	6	Graduate Student (research assistant)	Conducted research	Virginia, USA	no		no	
Leslie	Jaelyn	6	Graduate Student (research assistant)	Conducted research	Virginia, USA	no		no	
Tolin	Amani	6	Undergraduate Student	Conducted research	Virginia, USA	no		no	
Hawkins	PaShun	6	Undergraduate Student	Conducted research	Virginia, USA	no		no	
Nash	Jonathan	2	Undergraduate Student	Conducted research	Virginia, USA	no		no	
Richardson	Derrick	2	Undergraduate Student	Conducted research	Virginia, USA	no		no	
Reeves	T'Kiyah	2	Undergraduate Student	Conducted research	Virginia, USA	no		no	
Henson	Maria	2	Undergraduate Student	Conducted research	Virginia, USA	no		no	
Miller	Jessica	40	PI	Project Director at OSU	Oregon, USA	no			
Pelekai	Keala	500	Graduate Student (research assistant)	Conducted research	Oregon, USA	no			
King	Brittany	500	Graduate Student (research assistant)	Conducted research	Oregon, USA	no			
Williams	Victoria	500	Graduate Student (research assistant)	Conducted research	Oregon, USA	no			
Layton	Janelle	500	Graduate Student (research assistant)	Conducted research	Oregon, USA	no			
Babcock	Elizabeth	0.6	PD/PI	Project Director at UM-RSMAS	Florida, USA	yes	Bahamas, Belize, Brazil, Canada, China, Columbia	no	NA

Die	David	0.3	Co PD/PI	Co PI for UM-RSMAS.	Florida, USA	yes	Spain, Australia, France, Canada, Brazil, Portugal	no	NA
O'Farrell	Halie	0	Graduate Student (research assistant)	Finished dissertation on shark bycatch in longline fisheries	Florida, USA	no			
Denson	LaTreese	0	Graduate Student (research assistant)	Finishing dissertation on environmental drivers of spatio-temporal patterns in king mackerel larvae	Florida, USA	no			
Wilson	Adrienne	0	Graduate Student (research assistant)	Working on dissertation on lane snapper age, growth and population structure.	Florida, USA	no			
Cervera	Juan	4.5	Graduate Student (research assistant)	Working on MS on the distribution of essential fish habitat.	Florida, USA	no			
Mayes	Cristin	6	Graduate Student (research assistant)	Working on dissertation on ecosystem modeling and climate change	Florida, USA	no			
Best-Otubu	Chryston	6	Graduate Student (research assistant)	Working on dissertation on ecosystem modeling in Biscayne Bay.	Florida, USA	no			
Geiger	Savannah	5.5	Graduate Student (research assistant)	Conducted research, and mentored 3 undergraduates on LMRCS work	Georgia, USA	no	n/a	no	n/a
Hoskins-Brown	Dionne	5.5	Co PD/PI	Supervised students and staff, wrote proposals, performed research	Georgia, USA	no	n/a	no	n/a
Mackey	Shaneese	5.5	Graduate Student (research assistant)	Took classes, performed fieldwork, pursued certifications	Georgia, USA	no	n/a	no	n/a
Howard	Kris	5.5	Graduate Student (research assistant)	Took classes, performed fieldwork, pursued certifications	Georgia, USA	no	n/a	no	n/a
Young	Victoria	5.5	Faculty	Supervised students and staff, wrote proposals, performed research	Georgia, USA	no	n/a	no	n/a
Kenworthy	Matt	5.5	Postdoctoral (scholar, fellow, or	Supervised students and staff, wrote	Georgia, USA	no	n/a	no	n/a



			other post-doctoral position)	proposals, performed research					
Spaulding	Chelsea	5.5	Undergraduate Student	Took classes, performed research	Georgia, USA	no	n/a	no	n/a
Clax	Savannah	5.5	Undergraduate Student	Took classes, performed research	Georgia, USA	no	n/a	no	n/a
Day	Joe	5.5	Undergraduate Student	Took classes, performed research	Georgia, USA	no	n/a	no	n/a
Hammond	Erianna	5.5	Undergraduate Student	Took classes, performed research	Georgia, USA	no	n/a	no	n/a
Burns	William	5.5	Undergraduate Student	Took classes, performed research	Georgia, USA	no	n/a	no	n/a
Tay	Sena	5.5	Graduate Student (research assistant)	Took classes, performed research	Georgia, USA	no	n/a	no	n/a
Jagus	Rosemary	1.5	PD/PI	Supervised students and staff, written proposals, performed research	Maryland, USA				
Coleman	Nicholas	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Frey	Ben	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Green	Shadaesh a	3	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Pares	Olivia	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Ramarui	Kyari	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Paulinus	Chigbu	3	PD/PI	Supervised center activities, written proposals, trained students	Maryland, USA				
Margaret	Sexton	6	Faculty	Supervised center activities, student dev. activities	Maryland, USA	no			
Bradley	Stevens	6	Faculty	Supervised center research activities, research, trained students	Maryland, USA				
Tanesha	Hankerson	4.5	Other Professional	Communications activities	Maryland, USA	no			
Alex	Kessie	6	Other Professional	Budget and data management	Maryland, USA	no			
Ida	Tilghman	6	Other Professional	Administrative activities	Maryland, USA	no			
Detbra	Rosales	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			

Kasondra	Rubalcava	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Teemer	Barry	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
DaQuan	Davis	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Semaj	Fielding	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Shanelle	Haughton	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Ashley	Silver	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Tyler	Washington	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Jaymeelita	Colbert-Williams	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Joel	Williams	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Destiny	Coleman	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Nyla	Jeanpierre	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Glen	Colins	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Miyae	Felder	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Reem	Dafalla	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Shakira	Goffe	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Tahirah	Johnson	6	Graduate Student (research assistant)	Conducted research	Maryland, USA	no			
Imani	Wilburn	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			
Mya	Rufus	6	Undergraduate Student	Participated in student dev. activities	Maryland, USA	no			

**34. Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?**

Table 34.1: Unchanged active other support of PD/PIs and senior/key personnel.

<b>PD/PI or key personnel name</b>	<b>Description of support</b>	<b>Source of Support</b>	<b>Description of change</b>
Babcock, Elizabeth	Global Shark Meat study	Shark Conservation Fund via Dalhousie University	ongoing
Dionne Hoskins, Victoria Young	NOSB competition	Ocean Leadership	ongoing
Eric Schott	Nauplii culture and in vivo challenge to assess the ability of bacterial probiotics to protect shrimp against the pathogen AHPND for Epicore Bionetworks, Inc.	Epicore Bionetworks	ongoing
Eric Schott	Determining how variation in life history & connectivity drive pathogen-host dynamics	NSF	ongoing
Eric Schott	Molecular screening for human pathogens in the Middle Branch, Baltimore's other waterfront	Jim and Patty Rouse Foundation	ongoing
Eric Schott	Expanding access to marine science for High School student in under-served communities with an Open House private tour	Jim and Patty Rouse Foundation	ongoing
Eric Schott	Support for underrepresented minorities to participate in the IMET Summer Internship	Venable Foundation	ongoing
Eric Schott	Of Animals and Microbes: A Baltimore Harbor Investigations	France Merrick	ongoing
Eric Schott	Molecular Screening for Microbes in Baltimore's Harbor 2019/2020	Waterfront Partnership	ongoing
Jessica Miller	1 month of salary, OPE and indirect	North Pacific Research Board grant	ongoing
Jessica Miller	1 month of salary, OPE and indirect	Bonneville Power Administration	ongoing
Matt Kenworthy, Dionne Hoskins-Brown	Coastal Incentive grant to test alternative biogenic material for oyster reef restoration	GA Dept. of Natural Resources	ongoing

Paulinus Chigbu, Margaret Sexton, Ali Ishaque, Salina Parveen, Meng Xia	CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics in the mid-Atlantic Region; 9/1/2016 to 8/31/2021; \$5,000,000. Funding is for research, capacity building and training of students.	NSF	ongoing
Paulinus Chigbu, Margaret Sexton	UMES Research Experience for Undergraduates in Marine and Estuarine Science; 3/1/18 to 4/31/2022; \$ 298,905	NSF	ongoing
Paulinus Chigbu	Student Airborne Science Activation for MSI (SaSa) for training students in remote sensing; Amount=\$158,335, 2021-2026.	NASA	ongoing
Rosemary Jagus	Funding supports IMET Summer Internship, 2021	Bunting Foundation	ongoing
Rosemary Jagus	Funding supports IMET Summer Internship, 2021	Anonymous Donor	ongoing

### 36. Have other collaborators or contacts been involved?

**Table 36.1:** NOAA scientists who have collaborated with the Center during this reporting period.

Last name	First name	Title/Affiliation	Description of involvement
Ailloud	Lisa	SEFSC	NOAA mentor for Cristin Mayes
Alade	Larry	NEFSC	Committee member, NERTO mentor
Allman	Robert	SEFSC	PhD committee member and NERTO mentor for Adrienne Wilson
Batchelor	Nate	SEFSC Beaufort	NERTO Mentor
Busch	Shallin	NWFSC	Committee member for Williams
Cortes	Enric	SEFSC	Ph.D. committee member and NERTO mentor for Halie O'Farrell
Deary	Alison	AFSC	Informal mentor for Hilary Thalmann
Deshpande	Ashok	NEFSC	Committee member
Doerr	Jennifer	SEFSC Galveston	Grant Collaborator
Dudley	Peter	SWFSC, Santa Cruz	Collaborator, future NERTO mentor
Fonner	Robby	NWFSC	NERTO mentor for Brittany King
Freidland	Kevin	Research Marine Scientist, NEFSC	Collaborator
Gerard	Trika	SEFSC Miami	Program Collaborator
Harvey	Chris	NWFSC	Committee member for Cohn

Hill	Ron	SEFSC Panama City	Committee member for Shaneese Mackey
Huff	David	NWFSC	NERTO mentor for Pelekai
Jacobs	John	Research Fisheries Biologist, NOS	Collaborator
Jenson	Pam	NWFSC	Committee member
Johnson	Matthew	SEFSC Galveston	Grant Collaborator
Johnson	Ed	Physical Scientist	NERTO mentor
Krause	Douglas	SWFSC	NERTO mentor for Arona Bender and Jaelyn Leslie
Laurel	Ben	AFSC	Committee member for Hilary Thalmann
Leo	Jennifer	SEFSC Galveston	Grant Collaborator, NERTO mentor
Lindley	Steve	SWFSC, Santa Cruz	Collaborator
McElhany	Paul	Station Chief, NOAA	NERTO training
McLaughlin	Shawn	NOS, Oxford Laboratory	NERTO and outside committee member for Sierra Hildebrandt
Molineaux	Jonathan	NOAA Hqts, Silver Spring	Internship mentor
Munoz	Roldan	SEFSC Beaufort	NERTO Mentor
Patterson	Jody	Grays Reef NMS	Non-LMRCSC student mentor
Richards	Anne	Research Fisheries Biologist, NEFSC	NERTO mentor & collaborator
Robeson	Kimberly	Grays Reef NMS	NOAA mentor to Kris Howard; microplastics research with Sue Ebanks
Robillard	Eric	NEFSC, Woods Hole	Collaborator
Rogers	Lauren	AFSC	Informal mentor for Hilary Thalmann
Sasso	Chris	SEFSC	Mentor Luis-Rodriguez-Sanoguet
Schultz	Emma	SEFSC Pascagoula	Manuscript Collaborator
Shank	Burton	Research Fisheries Biologist, NOAA	NERTO mentor
Sharma	Rishi	NWFSC	Collaborator
Spires	Jason	NOS, Oxford Laboratory	NERTO and outside committee member for Sierra Hildebrandt
Thorson	James	AFSC	NERTO mentor for LaTreese Denson
Townsend	Howard	NEFSC, Oxford Lab	Committee member
Vogt	Bruce	Ecosystem Science Manager, NOAA	NERTO mentor
Walter	John	SEFSC	PhD. Committee member for LaTreese Denson
Walter,	John	SWFSC, Santa Cruz	Collaborator and mentor
Weinberg	James	Fishery Biologist	Collaborator
Weitkamp	Laurie	NWFSC	Committee member and NERTO mentor
Werner	Kevin	NWFSC	Committee member for King
Wikfors	Gary	NWFSC, Milford	Collaborator, committee member, and future NERTO mentor

**Table 36.2:** Other collaborators involved in Center activities during this reporting period.

Last name	First name	Title/Affiliation	Description of involvement
Alber	Merryl	Professor, UGA	Grant collaborator
Brandes	Jay	Professor, UGA	Use of Raman Spectroscopy instrumentation
Fortner	Sarah	Science Education Resource Center (SERC) at Carleton College	Grant collaborator
Frischer	Marc	Professor, UGA	Grant collaborator
Gleason	Daniel	Professor, Georgia Southern University	Grant collaborator
Johnson	Ronald	President, Sapelo Island Cultural and Revitalization Society	Grant collaborator
McIntosh	Dennis	Natural Resources Professor, DSU	Student Advisor
Ozbay	Gulnihal	Professor, DSU	Grant collaborator
Ricks-Santi	Luisiel	Asst. VP for Research	MS committee member for Josette McLean
Tripati	Aradhna	Professor, UCLA	Grant collaborator
Vulinec	Kevina	Natural Resources Professor, DSU	Student Advisor
Yager	Patricia	Professor, UGA	Grant collaborator

## 50. What were the outcomes of the award?

### a. Education Outcomes

1. **Outcome 1. Increased number, annually, of CSC post-secondary students, trained:** Twenty-five (25) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 13 B.S. Of these Cohort 1 students, eighteen (18) have graduated, including 4 Ph.D., 6 M.S., and 8 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 5 M.S., and 5 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty-two (22) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 7 M.S. and 11 B.S. students. Two students from Cohort 3 have graduated so far including 1 Ph.D. and 1 B.S. So far, sixteen (16) students including 3 Ph.D., 8 M.S., and 5 B.S. students have been recruited into Cohort 4. Eight (8) students have been recruited into Cohort 5 including 2 Ph.D., 1 M.S., and 5 B.S. students. Recruitment for this cohort is ongoing. A complete list of the students trained during this period and the financial support provided to them is available in Appendix I. Outputs include:
  - a. Increased quantitative and analytical skills – Students are acquiring quantitative and analytical skills by taking courses such as Data Management for scientists that was offered in Fall 2018, 2019, and 2020 and by participating in internships and REU programs. We have

also developed and deployed an online training module to introduce undergraduates to the principles of Data Management.

- b. Increased competence in applying STEM to decision-making, policy and management - This is addressed by the Cohort Experience Workshop, which will begin during 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 2018, 2019, and 2020 and will be offered every subsequent Fall. All graduate students are required to complete the course prior to graduation.
2. **Outcome 2: Increase number of CSC post-secondary students educated and graduated annually:** Twenty-five (25) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 7 M.S., and 13 B.S. Of these Cohort 1 students, eighteen (18) have graduated, including 4 Ph.D., 6 M.S., and 8 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 5 M.S., and 5 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty-two (22) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 7 M.S. and 11 B.S. students. Two students from Cohort 3 have graduated so far including 1 Ph.D. and 1 B.S. So far, sixteen (16) students including 3 Ph.D., 8 M.S., and 5 B.S. students have been recruited into Cohort 4. Eight (8) students have been recruited into Cohort 5 including 2 Ph.D., 1 M.S., and 5 B.S. students. Recruitment for this cohort is ongoing. A complete list of the students trained during this period and the financial support provided to them is available in Appendix I. Outputs include:
- a. Number of degrees earned annually in NOAA mission-related disciplines: Four (4) students graduated during this period, including 2 Ph.D., 1 M.S., and 1 B.S. student.
  - 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: Two master's students, Sierra Hildebrandt and Juan Cervera took part in NERTO internships under the supervision of NOAA scientists. These activities were conducted remotely due to COVID-19.
3. **Outcome 3. Increased CSC capacity to train and graduate students.** Ten collaborative research projects were funded in the previous reporting period, and applications are currently under review to be funded in the next period, which enable center scientists to be available to mentor and advise undergraduate and graduate students. In addition, 47 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 include:
- a. Number of seminars: 17

- b. New courses: 1
  - c. New programs: 0
  - d. New degrees offered to develop working skills and functional competencies to support the NOAA mission and workforce: 0
  - e. Total numbers of students supported by the LMRCS: 61
  - f. Total degrees awarded: 4
  - g. Degrees awarded to URM students: 3
4. **Outcome 4: 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 include:
- 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 = **24** URMs at the LMRCS took part in student development activities.
  - b. Increased number of URM students who select to pursue higher education in NOAA mission fields = **52** URMs at the LMRCS are pursuing higher education in NOAA mission fields during this reporting period.

b. Research Outcomes:

**1. Outcome 1. Increased NOAA mission-relevant research capacity at MSIs:** NOAA scientists are already collaborating with Center scientists as well as working with some of the graduate students; suitable mentors are being identified for the remaining students. The Center has post-doctoral research associate at UMES and SSU. 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 include:

**a. Number of research collaborations with NOAA and LMRCS faculty, staff and students:** Each of the ten (10) LMRCS TAB projects that were funded during the last period has a NOAA scientist as a collaborator. Those projects are ongoing.

**b. Number of NOAA scientists serving as mentors and advisors for student research:** 47 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 = 16**

**d. Number of uses of NOAA data in research and tool development = 2.** Halie O'Farrell (Ph.D. student at RSMAS), who graduated during this period used the U.S. pelagic longline observer data for her dissertation research. In addition, Kasondra Rubalcava (Ph.D. student at UMES) is using the long-term fish dataset collected by the Maryland Department of Natural Resources for her dissertation research aimed at developing an ecosystem model for the Maryland Coastal Bays.

**2. Outcome 2. CSC-supported faculty, staff and students' research directly aligned with NOAA's mission and strategic priorities:** Ten (10) collaborative research projects were funded by the LMRCS for the period of 2020 – 2021. 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 include:

	<b># from Projects Directly Supported with FY 16 Funds</b>	<b># from Leveraged Projects</b>
# of peer reviewed publications	6	28
# of presentations	3	7
# Tools developed	1	0
Use of LMRCSC research results and tools by NOAA & other stakeholders	0	0
# of instances LMRCSC publications are cited	92	627
# of LMRCSC students, staff or faculty recognized nationally for LMRCSC research	1	0

#### LMRCSC TAB-Funded Projects Currently Active

<b>Project Number</b>	<b>Principal Investigator</b>	<b>Title</b>	<b>Thematic Research Area</b>
<b>18-01</b>	Brittany King	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	FESS
<b>18-08</b>	Eric Alexander Lewallen	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys	SASI
<b>19-04</b>	David Secor	Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts	SASI
<b>19-06</b>	Hillary Thalmann	Thermal <i>impacts on juvenile Pacific Cod (Gadus macrocephalus)</i> foraging and growth in Gulf of Alaska nursery habitats	CLIME
<b>19-07</b>	Adrienne Wilson	Population structure and growth of lane snapper, a data limited species	SASI
<b>20-01</b>	Savannah M. Geiger	An analysis of distribution and abundance of microplastics in selected commercially important species in Northern Georgia coastal waters	HaBS

20-02	Sierra Hildebrandt	Investigating the Impacts of Adult-Oyster-Conditioned-Water on <i>Crassostrea virginica</i> Larval Setting Efficiency Utilizing Direct Setting in the Hampton River, Virginia	HaBS
20-03	Kyarii Ramarui	Proteomic analysis of two <i>Haematococcus pluvialis</i> strains as aquaculture feedstock	SNAP
20-04	Eric Schott	Life history and disease ecology of the blue crab, a key benthic-pelagic link in tropical and temperate American estuaries	SASI
20-05	Matt Kenworthy	Evaluating the effects of landscape scale habitat variability on white shrimp ( <i>Litopenaeus setiferus</i> ) population dynamics in Georgia estuaries	HaBS
20-06	Janelle Layton	Investigating the effects of climate change on heat shock proteins and development in the early life history stages of Nassau grouper	CLIME
20-07	Dennis McIntosh	Assessment of New Technologies for Post-Harvest Oyster Purification	SNAP
20-08	Shanelle Haughton	Evaluating physiological and immune responses of snow crabs ( <i>Chionoecetes</i> sp.) to <i>Hematodinium</i> infection	SASI
20-09	Victoria Williams	Understanding Adaptive Capacity: An Analysis of Community Perceptions and Policy Responses to Ocean Acidification and other marine stressors on the West Coast	CLIME
20-10	Imani Wilburn	The Occurrence of Microplastics in Maryland Coastal Bay Fishes	HaBS

\*Only currently active projects are included. CLIME: Climate Impacts on Marine Ecosystems; HaBS: Habitats and Biological Systems; SASI: Stock Assessment Support and Information; SNAP: Seafood, Nutrition, Aquaculture, and Pathology; FESS: Fishery Economics and Social Sciences

### TAB Project Abstracts

**Project Number** 18-01

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

**Thematic Research Area** FESS: Fishery Economics and Social Sciences

**Abstract:** NOAA Fisheries has a responsibility to provide the best available science for the management of living marine resources. Research has shown the value of diversified thinking and approaches in science and that diverse perspectives can improve our collective ability to solve problems. However, many racial and ethnic groups face the issue of being

underrepresented in marine and fisheries science professions, resulting in a workforce that does not reflect the diversity of the United States. This study focuses on the underrepresentation of racial and ethnic groups in marine and fisheries related science professions and aims to provide an analysis of how experiences and social identity shape marine and fisheries science related career decisions of individuals across career levels (undergraduates, graduates and professionals). This study uses in-depth interviews and a qualitative data analysis approach to analyze the effects of life experiences and identity on career decisions. Between February 2019 and June 2020, we conducted 46 in-depth semi-structured interviews with participants across different racial and ethnic groups (Black, White, Latino, Asian, Mixed-Race), and career levels (undergraduate, graduate, professional) at multiple conferences and meetings. Due to Covid-19 restrictions, the last three interviews were conducted using online video conferencing platform prior to the completion of data collection in June 2020.

**Principal Investigator:** Brittany King, Oregon State University

**Co-PI:** Kelly Biedenweg, Oregon State University

**NOAA Partner:** Kevin Werner, NWFSC: Northwest Fishery Science Center

**Other Partner:**

**Students:** Brittany King (PhD, OSU)

**Keywords:** Fisheries; Social science; Diversity

**Project Number** 18-08

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

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract**

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

**Principal Investigator:** Eric Alexander Lewallen, Hampton University

**Co-PI:** Carolina Bonin Lewallen, Hampton University

**NOAA Partner:** Laurie Weitkamp, NWFSC: Northwest Fishery Science Center

**Other Partner:** Linda Park, NWFSC: Northwest Fishery Science Center

**Students:** Josette McLean (MS, Hampton U); Janelle Layton (Undergraduate, Hampton U)

**Keywords:** Bycatch; Fisheries; Marine Biology; Protected Species; Population dynamics; Ecosystems

**Project Number** 19-04

**Title:** Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** Monkfish *Lophius americanus* sustains a key revenue stream for the stressed US Northeast groundfish fleets. Still, monkfish have been managed very conservatively because of major uncertainties in the stock assessment, the most significant of which is age structure and

growth in this long-lived species. Access and allocation of this resource to New England and Mid- Atlantic fleets is highly dependent upon the underlying productivity of monkfish and its assessment, both of which are uncertain owing to the lack of a valid ageing procedure. We propose to develop and validate novel ageing procedures for this species supporting assessment goals and focused student training in state-of-the-art fisheries techniques, marine chemistry, and stock assessment. This project will provide support to LMRCSC graduate student, Mr. Ben Frey, to work with Dr. Anne Richards, lead scientist for monkfish assessments, and the NEFSC Fisheries Biology Program.

**Principal Investigator:** David Secor, University of Maryland Center for Environmental Science

**Co-PI:** Rosemary Jagus, University of Maryland Center for Environmental Science

**NOAA Partner:** Anne Richards, NEFSC: Northeast Fishery Science Center

**Other Partner:**

**Students:** Benjamin Frey (MS, UMCES)

**Keywords:** Fisheries; Population dynamics

**Project Number** 19-06

**Title:** Thermal impacts on juvenile Pacific Cod (*Gadus macrocephalus*) foraging and growth in Gulf of Alaska nursery habitats

**Thematic Research Area** CLIME: Climate Impacts on Marine Ecosystems

**Abstract:** The Gulf of Alaska is influenced by thermal variation including climatic phenomena and marine heatwaves such as the 2014-2016 and 2019 heatwaves. Warming events are expected to impact age-0 Pacific Cod (*Gadus macrocephalus*) during summer growth in coastal nurseries and can influence patterns of foraging, selective mortality, and overwinter survival. Understanding thermal impacts on juvenile Cod is especially relevant given their recent declines in adult abundance and the closure of the fishery in 2020. I will examine juvenile Cod in Kodiak Island nurseries between 2006 and 2019 during representative warm and cold years in order to describe variability in nursery growth, diet composition, and trophic position using otolith increment, stomach content, and stable isotope analysis. Expected results will inform cod recruitment patterns in the face of climate change and contribute to nursery management during future warming.

**Principal Investigator:** Hillary Thalmann, Oregon State University

**Co-PI:** Jessica Miller, Oregon State University

**NOAA Partner:** Ben Laurel, AFSC: Alaska Fishery Science Center

**Other Partner:** Bradley Stevens, University of Maryland Eastern Shore

**Students:** Hillary Thalmann (MS, OSU)

**Keywords:** Fisheries; Protected Species; Population dynamics; Ecosystems; Habitats; Climate variability

**Project Number** 19-07

**Title:** Population structure and growth of lane snapper, a data limited species

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** Lane Snappers (*Lutjanus synagris*) are a data-limited species that range from North Carolina, the Gulf of Mexico (GOM) and south to Brazil. This study will collect 400 sagittal otoliths, fin clips, length/weight measurements from fish caught from East Florida to North Carolina. Otoliths will be processed, aged and two experienced readers will be used to ensure accurate ageing. A variety of growth models will be used to determine best fit. Genotyping by sequencing (GBS) will be used to determine genetic diversity. Results will complement a recent NOAA supported study that examined spatial and temporal variation in the age and growth of Lane Snapper in the

GOM and data will be used to support future NOAA stock assessments by providing information on population structure and growth.

**Principal Investigator:** Adrienne Wilson, University of Miami - Rosenstiel School of Marine and Atmospheric Science

**Co-PI:** Elizabeth Babcock, University of Miami - Rosenstiel School of Marine and Atmospheric Science

**NOAA Partner:** Robert Allman, SWFSC: Southwest Fishery Science Center

**Other Partner:** Dionne Hoskins-Brown, Savannah State University

**Students:** Adrienne Wilson (PhD, RSMAS); Savannah Clax (Undergraduate, RSMAS)

**Keywords:** Fisheries, Marine Biology, Population dynamics

**Project Number** 20-01

**Title:** An analysis of distribution and abundance of microplastics in selected commercially important species in Northern Georgia coastal waters

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** The various densities of plastics allow for particulate plastics to settle or aggregate in different habitats in the marine environment, thereby increasing their prevalence in a variety of organisms that inhabit areas where particulate plastics accumulate. The proposed research is to study the microplastic abundance in organisms of economic importance in Georgia in an effort to understand the ecological impact of microplastics in the aquatic, estuarine, and marine environments. The objectives of this proposal are to: (1) analyze microplastics in selected commercially important species and (2) to analyze the spatial abundance of microplastics in selected waters near Savannah, GA, USA.

**Principal Investigator:** Savannah M. Geiger, Savannah State University

**Co-PI:** Dr. Sue Ebanks, Savannah State University

**NOAA Partner:** Dr. Ashok Deshpande, NEFSC: Northeast Fishery Science Center

**Other Partner:** Mrs. Kimberly Roberson, NOS

**Students:** Joe Day (Undergraduate, SSU); Lady Volmar (Undergraduate, SSU); Alexandria Tennant (Undergraduate, SSU)

**Keywords:** Fisheries; Ecosystems; Habitats

**Project Number** 20-02

**Title:** Investigating the Impacts of Adult-Oyster-Conditioned-Water on *Crassostrea virginica* Larval Setting Efficiency Utilizing Direct Setting in the Hampton River, Virginia

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** An alternative technique to traditional remote setting of oysters is direct setting. Direct setting substantially reduces material handling and cost by deploying pediveliger stage oyster larvae onto suitable substrate in the field. In this study the impacts of varying concentrations of Adult- Oyster-Conditioned-Water (OCW) on *Crassostrea virginica* larval setting were investigated in the laboratory and field. In the laboratory, oyster larvae were introduced to setting chambers and allowed 7 days to settle in four treatments of varying concentrations. Field experiments were conducted in which oyster larvae were exposed to one of three treatments for 30 minutes and then directly set on artificial reefs. For the laboratory and field experiments treatment concentrations were 0.03-0.11 mg/L (control), 0.840-1.44 mg/L (low), 2.09-3.87 (medium), and 1.49-6.62 (high). Setting efficiencies in the laboratory and field varied among treatments. This research suggest that OCW may enhance setting efficiencies in direct setting.

**Principal Investigator:** Sierra Hildebrandt, Hampton University

**Co-PI:** Dr. Deidre Gibson, Hampton University

**NOAA Partner:** Shawn McLaughlin and Jason Spires, NOS: National Ocean Service

**Other Partner:**

**Students:** Sierra Hildebrandt (MS, Hampton University)

**Keywords:** Ecosystems; Habitats

**Project Number** 20-03

**Title:** Proteomic analysis of two *Haematococcus pluvialis* strains as aquaculture feedstock

**Thematic Research Area** SNAP: Seafood, Nutrition, Aquaculture, and Pathology

**Abstract:** The green microalga *Haematococcus pluvialis* produces an antioxidant pigment, astaxanthin, which is widely used in salmon aquaculture as feed additive. Current algae industry uses phototrophic cultivation for *H. pluvialis* production, however, under these conditions the growth rate and astaxanthin productivity are low. Two mutant strains of *H. pluvialis* have been generated through chemical mutagenesis that demonstrate increased heterotrophic growth and astaxanthin productivity, addressing the bottlenecks of *Haematococcus* production. To understand the molecular underpinning of this phenotype, we propose further molecular characterization of these two mutant strains through LC-MS/MS based proteomic analysis. The knowledge generated will help development of rational engineering strategies for improved astaxanthin production in microalgae and promote its use in aquaculture.

**Principal Investigator:** Kyarii Ramarui, University of Maryland Center for Environmental Science

**Co-PI:** Yantao Li, University of Maryland Center for Environmental Science

**NOAA Partner:** Gary Wikfors, NEFSC: Northeast Fishery Science Center

**Other Partner:** Allen Place, Joseph Pitula, UMCES, UMES

**Students:** Kyarii Ramarui (PhD, UMCES)

**Keywords:** Aquaculture; Social science; Plankton; Feedstock

**Project Number** 20-04

**Title:** Life history and disease ecology of the blue crab, a key benthic-pelagic link in tropical and temperate American estuaries

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** The blue crab, *Callinectes sapidus*, is an adaptable estuarine species that lives in Atlantic coastal regions from New England to Argentina. The species is a crucial part of the estuarine food web and supports a fishery worth \$200 million annually in the US. Across their range, blue crabs are infected by pathogenic viruses and protozoa that may interact with environmental and anthropogenic stressors to limit crab abundance. In Puerto Rico, *C. sapidus* is targeted by an artisanal fishery and provides income important to communities. Currently, no size or sex restrictions are in place to sustainably manage *Callinectes* spp. in Puerto Rico, and there is a lack of data on which to base fisheries management. In the tropics, *C. sapidus* is often sympatric with several other *Callinectes* species. Basic knowledge of *Callinectes* spp. distribution in estuaries in the San Juan metropolitan region can provide valuable insights into their ecological role and provide baseline data for monitoring abundance to inform resource management strategies. To address this knowledge gap, we plan to measure the abundance, sex ratio, female reproductive status, and diseases of *C. sapidus* and other *Callinectes* spp., including *C. exasperatus*, *C. ornatus*, *C. larvatus*, and *C. bocourti* by sampling 4 times per year, in a range of habitats (and environmental parameters) within a polyhaline estuary in the San Juan metropolitan area in Puerto Rico.

**Principal Investigator:** Eric Schott, University of Maryland Center for Environmental

**Co-PI:** Bradley Stevens, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** Mandy Bromilow, NOAA: Chesapeake Bay Office

**Other Partner:**

**Students:** Olivia Pares (MS, UMCES)

**Keywords:** Fisheries; Ecology; Pathology

**Project Number** 20-05

**Title:** Evaluating the effects of landscape scale habitat variability on white shrimp (*Litopenaeus setiferus*) population dynamics in Georgia estuaries.

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** Estuaries are recognized as important nursery habitats for penaeid shrimp species. Yet, there remain many questions about what exactly constitutes high-value, even critical, habitat for juveniles. In this study, we proposed to evaluate the nursery function of Georgia estuaries for white shrimp. We will evaluate relative abundance, growth, condition, and trophic dynamics of juvenile white shrimp among alternative landscape types. Furthermore, we will examine the use of stable isotope tags to identify areas within the estuary contributing greater proportions of individuals to the adult population. The results from this study will provide a better understanding of the population dynamics of estuarine and nearshore habitats and their contribution to fishery productivity.

**Principal Investigator:** Matt Kenworthy, Savannah State University

**Co-PI:** Dionne Hoskins-Brown, Savannah State University

**NOAA Partner:** Jennifer Doerr, SEFSC: Southeast Fishery Science Center

**Other Partner:** Maurice Crawford, UMES

**Students:** William Burns (Undergraduate, SSU); Kris Howard (MS, SSU)

**Keywords:** Fisheries; Ecosystems; Habitats

**Project Number** 20-06

**Title:** Investigating the effects of climate change on heat shock proteins and development in the early life history stages of Nassau grouper

**Thematic Research Area** CLIME: Climate Impacts on Marine Ecosystems

**Abstract:** Climate variability and change likely have major impacts on the early life history stages of commercially and recreationally valuable fish like Nassau grouper. Understanding these impacts will be essential to conservation and management efforts. Studies to date have noted phenotypic and survival differences in early life history stages of Nassau grouper reared at different temperatures. However, little is known on the drivers of these changes in bioenergetics and in gene expression during the early life history stages of this species. Our goal is to measure bioenergetic activity and use established genetic methods to investigate temperature induced changes in gene expression of early life stage Nassau grouper, collected from a spawning aggregation on Little Cayman, Cayman Island.

**Principal Investigator:** Janelle Layton, Oregon State University

**Co-PI:** Scott Heppell, Oregon State University

**NOAA Partner:** Steve Gittings, NOS: National Ocean Service

**Other Partner:**

**Students:** Janelle Layton (MS, OSU)

**Keywords:** Fisheries; Ecosystems

**Project Number** 20-07

**Title:** Assessment of New Technologies for Post-Harvest Oyster Purification

**Thematic Research Area:** SNAP: Seafood, Nutrition, Aquaculture, and Pathology

**Abstract:** Shellfish aquaculture is America's largest and fastest-growing marine aquaculture sector. A barrier to growth has been increasingly stringent post-harvest treatment requirements to counter illnesses from pathogenic vibrio bacteria. We aim to demonstrate the efficacy of two

technologies, individually and combined, in removing pathogens from aquaculture system water and oyster tissues through a series of controlled experiments as one of two pillars of the to-be-recruited Cohort 3 DSU graduate student's thesis research. These trials will help 'ensure a safe and healthy supply of seafood, and increase consumer confidence in the quality of seafood' through applying 'innovative science and technology' to mitigate risks. This work represents a novel application of two commercially available technologies developed for other uses by our industry partner, Paradigm LLC.

**Principal Investigator:** Dennis McIntosh, Delaware State University

**Co-PI:** Salina Parveen, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** John Jacobs, NOS: National Ocean Service

**Other Partner:** Dorothy Leonard, Ocean Equities, LLC.

**Students:** Caiti Czajkowski (MS, DSU)

**Keywords:** Aquaculture

**Project Number** 20-08

**Title:** Evaluating physiological and immune responses of snow crabs (*Chionoecetes* sp.) to *Hematodinium* infection

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** A commercially important crustacean pathogen, *Hematodinium* sp., is a parasitic dinoflagellate of the *Hematodinium* genus that can cause Bitter Crab Disease/Bitter Crab Syndrome (BCD/BCS). There are high rates of *Hematodinium* sp. infection in snow crabs native to the Bering Sea, which can result in soiled crab meat and thus cause significant losses to commercial stocks. *Hematodinium* may affect regulation of metabolic gene expression in infected crabs, based upon observed changes in biochemical composition. This study will explore this effect, in addition to the regulation of genes involved in the immune response in snow crabs. The effect of climate change on host snow crab immune function, and susceptibility to disease, is currently unknown. This study provides an opportunity to assess these parameters, and provide baseline information for assessment of the health of this fishery.

**Principal Investigator:** Shanelle Haughton, University of Maryland Eastern Shore

**Co-PI:** Joseph Pitula, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** Dr. Pamela Jensen, AFSC: Alaska Fishery Science Center

**Other Partner:**

**Students:** Shanelle Haughton (PhD, UMES)

**Keywords:** Fisheries; Marine Biology; Ecosystems

**Project Number** 20-09

**Title:** Understanding Adaptive Capacity: An Analysis of Community Perceptions and Policy Responses to Ocean Acidification and other marine stressors on the West Coast

**Thematic Research Area** CLIME: Climate Impacts on Marine Ecosystems

**Abstract:** Ocean acidification (OA) disrupts the carbonate chemistry of coastal ecosystems, which indirectly and directly affects communities that depend on critical marine organisms. OA research typically seeks to understand natural system responses; yet, there is insufficient research that examines community and institutional responses or, more generally, their vulnerability to OA. Considering the insufficient information to direct policy efforts to combat OA, this project aims to assess if and to what extent four shellfish communities along the coast of Oregon have adaptive capacity (AC) to OA. By understanding the perceptions of the four coastal communities alongside perceptions of Oregonian decision and policy makers, the project hopes to contribute to broader efforts to apply human AC to OA.

**Principal Investigator:** Victoria Moreno, Oregon State University



**Co-PI:** Dr. Ana Spalding, Oregon State University  
**NOAA Partner:** Dr. Shallin Busch, NWFSC: Northwest Fishery Science Center  
**Other Partner:**  
**Students:** Victoria Moreno (MS, OSU)  
**Keywords:** Fisheries; Social science; Ocean Acidification

**Project Number** 20-10

**Title:** The Occurrence of Microplastics in Maryland Coastal Bay Fishes

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** An important problem is plastic pollution in the ocean with millions of tons of plastic flowing into the ocean every year. The breakdown of larger pieces of plastic can form microplastics (< 5 mm) that are easily consumed by marine organisms thereby posing a threat to their populations. The Maryland Coastal Bays are home to a variety of commercial and recreational activities but few studies have been done regarding microplastic pollution. For my master's research, I plan to quantify the presence of microplastics in Maryland Coastal Bay fishes by comparing the percentage of fish contaminated with microplastics by feeding type and location. I will also research the feasibility of a technique to remove microplastics from the water without harming the environment.

**Principal Investigator:** Imani Wilburn, University of Maryland Eastern Shore

**Co-PI:** Dr. Maurice Crawford, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** Dr. Ashok Deshpande, NEFSC: Northeast Fishery Science Center

**Other Partner:** Dr. Kausik Das, The University of Maryland Eastern Shore

**Students:** Imani Wilburn (MS, UMES)

**Keywords:** Fisheries; Microplastics; Maryland Coastal Bays

### Appendix I: Student Funding During the 6 month Reporting Period

First	Last	URM (y or n)	Cohort #	Degree	Partner	Tuition	Stipend	Travel	NERTO	One-time Research Support	Professional Development
Amanda	Pappas	N	1	M.S.	DSU	605					
Marcus	Teat	Y	2	B.S.	DSU	3216	3840				
Caitlyn	Czajkowski	N	3	M.S.	DSU	8647	10500				
Luis	Rodriguez-Sanoguet	Y	3	M.S.	DSU	6811	10500				
Maria	Henson	Y	1	B.S.	HU	2500					
Sierra	Hildebrandt	N	2	M.S.	HU	9218	9500				
Josette	McLean	Y	2	M.S.	HU	9218	9500				
Amani	Tolin	Y	3	B.S.	HU	7500					
Arona	Bender	Y	3	M.S.	HU	9218	9000				
PaShun	Hawkins	Y	4	B.S.	HU	7500					

Jaelyn	Leslie	Y	4	M.S.	HU	9218	9000				
Jonathan	Nash	Y	5	B.S.	HU	2500					
T'Kiyah	Reeves	Y	5	B.S.	HU	2500					
Derrick	Richardson	Y	5	B.S.	HU	2500					
Brittany	King	Y	2	PhD	OSU	6536	7066	1649			
Keala	Pelekai	Y	3	MS	OSU	12172	10045	3323			
Janelle	Layton	Y	4	MS	OSU	10197	11611	3321			
Victoria	Williams	Y	4	MS	OSU	10197	11611	3321			
Halie	O'Farrell	Y	1	PhD	RSMAS						
Latreese	Denson	Y	2	PhD	RSMAS						
Adrienne	Wilson	Y	2	PhD	RSMAS	1618					
Juan	Cervera	Y	3	MS	RSMAS	15120	11481				
Cristin	Mayes	Y	4	PhD	RSMAS	15190	15156				
Chryston	Best-Otubu	Y	5	PhD	RSMAS	25900	15156				
Joe	Day	Y	2	BS	SSU						
Davielle	Drayton*	Y	2	M.S.	SSU						
Ambrose	Alexandria	Y	3	B.S.	SSU						
Mackey	Shaneese	Y	3	M.S.	SSU	1339	10500				
Chelsea	Spaulding	Y	4	B.S.	SSU	3001	5659				
Savannah	Geiger	N	4	M.S.	SSU	2929	21000		435		
Sena	Tay	Y	4	M.S.	SSU	3075	8750				
William	Burns	Y	5	B.S.	SSU	3001	7424				
Savannah	Clax	Y	5	B.S.	SSU	0	10179				
Kristafer	Howard	Y	5	M.S.	SSU	1477	8750				
Dante	Freeman	Y	2	B.S.	SSU						
Erianna	Hammond	Y	2	B.S.	SSU						
Michael	Williams	Y	2	B.S.	SSU						
Shadaesha	Green	Y	1	Ph.D.	UMCES					252	
Nicholas	Coleman	Y	2	M.S.	UMCES	13158	13618				
Benjamin	Frey	Y	3	M.S.	UMCES	4386	14765			1157	
Kyarii	Ramarui	Y	4	Ph.D.	UMCES	3655	17969	1670		2480	
Olivia	Pares	Y	5	Ph.D.	UMCES	8772	16628				
Detbra	Rosales	Y	1	Ph.D.	UMES			387			
Kasondra	Rubalcava	Y	2	Ph.D.	UMES	2049	15709				
Teemer	Barry	Y	3	B.S.	UMES		1561				
DaQuan	Davis	Y	3	B.S.	UMES	4279	3198				
Semaj	Fielding	Y	3	B.S.	UMES		655				
Tyler	Washington	Y	3	B.S.	UMES	4279					
Shanelle	Haughton	Y	3	Ph.D.	UMES	7688	13455				
Ashley	Silver	Y	3	Ph.D.	UMES	10411	12526				
Glen	Colins	Y	4	B.S.	UMES	5318					
Mya	Rufus	Y	4	B.S.	UMES	4279					
Shakira	Goffe	Y	4	M.S.	UMES	8836	3979				

Tahirah	Johnson	Y	4	M.S.	UMES	996	11311				
Imani	Wilburn	Y	4	M.S.	UMES	9477	10587				
Jaymeelita	Colbert-Williams	Y		No Degree	UMES						4676
Destiny	Coleman	Y		No Degree	UMES						4676
Glen	Colins	Y		No Degree	UMES						4676
Reem	Dafalla	Y		No Degree	UMES						699
Miyae	Felder	Y		No Degree	UMES						3599
Nyla	Jeanpierre	Y		No Degree	UMES						3599
Joel	Williams	Y		No Degree	UMES						4676
<b>TOTAL</b>						<b>280486</b>	<b>352188</b>	<b>13671</b>	<b>435</b>	<b>3889</b>	<b>26601</b>

## Appendix II: TAB Reports

### Project Number 18-01

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

**Thematic Research Area** FESS: Fishery Economics and Social Sciences

**Abstract:** NOAA Fisheries has a responsibility to provide the best available science for the management of living marine resources. Research has shown the value of diversified thinking and approaches in science and that diverse perspectives can improve our collective ability to solve problems. However, many racial and ethnic groups face the issue of being underrepresented in marine and fisheries science professions, resulting in a workforce that does not reflect the diversity of the United States. This study focuses on the underrepresentation of racial and ethnic groups in marine and fisheries related science professions and aims to provide an analysis of how experiences and social identity shape marine and fisheries science related career decisions of individuals across career levels (undergraduates, graduates and professionals). This study uses in-depth interviews and a qualitative data analysis approach to analyze the effects of life experiences and identity on career decisions. Between February 2019 and June 2020, we conducted 46 in-depth semi-structured interviews with participants across different racial and ethnic groups (Black, White, Latino, Asian, Mixed-Race), and career levels (undergraduate, graduate, professional) at multiple conferences and meetings. Due to Covid-19 restrictions, the last three interviews were conducted using online video conferencing platform prior to the completion of data collection in June 2020.

**Principal Investigator:** Brittany King, Oregon State University

**Co-PI:** Kelly Biedenweg, Oregon State University

**NOAA Partner:** Kevin Werner, NWFSC: Northwest Fishery Science Center

**Other Partner:**

**Students:** Brittany King (PhD, OSU)

**Keywords:** Fisheries; Social science; Diversity

**Start Date:** 9/1/2018

**End Date:** 9/30/2021

### Results to Date

This research project received final approval from Oregon State University's Institutional Review Board (IRB) in January 2019 and renewed approval in January 2020. Once IRB approval was obtained, Brittany attended multiple marine and fisheries science related conferences and

meetings from February–November to conduct in-person interviews. To date, Brittany has conducted 46 in-person semi-structured interviews across three marine and fisheries related science career level: undergraduate students (33%), graduate students (37%) and professionals (33%); and different racial and ethnic backgrounds: Black (35%) White (22%) Latino (22 %) mixed race (17%) Asian (4%). We completed data collection in June 2020. Interviews included questions about participants experiences in marine and fisheries related science professions, racial and ethnic identity, environmental identity and marine and fisheries related science identity. All completed interviews have been transcribed and preliminary analysis has revealed themes and trends, related to our research questions. Final analysis, manuscript preparation and submission is expected to be completed by September 2021.

#### **Relevance to NOAA**

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

#### **Broader Impacts**

This project explores a social science and human dimensions aspect of marine and fisheries science that is often overlooked. It aligns well with LMRCS missions to prepare a diverse student body for careers in marine and fisheries sciences through exemplary academic and research collaborations, by examining drivers that influence a diverse marine and fisheries science workforce. The project provides the LMRCS student researcher, Brittany King, the opportunity to integrate social science research into the LMRCS program to help better understand underrepresentation in marine and fisheries science professions.

#### **Presentations or Publications**

King, B. The Future of Fisheries: For the Profession. Oregon Chapter of the American Fisheries Society (March 2021) - Invited Plenary Speaker

King, B. Underrepresentation of ethnic and racial groups in marine and fisheries science profession: How significant life experiences shape a diverse workforce. Research Advances in Fisheries, Wildlife, and Ecology Symposium (RAFWE), Corvallis, OR (May 2020)

King, B. Underrepresentation of ethnic and racial groups in marine and fisheries science professions- Marine Science Identity. NOAA Living Marine Resources Cooperative Science Center Annual Science Meeting, Silver Spring, MD (June 2019)

King, B. Underrepresentation of ethnic and racial groups in marine and fisheries science professions. International Symposium on Society and Resource Management, Salt Lake City, UT (June 2018)

**Performance Measure:** 3.4e: Number and percentage of actions ongoing or completed to recover endangered and threatened species

**DOC Strategic Plan:** 3.1.2: Advance holistic, integrative ecosystem research (NOAA).

**NOAA RD Linkage:** D1a: Improved understanding of the economic and behavioral elements of coastal resilience

**Next Gen Priorities:** Diverse and constantly evolving capabilities in NOAA's workforce

**Project Number** 18-08

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

**Thematic Research Area** SASI: Stock Assessment Support and Information

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

**Principal Investigator:** Eric Alexander Lewallen, Hampton University

**Co-PI:** Carolina Bonin Lewallen, Hampton University

**NOAA Partner:** Laurie Weitkamp, NWFSC: Northwest Fishery Science Center

**Other Partner:** Linda Park, NWFSC: Northwest Fishery Science Center

**Students:** Josette McLean (MS, Hampton U); Janelle Layton (Undergraduate, Hampton U)

**Keywords:** Bycatch; Fisheries; Marine Biology; Protected Species; Population dynamics; Ecosystems

**Start Date:** 4/1/2019

**End Date:** 8/31/2021

### **Results to Date**

Virtual activities between members of the research team have continued on a weekly or bi-weekly basis. The primary goal of this pandemic period is to prepare a review paper on environmental DNA/RNA metabarcoding, and guide Ms. McLean toward completion of her thesis. Laboratory activities resumed in February 2021, when graduate students were allowed back on campus. Remaining laboratory supplies have been procured for the final stages of data collection. We anticipate that Ms. McLean will defend her thesis in the Spring 2021 or summer 2021.

### **Relevance to NOAA**

We will provide fundamental data for the direct assessment of Pacific lampreys by analyzing predator-prey relationships and habitat use, as well as distribution patterns. As a research program, we have the ability to perform large-scale training in laboratory-based genetics, gut content analysis, and forensics for students at Hampton University. In addition, we will provide students with opportunities for field-based research in marine and freshwater habitats.

### **Broader Impacts**

During the first year of this project we finalized specimen collections and sample processing (e.g., voucher preservation, gut dissection, gut content preservation). Josette McLean joined the research team in August 2019, and was trained in genetic laboratory techniques. Ms. McLean completed a 3 month internship with Dr. Weitkamp of the NOAA Northwest Fisheries Science Center during the summer of 2020. The second year of this project has focused on collecting genetic data, analysis of genetic and geospatial data, preparation of manuscripts (review and thesis), and presentation of results at online symposia. The master's student will likely graduate in May 2021 from the Department of Marine and Environmental Science at Hampton University.

### **Presentations or Publications**

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

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

Layton JM, Bonin CA, Pressley N, Park LK, Weitkamp LA, Lewallen EA. Genetic-based

methods for assessing prey composition and feeding ecology of Pacific lampreys. 23rd Annual School of Science Research Symposium, Hampton University, Hampton, VA April 11-12, 2018 (poster).

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

**Performance Measure:** 3.4c: Percentage of protected species stocks with adequate population assessments and forecasts 2.0

**DOC Strategic Plan:** 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources

**NOAA RD Linkage:** C4a: Improve survey capabilities to provide more accurate, precise and synoptic information of key marine populations.

**Next Gen Priorities:** Improved understanding of ecosystems to inform resource management decisions

#### **Project Number** 19-04

**Title:** Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** Monkfish *Lophius americanus* sustains a key revenue stream for the stressed US Northeast groundfish fleets. Still, monkfish have been managed very conservatively because of major uncertainties in the stock assessment, the most significant of which is age structure and growth in this long-lived species. Access and allocation of this resource to New England and Mid- Atlantic fleets is highly dependent upon the underlying productivity of monkfish and its assessment, both of which are uncertain owing to the lack of a valid ageing procedure. We propose to develop and validate novel ageing procedures for this species supporting assessment goals and focused student training in state-of-the-art fisheries techniques, marine chemistry, and stock assessment. This project will provide support to LMRCSC graduate student, Mr. Ben Frey, to work with Dr. Anne Richards, lead scientist for monkfish assessments, and the NEFSC Fisheries Biology Program.

**Principal Investigator:** David Secor, University of Maryland Center for Environmental Science

**Co-PI:** Rosemary Jagus, University of Maryland Center for Environmental Science

**NOAA Partner:** Anne Richards, NEFSC: Northeast Fishery Science Center

**Other Partner:**

**Students:** Benjamin Frey (MS, UMCES)

**Keywords:** Fisheries; Population dynamics

**Start Date:** 1/28/2019 **End Date:**

#### **Results to Date**

The project goal was to test for seasonal chemical cycles in hardpart constituents of monkfish for a series of sample years, corresponding to the strong 2015 year-class, evaluating these cycles against optical zonation patterns interpreted as annuli. Related objectives included, (1) training in monkfish hard part processing, age interpretations, otolith microchemical analysis, and age-structured stock assessments, (2) deploying the same analysis for a control species, black sea bass, for which annuli have been confirmed to form at an annual rate, (3) conduct microprobe analysis on monkfish and black sea bass hard parts, and (4) conduct time series analysis to identify dominant periodicities in microchemical profiles. Training: During fall 2019, EPP LMRCSC Fellow undertook a NERTO Internship at the NEFSC. The NERTO occurred between 9/9/19 and 12/3/19 and included a 2-week RV Bigelow leg from 10/9/19 to 10/25/19. This included work with (1) the NEFSC Fishery Biology Division (E. Robillard, S. Sutherlands,

and J. Dayton) (2) the RV Bigelow Fall Bottom Trawl Survey (Chief Scientist J. Kircun and Watch Chief A. Poquette) and (3) the Population Assessment and Biology Branch (A. Richards, L. Alade, G. Shepherd, P. Nitschke, T. Sheehan). Key training related to the TAB contract included hard part processing and interpretation of monkfish and black sea bass otoliths, illicia and vertebrae. Initial precision trials and analyses were conducted on hardpart interpretations. To better understand the assessment process and obtain samples of monkfish, Frey participated in leg three of the Fall Bottom Trawl Survey aboard the NOAA Ship, Henry B Bigelow. This experience trained Frey on how to classify, dissect, determine gender, and identify stomach contents of not only monkfish but the majority of species trawled in the Georges Bank. Frey also received exposure and training in the assessment process with Dr. Anne Richards. Hardpart samples were procured for monkfish and black sea bass and return to UMCES for further processing in support of Frey's thesis research. Training sessions occurred at the University of Maryland Nanotechnology Center (College Park), where Secor worked with Center lead, Dr. Philip Piccoli (Geology Dept.) to train Mr. Ben Frey, LMRCSC Fellow, on operation of the wave-length-dispersive electron microanalyzer (March 2020). Secor applied for special permission for Frey to conduct research at the Nanotechnology Center under institutional COVID restrictions at both UMCES and University of Maryland College Park. Hardpart preparation and analysis: From NEFSC hardpart archives and laboratory samples of black sea bass, 200 black sea bass otoliths, 144 monkfish illicia, 50 monkfish otoliths, and 21 monkfish vertebrae were procured for initial analyses. Of these 125 black sea bass otoliths, 87 monkfish illicia, and 42 monkfish otoliths, and 20 monkfish vertebrae have been processed for age interpretation and microprobe analysis. In five visits to the microprobe facility during July 2020, 60 black sea bass otoliths, 40 monkfish otoliths, 5 monkfish, and 1 monkfish vertebrae illicia were analyzed for Ca, Sr, P, and Mg. Hardpart profiles are being analyzed for periodicity and alignment with annular optical zones. Images of the mounted black seabass (n=60) and monkfish (n=40) hardparts captured via reflected light microscopy have been overlain with the backscatter electron images from the microprobe point assays through image manipulations to confirm and reveal the path of the assay along annular zonation.

#### **Relevance to NOAA**

This project has the potential to resolve uncertainties about monkfish growth and cohort assignment, and thereby provide validation for an ageing method that can be used to estimate population age structure and a growth model for use in quantitative assessment. This project seeks to validate a new aging method for monkfish through use of archived samples at NEFSC, and to develop a new growth curve, which is critical for assessment of this economically valuable species. In addition, this work may provide a method for correcting the 22-year time series of population age structure estimates based on inaccurate readings of vertebrae.

#### **Broader Impacts**

A central impact is in EPP LMRCSC training and NOAA workforce development. Projects related to hard part analysis for ageing are particularly amenable for student training and thesis topics as they are discrete with well-defined goals and are central to the best available approaches for assessing and managing species of commercial importance and conservation concern. Another important impact is initial recruitment of an LMRCSC student to the Chesapeake Biological Laboratory campus, which houses UMCES expertise in fisheries assessment science. The novel approach to age validation developed in this project is applicable to any unvalidated species to certify stock status.

#### **Presentations or Publications**

Frey, B.A., Secor, D., Richards, A., & Jagus, R. Current age and growth methods of Monkfish (*Lophius americanus*) The Need for Validation. LMRCSC 2020 Virtual Science Meeting. April 2020.

Frey, B.A., Secor, D., Richards, A., & Jagus, R. Monkfish Age Validation Using Hardpart Analysis of "Known" age Samples. LMRCSC Science Meeting, NOAA Silver Spring HQ, MD,

June 2019.

Frey, B.A., Secor, D., Richards, A., & Jagus, R. Monkfish Age Validation Using Hardpart Analysis of Known-age Cohorts. AFS Tidewater Meeting, Salisbury, MD, February 2019.

**Performance Measure:** 3.4b: Percentage of FSSI fish stocks with adequate population assessments and forecasts

**DOC Strategic Plan:** 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources

**NOAA RD Linkage:** D4b: Region-specific, nationwide, operational capability for ecological forecasting.

**Next Gen Priorities:** Sustainable fisheries and safe seafood for healthy populations and vibrant communities

**Project Number** 19-06

**Title:** Thermal impacts on juvenile Pacific Cod (*Gadus macrocephalus*) foraging and growth in Gulf of Alaska nursery habitats

**Thematic Research Area** CLIME: Climate Impacts on Marine Ecosystems

**Abstract:** The Gulf of Alaska is influenced by thermal variation including climatic phenomena and marine heatwaves such as the 2014-2016 and 2019 heatwaves. Warming events are expected to impact age-0 Pacific Cod (*Gadus macrocephalus*) during summer growth in coastal nurseries and can influence patterns of foraging, selective mortality, and overwinter survival. Understanding thermal impacts on juvenile Cod is especially relevant given their recent declines in adult abundance and the closure of the fishery in 2020. I will examine juvenile Cod in Kodiak Island nurseries between 2006 and 2019 during representative warm and cold years in order to describe variability in nursery growth, diet composition, and trophic position using otolith increment, stomach content, and stable isotope analysis. Expected results will inform cod recruitment patterns in the face of climate change and contribute to nursery management during future warming.

**Principal Investigator:** Hillary Thalmann, Oregon State University

**Co-PI:** Jessica Miller, Oregon State University

**NOAA Partner:** Ben Laurel, AFSC: Alaska Fishery Science Center

**Other Partner:** Bradley Stevens, University of Maryland Eastern Shore

**Students:** Hillary Thalmann (MS, OSU)

**Keywords:** Fisheries; Protected Species; Population dynamics; Ecosystems; Habitats; Climate variability

**Start Date:** 9/16/2018 **End Date:** 6/30/2021

### Results to Date

We are close to completing all diet analyses for juvenile Pacific Cod captured in July and August from 2006-2019, with the goal of these analyses to determine if prey community structure varies in relation to heatwave conditions in the Gulf of Alaska and to identify which prey taxa differ between heatwave years and the years before and between heatwave events. Preliminary results, using non-metric multidimensional scaling (NMS), Multiple Response Permutation Procedure (MRPP), and Indicator Species Analysis, suggest that community composition of juvenile Pacific Cod prey is associated with the presence of heatwaves in the Gulf of Alaska. Pre-heatwave cool years (2006-2013) overlapped very little in prey community composition with heatwave years (2014-2016, 2019). Years between the two heatwaves (2017- 2018), included shared prey species from both heatwave years and years prior to heatwaves. These shared characteristics suggest that diet composition of juvenile Pacific Cod may return to a pre-heatwave community composition if the system were allowed to recover without additional



thermal disturbances. During the marine heatwave events, juvenile Pacific Cod fed on larger polychaete worms and crangonid shrimps compared to their pre-heatwave diet of small copepods and gammarid amphipods. Juvenile Pacific Cod were larger during heatwave conditions, and this trend towards larger prey in warm years may be linked to their larger size and mouth gape width. We have analyzed ~50% of all otoliths in this project and anticipate completing otolith analyses by June 2021. Preliminary results suggest that juvenile Pacific Cod may be growing more quickly under heatwave conditions. We have collected stable isotope data for use in determining Pacific Cod trophic position through time, but have not yet analyzed this data. We anticipate completing this data analysis by summer 2021. I am also transitioning from a MS to a PhD, with anticipated graduation in summer 2024.

### **Relevance to NOAA**

Living marine resources such as Pacific Cod are critical for Alaska's commercial, subsistence, and recreational fishing industries and represent an important economic and nutritional resource at both a regional and national scale. This TAB project complements and expands ongoing Pacific Cod research within the NOAA Alaska Fisheries Science Center, including efforts to identify overwintering processes during the first year of life and the validation of an individual-based transport model for Pacific Cod. Quantifying trends in Pacific Cod growth and foraging within essential nursery habitat can illuminate changes in a nursery's ability to support a stenothermic species like Pacific Cod and lead to more effective precautionary management for long-term sustainability. For example, the North Pacific Fisheries Management Council sets an annual specific total catch for Gulf of Alaska Pacific Cod based on population- and ecosystem-level risk metrics. Growth patterns, condition, and diet composition of juveniles settling in coastal nurseries can be important metrics that indicate changes in the population and inform management decisions. Metrics such as these were used to help inform the 2020 closure of the fishery in response to unprecedented low biomass. In addition, climate-mediated declines in Pacific Cod have important ecosystem implications, with effects cascading up the food web to top predators such as salmon, marine mammals, and sea birds. The Kodiak Island beach seine time series is identified as a valuable dataset for the "ecosystem indicators" section of NOAA AFSC's Assessment of the Pacific Cod stock in the Gulf of Alaska because it is the only dataset for nursery-age Gulf of Alaska Pacific Cod that spans multiple thermal regimes and includes data from the 2014-2016 and 2019 marine heatwaves. Trends from these archived specimens can illustrate climate-mediated shifts in growth and production of juvenile Pacific Cod and aide in recovery efforts for the species.

### **Broader Impacts**

Stakeholders, fishermen, and related industry participants in Southeast Alaska are directly impacted by declines in Pacific Cod. To connect with other Pacific Cod scientists, I will work with Dr. Ben Laurel to help organize and participate in events connected to the Alaska Marine Science Symposium in Anchorage, with the purpose of connecting Pacific Cod scientists and stakeholders across the region to discuss current and future Pacific Cod research and potential collaborations. The first of these meetings was successfully implemented at the 2020 Alaska Marine Science Symposium and included a virtual follow-up meeting in February 2021.

### **Presentations or Publications**

Thalmann, HL, B Laurel, and JA Miller. Too hot to handle: effects of thermal variability on juvenile Pacific Cod foraging and growth. 2021 Alaska Marine Science Symposium. January 2021. Oral Presentation. Best Student Presentation Award.

Thalmann, HL, BJ Laurel, and JA Miller. Effects of thermal variability on juvenile Pacific Cod foraging and growth. 2020 NOAA LMRCS Virtual Science Meeting. April 2020. Oral Presentation.

Thalmann, HL, BJ Laurel, and JA Miller. Few surviving juvenile Pacific Cod are bigger, fatter, and shifting diets in a warm ocean year. Alaska Marine Science Symposium. Anchorage, AK. January 2020. Poster Presentation.

Thalmann, HL, BJ Laurel, and JA Miller. Thermal effects on pre-recruit Pacific Cod phenology, early growth, and prey quality in the Gulf of Alaska. 2019 Oregon American Fisheries Society Meeting Bend, OR. March 2019. Poster Presentation.

**Performance Measure:** 3.4e: Number and percentage of actions ongoing or completed to recover endangered and threatened species

**DOC Strategic Plan:** 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources

**NOAA RD Linkage:** C1b: Increase our knowledge and understanding of the mechanisms and impacts of environmental changes on marine species and ecosystems.

**Next Gen Priorities:** Recovered and healthy marine and coastal species

**Project Number** 19-07

**Title:** Population structure and growth of lane snapper, a data limited species

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** Lane Snappers (*Lutjanus synagris*) are a data-limited species that range from North Carolina, the Gulf of Mexico (GOM) and south to Brazil. This study will collect 400 sagittal otoliths, fin clips, length/weight measurements from fish caught from East Florida to North Carolina. Otoliths will be processed, aged and two experienced readers will be used to ensure accurate ageing. A variety of growth models will be used determine best fit. Genotyping by sequencing (GBS) will be used to determine genetic diversity. Results will complement a recent NOAA supported study that examined spatial and temporal variation in the age and growth of Lane Snapper in the GOM and data will be used to support future NOAA stock assessments by providing information on population structure and growth.

**Principal Investigator:** Adrienne Wilson, University of Miami - Rosenstiel School of Marine and Atmospheric Science

**Co-PI:** Elizabeth Babcock, University of Miami - Rosenstiel School of Marine and Atmospheric Science

**NOAA Partner:** Robert Allman, SWFSC: Southwest Fishery Science Center

**Other Partner:** Dionne Hoskins-Brown, Savannah State University

**Students:** Adrienne Wilson (PhD, RSMAS); Savannah Clax (Undergraduate, RSMAS)

**Keywords:** Fisheries, Marine Biology, Population dynamics

**Start Date:** 9/01/2019 **End Date:** 8/31/2021

### **Results to Date**

Due to COVID delays, I am still in the data collection phase. I have no results to present at this time.

### **Relevance to NOAA**

This study aims to address concerns raised in the recent SEDAR 49 data poor species assessment by increasing sampling of otoliths and tissue samples to examine stock structure and growth over the lane snappers US range. The evidence of multiple stocks will be investigated using the data we collect, thus improving the accuracy of assessment and allowing better advice on management decisions and the impact these decisions may have on anglers and coastal communities. Our project objectives directly align with NOAA's goal of the conservation of living marine resources. We will provide reliable and current information on Lane Snapper populations, growth, and age structure. Furthermore, the spatial and temporal comparisons will examine impacts caused by fishing and will enhance managers' ability to accurately quantify the abundance and distribution of Lane

Snapper. Previous studies indicated the potential for female Lane Snapper to experience heavier fishing pressure than males (Aiken 2001). This selection likely has an influence on the size structure of the species, which must be further examined. Using the data collected from this study, we can determine if different populations have different life history traits, which will enhance stock assessment and management recommendations. The genetic analysis will provide data that will define how populations are connected and also rates of adaptive change (Crawford and Oleksiak 2016). Data from this study will be used to increase confidence in estimates of population size, demographic patterns, and stock status. In the past, Lane Snapper have been grouped with other data limited species when developing management plans, landings data, and annual catch limits. This study will provide new age, growth, and genetic data that may find that Lane Snapper have unique life history traits and should be managed as such. Since Lane Snapper are data-limited, this study is vital to maintain the sustainability of the species and develop “optimal harvest strategies and determine the tradeoffs between alternative policy choices” (Hilborn and Walters 1991).

### **Broader Impacts**

Assessing a data-limited species can be very difficult for the scientists; however, the outcome of a stock assessment, and the management decisions that are made, can influence the lives of the communities that depend on the Lane Snapper. This study aims to collect data that will contribute to the long-term sustainability of the fishery and the genetic information will be used to identify population connectivity, thus increasing “the resilience of ecosystems, economies, and communities” that depend on Lane Snapper (Hilborn and Walters 1991). Collecting specimens through dockside sampling will encourage collaboration with local fishermen and allow us to build upon the relationship NOAA has within the fishing communities. These relationships are vital in order to have better cooperation with fishermen when management practices are being developed. The Lane Snapper fishery is driven by recreational fishermen. The NOAA Fisheries Economics of the United States Report, 2016 stated that Florida had the highest number of recreational fishing trips, the most money spent on trips (\$646.3 million), and the most recreational anglers to participate in fishing (3.7 million anglers), in the nation. Landings in the South Atlantic Region (East Florida, Georgia, North Carolina and South Carolina) totaled \$190.9 million and North Carolina had the highest revenue in the region (NOAA 2016). With Lane Snapper falling within the regions with the largest number of recreational fishers and landings, new and accurate data are needed immediately. This study will provide much needed information on the population structure and growth of Lane Snapper. Our findings will then be used to conduct a management strategy evaluation so we can provide new recommendations for management practices, such as regional size and catch limits. Therefore, with the collaboration of the anglers, we will increase our understanding of Lane Snapper and assist managers in making better predictions to prevent overfishing or even the collapse of the stock. Thus, our results will help protect the livelihoods of the coastal communities and people that depend on the Lane Snapper fishery.

**Presentations or Publications:** None to date

**Performance Measure:** 3.4a1: Fish Stock Sustainability Index (FSSI) (cumulative)

**DOC Strategic Plan:** 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources

**NOAA RD Linkage:** C4c: Develop integrated models that take advantage of synoptic data at various scales, to inform ecosystem-based management

**Next Gen Priorities:** Improved understanding of ecosystems to inform resource management decisions

**Project Number** 20-01

**Title:** An analysis of distribution and abundance of microplastics in selected commercially important species in Northern Georgia coastal waters

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** The various densities of plastics allow for particulate plastics to settle or aggregate in different habitats in the marine environment, thereby increasing their prevalence in a variety of organisms that inhabit areas where particulate plastics accumulate. The proposed research is to study the microplastic abundance in organisms of economic importance in Georgia in an effort to understand the ecological impact of microplastics in the aquatic, estuarine, and marine environments. The objectives of this proposal are to: (1) analyze microplastics in selected commercially important species and (2) to analyze the spatial abundance of microplastics in selected waters near Savannah, GA, USA.

**Principal Investigator:** Savannah M. Geiger, Savannah State University

**Co-PI:** Dr. Sue Ebanks, Savannah State University

**NOAA Partner:** Ashok Deshpande, NEFSC: Northeast Fishery Science Center

**Other Partner:** Kimberly Roberson, NOS

**Students:** Joe Day (Undergraduate, SSU); Lady Volmar (Undergraduate, SSU); Alexandria Tennant (Undergraduate, SSU)

**Keywords:** Fisheries; Ecosystems; Habitats

**Start Date:** 6/1/2020 **End Date:** 7/31/2021

**Results to Date**

Objective 1: To analyze microplastics in shrimp *Penaeus* spp., one UG student has been working on method development for shrimp digestions - cannonball jellies *Stomolophus meleagris*, and - spot *Leiostomus xanthurus* - one UG student has processed GI tract and gills for ~ 80 fish. Currently working on Raman microscopy analysis to get a final count of microplastics present within each fish. Objective 2: To analyze the spatial abundance of microplastics in selected waters near Savannah, GA, USA - one of PI Geiger's thesis chapters - samples were collected from within the lower Wassaw Sound Estuary, processed, and all samples analyzed on Raman.

**Relevance to NOAA**

The proposed research project correlates to the NOAA mission, namely to support habitats and biological systems (HaBS). The ecological role of microplastics in the marine environment will be addressed and will provide necessary preliminary work for continued microplastics research at Savannah State University. This information is relevant to the NOAA mission and focal point of creating sustainable, healthy habitats. Additionally, this proposal aligns with the 2019 NOAA Fisheries Priorities and Annual Guidance, specifically by amplifying the economic value of commercial and recreational fisheries while ensuring their sustainability. Furthermore, the proposed research aligns with NOAA's Marine Debris Program Strategic Plan for 2016-2020, namely to identify, assess and reduce the impacts of marine debris through detection, monitoring, source identification and innovative solutions. Investigating the prevalence of microplastics in commercially important species allows for the discovery of applicable information to pass regulations related to plastic use in Georgia. By identifying the specific microplastic compounds through GC/MS and Raman analysis, a better understanding of the plastic origin will be gained.

**Broader Impacts**

PI Geiger has created 3 K-12 classroom activities to communicate research that relates to this funded research. Activities include: (1) a puzzle map with data from objective 2 to visually represent microplastic abundances within coastal Georgia water

## Presentations or Publications

NOAA EPP Forum - PI Geiger - prepared but postponed due to COVID-19 "An analysis of microplastic abundance in organisms with varying foraging strategies in waters near Savannah, GA, USA"

1 Feb 2021 - LMRCSC Seminar Series - PI Geiger - "An analysis of microplastic abundance in organisms with varying foraging strategies in waters near Savannah, GA, USA"

NOAA EPP Forum - Joe Day - prepared but postponed due to COVID-19

**Performance Measure:** 3.4f: Number of habitat acres restored

**DOC Strategic Plan:** 3.1.2: Advance holistic, integrative ecosystem research (NOAA).

**NOAA RD Linkage:** C1b: Increase our knowledge and understanding of the mechanisms and impacts of environmental changes on marine species and ecosystems.

**Next Gen Priorities:** Improved coastal water quality supporting human health and coastal ecosystem services

## Project Number 20-02

**Title:** Investigating the Impacts of Adult-Oyster-Conditioned-Water on *Crassostrea virginica* Larval Setting Efficiency Utilizing Direct Setting in the Hampton River, Virginia

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** An alternative technique to traditional remote setting of oysters is direct setting. Direct setting substantially reduces material handling and cost by deploying pediveliger stage oyster larvae onto suitable substrate in the field. In this study the impacts of varying concentrations of Adult- Oyster-Conditioned-Water (OCW) on *Crassostrea virginica* larval setting were investigated in the laboratory and field. In the laboratory, oyster larvae were introduced to setting chambers and allowed 7 days to settle in four treatments of varying concentrations. Field experiments were conducted in which oyster larvae were exposed to one of three treatments for 30 minutes and then directly set on artificial reefs. For the laboratory and field experiments treatment concentrations were 0.03-0.11 mg/L (control), 0.840-1.44 mg/L (low), 2.09-3.87 (medium), and 1.49-6.62 (high). Setting efficiencies in the laboratory and field varied among treatments. This research suggest that OCW may enhance setting efficiencies in direct setting.

**Principal Investigator:** Sierra Hildebrandt, Hampton University

**Co-PI:** Deidre Gibson, Hampton University

**NOAA Partner:** Shawn McLaughlin and Jason Spires, NOS: National Ocean Service

**Other Partner:**

**Students:** Sierra Hildebrandt (MS, Hampton University)

**Keywords:** Ecosystems; Habitats

**Start Date:** 6/1/2020 **End Date:** 10/30/2020

## Results to Date

In the first lab experiment, setting efficiency was highest in the control (8.6%) and lowest in the high OCW (2.9%). The ammonia concentrations for each OCW treatment ranged from 0.12 mg/l in the control to 8.08 mg/l in the high OCW. Previous studies examining ammonia toxicity in oyster larvae found an increase in mortality and morphological damages when ammonia concentrations were above 6.36 mg/l (Reiner S.L. 2011). In the second lab experiment, the OCW bath time was reduced to 4 hours in order to reduce ammonia levels and compared to previous OCW studies. From the second lab study, setting efficiencies were higher in the low (34%) and medium (38.1%) OCW concentrations and lowest in the high OCW (18.9%). The ammonia concentrations for each treatment ranged from 0.04 mg/l to 2.44 mg/l. Using the results from the second lab experiment, low and high OCW concentrations were tested in the field to increase setting efficiencies. In the first field study, setting efficiencies varied between treatments. The average setting efficiency for the control, low, and high were 0.3%, 0.01%, and

0.04% respectively. During the experiment, the HAB, *Margalefidinium polykrikoides* bloom occurred, which has previously been shown to reduce growth and increase mortality by 20% in oyster larvae. In the second field study, setting efficiencies were calculated for all cages. Setting efficiencies for the control, low, and high were 0.64%, 0.76%, and 1.1%, respectively. These results suggest OCW does have the potential to increase setting efficiencies in the field. However, there are many variables that contribute to the success of direct setting, such as release method, that need to be further investigated.

#### **Relevance to NOAA**

The mission of NOAA Fisheries is "stewardship of living marine resources through science-based conservation and management and protection and restoration of healthy ecosystems." This project in addition to the direct setting technique aims to enhance oyster population recovery while minimizing cost and substrate replenishment. Specifically, this project investigates the use of a waterborne chemical cue to increase oyster setting efficiency in the field.

#### **Broader Impacts**

Direct setting has the potential to reduce cost associated with oyster restoration by reducing steps and cost in traditional remote setting (reduce need of substrate, reduce transportation and grow out transportation).

#### **Presentations or Publications**

Presented findings to NOAA Cooperative Oxford Laboratory on 10/26/2020; plan to publish results by June 2021. I also plan to present findings at Hampton University School of Science Symposium in April 2021 and at Chesapeake Bay Foundation Oyster Symposium

**Performance Measure:** 3.4f: Number of habitat acres restored

**DOC Strategic Plan:** 3.4.3: Enhance place-based conservation

**NOAA RD Linkage:** C5b: Supporting aquaculture as an effective tool for improving coastal community economies and improving habitat quality

**Next Gen Priorities:** Healthy habitats that sustain resilient and thriving marine resources and communities

#### **Project Number** 20-03

**Title:** Proteomic analysis of two *Haematococcus pluvialis* strains as aquaculture feedstock

**Thematic Research Area** SNAP: Seafood, Nutrition, Aquaculture, and Pathology

**Abstract:** The green microalga *Haematococcus pluvialis* produces an antioxidant pigment, astaxanthin, which is widely used in salmon aquaculture as feed additive. Current algae industry uses phototrophic cultivation for *H. pluvialis* production, however, under these conditions the growth rate and astaxanthin productivity are low. Two mutant strains of *H. pluvialis* have been generated through chemical mutagenesis that demonstrate increased heterotrophic growth and astaxanthin productivity, addressing the bottlenecks of *Haematococcus* production. To understand the molecular underpinning of this phenotype, we propose further molecular characterization of these two mutant strains through LC-MS/MS based proteomic analysis. The knowledge generated will help development of rational engineering strategies for improved astaxanthin production in microalgae and promote its use in aquaculture.

**Principal Investigator:** Kyarii Ramarui, University of Maryland Center for Environmental Science

**Co-PI:** Yantao Li, University of Maryland Center for Environmental Science

**NOAA Partner:** Gary Wikfors, NEFSC: Northeast Fishery Science Center

**Other Partner:** Allen Place, Joseph Pitula, UMCES, UMES

**Students:** Kyarii Ramarui (PhD, UMCES)

**Keywords:** Aquaculture; Social science; Plankton; Feedstock

**Start Date:** 5/1/2020 **End Date:** 8/31/2021

## Results to Date

Recently I have conducted a two-step cultivation experiment comparing a mutant *H. pluvialis* strain (KREMS 23D-3) against the wild type *H. pluvialis* in preparation for future proteomic analyses. The two-steps of the cultivation period included a 6-day heterotrophic growth period in which cultures were grown heterotrophically with a carbon source provided in the liquid growth medium in the form of sodium acetate. On Day 6, when cultures reached their maximum cell densities (cells/mL), they were transferred to bubbling columns where they were provided 1.5% CO<sub>2</sub> and were exposed to high light stress (c.a. 450 mol m<sup>-2</sup> s<sup>-1</sup>). Cultures were exposed to high light stress for five days. Throughout this entire cultivation period, various samples were collected to understand growth characteristics and nutrient consumption rates of the two strains. Growth curves were monitored by measuring cell density (cells/mL), optical density (750 nm), biomass concentration (mg/L), and cell morphology every day. Supernatant samples were also harvested to measure the rate of consumption of acetate, nitrate, and phosphate. Additionally, biomass samples for proteomic and for transcriptomic analyses were collected in the early time points of each stage of cultivation. At the end of high light stress, cultures were harvested, and the biomass was freeze dried for astaxanthin content, lipid content, and lipid composition analysis. Preliminary results showed that the mutant strain achieved a slightly higher cell density than the wild type on the final day of during stage 1 that was statistically significant (p-value < 0.05). On Days 3, 4, and 5 of stage 1, the OD750 of the mutant was also higher than the wild type with statistical significance. However, after transition to (Days 7-11) high light stress, the wild type cell density and OD750 exceeded that of the mutant strain. Conversely, on Days 7-11, the mutant biomass concentration (mg/L) and biomass per cell (ng/cell) were higher than the wild type, with a statistically significant difference on Days 8 and 9, and on Days 7, 8, 9, and 10, respectively. This suggests that under high light stress, the mutant cells do not divide as much as the wild type cells, making their cell densities lower, but the individual cells or the mutant are larger than the wild type cells. Biomass for astaxanthin content, lipid content, and lipid composition will be analyzed next to determine how the mutant performs in comparison with the wild type. Additionally, nutrient concentration in the supernatant will be analyzed to better understand how the mutant and wild type consume nutrients under these cultivation conditions.

## Relevance to NOAA

This research addresses the Seafood, Nutrition, Aquaculture, and Pathology (SNAP) Research Thematic Area. This study will elucidate the molecular basis of acetate metabolism and astaxanthin biosynthesis in the microalga *H. pluvialis*. The knowledge generated will help in the development of rational engineering strategies for improved astaxanthin production in the algae and aquaculture industry. Greater yield of algae-derived astaxanthin can allow its increased use as a feedstock in aquaculture, where astaxanthin is beneficial both for achieving a pink flesh color and for improving the health of fish stocks. Our work will thus address NOAA's mission in developing economically and environmentally sustainable marine aquaculture. The project findings will be continuously reported to the LMRCS in six-month reports, submitted for publication in peer reviewed journals, and presented at scientific conferences.

## Broader Impacts

Currently, the primary bottlenecks for the algae astaxanthin industry are the low biomass and astaxanthin yield of the producer microalga *H. pluvialis*. As a result, the algae astaxanthin price is as high as ca. \$7000/kg. Our work will address these challenges to reduce cost and allow for stable, high-yield production of *Haematococcus* astaxanthin. Success of this technology will generate a novel culture system for commercial scale production of natural astaxanthin that could ultimately lower the production cost to <\$1,000/kg crystalline, much lower than current algae industry (ca. \$7000/kg). This would lead to a paradigm shift in algae astaxanthin production and its application in aquaculture, making algae astaxanthin competitive in the aquafeed market (predicted to be about \$500M in 2022). We will estimate and compare the production cost and economic efficiency of our technology with current technology in the

aquafeed market. Through this project, one LMRCSC PhD student (Ms. Ramarui) and at least one undergraduate intern from UMES will be trained. The broader impact of our work including the improved economics of aquafeed will be communicated to the public through NOAA EPP meetings, the annual IMET Open House event (over 600 attendees in 2019), etc.

**Presentations or Publications:** None to date.

**Performance Measure:** 3.4a1: Fish Stock Sustainability Index (FSSI) (cumulative)

**DOC Strategic Plan:** 3.4.2: Improve recovery of listed species through innovative partnerships

**NOAA RD Linkage:** C5c: Create new technologies for better siting aquaculture facilities

**Next Gen Priorities:** Sustainable fisheries and safe seafood for healthy populations and vibrant communities

**Project Number** 20-04

**Title:** Life history and disease ecology of the blue crab, a key benthic-pelagic link in tropical and temperate American estuaries

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** The blue crab, *Callinectes sapidus*, is an adaptable estuarine species that lives in Atlantic coastal regions from New England to Argentina. The species is a crucial part of the estuarine food web and supports a fishery worth \$200 million annually in the US. Across their range, blue crabs are infected by pathogenic viruses and protozoa that may interact with environmental and anthropogenic stressors to limit crab abundance. In Puerto Rico, *C. sapidus* is targeted by an artisanal fishery and provides income important to communities. Currently, no size or sex restrictions are in place to sustainably manage *Callinectes* spp. in Puerto Rico, and there is a lack of data on which to base fisheries management. In the tropics, *C. sapidus* is often sympatric with several other *Callinectes* species. Basic knowledge of *Callinectes* spp. distribution in estuaries in the San Juan metropolitan region can provide valuable insights into their ecological role and provide baseline data for monitoring abundance to inform resource management strategies. To address this knowledge gap, we plan to measure the abundance, sex ratio, female reproductive status, and diseases of *C. sapidus* and other *Callinectes* spp., including *C. exasperatus*, *C. ornatus*, *C. larvatus*, and *C. bocourti* by sampling 4 times per year, in a range of habitats (and environmental parameters) within a polyhaline estuary in the San Juan metropolitan area in Puerto Rico.

**Principal Investigator:** Eric Schott, University of Maryland Center for Environmental

**Co-PI:** Bradley Stevens, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** Mandy Bromilow, NOAA: Chesapeake Bay Office

**Other Partner:**

**Students:** Olivia Pares (MS, UMES)

**Keywords:** Fisheries; Ecology; Pathology

**Start Date:** 9/1/2020 **End Date:** 6/30/2022

### Results to Date

Prior to field work in Puerto Rico, Olivia Pares, Mingli Zhao, and Eric Schott tested the function of traps designed and constructed for capturing crabs in PR estuaries. Traps were deployed in Baltimore Harbor from piers, and in open water in strings of 5 traps marked with buoys. Because of complications of Covid19, we did not collaborate with DNR (coastal bays) on this exercise. Instead, we hired a local commercial fisherman to instruct us on the deployment of traps. Social distancing and masks were used in this open air activity in which only 2 people were on board the fishing vessel at any time. In October, Olivia transported 20 semi-assembled blue crab traps from MD to PR, completed assembly of all of them, and deployed them in the San Juan estuary. She worked with a local fishing charter company to deploy the traps. She arranged all the logistics for field work, adapting to Covid19 conditions. She measured and



dissected crabs in PR to record ovary development, and returned to Baltimore with crabs or crab legs for disease analyses. Two field samplings have been conducted in Laguna La Torrecillas Puerto Rico, October 2020 and January 2021. During those trips, we collected a total of 83 crabs in 3 days, of which 39% were *C. sapidus*, 31% were *C. bocourti*, 14% were *C. similis*. Both *C. larvatus* and *C. exasperatus* were 3%, and *C. ornatus* was 14%. We collected a total of 42 crabs in Laguna La Torrecillas in a 3-day period, of which 60% were *C. sapidus*, 30% were *C. bocourti*, 0 % were *C. similis*, 5% *C. larvatus*, 2% *C. exasperatus* and *C. ornatus* was 2%. Life history metrics and female reproductive status were also recorded in both locations. October and January samples were tested for CsRV1 and no crabs were positive for CsRV1. We are currently testing for *Hematodinium* spp. infections.

### **Relevance to NOAA**

This project is relevant to NOAA priority for “Improving sustainability, management, and assessment of stocks” and the LMRCSC Research Thematic area “SASI: Stock Assessment Support and Information.” This project has begun to measure *Callinectes* spp. abundance, age structure, and reproductive biology. It will start to define habitat use and distribution patterns in the estuary. In this regard, it also addresses the “HaBS: Habitats and Biological Systems” priority. The study is adding to the local collection of water quality, including dissolved oxygen, on the dates that crabs are trapped.

### **Broader Impacts**

The blue crab fishery in Puerto Rico is locally significant as a source of income and protein. However, it requires better regulation and lacks critical baseline data (abundance, habitat use, size at maturity, etc.) This project will produce first-of-its-kind data that will be made available to managers through the contacts at the San Juan Bay Estuary Program, academia, and local fishers. Simply initiating this kind of study has begun to raise awareness and interest in a resource. Making our research accessible to local high school students and teachers facilitates this awareness.

### **Presentations or Publications**

LMRCSC 2020 Virtual Science Meeting - NOAA EPP/MSI 10th Biennial Education and Science Forum

**Performance Measure:** 3.4b: Percentage of FSSI fish stocks with adequate population assessments and forecasts

**DOC Strategic Plan:** 4.2 - Provide Accurate Data to Support Economic Activity

**NOAA RD Linkage:** C1b: Increase our knowledge and understanding of the mechanisms and impacts of environmental changes on marine species and ecosystems.

**Next Gen Priorities:** Sustainable fisheries and safe seafood for healthy populations and vibrant communities

### **Project Number** 20-05

**Title:** Evaluating the effects of landscape scale habitat variability on white shrimp (*Litopenaeus setiferus*) population dynamics in Georgia estuaries.

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** Estuaries are recognized as important nursery habitats for penaeid shrimp species. Yet, there remain many questions about what exactly constitutes high-value, even critical, habitat for juveniles. In this study, we proposed to evaluate the nursery function of Georgia estuaries for white shrimp. We will evaluate relative abundance, growth, condition, and trophic dynamics of juvenile white shrimp among alternative landscape types. Furthermore, we will examine the use of stable isotope tags to identify areas within the estuary contributing greater proportions of individuals to the adult population. The results from this study will provide a better understanding of the population dynamics of estuarine and nearshore habitats and their

contribution to fishery productivity.

**Principal Investigator:** Matt Kenworthy, Savannah State University

**Co-PI:** Dionne Hoskins-Brown, Savannah State University

**NOAA Partner:** Jennifer Doerr, SEFSC: Southeast Fishery Science Center

**Other Partner:** Maurice Crawford, UMES

**Students:** William Burns (Undergraduate, SSU); Kris Howard (MS, SSU)

**Keywords:** Fisheries; Ecosystems; Habitats

**Start Date:** 6/15/2020 **End Date:** 12/30/2021

### **Results to Date**

During summer and fall of 2020 we conducted monthly trawl and cast net sampling surveys for white shrimp at our nine primary tidal creeks across the three main regions of the estuary being evaluated. Our preliminary analysis compared shrimp catch per unit effort (CPUE) among the different regions, months sampled, and marsh platform elevations (high, medium, and low). Preliminary analysis of trawl survey data suggests that there are differences in CPUE among the different regions of the estuary and months sampled; however there were no statistical differences between the three marsh platforms elevations considered. Analysis of the cast net catch data indicates that there is an effect of region, marsh platform, and month on shrimp CPUE. Mean CPUE on average was lower in the low marsh platform elevation tidal creeks. During our monthly collection surveys we retained up to 100 individual shrimp to quantify Fulton's K condition indices. Preliminary analysis suggests that there is an effect to region, month, and marsh platform elevation on mean condition index of white shrimp. On average, mean condition indices were higher for individuals collected at medium and high marsh platform elevation tidal creeks. This spring we will conduct drone surveys of our study sites to further evaluate how tidal creek habitat characteristics (marsh platform elevation, marsh continuity, and quantity of oyster reef and intertidal mud habitat) influence CPUE and condition of shrimp. Currently, we are preparing shrimp tissue for stable isotope analysis. Stable isotope data will be used to gain a better understanding of resource use across the regions of the estuary and the different marsh platform elevation creek classifications. Additionally, we will evaluate the spatial variability in isotope signatures to be able to identify putative nursery areas. Stable isotope signatures from adults emigrating from the estuary will be compared with juvenile signatures to identify where individuals came from. Lastly, I have undergraduate students evaluating relationships between shrimp growth and RNA:DNA concentration ratios. Last fall, undergraduate students conducted a mesocosm experiment to directly measure shrimp growth. Tissue was extracted from each individual shrimp and the students are currently working through protocols to extract nucleic acids to quantify concentrations of DNA and RNA.

### **Relevance to NOAA**

This study will directly address top goals and priorities outlined by NOAA Fisheries. Specifically the data collected will address needs to "Incorporating an understanding of ecosystem, climate, and habitat condition into assessments and management of U.S. fisheries by "quantifying the linkages between habitat and fishery productivity", which are priorities highlighted in the NOAA Fisheries Priorities and Annual Guidance 2019. Furthermore, this study will address the goal of "Conserving Habitat for Managed Fisheries and Protected Resources" outlined in the NOAA Fisheries Habitat Enterprise Strategic Plan 2016-2020. Specifically, these data can help stock scientists incorporate habitat specific data on white shrimp population dynamics into assessments of shrimp stocks in southeastern U.S. estuaries. Whereas these efforts have been prevalent in Gulf of Mexico states, to the best of our knowledge, efforts to quantitatively link habitat and white shrimp production are limited along southeastern U.S. coastlines.

### **Broader Impacts**

Our overarching goal is that coastal fisheries and habitat managers can use these data to rank

the “value” of individual locations within Georgia estuaries and that this information can guide resource managers in prioritizing conservation plans to maximize ecosystem function and fishery production. For example, managers can use this data to establish regulations for the recreational shrimp and commercial bait shrimp fisheries in Georgia to protect highly productive locations within the estuary. Currently there are no limitations on the locations where these fishing activities can occur.

**Presentations or Publications**

P.I. Matt Kenworthy presented preliminary results as part of an invited seminar given to the University of Georgia Department of Marine Science

P.I. Matt Kenworthy will be giving a virtual presentation on this project at the 2021 Georgia Water Resources Conference

**Performance Measure:** 3.4a1: Fish Stock Sustainability Index (FSSI) (cumulative)

**DOC Strategic Plan:** 3.1.2: Advance holistic, integrative ecosystem research (NOAA).

**NOAA RD Linkage:** C1b: Increase our knowledge and understanding of the mechanisms and impacts of environmental changes on marine species and ecosystems.

**Next Gen Priorities:** Healthy habitats that sustain resilient and thriving marine resources and communities

**Project Number** 20-06

**Title:** Investigating the effects of climate change on heat shock proteins and development in the early life history stages of Nassau grouper

**Thematic Research Area** CLIME: Climate Impacts on Marine Ecosystems

**Abstract:** Climate variability and change likely have major impacts on the early life history stages of commercially and recreationally valuable fish like Nassau grouper. Understanding these impacts will be essential to conservation and management efforts. Studies to date have noted phenotypic and survival differences in early life history stages of Nassau grouper reared at different temperatures. However, little is known on the drivers of these changes in bioenergetics and in gene expression during the early life history stages of this species. Our goal is to measure bioenergetic activity and use established genetic methods to investigate temperature induced changes in gene expression of early life stage Nassau grouper, collected from a spawning aggregation on Little Cayman, Cayman Island.

**Principal Investigator:** Janelle Layton, Oregon State University

**Co-PI:** Scott Heppell, Oregon State University

**NOAA Partner:** Steve Gittings, NOS: National Ocean Service

**Other Partner:**

**Students:** Janelle Layton (MS, OSU)

**Keywords:** Fisheries; Ecosystems

**Start Date:** 9/21/2020 **End Date:** 6/10/2022

**Results to Date**

Due to travel restrictions from COVID19, our field season was postponed and no results have been obtained. I am still in the process of data collection by taking various measurements of Grouper larvae.

**Relevance to NOAA**

As stated in the request for proposals for this funding mechanism: “The LMRCSC will conduct research that supports effects of climate on the distribution and production of living marine resources, including reproduction, growth, mortality, diseases and contaminants, and sustainability.” We will specifically provide fundamental data for the direct assessment of Nassau Grouper by analyzing and comparing the impacts of climate change on the early life history stages of this species in tropical water. We will have the ability to perform student

training in fish collection and rearing, laboratory-based genetics, and data analysis. In addition, the data directly relate to the mission of NOAA fisheries by influencing science-based conservation and management of living marine resources that will lead to the protection of healthy ecosystems. Given that Nassau Grouper are part of the management portfolio of three different Fishery Management Councils (SAFMC, GFMC, CFMC), these results have a direct impact on a federally managed species.

**Broader Impacts**

The data from our work will provide the information necessary to help conserve and manage Nassau Grouper. Economically, these fish are extremely valuable for commercial and recreational practices. Throughout the Caribbean region the fishing industry contributes about \$85-90 million annually to the economy. Sales from Nassau Grouper contributes about \$1.5 million to this industry (BREEF, 2014). This industry employs thousands of fishers who need to be able to continue their livelihood over time. Culturally, Nassau Grouper represent an important icon species, having played a significant role in the lives of Caribbean populations for centuries. This species is an important food fish for Bahamian culture. A popular dish, boil fish, is traditionally created with Nassau Grouper. Finally, tourists from around the world visit the Caribbean specifically to dive amongst the regions coral reefs and to interact with big fish. The opportunity to encounter threatened species like Nassau Grouper in the wild adds value to tourism.

**Presentations or Publications:** None to date

**Performance Measure:** 3.4e: Number and percentage of actions ongoing or completed to recover endangered and threatened species

**DOC Strategic Plan:** 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources

**NOAA RD Linkage:** C1b: Increase our knowledge and understanding of the mechanisms and impacts of environmental changes on marine species and ecosystems.

**Next Gen Priorities:** Recovered and healthy marine and coastal species

**Project Number** 20-07

**Title:** Assessment of New Technologies for Post-Harvest Oyster Purification

**Thematic Research Area:** SNAP: Seafood, Nutrition, Aquaculture, and Pathology

**Abstract:** Shellfish aquaculture is America's largest and fastest-growing marine aquaculture sector. A barrier to growth has been increasingly stringent post-harvest treatment requirements to counter illnesses from pathogenic vibrio bacteria. We aim to demonstrate the efficacy of two technologies, individually and combined, in removing pathogens from aquaculture system water and oyster tissues through a series of controlled experiments as one of two pillars of the to-be-recruited Cohort 3 DSU graduate student's thesis research. These trials will help 'ensure a safe and healthy supply of seafood, and increase consumer confidence in the quality of seafood' through applying 'innovative science and technology' to mitigate risks. This work represents a novel application of two commercially available technologies developed for other uses by our industry partner, Paradigm LLC.

**Principal Investigator:** Dennis McIntosh, Delaware State University

**Co-PI:** Salina Parveen, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** John Jacobs, NOS: National Ocean Service

**Other Partner:** Dorothy Leonard, Ocean Equities, LLC.

**Students:** Caiti Czajkowski (MS, DSU)

**Keywords:** Aquaculture

**Start Date:** 9/1/2020 **End Date:** 8/31/2022

## Results to Date

In the months since beginning at DSU, Caiti has been working on sourcing project supplies, readying her experimental systems, and drafting her MS thesis proposal. With respect to her thesis proposal, we are currently on the final revision, and by the end of the current semester (Spring 2021) will have selected the remaining members of the thesis committee and circulated the proposal for their review. Progress on the experiment systems is moving, albeit more slowly than we'd hoped. This is in large part due to delays in purchasing, etc., stemming from COVID impacts on University functions. Despite this challenge, we have designed, fabricated and tested two iterations of our exposure chambers that are the crucial element to adapt the existing commercially available technologies for use in aquaculture.

## Relevance to NOAA

Our goal is to manage harmful pathogens that affect human health worldwide. Specifically, our work will help to 'ensure a safe and healthy supply of seafood, and increase consumer confidence in the quality of seafood' through the application of 'innovative science and technology' to mitigate risks.

## Broader Impacts

There are more than 34,000 Vp infections in the U.S. each year, with about \$40 million in associated economic costs. Vv infections, though rarer, are more likely to lead to hospitalization and serious illness, including death, with mortality rates of 30-40%, resulting in \$320 million in economic losses each year, including medical services, lost wages, and cost of premature death (Muhling et al. 2017). The U.S. shellfish industry's many small farms operate on a narrow financial margin, with current PHP technologies beyond the reach of most. If successful, our approach to post-harvest shellfish purification will allow shellfish farmers to provide vibrio-free shellfish to their consumers (and, eventually, shellfish free of all pathogens).

**Presentations or Publications:** None to date

**Performance Measure:** 3.4a1: Fish Stock Sustainability Index (FSSI) (cumulative)

**DOC Strategic Plan:** 3.1.2: Advance holistic, integrative ecosystem research (NOAA).

**NOAA RD Linkage:** C5a: Enhance current species culture methods and identify new commercially viable species.

**Next Gen Priorities:** Sustainable fisheries and safe seafood for healthy populations and vibrant communities

## Project Number 20-08

**Title:** Evaluating physiological and immune responses of snow crabs (*Chionoecetes* sp.) to *Hematodinium* infection

**Thematic Research Area** SASI: Stock Assessment Support and Information

**Abstract:** A commercially important crustacean pathogen, *Hematodinium* sp., is a parasitic dinoflagellate of the *Hematodinium* genus that can cause Bitter Crab Disease/Bitter Crab Syndrome (BCD/BCS). There are high rates of *Hematodinium* sp. infection in snow crabs native to the Bering Sea, which can result in soiled crab meat and thus cause significant losses to commercial stocks. *Hematodinium* may affect regulation of metabolic gene expression in infected crabs, based upon observed changes in biochemical composition. This study will explore this effect, in addition to the regulation of genes involved in the immune response in snow crabs. The effect of climate change on host snow crab immune function, and susceptibility to disease, is currently unknown. This study provides an opportunity to assess these parameters, and provide baseline information for assessment of the health of this fishery.

**Principal Investigator:** Shanelle Haughton, University of Maryland Eastern Shore

**Co-PI:** Joseph Pitula, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** Dr. Pamela Jensen, AFSC: Alaska Fishery Science Center

**Other Partner:****Students:** Shanelle Haughton (PhD, UMES)**Keywords:** Fisheries; Marine Biology; Ecosystems**Start Date:** 5/1/2020 **End Date:** 5/1/2021**Results to Date**

Thus far, samples have been collected and processed for further application. 200 Immature Tanner crabs were collected (115 females and 85 males), physiological observations recorded, and blood and tissue samples from each individual were collected. RNA has been extracted from hepatopancreas tissue of all individuals, with RNA yielded from 94 of the 200 samples. DNA extractions have also been completed for all 200 individuals, with yields from all 200 samples. 16s PCR analysis has been completed for all 200 samples to detect presence of bacteria in blood samples; 108 of 200 samples tested positive for 16s. Currently, qPCR to determine *Hematodinium* infection status of all 200 individuals is underway. Next, individual samples will be selected and flow cytometry will be completed to detect the number of immune cells in blood samples; trehalose and ecdysteroid assays will also be completed.

**Relevance to NOAA**

The effect of climate change on host snow crab immune function and susceptibility to disease is currently unknown. This study provides an opportunity to assess these parameters within the context of a disease known to seriously impact this economically important species. Therefore, we are fulfilling NOAA's mission of science and stewardship as our results can provide credence to arguments that attempt to demonstrate the consequences of climate change, in an effort to sustain crustacean (and other) fisheries. We are also providing baseline data for general studies into immune function in the system. This work is complementary to a funded project in the lab of our NOAA collaborator (Pam Jensen), helping to build partnerships between NOAA and UMES. Dr. Jensen will continue to act as a committee member for my dissertation. It also will serve as the foundation for a comparative study between infections of *Chionoecetes* and *Callinectes sapidus*.

**Broader Impacts**

*Chionoecetes* sp. crabs are an economically important fishery of Alaska and the United States. High rates of *Hematodinium* infection can potentially cause drastic population decline, leading to loss of a fishable resource and commercial losses from BCD. At monitoring sites set up for *Hematodinium* sp. in *Chionoecetes*, infection rates have steadily and annually climbed from 2014 to 2017 from single digit infection rates to all-time highs of 54% & 49% in immature snow crabs, respectively (Pam Jensen, personal communication). This increase is thought to be linked to climate change, and has important implications for the impact on the fishery and dependent communities in Alaska.

**Presentations or Publications**

Haughton, S. Pitula, J. (April 2020) "Evaluating Physiological and Immune Responses of Tanner crab (*Chionoecetes bairdi*) to *Hematodinium* sp. Infection". LMRCS 2020 Virtual Science Meeting.

Haughton, S. Jensen, P. Pitula, J. (September 2020) "Evaluating Physiological and Immune Responses of Tanner Crab (*Chionoecetes bairdi*) to *Hematodinium* sp. Infection". AFS 2020 Virtual Meeting.

**Performance Measure:** 3.4a1: Fish Stock Sustainability Index (FSSI) (cumulative)**DOC Strategic Plan:** 3.1.2: Advance holistic, integrative ecosystem research (NOAA).**NOAA RD Linkage:** C1b: Increase our knowledge and understanding of the mechanisms and impacts of environmental changes on marine species and ecosystems.**Next Gen Priorities:** Improved understanding of ecosystems to inform resource management decisions

**Project Number** 20-09

**Title:** Understanding Adaptive Capacity: An Analysis of Community Perceptions and Policy Responses to Ocean Acidification and other marine stressors on the West Coast

**Thematic Research Area** CLIME: Climate Impacts on Marine Ecosystems

**Abstract:** Ocean acidification (OA) disrupts the carbonate chemistry of coastal ecosystems, which indirectly and directly affects communities that depend on critical marine organisms. OA research typically seeks to understand natural system responses; yet, there is insufficient research that examines community and institutional responses or, more generally, their vulnerability to OA. Considering the insufficient information to direct policy efforts to combat OA, this project aims to assess if and to what extent four shellfish communities along the coast of Oregon have adaptive capacity (AC) to OA. By understanding the perceptions of the four coastal communities alongside perceptions of Oregonian decision and policy makers, the project hopes to contribute to broader efforts to apply human AC to OA.

**Principal Investigator:** Victoria Moreno, Oregon State University

**Co-PI:** Dr. Ana Spalding, Oregon State University

**NOAA Partner:** Dr. Shallin Busch, NWFSC: Northwest Fishery Science Center

**Other Partner:**

**Students:** Victoria Moreno (MS, OSU)

**Keywords:** Fisheries; Social science; Ocean Acidification

**Start Date:** 7/1/2020 **End Date:**

**Results to Date**

Due to COVID, I was unable to make actual site visits and conduct in person interviews with members in the community, so TAB funds have not been used to date. However, I was able to persist and complete 15 interviews and have begun analysis. Additionally, the policy analysis component has also been completed.

**Relevance to NOAA**

The project seeks to develop a framework to analyze the adaptive capacity of Oregonian wild-capture reliant communities to inform OA policy. NOAA has several intersecting missions, including studying vulnerability and increasing awareness of the current environmental challenges, including impacts on marine ecosystem businesses, and communities. Vulnerability is typically understood to be a combination of exposure, sensitivity, and adaptive capacity. This project will directly study adaptive capacity, a crucial segment of vulnerability and will explore how wild-capture reliant fisherman and community members perceive the issue of OA. Stakeholder interviews will help us understand vulnerability by providing insight on whether stakeholders have the necessary socio-economic tools and readiness to adapt to the impacts of OA. The understanding of wild-capture reliant crab fishermen awareness levels will shed light on the alignment of current policies with stakeholder concerns. By analyzing policy alignment, this study can provide evidence of where efforts to increase awareness of OA impacts and adaptation strategies can be refined. This study will also help to increase awareness in government and academic readers about the ways in which OA affects various social and economic processes within the Crab Industry in Oregon.

**Broader Impacts**

Adequately measuring the adaptive capacity of wild-capture reliant communities will provide insights for policymakers at local scales that can then translate into better regional policies and initiatives. This study will contribute to our growing understanding of how ocean acidification (OA) affects human behavior, which has traditionally been studied primarily from a natural and physical science perspective. By uncovering the perceptions of OA impacts and needs associated with adaptation strategies to respond to said impacts, we aim to help policymakers devise and implement policies that are better aligned to the needs of the community.

**Presentations or Publications:** None to date

**Performance Measure:** 3.4d: Number of protected species designated as threatened, endangered or depleted with stable or increasing population levels

**DOC Strategic Plan:** 3.4.3: Enhance place-based conservation

**NOAA RD Linkage:** C2a: Understand the processes of ocean acidification and its consequences for marine organisms, ecosystems, and human communities.

**Next Gen Priorities:** Resilient coastal communities that can adapt to the impacts of hazards and climate change

**Project Number** 20-10

**Title:** The Occurrence of Microplastics in Maryland Coastal Bay Fishes

**Thematic Research Area** HaBS: Habitats and Biological Systems

**Abstract:** An important problem is plastic pollution in the ocean with millions of tons of plastic flowing into the ocean every year. The breakdown of larger pieces of plastic can form microplastics (< 5 mm) that are easily consumed by marine organisms thereby posing a threat to their populations. The Maryland Coastal Bays are home to a variety of commercial and recreational activities but few studies have been done regarding microplastic pollution. For my master's research, I plan to quantify the presence of microplastics in Maryland Coastal Bay fishes by comparing the percentage of fish contaminated with microplastics by feeding type and location. I will also research the feasibility of a technique to remove microplastics from the water without harming the environment.

**Principal Investigator:** Imani Wilburn, University of Maryland Eastern Shore

**Co-PI:** Dr. Maurice Crawford, University of Maryland Eastern Shore (UMES)

**NOAA Partner:** Dr. Ashok Deshpande, NEFSC: Northeast Fishery Science Center

**Other Partner:** Dr. Kausik Das, The University of Maryland Eastern Shore

**Students:** Imani Wilburn (MS, UMES)

**Keywords:** Fisheries; Microplastics

**Start Date:** 6/1/2020 **End Date:** 12/31/2021

### **Results to Date**

Originally, I started with 221 fish. Because of some technical difficulties such as the vacuum pump not working and most of the samples being contaminated, I do not have any numerical results. However, I have adjusted my techniques and anticipate acquiring data this semester to complete my thesis by the end of the year.

### **Relevance to NOAA**

My research supports NOAA's long-term goal to improve and protect the health of marine ecosystems, habitats, species, and populations. This research falls under the LMRCSC thematic research area of the habitats and biological systems, specifically touching on the impacts of human activities on marine habitats and species. The project also supports the goal of NOAA's resilient coastal communities because of my efforts to develop a method to remove microplastics from water.

### **Broader Impacts**

Plastics and microplastics have serious impacts on wildlife, but little is known about how it may affect human health. Kosuth et al (2018) found microplastics present in packaged sea salt, beer, bottled water and tap water, confirming that people have begun ingesting microplastics, directly and indirectly, but the possible health effects are still not clear. Widespread presence of microplastics in fish could discourage customers from purchasing fish and negatively affect the industry. Overall, the issue of microplastics is not very well known to the public. I plan to create educational materials for the public so they can learn more about microplastics. I intend to



develop flyers and hands-on activities for K-12 students so they may learn about microplastics and its effects. These materials would be disseminated during outreach events conducted by the UMES AFS Subunit at local environmental events like Earth Day at the Salisbury Zoo and Bay Day hosted by the Maryland Coastal Bays Program. Because of the Covid19 pandemic, no K-12 activities have taken place at this time.

**Presentations or Publications:** None to date

**Performance Measure:** 3.4a1: Fish Stock Sustainability Index (FSSI) (cumulative)

**DOC Strategic Plan:** 3.4.3: Enhance place-based conservation

**NOAA RD Linkage:** D2a: Determine combined effects of environmental stressors on coastal species and ecosystems.

**Next Gen Priorities:** Healthy habitats that sustain resilient and thriving marine resources and communities

### Appendix III: Leveraged funds

#### Post-Secondary Student Support:

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
NSF	Grant	9/1/2016 – 8/31/2021	\$5,000,000	\$500,000	P. Chigbu; M. Sexton; A. Ishaque; S. Parveen	CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics	Funds support PIs salaries, students, research
NSF	Grant	3/1/18-4/30/21	\$298,905		P. Chigbu; M. Sexton	University of Maryland Eastern Shore Research Experience for Undergraduates in Marine and Estuarine Science	Funds support summer interns
NASA	Grant	2021-2026	\$158,335	\$5,278	P. Chigbu	Student Airborne Science Activation for MSI (SaSa) for training students in remote sensing	Funds support student training
NSF	Grant	8/1/18-7/31/21	\$741,820	\$10,000	Cuker and Lewallen	Multicultural Diversity in the Aquatic Sciences	Funds are used to support students to ASLO conference.
NSF-IUSE	continuing grant	7/26/2018-7/31/2021	\$517,552		Sue Ebanks, Edith Davis, Reginald Archer	Expanding HBCU Pathways for Geoscience Education	students available for recruitment; leveraged funds
NSF	Supplement	7/26/2018-7/31/2021	\$103,507		Sue Ebanks, Edith Davis, Reginald Archer	Expanding HBCU Pathways for Geoscience Education	students available for recruitment; leveraged funds
Ratcliffe Foundation	Grant	7/1/14 - 6/30/23	\$1,895,947	\$74,106	Russell Hill	Award to cultivate the leadership and business skills necessary to bring their research into commercial markets and to provide students with an enhanced appreciation of the potential business	Funds support graduate student stipends

						implications of their research.	
Charles & Lois Miller Foundation	Grant	2/1/21 - 1/31/22	\$10,000		Russell Hill	Contribution to the IMET Summer Internship program	Funding supports IMET Summer Internship, 2021
Bunting Foundation	Award	01/01/21-12/31/21	\$50,000		Rosemary Jagus	Contribution to the IMET Summer Internship program	Funding supports IMET Summer Internship, 2021
Anonymous Donor	Award	01/01/21-12/31/21	\$20,000		Rosemary Jagus	Contribution to the IMET Summer Internship program	Funding supports IMET Summer Internship, 2021
Jim and Patty Rouse Foundation	Grant	4/15/21 - 5/15/21	\$3,000		Eric Schott	Expanding access to marine science for High School student in under-served communities with an Open House private tour	Funding supports IMET Open House, 2022
Venable Foundation	Grant	12/1/20 - 11/30/21	\$10,000		Eric Schott	Support for underrepresented minorities to participate in the IMET Summer Internship	Funding supports IMET Summer Internship, 2021

### Collaborative Research:

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
NSF-OCE	Grant	5/1/21-4/30/26	\$60,500		Gibson	Cold Tongue Mixing	Funds used to support student travel for research in Ghana.
NSF-BIO-IOS	Grant	8/1/2019 - 7/31/2024	\$700,000	\$70,000	Horodysky	CAREER: Investigating environmental acidification and temperature as drivers of morphological alteration and physiological deficits in auditory systems of soniferous fishes	Research topics provided for LMR CSC funded student
NSF RIA	Grant	8/1/2020-7/31/2023	\$299,999	\$5,000	Lewallen	Epigenomic adaptations of dolphin skin	Research topics and supplies provided for LMR CSC funded student
Shark Conservation Fund via Dalhousie University	Grant	1/1/2020-1/30/2020	\$16,500	\$5,500	Elizabeth Babcock	Unlocking the global shark meat trade	Provides partial salary support for E. Babcock

NOAA/NMFS	MOU	January 2000-continuing	\$100,000	\$50,000	Dionne Hoskins	NOAA CMER	Support a NMFS FTE for a CMER program
Ocean Leadership	Grant	December 1, 2018 – June 30, 2019	\$10,000	\$10,000	Dionne Hoskins, Victoria Young	NOSB Regional Site	Produce the GA-SC NOSB competition
NOAA Ocean Acidification Program	Grant	October 2021-September 2024	\$182,306		Jennifer Leo, Jennifer Doer, Chris Hintz, Dionne Hoskins-Brown, Matthew Johnson	Synergistic science to advance HBCU student learning in changing ecosystems: Scaling up education and the ecological effects of OA on coastal marsh systems	Support for an LMRCS grad student
NSF Coastlines and People	Grant	October 2021-September 2024	\$1,298,284		Daniel Gleason, Kania Greer, Chris Hintz, Antionette Jackson, Dionne Hoskins-Brown	Coastal Research Integrating Society and Environment (C-RISE)	Support on climate change and social science in fisheries
NOAA Ocean Acidification Program	Grant	October 2021-September 2024	\$665,000		Patricia Yager, Charlie Phillips, Thomas Bliss, Justin Manley, Dionne Hoskins-Brown, Brian Hopkinson, Marilyn Hemmingway, Ronald Johnson, Janet Reimer-Gill, Emily Hall	Managing the Impact of Coastal Acidification and Ocean Warming on Georgia's Growing Shellfish Industry	Support on climate change, aquaculture, and social science in fisheries
NSF LTER Program	ROA +REU	2021-22	\$32,844		Merryl Alber, Dionne Hoskins-Brown	Local Ecological Knowledge in Gullah Geechee Communities	Support for social science in fisheries
NSF Coastlines and People	Grant	October 2021-September 2024			Kim Cobb, Jill Gambill, Phillip Omunga, Mildred McClain	Harnessing sea level sensors as tools for advancing climate justice in coastal Georgia communities	partial salary for Young, program support
Stephenson Pope Babcock Foundation	Grant	1/1/20 - 12/31/21	\$8,000	\$2,896	Feng Chen	Microbial communities on microplastic particles in marine environments	Funds support IMET outreach and interns
Various Donors	Award	7/1/16 - 6/30/21	\$215,079	\$3,305	J. Sook Chung	Blue Crab Genome Initiative	Funds provide data for intern research
United Way	Grant	10/1/19 - 3/31/21	\$234,574	\$49,483	Russell Hill	FISH Project: Providing fresh	Funding to support food insecurity

						and healthy seafood to underserved communities	
MIPS	Grant	2/1/20 - 7/31/21	\$100,000	\$12,584	Yantao Li	<i>In situ</i> astaxanthin production in microalgae	Funds support Kia Ramarui (Cohort IV) research
NSF	Grant	7/1/17 - 6/30/21	\$362,497	\$18,721	Eric Schott	Determining how variation in life history & connectivity drive pathogen-host dynamics	Funds support PI's salary and Olivia Pares (Cohort 5) stipend
NSF	REU Supplement	03/01/19- 6/30/21	\$31,288	\$1,005	Eric Schott	Determining how variation in life history & connectivity drive pathogen-host dynamics	Supplemental funds for summer intern
France Merrick	Grant	5/1/18 - 4/30/21	\$71,383	\$7,937	Eric Schott	Of Animals and Microbes: A Baltimore Harbor Investigations	Funds support PI's salary
Waterfront Partnership	Grant	5/1/19 - 6/30/21	\$29,759	\$9,352	Eric Schott	Molecular Screening for Microbes in Baltimore's Harbor 2019/2020	Funds support PI's salary and former summer intern's salary
Jim and Patty Rouse Foundation	Grant	1/1/20 - 6/30/21	\$3,000	\$333.33	Eric Schott	Molecular screening for human pathogens in the Middle Branch, Baltimore's other waterfront	Funding supports former IMET Summer Interns
MD DNR	Grant	8/7/19 - 6/30/22	\$515,421	\$85,903.50	David Secor	Reproductive Habitat of Chesapeake Bay Distinct Population Segment in the Nanticoke River	Funds support Nicholas Coleman (Cohort II) stipend and research

## Appendix IV: LMRCS C External Evaluation: Year 5 Mid-Year Report

### LMRCS C Mid-Year Report March 10, 2021

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

was reviewed and approved by internal project leadership, and also was submitted with the project proposal for review and approval by NOAA EPP. This current mid-year report for program year five has been written by Drs. Bishop and Walters and submitted to the LMRCSC Project Director. It should be noted that year five has been substantially impacted due to the SARS-COVID Emergency Response conditions which have been implemented across the nation, implicating each of the institutions where LMRCSC is implemented. These responses have included significant shifting of face to face activities to online communications methods, and creating programming planning and implementation complications. Due to these responses, NOAA EPP has issued a one year no-cost extension to the LMRCSC to continue and finalize planned activities for the project period. The external evaluators included select response items on the student survey reported below to attempt to ascertain some of the impact of these COVID responses on the LMRCSC students themselves. The evaluators have continued to participate in monthly leadership committee calls and recurring education committee calls during the COVID response period in year five, and have provided evaluation updates at these committee meetings.

Among the significant programs implemented under LMRCSC is the *Data Management for Scientists* graduate course taught online as a requirement for all students in the program. This current mid-year report provides summaries of a survey which was implemented for a second year on this graduate course, with some cross-comparisons from the findings and observations from the first implementation of this same survey.

Additionally, on a rotating basis across the project period, the evaluators have collected response data directly from the graduate students (and undergraduates, although after the undergraduate evaluation report was distributed in fall 2020, no undergraduate students completed the survey). This current mid-year report includes summaries of these graduate student responses for this current programming year, as well as the responses to the COVID related items as noted above.

### *Data Management Course Survey Report 2020*

There were thirteen graduate students sequenced to take the data management course this cycle. Of this number, ten completed the course, one only audited the course, one deferred until next year, and one did not pass. Five of the students completed a twenty-two question survey about the Fall 2020 data management course, after three invitations to complete the survey which were sent out by the LMRCSC administration staff.

### *Students' Data Management Foundation and Background*

The respondents conveyed mixed ratings of their ability in data management prior to taking this course, with only one person stating, "above average." Each of the five respondents listed either one-three credit hours or four-six credit hours as hours of statistics or data management that they had previously taken. After taking the course, all five respondents rated their ability as "average." This was interesting in that one person's self-rating dropped to average from above average and two people's understanding increased to "average." The respondents learned about the class from several sources, including an advisor, cohort members and mentors as well as noting that it was recommended or mandatory for their program.

### *Overall Ratings*

The overall course rating (Question ten) given by four of the respondents was: "low quality." (three people) And Neither "high" nor "low" (one person). The overall rating of instruction (Question seventeen) was rated "average" by four of the five respondents and one

person rated it “Below Average.” One person said, “it has been easier to understand this course watching videos on YouTube.” It should be noted that LMRCSC administrative team and the external evaluators have begun a conversation in concern over these ratings (even though the survey response is low) and are planning structured interviews with the graduate students on the specific topic of this data management course to pursue solutions to possible concerns.

### *The Structure of the Course*

The perception of the pace of the course was mixed, with three people saying it was too fast, one student too slow, and one suggesting it was paced perfectly. The amount of work required was also viewed in different ways by the different respondents. For two respondents the work exceeded their expectations. For two people their expectations were met, with one person saying it was below expectations for amount of work. Quotes reveal the difficulties with the amount of work required:

*“The class was very slow and the communication with the instructor was not the best.” “The material was very difficult to grasp so I ended up spending a lot more time doing assignments.”*

When asked about the appropriateness of the course software, two of the five respondents felt it was appropriate. However, the other three respondents said it was not appropriate with one person explaining about their inability to get the software running and the ensuing damage to their computer. Two people clearly felt that this software was not helpful for their research and the data they collect. One person felt R programming or even SAS would have been more beneficial than MySQL. A quote illustrated this frustration, “Most assignments were to take our own data and use the software to analyze it but I felt like that did not make sense. Using this software for my own research would not make my data analysis easier or more organized.” One person expressed a positive view of the course structure, saying that it was positive: “He taught us the format of the computing language before we even started coding.”

When asked about the effectiveness of the online course format, the reaction was mixed, with two students saying it was effective and three respondents saying it was not effective. Comments about the online format included:

- “To be effective more than just talking live in a computer is needed.”
- “Give the assignments written because it is hard to get all the instructions by hearing them one time with a connection that is cutting off.”
- “The Professor could not physically see the error codes and messages being displayed to the students so his response to us was to just look it up on google.”
- “While the lessons were being recorded, very often the screen cut off so what the professor was showing could not even be seen, making the recordings unhelpful.”
- One person said, “This course does not need to be taught online.”

### *The Usefulness and Timing of this Course*

All five respondents indicated that the course content was not used by them in either a NERTO or a TAB. When asked (item eight) if the course was helpful for their career, two answered “yes” and three answered “no.” When asked about the helpfulness of this course for meeting other LMRCSC students, two students said “yes” and three people said “no.” Even with the low response rate (about fifty percent) to the survey, this proportion of negative reactions is a concern and part of the current conversation about the course that was noted above.

When asked if this course was offered at a helpful time in their academic course of study, the responses were mixed. Although two people indicated that it was at an appropriate

academic time, three disagreed. One person said it would have been better at the beginning semester and one person said it conflicted with another course, therefore creating difficulty. One person explained with a strong statement about the inappropriateness of this course: “I answered no because I really didn’t find this course helpful or relevant for my research, so it really doesn’t matter when it is offered.” An additional quote took the same, negative approach: “I did not find this course helpful for my future career as majority of my data has to do with numbers; Nothing that could help me in the case of organizing colony counts, sample sizes, etc.” And a third concerning response: “Course gave me insight on some data management tools but background information on how to utilize it was not clear.” Two respondents felt it was helpful to learn the concepts, but one said, “I don’t think that will be useful in my future work or career. We did not delve deeply into the topic for me to feel like I can use this programming language in the future.”

### *Student Learning Outcomes and Benefits*

When asked about their improvement of ability to develop a data management plan, responses indicated various perspectives: two said “yes”, two said “no,” and one person was “not sure.” This mixed reaction was also reflected in their responses to the ability to manipulate and analyze data, with one student stating this skill improved because of the class, two students saying “no,” and two students being “Not Sure.” A similar pattern of mixed reactions was also articulated when asked about the effectiveness of the hands-on activities supporting their learning. The students did indicate that there were some beneficial skills developed in the course:

- Getting a general overview of how databases are made and managed
- Learning how to create a database
- Creating parent and child databases
- Creating a data management plan using DMP tool

Question thirteen of the survey asked respondents the primary benefits of taking this course. While two respondents listed skills such as using data management tools and increasing knowledge of computational tools, other respondents reflected less positive reactions. One person said the main benefit was fulfilling the LMRCSC requirement and meeting other LMRCSC students. Three quotes illustrate lack of benefits associated with this course:

“No benefits, this class gave me so much stress that it is affecting me in other classes.”

“I couldn’t complete the course because the program need for this course damaged my computer....”

“I honestly do not know what the primary benefit of this course was. I felt as though I had a much harder time organizing my data on the MySQL software than using excel.”

### *Challenges and Criticisms*

Question fourteen asked specifically about course challenges, and the difficulties mentioned elsewhere were reiterated and expanded in responses to this question. This question evoked strong responses. Some respondents indicated great difficulty following the course and understanding the content that was being presented. Two of the students said they did not have a clear understanding of assignments or what the course expectations were. Furthermore, Wi-Fi difficulties and challenges with using Mac software, learning how to correctly use MySQL Workbench, setting up problems correctly, and correcting script errors created challenges. One

person mentioned lack of interaction with the other students to be a challenge. There was an issue with incompatibility with the professor using a Windows computer and student having a MacBook, forcing the student to use YouTube for information to complete assignments. Again, students' narrative responses highlight their perceptions related to challenges with this class:

- "Downloading a program affected my computer and my studies in other classes as this computer is only tool for everything we do."
- "Couldn't download a data management program into my computer."
- "Often the professor gave us homework assignments but completed them in class."
- "I did not feel as though the information was being thoroughly shared and explained..."
- "I learned more in a couple you tube videos than in this class, which was very slow and unclear. It was hard to know what I was being asked." Additionally, this person stated that "the recordings of this class are very bad."
- "He kept switching between languages, so it was hard to tell what the right syntax was for a given language. Sometimes materials provided were only compatible with one syntax or software, so those students who were using the other version either could not use the file or had to significantly edit the file in order for it to work, which required a lot of additional work."

One quote highlights a substantive difficulty: "It was also challenging because people were using different computers (Mac vs PC) and coding languages (My SQL vs SQL server) and we kept jumping back and forth between all of those, so it was hard to get a grasp on the syntax that would work best for my computer."

### **Suggestions and Ideas for Improvement**

The overall sense from the student responses was this course needs to be improved. This follows on from and reiterates the 2019 survey results, which also indicated that there were definite improvements needed. In comparing the student responses from the 2019 administration of the course and the follow-on survey, it is difficult to see that the course has improved, with many examples of student concerns continuing into this second year survey. However, in fairness to the instructor and the LMRCSA team, only five of the ten students who completed the course took the time to complete the survey, and so sampling bias toward negative responses is an authentic concern in interpreting these course evaluation data. This is in part the motivation for an ongoing conversation among LMRCSA administration staff and external evaluators to design and conduct further data collection from a larger set of course student participants to seek concrete and actionable interventions to revise this data management course moving forward. This process will be part of the external evaluation annual report this coming summer.

Based on the student surveys for both 2019 and 2020, looking for replicated concerns from students, the following ideas seem to warrant consideration for course revision moving forward:

- Delineate clearer expectations in the master syllabus and distribute this to students;
- Provide written material to support the classes (this was requested by the student but not received);
- Provide a syllabus or hub where all class materials could be stored. These suggestions were mentioned in both program years. It is imperative that a syllabus be presented to the students and this should be remedied. It is unclear how a university could allow a credit course to be offered without distributing a syllabus to students;



- The syllabus should state the software and hardware requirements and where these are to be obtained;
- Effort should be invested to enhance the interactivity of the course, between and among students and the faculty;
- Consider the match between student learning outcomes and objectives and the assignments and assessments incorporated in the class;
- Explore screen-sharing capability to enhance learning;
- Consider the use of prerecorded instructions for software and hardware use and common or typical problems which may be encountered; and
- Seek handouts from the software publisher with common terminology, syntax error codes, and guidance—these are commonly available upon software adoption and seem not to have been distributed to students.

### *Final Observations*

A final question asked for any other comments the respondents wished to share with the evaluators. One person reiterated the stress that this course generated and the frustration that the course caused in damaging the laptops used for the course. This person exclaimed “I need to find the way to pass this course.... Required work on a program I don’t have, and I need it to graduate from my program.” Another person mentioned the difficulty to get properly enrolled in the course at their university, saying that “the course number and name should be in the online course catalog.” And once more the respondent mentioned the absolute need for a syllabus and online hub to keep track of all course materials and when assignments were due. The concerns and frustrations which are apparent in these survey responses need to be considered, and with suggestions for improvement being carefully reviewed, addressed, and remedied. Given the recurrence of some of these negative responses from multiple students in multiple years, it is not clear to the external evaluators that the course survey data was used for continuous quality improvement of this data management course.

### *LMRCSC Graduate Student Survey Fall 2020*

Of the eleven graduate students enrolled in this cohort, seven responded to this thirty-one-question survey. Given the funding provided to graduate and undergraduate students by LMRCSC, it is recommended that consideration be given to requiring participation in the external evaluation of the project by select and periodic survey responses be required of students. The survey questions ranged from student academic information, to background questions on their interest in science. Queries were made about extracurricular activities, course work and meaningful career preparation. Benefits and challenges were explored. These categories further serve as the framing categories of the structured student interviews which are conducted annually by the external evaluators to enhance the credibility and reliability of the overall evaluation process and to aid data interpretations. The responding students were from each LMRCSC participating university except Savannah State and the University of Miami. Six of the seven students were pursuing an MS degree and one respondent was a PhD student.

The degrees students are seeking are in Biology and Environmental Science (two students). Fisheries (two students), Marine Estuarine Environmental Science (two students) and Natural Resources (one student). None of the seven respondents had changed their major as a result of their participation in LMRCSC. When asked about their undergraduate degree, five students said their undergraduate degree was in Biology and two had degrees in Marine Science.

The survey then considered a set of career related questions. When asked about their ideal job, several respondents specifically indicated that they would prefer to work for NOAA. Several others desired a job in their field or in laboratory research; other goals mentioned included to work on an aquaculture farm, serve as a policy advisor, or to become a professor. When asked how and when they began considering a career in science, it was interesting to note that childhood experience played a key role. They used phrases to represent this early interest “I’ve always been interested in science since I was a child...as early as I can remember.” Two students mentioned that high school was the starting point of their interest and two others mentioned this occurred at the undergraduate level. When asked about the reason why they wanted to pursue a career related to science, a strong sentiment emerged on the part of the responding students that this was interesting and fulfilling. The altruistic motivation was illustrated by comments such as “help make the world a better place”, “contributing to a cause greater than myself and desire to add diversity to the field.” One student wanted to bridge science and policy.

When describing the research or field experiences they had participated in because of LMRCSC, respondents mentioned virtual NERTO and TAB projects with description of specific research about oysters and leopard seals. Two new students had not conducted research yet. The research projects mentioned were:

- New technology for oyster post-harvest treatment (aquaculture)
- Impact of oyster conditioned water on oyster setting efficiency
- Qualifying microplastics in coastal bay fish
- Impact of climate change on Nassau grouper
- Effects of climate change on leopard seals
- Proteomics

In addition to the specific research topic, the respondents mentioned that the value was also in learning how to implement a research project, create mentorships, acquire statistical and analytical skills, present findings, and build a network. One person stated, “It provides me the opportunity to fully develop, run, analyze, and report on a scientific project of my own....” One comment eloquently stated that the LMRCSC funding allowed “me to grow as a scientist and a scholar.”

An additional set of questions probed awareness of LMRCSC, source of that awareness, and mentoring background. Six out of seven students had received an orientation or information about the LMRCSC from someone at their home institution. The students described professional mentors who have guided them academically, helping students navigate the science field, providing guidance on a number of issues and helping students in the lab. Likewise, supportive faculty were identified and glowing positive comments about specific individuals were made. The specifically named mentors and faculty with these appreciative comments can be found in the attached raw data. An example comment illustrates the appreciation “The advice she gives comes from a place of caring and wanting the best for me as a student.”

Students mentioned a number of organized, school-based science programs, including conferences and meetings, courses, and publications from which they had benefited. Two of the respondents were EPP/MSI scholars. For extracurricular science-related activities, four out of seven respondents indicated involvement in extracurricular and community service activities, including citizen science projects, Governor School, AFS, and a Diversity Collaborative, and volunteering at a museum. All seven students said they remain in communication with a key high school or undergraduate faculty member. When asked about immediate family in a science career, only two indicated they had a family member engaged in science. Key adults in their lives were important in encouraging these students’ interest in a science career. They

mentioned their parents, and an uncle as specifically supportive of their interest. When asked about employment prospects in science, the respondents perceived their employment prospects within their chosen career as very employable (three students) and Moderately employable (four students).

Students were asked about positive or beneficial LMRCSC activities from the prior year. The responses included:

- ASLO;
- Graduate seminar series;
- OSU virtual monthly meetings; and
- TAB proposal process “This was the first grant that I’ve ever applied for, so it was a very informative and valuable experience.”

The students said that these activities were the most significant because in many cases the listed activity was the only activity due to the emergency responses tied to COVID. The most beneficial courses were listed as Marine Population Dynamics, Conservation Biology, Fisheries Management and Life History of fishes, Biostatistics and Statistics. One student listed next generation sequence analysis using Unix based tools as a good introduction to computing languages.

Of key interest in this program is how LMRCSC has enhanced the students’ knowledge of NOAA. Students mentioned that the program has made them aware of more job opportunities across NOAA. One person stressed the increased realization of the importance of diversity to NOAA. One person highlighted increased knowledge of international treaties, and agreement to protect Antarctic marine Living resources, which NOAA leads.

The respondents acknowledged limited interaction with other students or professors in the LMRCSC. Five people said this interaction was “low.” When asked about their knowledge of NOAA EPP, the responses were mixed. Two people said they had high knowledge while two said medium knowledge and three people said they only had low knowledge. When asked about continuing interaction LMRCSC through an Alumni Association, all seven students were interested or very interested in a potential alumni association. This seems to be an opportunity for a sustainability element for the LMRCSC moving forward, to leverage the involvement of these alumni.

When asked to reflect on their perceived greatest challenge moving forward in completing their career-related education, the responses were varied and offered some insight for potential remedies. The COVID-19 pandemic responses and challenges to the national economy and workforce were near the top of the list for a couple students. Other challenges included:

- Funding;
- Expenses for a cross-country move for potential job;
- Lack of help by professors when courses are on other campuses; and
- Public speaking and science communication weaknesses.

These comments point to possible solutions to be considered by the LMRCSC team. One suggestion would be to offer short courses or webinars on public speaking and science communication, taught by experts in these fields. The concern about professorial help when courses are offered at other campuses could be remedied through a structured online support or centralized advisement process. Perhaps there could be a team-teaching approach to involve a professor at the student’s own institution.

A final question was asked about students’ university responses to COVID and the impact on the students’ education. Responses included:

- Curtailed travel

- Decreased time in laboratories and decreased learning of lab techniques;
- Limited meetings with advisors or committee members;
- Some impact on course work with some professors, though it was mentioned that some university courses were already set up for virtual teaching;
- Difficulty in adapting to online work; and
- Feeling disconnected from LMRCSC and the other students.

When asked to offer ideas for additional support that would be helpful, the students provided some insights, which included:

- Career pathway meetings or discussions;
- Networking on a virtual platform;
- Fellowships or internships; and
- One person commented, “I feel that more information and resources from the LMRCSC would be helpful, especially in regards to making sure we are aware of all the requirements we need to fulfill for the LMRCSC.”

#### *Additional Activity by the External Evaluators and Final Summary Discussion at the Mid-Year*

While this current mid-year report is a snapshot of some student responses to two ongoing LMRCSC activities during the program year, there are additional activities which the evaluators have conducted or participated in which have involved significant effort.

First, in response to the year four IERT panel recommendations, the external evaluators invested significant effort to create a TAB post-project summative assessment which was built on the review criteria used to award these grant projects to students. This post-assessment instrument was revised several times and then provided to the LMRCSC administration for dissemination to the TAB students as they finish their projects—including any current or continuing students who have already completed a TAB project. As of this mid-year report date, this post-assessment has not been distributed to students, or else the students have simply not responded to the survey. The evaluators are maintaining this survey as an “open” instrument in data collection software and would like guidance from the LMRCSC director for this ongoing cost—if the survey is not going to be administered, it should be closed out.

In addition to this TAB post-assessment, again, recommended by the IERT panel report, an additional set of instruments and rubric were prepared in view of an assessment of the Core Professional Skills and Competencies which students develop across their LMRCSC participation. This process has not moved forward, and it is likely that the various institutional responses to COVID have certainly impacted the discussions and timetable for implementing this assessment item. It is recommended that this process and activity be further discussed at a monthly leadership team conference call in view of continuing this effort.

Third, there was an undergraduate student survey which was developed during year four based on the rotation plan for assessing student perceptions and activities in the LMRCSC. This survey was distributed electronically to the undergraduate students by LMRCSC leadership. Unfortunately, no useful sample of students responded to the survey this year. It is likely that the fall semester was hectic and somewhat chaotic for these young adults due to the COVID responses at their respective universities, nevertheless, it is critical that students participate in these evaluation efforts as a part of their support commitments for LMRCSC. This issue should be discussed by the project leadership team. There were reminders emailed out to prompt students, but these failed to yield additional responses.

Finally, significant effort was invested in developing, implementing, and reporting on the Data Management Course post-assessment in 2019 (with a final written report) and again in 2020 (reported above). The strong similar concerns of students over two consecutive years of

the course have warranted an ongoing conversation among the LMRCSC administration and external evaluators which should continue. To effectively demonstrate continuous quality improvement through the use of performance assessment data, the LMRCSC team should demonstrate some response to the persistent student negative assessments of the course in a tangible manner. Surely, the low sample size may in fact indicate that the larger proportion of student completers have no concerns to warrant their attention to completing the post-assessment survey—this would be a fairly typical sample bias here—but this should be ascertained through follow-up communication with a larger set of these students to ensure a quality experience of this critical program element.

## Appendix V: Performance Metrics from Implementation Plan

Education Performance Metrics:

Activities/Programs	2020/21	
	Proposed (12 months)	Accomplished (6 months)
# Students trained in NOAA related	56 (42*)	61(58*)
# B.S. Students who graduate in NOAA	6 (4*)	1(1*)
# M.S. Students who graduate in NOAA	11 (9*)	1(0*)
# Ph.D. Students graduating in NOAA	1*	1(1*)
# of internships (e.g. NERTO) at NOAA facilities	12	2
# of URM students in development activities that will lead them to attain degrees and/or employment	12*	57
# of EPP-funded graduates who participate in and complete agency mission-related postdoc. Level programs	2	2
Amount of leveraged funds (\$) for education and training	500K	\$615K
# of student presentations at conferences (average)	20	3
# of student co-authored publications	10	5

Research Performance Metrics:

Activities	2020/21	
	Proposed (12 months)	Accomplished (6 months)
Science Meeting date	June	Scheduled for April
# of collaborative research projects (TAB Proposals) funded	6 to 10	Currently under review
# of new & continuing proposals funded (leveraged funding)	12	35
# of scientific presentations at conferences	50 (15*-90)	10(3*)
# of theses & dissertations produced	12	2

# of peer-reviewed publications	10*-30 (25)	34(5*)
Amount of leveraged funds (\$)	\$3 million	\$1.1 Million
of NOAA scientists serving as mentors and advisors for student research each year	>20	47
# of intra-institutional partnerships in support of NOAA's mission	Average of 4	15
# of times LMRCSC publications have been cited	Will be documented	627 (92 from directly funded papers)

Administrative Performance Metrics:

Activities	2020/21	
	Proposed	Accomplished
Submission of monthly invoices to UMES	Monthly	Average time between invoices = 1.06 months
Successful execution of sub-awards (< 60 days of receiving award notification from NOAA EPP)	October or earlier	October (DSU, UMCES), November (HU, OSU, SSU), January (RSMAS)
Evaluate budget to ensure center funds are expended in accordance with budgets approved by NOAA EPP and in compliance with federal and state guidelines	Every 6 months	Every 6 months
Holding of LMRCSC Science meetings at NOAA facilities	Summer	Planned for 4/6-4/7/2021
Funding of collaborative research projects via TAB review process	Spring	Currently under review
Submission of semi-annual reports	Every 6 months	Every 6 months
Submission of student tracker data	Every 6 months	Sept. 2020
Executive Committee meetings	Monthly	Monthly
Updating of the LMRCSC Website	Weekly	Weekly
Meeting of the LMRCSC Education/Outreach Committee	Once every four months	Sept. 2020, Oct. 2020, Feb. 2021
# of featured articles in print or digital media per year referencing LMRCSC	At least 50	2

## LMRCSC Budget (Amount Received, Spent and Remaining), Years 1 to 5

### Amount Received

Amount Received	Non-Student	Student	Total Received
UMES/CENTER	\$ 4,760,171.52	\$ 4,442,516.19	\$ 9,202,687.71
DSU	\$ 642,826.01	\$ 747,176.88	\$ 1,390,002.89
HU	\$ 580,933.13	\$ 662,330.77	\$ 1,243,263.90
OSU	\$ 297,416.60	\$ 867,395.80	\$ 1,164,812.40
SSU	\$ 792,101.31	\$ 852,064.01	\$ 1,644,165.32
RSMAS	\$ 181,832.67	\$ 829,095.71	\$ 1,010,928.38
UMCES	\$ 625,077.15	\$ 927,031.27	\$ 1,552,108.42
<b>LMRCSC (All Institutions)</b>			<b>\$ 17,207,969.0</b>

### Amount Spent

Amount Spent	Non-Student	Student	Total Spent
UMES/CENTER	\$ 4,124,671.08	\$ 2,191,087.16	\$ 6,315,758.24
DSU	\$ 442,403.06	\$ 270,455.93	\$ 712,858.99
HU	\$ 349,547.30	\$ 299,715.41	\$ 649,262.71
OSU	\$ 166,078.61	\$ 516,573.98	\$ 682,652.59
SSU	\$ 439,103.71	\$ 500,811.75	\$ 939,915.46
RSMAS	\$ 80,343.70	\$ 546,961.53	\$ 627,305.23
UMCES	\$ 370,220.01	\$ 464,935.82	\$ 835,155.83
<b>LMRCSC (All Institutions)</b>			<b>\$ 10,762,909.1</b>

### Amount Remaining

Amount Remaining	Non-Student	Student	Total Remaining
UMES/CENTER	\$ 635,500.44	\$ 2,251,429.03	\$ 2,886,929.47
DSU	\$ 200,422.95	\$ 476,720.95	\$ 677,143.90
HU	\$ 231,385.83	\$ 362,615.36	\$ 594,001.19
OSU	\$ 127,277.19	\$ 354,882.62	\$ 482,159.81
SSU	\$ 352,997.60	\$ 351,252.26	\$ 704,249.86
RSMAS	\$ 97,608.97	\$ 286,014.18	\$ 383,623.15
UMCES	\$ 254,857.14	\$ 462,095.45	\$ 716,952.59
<b>LMRCSC (All Institutions)</b>			<b>\$ 6,445,060.0</b>



## DEPARTMENT OF COMMERCE RESEARCH PERFORMANCE PROGRESS REPORT (RPPR)

*For instructions, please visit*

[http://www.osec.doc.gov/oam/grants\\_management/policy/documents/RPPR%20Instructions%20and%20Privacy%20Statement.pdf](http://www.osec.doc.gov/oam/grants_management/policy/documents/RPPR%20Instructions%20and%20Privacy%20Statement.pdf)

AWARD INFORMATION	
1. Federal Agency: Department of Commerce / NOAA	2. Federal Award Number: NA16SEC4810007
3. Project Title: Living Marine Resources Cooperative Science Center	
4. Award Period of Performance Start Date: 09/01/2016	5. Award Period of Performance End Date: 08/31/2022
PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR	
6. Last Name and Suffix: Sexton , null	7. First and Middle Name: Maggie , L
8. Title: Assistant Director LMRCSC	
9. Email: masexton@umes.edu	10. Phone Number: 410-621-1049
AUTHORIZING OFFICIAL	
11. Last Name and Suffix: Bolek , null	12. First and Middle Name: Catherine , null
13. Title: Director	
14. Email: csbolek@umes.edu	15. Phone Number: 410-651-6714
REPORTING INFORMATION	
Signature of Submitting Official:  N/A	
16. Submission Date and Time Stamp:	17. Reporting Period End Date: 02/28/2021
18. Reporting Frequency:  <input type="radio"/> Annual <input checked="" type="radio"/> Semi-Annual <input type="radio"/> Quarterly	19. Report Type:  <input checked="" type="radio"/> Not Final <input type="radio"/> Final
RECIPIENT ORGANIZATION	
20. Recipient Name: UNIVERSITY OF MARYLAND EASTERN SHORE	
21. Recipient Address: 11868 ACADEMIC OVAL, PRINCESS ANNE, MD 21853-1295 USA	
22. Recipient DUNS:082611302	23. Recipient EIN:526002033



**ACCOMPLISHMENTS**

24. What were the major goals and objectives of this project?

Nothing to Report

25. What was accomplished under these goals?

Nothing to Report

**ACCOMPLISHMENTS (cont'd)**

26. What opportunities for training and professional development has the project provided?

27. How were the results disseminated to communities of interest?

*Attach a separate document if more space is needed for #6-10, or #24-50.*

**ACCOMPLISHMENTS (cont'd)**

28. What do you plan to do during the next reporting period to accomplish the goals and objectives?

**PRODUCTS**

29. Publications, conference papers, and presentations

Nothing to Report

**PRODUCTS (cont'd)**

30. Technologies or techniques

Nothing to Report

31. Inventions, patent applications, and/or licenses

Nothing to Report

*Attach a separate document if more space is needed for #6-10, or #24-50.*

**PRODUCTS (cont'd)**

32. Other products

Nothing to Report

**PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS**

33. What individuals have worked on this project?

Nothing to Report

**PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS (*cont'd*)**

34. Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

Nothing to Report

35. What other organizations have been involved as partners?

Nothing to Report

*Attach a separate document if more space is needed for #6-10, or #24-50.*

**PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS (cont'd)**

36. Have other collaborators or contacts been involved?

Nothing to Report

**IMPACT**

37. What was the impact on the development of the principal discipline(s) of the project?

Nothing to Report

**IMPACT (cont'd)**

38. What was the impact on other disciplines?

Nothing to Report

39. What was the impact on the development of human resources?

Nothing to Report



**IMPACT (cont'd)**

40. What was the impact on teaching and educational experiences?

Nothing to Report

41. What was the impact on physical, institutional, and information resources that form infrastructure?

Nothing to Report

**IMPACT (cont'd)**

42. What was the impact on technology transfer?

Nothing to Report

43. What was the impact on society beyond science and technology?

Nothing to Report

**IMPACT (cont'd)**

44. What percentage of the award's budget was spent in foreign country(ies)?

null , null

**CHANGES/PROBLEMS**

45. Changes in approach and reasons for change

Nothing to Report

**CHANGES/PROBLEMS (cont'd)**

46. Actual or anticipated problems or delays and actions or plans to resolve them

Nothing to Report

47. Changes that had a significant impact on expenditures

Nothing to Report

**CHANGES/PROBLEMS (cont'd)**

48. Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Nothing to Report

49. Change of primary performance site location from that originally proposed

Nothing to Report

**PROJECT OUTCOMES**

50. What were the outcomes of the award?

Nothing to Report

**DEMOGRAPHIC INFORMATION FOR SIGNIFICANT CONTRIBUTORS (VOLUNTARY)**

Gender:

- Male
- Female
- Do not wish to provide

Ethnicity:

- Hispanic or Latina/o Not
- Hispanic or Latina/o Do not
- wish to provide

Race:

- American Indian or Alaska Native Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Do not wish to provide

Disability Status:

- Yes
  - Deaf or serious difficulty hearing
  - Blind or serious difficulty seeing even when wearing glasses
  - Serious difficulty walking or climbing stairs
  - Other serious disability related to a physical, mental, or emotional condition
- No
- Do not wish to provide

*Attach a separate document if more space is needed for #6-10, or #24-50.*