Performance Report for Cooperative Agreement No: NA16SEC4810007
for the Period from March 1 to August 31, 2020

University of Maryland Eastern Shore

Living Marine Resources Cooperative Science Center

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I.   Accomplishments

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

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

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

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

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

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

1.   Major Activities:
Education Goals:
Student Recruitment Activities: During this period, recruitment activities focused on recruiting qualified undergraduates from existing student populations at partner institutions as well as outside activities. Typical recruitment activities at professional meetings and campus events were minimal. However, we have begun planning for an online recruitment event that will take place in the next reporting period. A selection of activities that took place during this period include:

DSU: Doing online recruitment and recruiting DSU undergraduate students
HU: Distributed announcements for graduate student opportunity via LMRCSC email and the MAS newsletter.
OSU: Worked with 4 potential new graduate candidates, one went to University of Miami-RSMAS, one elsewhere, one starts this fall at OSU (Janelle Layton), and the other student is applying.
RSMAS: Research Ethics (RSM 700) is offered every fall, and required for RSMAS graduate students
SSU: Google hangout meetings were used to recruit 2 URM students
UMCES: Attendance at local college science and job fairs. Hosted visit by UMBC Biology Club. Held IMET Virtual Summer Undergraduate Internship
UMES: Recruited undergraduate students through Geoscience Bridge Program (online) and Rising Sophomore Experiential Training Program (abbreviated due to COVID)

Training and Preparation of students for careers in marine and fisheries science: Enhanced engagement with NOAA Scientists to Identify Opportunities for NOAA
Training of students has continued through regular center-wide seminars that included during this period an Orientation for students and Graduate Seminar Series. Additional activities occurred at individual partner institutions:

DSU: All DSU graduate students are engaged and preparing for careers in the marine and fisheries sciences. DSU recruited 1 graduate student and has identified 2 more URM graduate students.

HU: The HU undergraduate and graduate curriculum prepares students for careers in marine science. All students were engaged in semester research. Other workshop activities were postponed due to COVID-19 restrictions.

OSU: Bimonthly or monthly meetings with students regarding research; professional development discussions regarding professional societies; encouraged and supported student joining AFS and participation in 2020 Virtual Meeting

SSU: R is being taught by Matt Kenworthy in graduate statistics course

UMES: Graduate students meet monthly and undergraduate students meet twice monthly with Dr. Sexton to discuss professional development topics. Spring topics focused on COVID-19 related academic concerns, professional communications generally and in an online environment, and time and stress management. Topics are determined based on student requests and feedback.

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. Since all undergraduate internships at UMES were canceled for the summer, the students who would have participated in the Rising Sophomore Experiential Training Program were engaged online with an introduction to the LMRCSC and professional development seminar. Plans are underway to support a research internship for these students in the future.

Scott B. Gudes Public Service Graduate Scholarship in Marine Resource Conservation –
Plans are underway to select and announce the next Scott B. Gudes Scholar.

Research Goal:
In 2019-2020, eleven active TAB projects were investigated by students and scientists at LMRCSC partner institutions. Three of these began in 2018, four in 2019, and four in 2020. Ten new projects were proposed and funded in 2020; because of the covid-19 pandemic field work for most of the projects have not begun. The following table and list of abstracts describe only those projects that were active in the last year.

Table 1. TAB projects during this period*

Project Number	Principal Investigator	Title	Thematic Research Area
18-01	Brittany King	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	Fishery Economics and Social Science
18-03	LaTreese Denson	Sensitivity of indices of abundance to the specification of environmental covariate in spatiotemporal geostatistical models	Stock Assessment Support Information
18-06	Detbra Rosales	Assessing the impacts of harmful dinoflagellates and *Vibrio* spp. on oyster aquaculture In the Delaware Inland Bays.	Habitats and Biological Systems
19-02	Shanelle Haughton	Evaluating physiological and immune responses of snow crabs (*Chionoecetes* sp.) to *Hematodinium* infection	Stock Assessment Support Information
19-04	David Secor	Validation of monkfish age and growth using microconstituent analysis of hardparts	Stock Assessment Support Information
19-05	Keala Pelekai	Utilizing Pacific Lamprey anatomical structures as records of age, natal origin, & trophic patterns	Stock Assessment Support Information
19-07	Adrianne Wilson	Population structure and growth of lane snapper, a data limited species	Stock Assessment Support Information
20-01	Savannah Geiger	An analysis of distribution and abundance of microplastics in selected commercially important species in Northern Georgia coastal waters	Habitats and Biological Systems
20-02	Sierra Hildebrandt	Investigating the impacts of adult-oyster-conditioned-seawater on the setting efficiency of *Crassostrea virginica* larvae utilizing direct setting in the Ffield	Habitats and Biological Systems
20-05	Matt Kenworthy	Evaluating the effects of landscape scale habitat variability on white shrimp (*Litopenaeus setiferus*) population dynamics in Georgia estuaries.	Habitats and Biological Systems
20-10	Imani Wilburn	The occurrence of Microplastics in the Maryland Coastal Bays	Habitats and Biological Systems

Only currently active projects are included.

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

Data Management and QA/QC: The Data Management course is currently being offered in Fall 2020. Thirteen (13) 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.

Administration Goals:

a) The Center conducted its monthly Executive Committee, Education Committee, and Science Committee meetings.
b) The Center participated in and responded to the Independent External Review, submitted the response to NOAA EPP.
c) Additionally, the Center prepared and submitted a proposal to NOAA EPP requesting fifth year funds to support increased recruitment, participation, mentoring and graduation of students from underrepresented communities and to conduct research.

2.   Specific Objectives:

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

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

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

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

> **Objective 2.1**: Use relevant research-based curricula to provide students with the highest quality education in marine and fisheries sciences
>
> **Objective 2.2**: Use Virtual Campus technology to provide students with the opportunity to learn from some of the nation's leading scholars in marine and fisheries sciences
>
> **Objective 2.3**: Ensure that curricula of degree programs at partner institutions address current challenges and emergent needs within the profession
>
> **Objective 2.4**: Link students to professional networks and employment opportunities in marine and fisheries sciences

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

> **Objective 3.1**: Integrate the Center's research agenda with NOAA Fisheries research priorities in four key thematic areas: ecosystem change and prediction, stock assessment support, habitat research and protection, and safe seafood and aquaculture
>
> **Objective 3.2:** Foster collaborative research programs to strengthen the research capacities of partner institutions by leveraging the significant strengths and resources of research universities as infrastructure for capacity building
>
> **Objective 3.3**: Develop faculty recruitment and retention practices that ensure that the collective capacity of scholars affiliated with the Center represents significant concentrations of strength in the four key research thematic areas

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

> **Objective 4.1:** Establish an Administrative Structure to enhance center operations and provide supportive environment for training and mentoring of students, and for research in marine and fisheries sciences
>
> **Objective 4.2:** Monitor and ensure compliance with Center Award Conditions

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

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

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

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

Objective 6.1: Assess and evaluate center educational programs

Objective 6.2: Assess and evaluate center research

Objective 6.3: Assess and evaluate administration

3. Significant Results:

Education Goals:

Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 8 M.S., and 11 B.S. Of these Cohort 1 students, sixteen (16) have graduated, including 2 Ph.D., 5 M.S., and 9 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 9 M.S., and 7 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 6 M.S. and 11 B.S. students. One B.S. student from Cohort 3 has graduated. So far, Twelve (12) students including 3 Ph.D., 6 M.S., and 3 B.S. students have been recruited into Cohort 4.

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 2020 RSET interns. Because of the circumstances surrounding the COVID-19 response, UMES did not allow internship activities on campus this summer. We engaged the students, who would have been selected, in a webinar to introduce the LMRCSC, its objectives, and its opportunities. The participants were encouraged to apply to the LMRCSC Undergraduate Scholarship at their home institutions, and plans are currently underway to include these students in experiential internships as soon as UMES allows. These students will also be included in future opportunities for guidance regarding the NOAA EPP and Hollings Scholarship applications.

Scott B. Gudes Public Service Graduate Scholarship in Marine Resource Conservation: Plans are underway to select the next Scott B. Gudes scholar.

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

a) Data Management course is currently being taught in Fall 2020.

b) Two installments of the Graduate Student Seminar Series took place during this period (monthly, March and April 2020). Planning is underway for the Fall Seminar Series, which will begin during the next reporting period.

c) Center Faculty and Staff hosted an online listening session, facilitated by Dr.

Dionne Hoskins Brown, to give students the opportunity to communicate with us as well as each other about the challenges they are facing as a result of COVID-19 and other current events.

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.

Research Goals:

Eleven (11) collaborative research projects (Table 1) were underway after selection for funding by the LMRCSC after reviews by the Technical Advisory Board (TAB). Other research projects supported with leveraged funds from agencies such as NOAA, NSF, USDA, are on-going at the LMRCSC.

Administration Goals:

a) The Center held its monthly Executive Committee meetings during which plans to execute student development and professional activities were discussed.

b) The Center participated in and responded to the Independent External Review, submitted the response to NOAA EPP.

c) The Center held its annual Science Meeting virtually using Google Meet on April 29, 2020.

4.   Key outcomes or other achievements:

a) A total of 83 students (24 in Cohort 1, 24 in Cohort 2, 20 in Cohort 3, 12 in Cohort 4, 3 in Cohort 5) have been recruited to the Center

b) External Evaluation of the LMRCSC is continuing.

c) New proposals have been submitted to various agencies to leverage funding in order to support additional students.

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

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

- Thirteen (13) students are currently enrolled in the Data Management for Scientists course that is being offered in fall 2020.
- Four (4) students took part in NERTO internships at NOAA facilities under the supervision of NOAA scientists.

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

- LMRCSC scientists and students have made 19 presentations of their work at professional conferences including 8 by students.

- Center Scientists produced 31 peer-reviewed publications with 7 student author and also published one book.

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

Education Goals: As examples, the Center will:
a) Continue its efforts to recruit students into the Center;
b) Continue planning for the next workshop on Literacy in NOAA related sciences for Spring 2021. We are currently planning to hold this workshop virtually to accommodate ongoing travel restrictions for both universities and NOAA employees.
c) Continue to engage NOAA scientists in order to enhance research collaborations and identify scientists to serve on graduate student thesis and dissertation committees; work with students to identify sites for NERTO.
d) Continue to mentor students and encourage them to present research results at professional meetings, and publish their work in peer-reviewed journals.

Research Goals: As examples, the Center will:
a) Continue to seek leveraged funds to support students.
b) Solicit proposals to fund through the TAB process
c) Continue research on TAB funded projects and projects supported with leveraged funds.
d) Continue efforts to publish results from prior awards and present at scientific meetings

Administration Goals: Examples are given below.
a) Continue Executive Committee meetings
b) Continue to collect data for evaluation of Center's activities, programs, and accomplishments
c) Continue to disseminate information about the Center to the public including producing Newsletters.
d) Ensure that all students have taken Ethical Conduct of Research Training course

II. Products of Award

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

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

Degrees Awarded: The center awarded 12 degrees during the current funding period including 8 B.S., 3 M.S., and 1 Ph.D. They are listed below.

Table 2: LMRCSC Graduates September 1, 2019-February 29, 2020

Last Name	First name	Institution	Degree	Cohort #	Graduation Date	Postgraduate information
Chryston*	Best-Otubu	UMES	B.S.	1	May-20	Enrolled at RSMAS for Ph.D.
Fenwick*	Ileana	HU	B.S.	1	May-20	Accepted to PhD program in Quantitative Fisheries at UNC Chapel Hill
India*	Oliver	UMES	B.S.	1	May-20	Seeking opportunities
Layton*	Janelle	HU	B.S.	2	May-20	Accepted to MS program at OSU
Milton*	Milton	HU	B.S.	1	Aug-20	Applying for MS program at VT
Nylah*	McClain	UMES	B.S.	1	May-20	Enrolled at UMES for M.S.
Rhyan*	Knight	UMES	B.S.	3	May-20	Enrolled at UMES for M.S.
Tay*	Sena	SSU	B.S.	3	20-May	Enrolled in M.S. program at SSU
Enid*	Munoz-Ruiz	UMES	M.S.	2	May-20	Planning to enroll at UMES for a Ph.D.
Mayes*	Cristin	HU	M.S.	1	Aug-20	Continuing PhD program at RSMAS
Lawrence*	Amanda	UMCES-IMET	M.S.	2	20-Aug	Currently Knauss Fellow at EPA
Hanif*	Ammar	UMCES-IMET	Ph.D.	1	May-20	Looking for 'Omics position at NOAA, eligible for direct hire

*URM

Publications in Journals:

Tables 3a-c contain manuscripts published and theses/dissertations produced during this period and those currently under review, whereas Table 4 contains presentations at scientific meetings. A justification of how each manuscript is associated with the LMRCSC is included to the right of the citation.

Table 3a. Thirty-one (31) publications (3 student authors identified by *) produced by the Center; LMRCSC scientists are in bold

Publications in journals	Justification	Status
Cardeñosa, D., Fields, A.T., **Babcock, E.A**., Shea, S.K.H, Feldheim, K.A. and Chapman, D.D. (2020). Species composition of the largest shark fin retail-market in mainland China. Scientific Reports 10(1): 1-10. doi:10.1038/s41598-020-69555-1	Leveraged	Published
Ali, P, Shah, AA, Hasan, F, Hertkorn, N, Gonsior, M, Sajjad, W. and **Chen, F.** (2020). A Glacier Bacterium Produces High Yield of Cryoprotective Exopolysaccharide. Front. Microbiol. 10:3096.	Leveraged	Published

Benjamin B. Lee, **Eric J. Schott**, Donald C. Behringer, Jamie Bojko, Andrew Kough and Louis V. Plough (2020). Rapid Genetic Identification of the Blue Crab *Callinectes sapidus* and Other *Callinectes* spp. Using Restriction Enzyme Digestion and High Resolution Melt (HRM) Assays. Frontiers in Marine Science. Vol 7	Article 633 doi: 10.3389/fmars.2020.00633	leveraged	Published
Chung, JS (2020). Hepatopancreas trehalose-6-phosphate synthase modulates carbohydrate levels in the blue crab *Callinectes sapidus* in feeding and emersion. J. Shellfish Res. 39: 449-459.	Leveraged	Published
Chung, JS, A. Christie, and E. Flynn (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, *Cancer borealis.* 295:113522. doi: 10.1016/j.ygcen.2020.113522.	Leveraged	Published
Cruz-Marrero*, W., C. A. Harms-Tuohy, R. Appeldoorn, and **B. G. Stevens**. (2020). Comparison of video camera sled with diver surveys for queen conch *Lobatus gigas* (Linnaeus, 1758) density estimates in the west coast of Puerto Rico. Bulletin of Marine Science. doi.org/10.5343/bms.2019.0087	Cohort 3 Student	Published
Cullen, D.W. and **Stevens, B.G.** (2020). A brief examination of underwater video and hook-and-line gears for sampling black sea bass (*Centropristis striata*) simultaneously at 2 Mid-Atlantic sites off the Maryland coast. J. Northw. Atl. Fish. Sci., 51**:** 1–13. doi:10.2960/J.v51.m725.	TAB	Published
Fucich, D. and Chen, F. (2020). Presence of toxin-antitoxin systems in picocyanobacteria and their ecological implications. The ISME Journal, https://doi.org/10.1038/s41396-020-00746-4	Leveraged	Published
Garcia-Barcia, L., Argiro, J. **Babcock ,E.A**., Cai, Y., Shea ,S.K.H., and Chapman, D.D. (2020) Mercury and arsenic in processed fins from nine of the most traded shark species in the Hong Kong and China dried seafood markets: The potential health risks of shark fin soup. Marine Pollution Bulletin 157: 111281. doi:10.1016/j.marpolbul.2020.111281	Leveraged	Published
Hasenei[†] A, D Kerstetter, **AZ Horodysky**, and RW Brill (2020). Physiological limits to inshore invasion of Indo-Pacific lionfish (*Pterois* spp.); insights from the functional characteristics of their visual system and hypoxia tolerance. Biological Invasions. 22: 2079-2097	Leveraged LMRCSC faculty	Published
Hoskins-Brown, D. L. (2020). Tales of Landings and Legacies: African-Americans in Georgia's Coastal Fisheries. Culture, Agriculture, Food and Environment. June 2020	Supported student research in 2011 and 2016 awards	Published

Jung, H, Tomer Ventura, **Chung, JS**, Woo-Jin Kim, Bo-Hye Nam, Hee Jeong Kong, Young-Ok Kim, Min-Seung Jeon, Seong-il Eyun (2020). Twelve quick steps for genome assembly and annotation in the classroom. PLOS Computational Biology.	Leveraged	Published
Kellock, C., Cole, C., Penkman, K. Evans, D., Kroger, R., Hintz, C., Hintz, K., Finch, A. Allison, N. (2020). The role of aspartic acid in reducing coral calcification under ocean acidification conditions. Sci Rep **10,** 12797. https://doi.org/10.1038/s41598-020-69556-0	Leveraged	Published
Markin, E.L. and **D.H. Secor**. (2020). Growth of juvenile Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in response to dual-season spawning and latitudinal thermal regimes. Fishery Bulletin 118:74-86.	Leveraged	Published
Martínez Rivera*, S., and **B. G. Stevens**. (2020). Embryo development and fecundity of red deep-sea crab, *Chaceon quinquedens* (Smith, 1879), in the Mid-Atlantic Bight, determined by image analysis. Journal of Crustacean Biology 40(3):230-236. https://doi.org/10.1093/jcbiol/ruaa017	TAB	Published
Martínez-Rivera*, S., W. C. Long, and **B. G. Stevens.** (2020). Physiological and behavioral sexual maturity of female red deep-sea crabs *Chaceon quinquedens* (Smith, 1879) (Decapoda: Brachyura: Geryonidae) in the Mid-Atlantic Bight. Journal of Crustacean Biology 40(3):330-340. 10.1093/jcbiol/ruaa007.	TAB	Published
Miller, J.A. and Hurst, T. P. Growth Rate, Ration, and Temperature Effects on Otolith Elemental Incorporation. Frontiers in Marine Science.	Leveraged	Published
Mingli Zhao, Donald Behringer, Jamie Bojko, Andrew Kough, Louis Plough, Camila Prestes dos Santos Tavares, Alfonso Aguilar-Perera, Omar Shamir Reynoso, Govind Seepersad, Omardath Maharaj, Matthew Sanders, Daniela Carnales, Graciela Fabiano, Daniel Carnevia, Mark Freeman, Nicole Atherley, Lexa Medero-Hernandez, Eric Schott. (2020). Climate and season are associated with prevalence and distribution of trans-hemispheric blue crab reovirus (*Callinectes sapidus* reovirus 1): Prevalence and distribution of blue crab reovirus". Marine Ecol Progr Ser. V 647 p123-133 https://www-int-res-com.proxy-um.researchport.umd.edu/abstracts/meps/v647/p123-133/	leveraged	Published
Ou, H., M. Li, S. Wu, L. Jia, **R. T. Hill**, and J. Zhao. (2020). Characteristic microbiomes correlate with polyphosphate accumulation of marine sponges in South China Sea areas. Microorganisms. 8:63.	leveraged	Published
Redding, S.G., L.W. Cooper, M. Castonguay, C. Wiernicki, and **D.H. Secor**. (2020). Northwest Atlantic mackerel population structure evaluated using otolith ^{18}O composition. ICES Journal of Marine Science. doi:10.1093/icesjms/fsaa117.	leveraged	Published

Rothermel, E.R., M.T. Balazik, J.E. Best, D.A. Fox, B.I. Gahagan, D.E. Haulsee, A.L. Higgs, M.H.P. O Brien, M.J. Oliver, I.A. Park, and **D.H. Secor**. (2020). Comparative migration ecology of striped bass and Atlantic sturgeon in the US Southern Mid-Atlantic Bight flyway. PloS One 15(6): e0234442. DATA: Dryad (https://doi.org/10.5061/dryad.6hdr7sqx3).	leveraged	Published
Schweitzer[†] C, **A Horodysky**, A Price, and B Stevens. (2020). Impairment indicators for predicting delayed mortality in black sea bass (*Centropristis striata*) discards within the commercial trap fishery. Conservation Physiology. 8(1): coaa068.	Leveraged LMRCSC faculty	Published
Secor, D.H. O'Brien, B.J. Gahagan, J.C Watterson, and D. Fox. (2020). Differential migration in Chesapeake Bay striped bass. PloS One 15: e0233103. DATA: Dryad, Dataset, https://doi.org/10.5061/dryad.1zcrjdfnw	leveraged	Published
Stevens, Bradley G. (2020). The ups and downs of traps: environmental impacts, entanglement, mitigation, and the future of trap fishing for crustaceans and fish, ICES Journal of Marine Science. fsaa135, https://doi.org/10.1093/icesjms/fsaa135	LMRCSC DRS	Published
Thalmann, H.L., Daly, E.A. and Brodeur, R.D. (2020). Two anomalously warm years in the northern California Current: impacts on early marine Steelhead diet composition, morphology, and potential survival. Transactions of the American Fisheries Society.	Leveraged	Published
Vinagre, AS, Jorge Felipe Argenta Model, Éverton Lopes Vogt, Leonardo Maihub Manara, Márcia Trapp, Roselis Silveira Martins Da Silva and **Chung, JS.** (2020). Diet composition and long-term starvation does not affect crustacean hyperglycemic hormone (CHH) transcription in the burrowing crab *Neohelice granulata* (Dana, 1851)**.** Comparative Biochemistry and Physiology, Part A 247, 110738	leveraged	Published
Wang Z, Lee Y, Scherr D, Senger R, **Li Y**. and He, Z. (2020). Mitigating nutrient accumulation with microalgal growth towards enhanced nutrient removal and biomass production in an osmotic photobioreactor. Water Research, 182, 116038	leveraged	Published
Wenker*, R. P., and B. G. Stevens. (2020). Sea whip coral *Leptogorgia virgulata* in the Mid-Atlantic Bight: Colony complexity, age, and growth. PeerJ 8:e8372+A3:C9	Cohort 1 Student	Published
Wiernicki, CJ, D Liang, H Bailey, and DH Secor. (2020). The effect of swim bladder presence and morphology on sound frequency detection for fishes. Reviews in Fisheries Science and Aquaculture https://doi.org/10.1080/23308249.2020.1762536	leveraged	Published

Zhang Y, Ye Y, Ding W, Mao X, **Li Y**, Gerken H and Liu J. (2020). Astaxanthin Is Ketolated from Zeaxanthin Independent of Fatty Acid Synthesis in *Chromochloris zofingiensis.* Plant Physiology, 183, 883-897.	leveraged	Published
Edje, B., Ishaque, A.B. and **Chigbu, P**. (2020). Spatial and Temporal Patterns of $\delta^{13}C$ and $\delta^{15}N$ of Suspended Particulate Organic Matter in Maryland Coastal Bays, USA. Water, 12, 2345; doi:10.3390/w12092345.	Leveraged	Published

Table 3b. Two (2) publications under review or accepted was produced by the center (*Student)

Publications under review or accepted	Justification	Status
Olsen, N.A.*, and B.G. Stevens. (2020). Size at Maturity, Shell Conditions, and Morphometric Relationships of Male and Female Jonah Crabs Cancer borealis in the Mid-Atlantic Bight. North American Journal of Fisheries Management.	TAB	In Press
Edje, B. and Chigbu, P. (2020). Assessments of the diets of copepods in Maryland Coastal Bays using stable isotopes of carbon and nitrogen. Regional Studies in Marine Science.	Leveraged	Submitted

Table 3c: Four (4) theses and dissertation were produced by the center.

Theses/Dissertations	Justification
Fenwick, I. (2020). *Assessing Eastern Oyster, Crassostrea virginica, Spat Abundance in the Hampton River* (Senior Thesis. Dr. Deidre Gibson was her advisor)	Cohort 1
Layton, J. (2020). *The Feeding Ecology of Pacific Lampreys Assessed by Gut Fullness,* (Senior Thesis, Dr. Eric Lewallen was her advisor)	Cohort 2
Milton, I. (2020). *Assessing Viability of microRNAs as Biomarkers for Blue Crab Health, Callinectes sapidus, and Comparison of Crustacean miRNAs* (Senior Thesis, Dr. Carolina Lewallen was his advisor)	Cohort 1
Munoz-Ruiz, E. (2020) *Assessment of microplastic fibers in Placopecten magellanicus*. M.S. Thesis, University of Maryland Eastern Shore	Cohort 2

Conference Papers, Posters and Presentations: The following tables contain presentations made during this period. A justification of how each presentation is associated with the LMRCSC is included to the right of the citation.

Table 4. Nineteen (19) oral presentations (8 student presenters); LMRCSC Scientists in bold

Oral presentations at professional meetings	Justification
Babcock, E. A. and O'Farrell*, H. (2020). Developing a standardized methodology for estimating bycatch of rare species in the Gulf of Mexico. Presented at LMRCSC Virtual Science Meeting. April 29, 2020	LMRCSC Cohort 2 student, TAB

Bachvaroff, T.R. (2020). DNA databases and high throughput sequencing. IMET Virtual Summer Internship Program, June 2020.	Leveraged
Coleman*, N. (2020). Use of video to study predator/prey interactions. SERC, Aug 2020	Leveraged
Frey*, B.A., **Secor, D**., Richards, A. and **Jagus, R.** (2020). Monkfish age validation using hardpart analysis of known-age cohorts. NOAA LMRCSC 2020 Virtual Science Meeting, MD, April 2020.	TAB, one-time
Hill, R.T. (2020). Featured panelist. UMBC College of Natural and Mathematical Sciences Career Day. Spoke to 100 undergraduate students on career opportunities in the marine and environmental sciences. UMBC, March 2020.	Leveraged
Hill, R.T. (2020). Invited seminar: "Drugs from the Sea". Lunchtime Lecture at the Maryland Science Center 13 March, 2020.	Leveraged
Hill, RT (2020). UMBC Connects: Employers in the Sciences. Virtual information session for Undergraduate Science students, during university closure caused by COVID-19 pandemic. 17th April, 2020.	Leveraged
Hill, RT (2020). Microbially mediated nutrient cycles in marine sponges through FEMS Microbiology Ecology. This was the inaugural FEMS Microbial Ecology webinar and was attended by 260 people across the world. July 9, 2020.	Leveraged
Hoskins-Brown, D.L. (2020). Climate Change and Vulnerabilities for Coastal Communities of Color for the South Miami Dade NAACP Environmental and Climate Justice Town Hall, July 20, 2020 (via Zoom)	Leveraged
Jagus, R. and *Hanif, A. (2020). Differences in the diet of Gulf menhaden at two locations in Apalachicola Bay, FL, by DNA metabarcoding. NOAA LMRCSC 2020 Virtual Science Meeting, MD, April 2020.	TAB, one-time
Jagus, R. (2020). Molecular Tools for Fisheries and Environmental Biologists, IMET Virtual Summer Internship Program, June 2020.	Leveraged
King*, B. (2020). Underrepresentation in marine and fisheries science professions: How social identities influence career experiences. Research Advances in Fisheries, Wildlife, and Ecology Symposium (RAFWE), Corvallis, OR, May 2020	LMRCSC student presenter
King*, B. (2020). Utilizing cloud-based services in a time of uncertainty: perceptions of natural marine resource management. Presented at NOAA Living Marine Resources Cooperative Science Center Annual Science Meeting, April 2020	LMRCSC student presenter
Pares*. O. and **Schott, E.S.** (2020). Life history and disease ecology of the Blue Crab, *Callinectes sapidus*, a key benthic-pelagic link, in Puerto Rico. NOAA LMRCSC 2020 Virtual Science Meeting, MD, April 2020.	TAB, one-time

Pelekai*, K.P., Hess, J., Porter, L. and J. Miller. (2020). Evaluation of Pacific Lamprey statoliths and eye lenses as records of age, natal origin, and trophic history. NOAA LMRCSC Virtual Science Meeting. April 2020	LMRCSC student presenter
Schott, E.S. (2020). A community of students and citizen scientists are revealing the biodiversity of an urban harbor. NOAA LMRCSC 2020 Virtual Science Meeting, MD, April 2020.	Leveraged
Schott, ES. (2020). Long term approaches on health and biodiversity in Baltimore Harbor. IMET Virtual Summer Internship Program, June 2020.	Leveraged
Thalmann*, H.L., Laurel, B.J., Miller, J.A. (2020). Few surviving juvenile Pacific Cod are bigger, fatter, and shifting diets in a warm ocean year. NOAA LMRCSC Virtual Science Meeting. April 2020	LMRCSC student presenter
Wilson*, A. and **Babcock, E. A.** (2020) Age, growth, and genetic diversity of Lane Snapper, a data limited species. Presented at LMRCSC Virtual Science Meeting. April 29,2020	LMRCSC Cohort 1 student

Other Publications:

Other publications	Justification	Status
Cuker, B. Diet for a Sustainable Ecosystem: The science for recovering the health of the Chesapeake Bay and its people, Springer.	Leveraged Faculty	Published

Technologies or Techniques: None

Patents: None

Inventions: None

Websites: www.umes.edu/lmrcsc

Products: None

III. Participants in Award Performance

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

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

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

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

First name	Last Name	Partner Institution	Most Senior Project Role	Project Hours Worked per Month
Stacy	Smith	DSU	Principal Investigator	80
Christopher	Heckscher	DSU	Advisor	0
Gulni	Ozbay	DSU	Co-advisor	10
Dennis	McIntosh	DSU	Participating	20
Kevina	Vulinec	DSU	Co-advisor	10
Grant	Blank	DSU	Participating	15
Deidre	Gibson	HU	PI	40
Carolina	Lewallen	HU	Faculty	80
Benjamin	Cuker	HU	Faculty	10
Jessica	Miller	OSU	PI	45
Elizabeth	Babcock	RSMAS	Principal Investigator	7
David	Die	RSMAS	Faculty	3.5
Dionne	Hoskins-Brown	SSU	Principal Investigator	40
Victoria	Young	SSU	Education Expert	160
Tara	Cox	SSU	Faculty	20
Sue	Ebanks	SSU	Faculty	10
Chris	Hintz	SSU	Faculty	10
Rosemary	Jagus	UMCES-IMET	LMRCSC Co-PI	80
Paulinus	Chigbu	UMES	Principal Investigator	80
Tanesha	Hankerson	UMES	Communications and Outreach Specialist	124
Alexander	Kessie	UMES	Coordinator for Budget and Data Management	160

Judith	Rose	UMES	Coordinator	76
Cy'Anna	Scott	UMES	Recruiter	80
Margaret	Sexton	UMES	Assistant Director	160
Bradley	Stevens	UMES	DRS	160
Ida	Tilghman	UMES	Administrative Assistant	160

2. What organizations have been involved as partners?

Provide additional information such as:

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

Type of partner organization	Name	Location	Partners contribution to the project
State government	DNREC	Dover, DE	Helped with student permits
Non profit	Chesapeake Bay Foundation	Richmond, VA	Helped students with oyster restoration project
Tribal government	Columbia River Intertribal Fish Commission	Portland, OR	advised student, provide samples
Tribal government	Yakama Nation Fisheries	Prosser, OR	informal student advisor and collaborator, providing samples
State government	GADNR	Brunswick, GA	Nets, serve on committee

Have other collaborators or contacts been involved? Yes If Yes, describe involvement and time spent.

Last name	First name	Title/Affiliation	Description of involvement
Coyne	Kathy	DE Sea Grant head/Prof UD	Helping student with DNA analysis/lab space
Galvez	Brian	DNREC	Helped with student project/permits
Hess	Jon	Geneticist	Advised student, provide samples
Lampman	Ralph	Fisheries Biologist	Collaborator and providing lamprey samples
Gleason	Daniel	Professor, Georgia Southern University	Grant collaborator

Have NOAA collaborators or contacts been involved?

Yes. If Yes, describe involvement and time spent.

Last name	First name	Title/Affiliation	Description of Involvement
Allman	Robert	SEFSC	Ph.D. committee member and NERTO mentor for Adrianne Wilson
Baker-Yeboah	Sheekela	NOAA mentor	Mentor to undergraduate student
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 Thalmann
Deshpande	Ashok	Res. Chemist, NEFSC	M.S. committee member of Davielle Drayton; NERTO Mentor
Dudley	Peter	Project scientist, SWFSC	Collaborator and mentor
Fonner	Robby	NWFSC	NERTO mentor for King
Forgerty	Michael	NEFSC	NERTO advisor
Freidland	Kevin	Research Marine Scientist	Collaborator
Gerard	Trika	Chief of Staff, SEFSC	Partners on recruitment and engagement strategies to meet DEI objectives
Hill	Ron	Director, Panama City Laboratory	Serve on an internal committee to collaborate of the use of UAS for habitat monitoring in the South Atlantic, Gulf, and Caribbean
Huff	David	NWFSC	NERTO mentor for Pelekai
Jacobs	John	Research Fisheries Biologist	Collaborator
Jensen	Pam	NOAA Mentor, NERTO Mentor	NERTO mentor
Johnson	Matthew	SEFSC	Supervisor of DHB, collaborator on proposals
Johnson	Ed	Physical Scientist	NERTO mentor
Laurel	Ben	AFSC	Committee member for Thalmann
Leo	Jennifer	SEFSC	NERTO mentor for Juan Cervera
McElhany	Paul	Station Chief	NERTO training
McLaughlin	Shawn	Oxford Laboratory	NERTO advisor
Merino	Joy	SEFSC	
Richards	Anne	Research Fisheries Biologist, NEFSC	NERTO mentor & collaborator
Roberson	Kim	Research Coordinator, Grays Reef NMS	Served on student committee, collaborated on TAB
Robillard	Eric	NESFC, Woods Hole	Collaborator

Rogers	Lauren	AFSC	Informal mentor for Thalmann
Shank	Burton	Research Fisheries Biologist	NERTO mentor
Sharma	Rishi	NWFSC	Collaborator
Spires	Jason	Oxford Laboratory	NERTO advisor
Thorson	James	AFSC	NERTO mentor for LaTreese Denson
Townsend	Howard	NOAA mentor	NERTO mentor
Vogt	Bruce	Ecosystem Science Manager	NERTO mentor
Walter	John	SEFSC	PhD. Committee member for LaTreese Denson
Walter,	John	SEFSC, Santa Cruz	Collaborator and mentor
Weinberg	James	Fishery Biologist	Collaborator
Weitkamp	Laurie	NWFSC	NOAA TAB collaborator; Committee member for Pelekai
Werner	Kevin	NWFSC	Committee member for King
Werner	Cisco	*Dir. of Scientific Programs and Chief Science Advisor, NMFS*	Provided guidance on research development at SSU
Wikfors	Gary	NWFSC, Milford	Collaborator and mentor

IV. Impacts of Award

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

Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 8 M.S., and 11 B.S. Of these Cohort 1 students, sixteen (16) have graduated, including 2 Ph.D., 5 M.S., and 9 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 9 M.S., and 7 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 6 M.S. and 11 B.S. students. One B.S. student from Cohort 3 has graduated. So far, Thirteen (13) students including 3 Ph.D., 7 M.S., and 3 B.S. students have been recruited into Cohort 4. Of these 80 students in Cohorts 1-4, at least 73 of them belong to underrepresented minority groups. Three students, 1 Ph.D., 1 M.S., and 1 B.S., have so far been recruited to Cohort 5. LMRCSC activities focus on training programs that are preparing students for work on essential fish habitat, marine protected species and ecosystems. The future workforce candidates, our students, are gaining valuable experiences via the cohort experience so they will have colleagues after they graduate. Developing these relationships early will help them in the future. The NOAA mentor experience will prepare students for their first NOAA 'job' experience. Under the tutelage of a mentor, the students will develop work skills, such as co-worker interactions, proper workplace etiquette, etc.

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

DSU: Training undergraduate students from other disciplines can be challenging initially because of lack of knowledge. Some students have switched majors to marine and fisheries sciences.

HU: One student and 3 faculty from Biological Sciences are now working in the LMRCSC funded genetics lab. Four M.S. students are recruited through the Biology Department to work with Marine and Environmental Science faculty.

RSMAS: LMRCSC students are active in improving Diversity, Equity and Inclusion at the University of Miami.

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

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

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

The project is helping the Center to build capacity at Center Institutions through hiring of postdoctoral fellows, new staff, and support of scientists in NOAA related science disciplines, and enhanced collaboration with NOAA scientists. Funds leveraged from external sources by Center scientists are being used to train additional students and to build infrastructure for research and education. The Center is establishing federal guidelines as an expectation of minimal student support. These are unprecedented and are communicating a standard for what is needed to guide a student through a degree. The LMRCSC award supports student research to a degree that allows students to explore more sophisticated approaches with distant collaborators.

What is the impact of the NOAA award on the Center's data and information resources?
The NOAA award has enabled the LMRCSC to acquire fisheries and environmental data from research activities that have been or are being used for publications and presentations at professional meetings. Students and faculty are required to follow the data management plan in order to build more uniform and usable data sets. Meta-data is made accessible on the website as projects are completed. Additionally, data on student enrollment, graduation and participation in professional development activities are being collected and are being used together with results from the assessments and evaluations of the Center by LMRCSC external evaluators to improve on the Center's performance, and to determine the extent to which the Center is accomplishing its goals and objectives.

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

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

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

Research results have been published, and presented at scientific meetings and stock assessment working groups. Center researchers and students at SSU are developing the use of unmanned aircraft for habitat assessment.

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

HU   LMRCSC funds underrepresented students in research and prepares them for continued higher education. No outreach activities at K-12 schools and at Community and City-wide organizations were conducted this period due to COVID-19.

RSMAS PhD students participated in outreach activities for elementary and high school students, and participated in the RSMAS diversity committee and the University of Miami Black Students Association.

V. Changes/Challenges

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

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

COVID-19 has had a significant impact across the Center. At least two students who were previously recruited to the Center have delayed their enrollment. The NERTO process has slowed due to the need to reimagine them as virtual experiences. Research activities have slowed due to restrictions on travel, field work, and use of laboratory space, and some students have been impacted by illness or deaths in their families.

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

The impacts of COVID-19 described above are expected to continue through the next reporting period. Adaptations are in place to deliver courses electronically, and some research activities have been moved to homes or online, but the slowing of research is expected to delay graduations.

Changes that have a significant impact on expenditures:

These changes were detailed in the budget justifications submitted for the ceiling increase for Year 5 funds.

VI. Special Award Conditions

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

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

The report of the year 4 External Evaluations of the LMRCSC conducted during this reporting period by a team from the College of Explorations (COE) is presented in Appendix I.

Direct Student Support – Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 8 M.S., and 11 B.S. Of these Cohort 1 students, sixteen (16) have graduated, including 2 Ph.D., 5 M.S., and 9 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 9 M.S., and 7 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 6 M.S. and 11 B.S. students. One B.S. student from Cohort 3 has graduated. So far, thirteen (13) students including 3 Ph.D., 7 M.S., and 3 B.S. students have been recruited into Cohort 4. Three students, 1 Ph.D., 1 M.S., and 1 B.S., have so far been recruited to Cohort 5. Recruitment is ongoing.

Participant Beneficiaries

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

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

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

First	Last	Cohort #	Degree	Partner	Tuition	Stipend	Travel	NERTO	One-time Research Support	Professional development
Amanda	Pappas	1	M.S.	DSU		4,038				
Ileana	Fenwick*	1	B.S.	HU		4,050				
Isaiah	Milton*	1	B.S.	HU		3,955				
Hillary	Thalmann	1	PhD	OSU			659			
Halie	O'Farrell*	1	Ph.D.	RSMAS	2,100					
Ammar	Hanif*	1	Ph.D.	UMCES					5,000	
Chryston	Best-Otubu*	1	B.S.	UMES	4,279	1,100				
Nylah	McClain*	1	B.S.	UMES	4,279	880				
Marcus	Teat	2	B.S.	DSU	3,216	5,390				
Sierra	Hildebrandt	2	M.S.	HU	12,496	9,000			8,250	
Janelle	Layton*	2	B.S.	HU		4,050				
Josette	McLean*	2	M.S.	HU	12,496	9,000				
Brittany	King*	2	PhD	OSU	9,744	12,130	959			
LaTreese	Denson*	2	Ph.D.	RSMAS			1,334			
Adrianne	Wilson*	2	Ph.D.	RSMAS	21,000	15,156				
Joe	Day*	2	BS	SSU	0	0				
Davielle	Drayton*	2	M.S.	SSU	0	0				
Sena	Tay*	2	M.S.	SSU	3,075	4,000				
Enid	Munoz-Ruiz*	2	M.S.	UMES	2,598	10,469				
Kasondra	Rubalcava*	2	Ph.D.	UMES	1,669	11,678				
Caitlyn	Czajkowski	3	M.S.	DSU	5,863					
Luis	Rodriguez-Sanoguet*	3	M.S.	DSU	6,811	10,500				
Arona	Bender*	3	M.S.	HU	12,496	9,000				
Kathryn	Cruz	3	B.S.	HU		3,750				
Amani	Tolin*	3	B.S.	HU	5,000	3,750				
Keala	Pelekai*	3	MS	OSU	7,723	14,526	848			
Juan	Cervera*	3	M.S.	RSMAS		10,715				
Ambrose	Alexandria*	3	B.S.	SSU	0	0				
Mackey	Shaneese*	3	M.S.	SSU	1,339	10,500				
Benjamin	Frey*	3	M.S.	UMCES	9,503	14,418	838		904	
Teemer	Barry*	3	B.S.	UMES	5,487	1,457				
DaQuan	Davis*	3	B.S.	UMES	4,279	880				
Semaj	Fielding*	3	B.S.	UMES	4,279	1,628				

First	Last	Cohort #	Degree	Partner						
Shanelle	Haughton*	3	Ph.D.	UMES	12,750	12,732				584
Rhyan	Knight*	3	B.S.	UMES	4,279	715				
Ashley	Silver*	3	Ph.D.	UMES	13,950	12,660				
Tyler	Washington*	3	B.S.	UMES	4,279	858				
PaShun	Hawkins*	4	B.S.	HU	5,000					
Jaelyn	Leslie*	4	M.S.	HU	6,145	1,500				
Victoria	Williams	4	MS	OSU	6,741	14,298	848			
Cristin	Mayes*	4	Ph.D.	RSMAS	4,200	15,156				
Savannah	Geiger	4	M.S.	SSU	8,885	21,000				
Chelsea	Spaulding*	4	B.S.	SSU	3,001	5,659				
Kyarii	Ramarui*	4	Ph.D.	UMCES	5,117	18,459	467			
Shakira	Goffe*	4	M.S.	UMES	2,793					
Tahirah	Johnson*	4	M.S.	UMES	6,306	11,784				
Mya	Rufus*	4	B.S.	UMES	4,279					
Imani	Wilburn*	4	M.S.	UMES	4,800	7,673				

Underrepresented minorities

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

First	Last	Cohort #	Degree	Partner	Cohort Experience	NERTO	Ethical Conduct of Research Training	Data Management Course	NOAA Mentor
Amanda	Pappas	1	M.S.	DSU	Spr. 19	Fall 19	Fall 18	Fall 19	Y
Ileana	Fenwick*	1	B.S.	HU	Fall 17	n/a	Spr. 18	Spr. 18	n/a
Isaiah	Milton*	1	B.S.	HU	Fall 17	n/a	Spr. 18	Spr. 18	n/a
Hillary	Thalmann	1	Ph.D.	OSU	Apr-19	Spr. 20	Fall 8	Fall 19	Y
Halie	O'Farrell*	1	Ph.D.	RSMAS	Spr. 18	Sum 18	Fall 16	Fall 17	Y
Ammar	Hanif*	1	Ph.D.	UMCES	Spr. 18	Fall 18	Fall 17	Fall 17	Y
Chryston	Best-Otubu*	1	B.S.	UMES	n/a	n/a	Sum 17	n/a	n/a
Nylah	McClain*	1	B.S.	UMES	n/a	n/a	Sum 17	n/a	n/a
Marcus	Teat	2	B.S.	DSU	n/a	n/a		n/a	n/a
Sierra	Hildebrandt	2	B.S.	HU	Fall 17	n/a	Spr. 18	Spr. 18	Y
Janelle	Layton*	2	M.S.	HU	Spr. 21	Sum. 20	Spr. 20	Fall 19	Y
Josette	McLean*	2	M.S.	HU	Spr. 21	Sum. 20	Spr. 20	Fall 19	Y
Brittany	King*	2	PhD	OSU	Mar-18	Sept-Nov 20	Spr. 19	Spr. 20	Y
LaTreese	Denson*	2	Ph.D.	RSMAS	Spr. 19	Fall 18	Fall 15	Fall 18	Y
Adrianne	Wilson*	2	Ph.D.	RSMAS	Spr. 18	Sum 18	Fall 17	Fall 18	Y
Joe	Day*	2	BS	SSU	n/a	Fall 18	n/a	n/a	n/a

Davielle	Drayton*	2	M.S.	SSU	Sum 18	Fall 19	Sum 18	Fall 18	Y
Sena	Tay*	2	M.S.	SSU	Spr. 21	n/a	n/a	n/a	n/a
Enid	Munoz-Ruiz*	2	M.S.	UMES	Spr. 18	Fall 18	Spr. 18	Fall 18	Y
Kasondra	Rubalcava*	2	Ph.D.	UMES	Spr. 18	Sum 19	Fall 18	Fall 18	Y
Caitlyn	Czajkowski	3	M.S.	DSU	Spr. 20	TBD	Sum. 20	Fall 21	TBD
Luis	Rodriguez-Sanoguet*	3	M.S.	DSU	Spr. 20	TBD	Spr. 20	Fall 21	TBD
Arona	Bender*	3	M.S.	HU	Spr. 21	Sum. 21	Spr. 20	Fall 20	Y
Kathryn	Cruz	3	B.S.	HU	Fall 18	n/a	Spr. 19	n/a	n/a
Amani	Tolin*	3	B.S.	HU	Fall 20	n/a	Fall 20	Spr. 19	n/a
Keala	Pelekai*	3	MS	OSU	Apr-19	Fall 20	Fall 2018	Fall 19	Y
Juan	Cervera*	3	M.S.	RSMAS	Spr. 21	Sum 20	Fall 19	Fall 19	Y
Ambrose	Alexandria*	3	B.S.	SSU	n/a	Fall 18	Sum 19	n/a	n/a
Mackey	Shaneese*	3	M.S.	SSU	Sum 19	Fall 18	Spr. 19	Fall 19	n/a
Benjamin	Frey*	3	M.S.	UMCES	Spr. 19	Spr. 19	Fall 19	Fall 19	Y
Teemer	Barry*	3	B.S.	UMES	n/a	n/a	Fall 18	n/a	n/a
DaQuan	Davis*	3	B.S.	UMES	n/a	n/a	Sum 18	n/a	n/a
Semaj	Fielding*	3	B.S.	UMES	n/a	n/a	Spr. 19	n/a	n/a
Shanelle	Haughton*	3	Ph.D.	UMES	Spr. 19	Sum 19	Spr. 19	Fall 19	Y
Rhyan	Knight*	3	B.S.	UMES	n/a	n/a	Spr. 19	n/a	n/a
Ashley	Silver*	3	Ph.D.	UMES	Spr. 21	TBD	Fall 20	Fall 20	TBD
Tyler	Washington*	3	B.S.	UMES	n/a	n/a	Sum 18	n/a	n/a
PaShun	Hawkins*	4	B.S.	HU	Fall 20	n/a	Spr. 20	Spr. 21	n/a
Jaelyn	Leslie*	4	M.S.	HU	Spr. 21	Sum. 21	Spr. 21	Fall 20	TBD
Victoria	Williams*	4	MS	OSU	TBD	Jan to June 21	TBD	TBD	Y
Cristin	Mayes*	4	Ph.D.	RSMAS	n/a	Sum 21	Fall 19	n/a	Fall 20
Savannah	Geiger	4	M.S.	SSU	Spr. 21	Sum 20	Sum 20	Fall 19	Y
Chelsea	Spaulding*	4	B.S.	SSU	n/a	n/a	Sum 20	n/a	n/a
Kyarii	Ramarui*	4	Ph.D.	UMCES	Spr. 21	Spr. 21	Fall 19	Fall 20	Y
Shakira	Goffe*	4	M.S.	UMES	Spr. 21	TBD	Fall 19	Fall 19	TBD
Tahirah	Johnson*	4	M.S.	UMES	Spr. 21	TBD	Fall 19	Fall 20	TBD
Mya	Rufus*	4	B.S.	UMES	n/a	n/a	Sum 19	n/a	n/a
Imani	Wilburn*	4	M.S.	UMES	Spr. 21	Sum 21	Spr. 20	Fall 20	TBD
William	Burns	5	B.S.	SSU	n/a	n/a	Sum 20	n/a	n/a
Kristafer	Howard	5	M.S.	SSU	Spr. 21	Spr. 21	Fall 20	Fall 21	Y
Olivia	Pares*	5	Ph.D.	UMCES	Spr. 21	TBD	TBD	Fall 10	Y

*Underrepresented minorities

Professional Development - Award Recipient Must Report Activities Accomplished for

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

Three rising sophomores (Savannah Clax, SSU; Daylah McCullough, UMES; Rene Thompson, UMES) were accepted to the RSETP for 2020. Due to restrictions on research and activities on campus, this program was abbreviated to a virtual introduction to the LMRCSC hosted by Drs. Young and Sexton on June 3, 2020. These students were introduced to the opportunities provided by the center and encouraged to apply for the LMRCSC undergraduate scholarship. They will also be included in all workshops relating to the NOAA EPP and Hollings Scholarship application process, which are being planned in a cross-center effort by the Education Experts.

<u>Individual Student Development Plan</u>. Center activities to ensure completion, monitoring and student success.

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

2. <u>Student Preparation for Success in the Career Path Relevant to the Center Award</u>. Provide Center activities with activity titles, participants, outcomes for Center measures of success.

Student name(s)	Activity name and/or description
Isaiah Milton	Research training in crustacean genetics
Ileana Fenwick	Research training in oyster restoration
Janelle Layton	Research training in marine fisheries genetics
Kathryn Cruz	Research training in marine mammal genetics
Amani Tolin	Research training in oyster restoration
PaShun Hawkins	Research training in marine microbiology
Sierra Hildebrandt	Research training in oyster restoration
Josette McLean	Research training in marine fisheries genetics
Arona Bender	Research training in marine mammal genetics
Jaelyn Leslie	Research training in marine mammal stranding and pollutants
Brittany King	Fisheries and Wildlife Graduate Student Association, Co-President, 2020-Present
Brittany King	Oregon State University Graduate Student Advisory Council, Member (2018-Present)

Brittany King	Fisheries and Wildlife Graduate Student Association, Member, (2017-Present)
Brittany King	Oregon State University Black Graduate Student Association, Member (2017-Present)
Adrianne Wilson	Advanced to candidacy, presented research at LMRCSC Science Meeting
Juan Cervera	Took TA training. Attended ESRI Online Conference July, 2020
Shaneese Mackey	FAA re-certification
Kristafer Howard	Advanced Diving certification
Nicholas Coleman	Training with Chuck Spence, MS DNR, to track tagged Atlantic sturgeon. Training with Dewayne Fox, DSU, on side scan sonar surveys. Attended weekly lab meetings
Benjamin Frey	Training with Philip Piccoli, UMCP on the wave-length-dispersive electron microanalyzer. Attended virtual Mid-Atlantic Fisheries Management Council SSC Meeting, May 2020. Attended weekly lab meetings
Shadaesha Green	Ph.D. Webinar: Leveraging LinkedIn, Online webinar, April 6, 2020. Ph.D. Webinar: Evaluating Job Offers, Online webinar April 7, 2020. Rita B. Leahy Career Series - Careers with the Federal Government, Online webinar, April, 2020. Navigating USAjobs and the Federal Hiring Process for Graduate Students: Advice froman Expert, Online webinar, April 2020. High Profile Scientific Publishing (hosted by PROMISE: Maryland's Alliance for Graduate Education and the Professoriate), Online webinar, May 2020. Preparing to Publish (hosted by PROMISE: Online webinar, May 2020.
Ammar Hanif	Continuing collaboration at NOAA Oxford Lab.
Amanda Lawrence	Successfully defended M.S. thesis and graduated
Olivia Pares	Ph.D. Webinar: Leveraging LinkedIn, Online webinar, April 6, 2020. Ph.D. Webinar: Evaluating Job Offers, Online webinar April 7, 2020. Rita B. Leahy Career Series - Careers with the Federal Government, Online webinar, April 2020. Navigating USAjobs and the Federal Hiring Process for Graduate Students: Advice froman Expert, Online webinar, April 2020. High Profile Scientific Publishing (hosted by PROMISE: Maryland's Alliance for Graduate Education and the Professoriate), Online webinar, May 2020. Preparing to Publish (hosted by PROMISE: Online webinar, May 2020. Attended weekly lab meetings

Kiari Ramarui	Ph.D. Webinar: Leveraging LinkedIn, Online webinar, April 6, 2020. Ph.D. Webinar: Evaluating Job Offers, Online webinar, April 7, 2020. Rita B. Leahy Career Series - Careers with the Federal Government, Online webinar, April 2020. Navigating USAjobs and the Federal Hiring Process for Graduate Students: Advice from an Expert, Online webinar, April 2020. High Profile Scientific Publishing (hosted by PROMISE: Maryland's Alliance for Graduate Education and the Professoriate), Online webinar, May 2020. Preparing to Publish (hosted by PROMISE: Online webinar, May 2020. Attended weekly lab meetings.
Kathryn Cruz	Research training in marine mammal genetics, will continue research on HU campus.
Nicole Kleponis	Engagement with OSU faculty/salmon project
Amanda Pappas	Working with University of Delaware faculty for PCR training
Shadaesha Green	Career Development and Skills Webinar, University of Maryland Career Center, Ratcliffe Environmental Entrepreneurs Fellowship (REEF) Program
Kyari Ramarui	FASEB: Time Management and Workplace Culture: Do Longer Hours Mean Higher Productivity and Increased Passion; ERN Poster Presentation Training Webinar
Hillary Thalmann	OSU Fisheries and Wildlife Mentorship Program, Introduction to R Graphics and ggplot Workshop. Along with two other program coordinators, she developed this workshop and taught it to a group of ~15 undergraduates in winter 2020.
Hillary Thalmann	OSU Fisheries and Wildlife Mentorship Program, Introduction to R Workshop. Along with two other program coordinators, she developed this workshop and taught it to a group of ~20 undergraduates in fall 2019.
Hillary Thalmann	Mentoring 4 UG student researchers in lab techniques
Brittany King	Teaching Mentoring Conference
Brittany King	Oregon State University Presidential Search Stakeholder Group, Member
Brittany King	Oregon State University Graduate Student Advisory Council, Member
Shaneese Mackey, Davielle Drayton	R Workshop
Shaneese Mackey	UA Workshop
Shaneese Mackey, Savannah Geiger	Resource Tracking Workshop

Post-Doctoral Program -

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

UMES: We are currently searching for our next Postdoctoral Fellow after Dr. Dan

Cullen completed his Fellowship in March 2020. The covid-19 pandemic has caused a delay in hiring a new Postdoctoral Fellow.

SSU: Dr. Matt Kenworthy completed his FAA certification preparation.

Pre-Publication Manuscript Submission -

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

	Target # of manuscripts	Proposed date of submission
DSU Faculty	1	Apr. 2020
DSU Students	2	May 2020
HU Faculty	6	Fall 2020 – Spr. 2021
HU Students	0	
OSU Faculty	0	
OSU Students	0	
RSMAS Faculty	2	2020
RSMAS Students	4	2020
SSU Faculty	2	6/1/2021
SSU Students	2	6/1/2021
UMCES Faculty	7	Fall 2020 – Spr. 2021
UMCES Students	4	Fall 2020 – Spr. 2021
UMES Faculty	2	Fall 2020 – Spr. 2021
UMES Students	0	

Papers currently in review or in press: *Students. LMRCSC scientists in bold

Publications under review or accepted	Justification	Status
Olsen, N. A., and **B. G. Stevens.** (2020). Size at maturity, shell conditions, and morphometric relationships of male and female Jonah Crabs *Cancer borealis* in the Mid-Atlantic Bight. North American Journal of Fisheries Management.	TAB	In Press
Edje, B. and **Chigbu, P.** (2020). Assessments of the diets of copepods in Maryland Coastal Bays using stable isotopes of carbon and nitrogen. Regional Studies in Marine Science.	Leveraged	Submitted

NOAA Substantial Involvement and Collaborative Engagement

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

Mentor	LMRCSC Student	LMRCSC Institution	Cohort #	Start date	Role	Time Commitment	Line Office	Project Title
Howard Townsend	Brian Galvez	DSU	1		Committee member	3 months	NOAA NEFSC	Trophic ecology of Atlantic Weakfish in the Delaware Bay using stomach content and stable isotope analyses
Gary Wikfors	Amanda Pappas	DSU	1	Jan-17	Collaborator/Committee member	3 months	NOAA NEFSC	Ecology of a toxic harmful algal bloom species (*Dinophysis acuminata*) in the Delaware Inland Bays
Laurie Weitkamp	Angie Munguia	OSU	1	Jun-18 / 1-Sep-17		~1.5 month/yr	NOAA NWFSC	Characterizing feeding ecology and food web linkages of yearling chinook salmon (*Onchorhynchus tshawytscha*) emigrating through the lower Columbia River and Estuary
Ben Laurel	Hillary Thalmann	OSU	1		Committee member for Thalmann		AFSC	Thermal impacts on pre-recruit Pacific Cod (*Gadus macrocephalus*) phenology, growth, and foraging patterns in Gulf of Alaska nursery habitats
Enric Cortes	Halie O'Farrell	RSMAS	1	2015	Committee member, NERTO mentor	3 month NERTO	NOAA SEFSC	Evaluation of the effect of size and sex-based spatial segregation on shortfin mako

								fishery sustainability
Patricia Rosel	Emily Griffin	SSU	1	1-Sep-17	Committee member, communicating collaborator		NOAA NMFS Lafayette	Refining stock structure of common bottlenose dolphins (*Tursiops truncatus*) through photo-identification and genetic analysis
Burton Shank	Shadaesha Green	UMCES-IMET	1	1-Sep-16	collaborator		NMFS	Reproductive strategy of female deep-sea red crab
James Weinberg	Shadaesha Green	UMCES-IMET	1	1-Sep-16	committee member		NMFS	Reproductive strategy of female deep-sea red crab
Bruce Vogt	Shadaesha Green	UMCES-IMET	1	1/19/2019	NERTO mentor		NCCOS	Striped Bass Habitat Indicator for the Chesapeake Bay
Kevin Friedland	Ammar Hanif	UMCES-IMET	1	11/13/2013	committee member		NMFS	Assessing temporal changes of the microbial community in gills of invasive dreissenid mussels collected from Lake Michigan
John Jacobs	Ammar Hanif	UMCES-IMET	1	11/16/2017	TAB collaborator		NCCOS	Diet and microbiota of Eastern oyster
Ed Johnson	Ammar Hanif	UMCES-IMET	1	1/30/2018	NERTO mentor		NCCOS	Diet and microbiota of dreissenid mussels
Sheekela Baker-Yeboah	India Oliver	UMES	1	9/1/2016	NOAA mentor		NOAA EPP/MSI	Exploring Ocean Optical Properties using Satellite and in situ Data.
Jen Zamon	Nicole Kleponis	DSU	2	Jan-18	Committee member	3 months	NOAA NWFSC	Assessing the relative abundance of the wintering red-throated loon in the Delaware Bay
Laurie Weitkamp	Janelle Layton	HU	2	1-Sep-18	TAB collaborator	2 yrs	NOAA NWFSC	The feeding ecology of Pacific lampreys

								assessed by gut fullness and prey identification
Jason Spires	Sierra Hildebrandt	HU	2	9/1/2019	TAB collaborator, committee member, and NERTO mentor	2 years	Oxford lab	Development of alternative oyster setting methods (direct setting). Oyster larvae deployment tool development and larval setting efficiency testing.
Laura Weitkemp	Josette McLean	HU	2	9/1/2019	TAB collaborator, committee member, and NERTO mentor	2 years	NWFSC	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys.
Kevin Werner	King	OSU	2		Committee member for King		NWFSC	Underrepresentation of Racial and Ethnic Groups in Marine and Fisheries Science Professions
Robby Fonner	King	OSU	2		NERTO mentor for King		NWFSC	Ecological, Institutional and Social Influences on Habitat Restoration Efforts in the Pacific Northwest
Robert Allman	Adrianne Wilson	RSMAS	2	2017	NERTO mentor, Committee member	3 month NERTO	NOAA SEFSC	Ageing methods for lane snapper, a data poor species
James Thorson	LaTreese Denson	RSMAS	2	2019	NERTO mentor	3 month NERTO	NOAA AFSC	Environmental influences on indices of abundance for King Mackerel in the Gulf of Mexico examined through spatiotemporal geostatistical models
John Walter	LaTreese Deson	RSMAS	2	2019	Committee member	committee member	NOAA SEFSC	King mackerel geostatistical analysis.
Ashok Deshpande	Davielle Drayton	SSU	2	1-Jan-18	Committee member, communicating collaborator	~4 mo (incl. NERTO)	NOAA NEFSC	Evaluation of microplastic consumption by the eastern

								oyster, *Crassostrea virginica*, in Savannah GA
Peter Dudley	Nicholas Coleman	UMCES-CBL	2	1/21/2020	collaborator		NMFS	Use of acoustic telemetry and imagery to study population size of Atlantic sturgeon in Chesapeake Bay
Burton Shank	Amanda Lawrence	UMCES-IMET	2	9/1/2017	committee member		NMFS	Size and maturity of male red crabs
Paul McElhany	Amanda Lawrence	UMCES-IMET	2	10/1/2018	NERTO mentor		NMFS	Effect of CO2 on the physiology of Dungeness crab
Ashok Deshpande	Enid Munoz Ruiz	UMES	2	9/1/2017	NOAA/NERTO mentor		NOAA, NMFS	Assessment of Microplastics and dPolybrominated Diphenyl Ethers (PBDEs) in Scallops as Possible Indicators of Plastic Pollutions
Howard Townsend	Kasondra Rubalcava	UMES	2	9/1/2017	NOAA mentor		NOAA, NMFS	Spot fish recruitment and density-dependent growth in the Maryland Coastal Bays
Douglas Krause	Arona Bender	HU	3	1/4/2020	TAB collaborator	2 years	SWFSC	Genetic approaches for monitoring the effects of climate change on leopard seals in the Antarctic Peninsula
Laurie Weitkamp	Pelekai	OSU	3		Committee member for Pelekai		NWFSC	Evaluation of Pacific Lamprey (*Entosphenus tridentatus*) statolith morphology and ageing potential
David Huff	Pelekai	OSU	3		NERTO mentor		NWFSC	NOAA Acoustic Data Management and Sharing

Jennifer Leo	Juan Cervera	RSMAS	3	2019	NERTO mentor	3 month NERTO	NOAA SEFSC	Mangroves as essential fish habitat
Ron Hill	Shaneese Mackey	SSU	3	5/26/2019	Committee member, communicating collaborator	~4 mo (incl. NERTO)	NOAA SEFSC	Development of an Unmanned Aerial System (UAS) approach to assess restored and natural oyster reefs of coastal Georgia saltwater marshes
Anne Richards	Benjamin Frey	UMCES-IMET	3	Sep-18	TAB collaborator & NERTO mentor		NMFS	Monkfish Age Validation Using Hardpart Analysis of Known-age Cohorts
Pam Jensen	Shanelle Haughton	UMES	3		NOAA Mentor, NERTO Mentor		AFSC	Understanding *Hematodinium* sp. in Alaskan crabs: new hosts, improved detection and health effects in a changing ocean
Shallin Busch	Williams	OSU	4		Committee member for Williams		NWFSC	Understanding adaptive capacity: an analysis of community perceptions and policy responses to ocean acidification and other marine stressors on the West Coast
Ashok Deshpande	Savannah Geiger	SSU	4	1-Sep-19	Committee member, communicating collaborator	~4 mo (incl. NERTO)	NOAA NEFSC	An investigation of microplastic concentrations present in a variety of marine organisms at varying geographical locations in the Georgia Bight
Gary Wikfors	Kiari Ramarui	UMES-IMET	4	9/1/2020	NERTO mentor and committee member		NMFS	Proteomic Analysis of two *Haematococcus pluvialis* Mutant Strains as Aquaculture Feedstock

Roldan Munoz	Kristafer Howard	SSU	5	8/1/2020	NERTO Mentor	~4 mo (incl. NERTO)	NOAA SEFSC	In development

CSC Programmatic Special Award Conditions

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

A. Provide FY16 Center award information for:
1. **Number of EPP-funded post-secondary students from underrepresented minority communities** who are trained **40** and graduated **12** in NOAA- mission sciences.
2. **Total number of EPP-funded post-secondary students** who are trained **48** and graduate **12** in NOAA-mission fields relevant to this announcement.
3. **Number of EPP-funded graduates who enter the NOAA mission workforce as hires** by NOAA **1**, NOAA contractors **0**, NOAA partners **0**, resource management agencies **0**, NGO community **0**, academia **0** or as entrepreneurs **0**.
4. **Number of EPP-funded graduates who participate in and complete NOAA agency mission-related postdoctoral level programs 0**.
5. **Total new funds leveraged with NOAA EPP award** (including post-secondary student support) = **$38,470.**

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

5. CSC Desired Program Level Outcomes and Outputs
5.1 Education and Training
Outcome 1. Increased number, annually, of CSC post-secondary students, trained.
Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 8 M.S., and 11 B.S. Of these Cohort 1 students, sixteen (16) have graduated, including 2 Ph.D., 5 M.S., and 9 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 9 M.S., and 7 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 6 M.S. and 11 B.S. students. One B.S. student from Cohort 3 has graduated. So far, thirteen (13) students including 3 Ph.D., 7 M.S., and 3 B.S. students

have been recruited into Cohort 4. Three students have been recruited to Cohort 5, 1 Ph.D., 1 M.S., and 1, B.S. Recruitment is ongoing.

Outputs:

(a)　　　　Increased quantitative and analytical skills – Students are acquiring quantitative and analytical skills by taking courses such as Data Management for scientists that was offered in fall 2018, 2019, and 2020 and by participating in internships and REU programs.

(b) Increased competence in applying STEM to decision making, policy and management.

This is addressed by the Cohort Experience Workshop, which will be held in Spring 2021.

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.

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

Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 5 Ph.D., 8 M.S., and 11 B.S. Of these Cohort 1 students, sixteen (16) have graduated, including 2 Ph.D., 5 M.S., and 9 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 9 M.S., and 7 B.S. students. Of the Cohort 2 students, 10 have graduated, including 3 Ph.D., 3 M.S., and 4 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 3 Ph.D., 6 M.S. and 11 B.S. students. One B.S. student from Cohort 3 has graduated. So far, thirteen (13) students including 3 Ph.D., 7 M.S., and 3 B.S. students have been recruited into Cohort 4.

(a) **Number of degrees earned annually in NOAA mission-related disciplines** – Twelve (12) students graduated this period, including 1 Ph.D., 3 M.S., and 9 B.S. students.

(b) **Number of students (total and URM) who participated in professional development opportunities, to include at least one on-site experiential research and training opportunity at a NOAA Lab, office, or facility with tangible training and research**: Four (4) students took part in NERTO internships under the supervision of NOAA scientists. One additional student took part in TAB funded activities under the supervision of a NOAA scientist. All of these activities were conducted online due to COVID-19.

Student Name	Activity/project title	NOAA personnel involved
Sierra Hildebrandt	NERTO	Jason Spires and Shawn Mclaughlin
Josette McLean	NERTO	Laura Weitkemp
Janelle Layton	TAB	Laura Weitkemp
Brittany King	Ecological, Institutional and Social Influences on Habitat	Robby Fonner

	Restoration Efforts in the Pacific Northwest	
Juan Cervera	Essential Fishery Habitat Mapper	Jennifer Leo

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

The grant has made it possible for 10 collaborative research projects to be funded/selected for funding during the period of 2020 – 2021, which will enable more Center scientists to be available to mentor and advice undergraduate and graduate students. In addition, 39 NOAA scientists have been identified to serve as mentors of the students during the NERTO program or as collaborators in the TAB funded projects. The NERTO has increased exposure to NOAA training and encouraged faculty to increase their flexibility in scheduling graduate students' field work and academic schedules.

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

Outputs	# During this Reporting Period
Seminars	24
New courses offered	0
New programs developed	0
New degrees offered	0
# of students supported by the LMRCSC	54
Total degrees awarded	12
Degrees awarded to URMs	12

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

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

Outputs:

(a) Increased number of URM students in student development activities that will lead them to the attainment of degrees and/or employment in NOAA mission fields = **19** URMs at the LMRCSC took part in student development activities.

(b) Increased number of URM students who select to pursue higher education in NOAA mission fields = **40** URMs at the LMRCSC are pursuing higher education in NOAA mission fields during this reporting period.

5.2 Scientific Research

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

NOAA scientists are already collaborating with Center scientists as well as working with some of the graduate students; suitable mentors are being identified for the remaining students. The Center 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:

(a) **Number of research collaborations with NOAA and LMRCSC faculty, staff and students**: Each of the ten (10) newly funded LMRCSC TAB projects has a NOAA scientist as a collaborator.
(b) **Number of NOAA scientists serving as mentors and advisors for student research**: 39 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** = 10
(d) **Number of uses of NOAA data in research and tool development** = 2. Halie O'Farrell (Ph.D. student at RSMAS) is using the U.S. pelagic longline observer data for her dissertation research. In addition, Kasondra Rubalcava (Ph.D. student at UMES) is using the long-term fish dataset collected by the Maryland Department of Natural Resources for her dissertation research aimed at developing an ecosystem model for the Maryland Coastal Bays.

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

Ten (10) collaborative research projects were funded by the LMRCSC 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:

	# from Projects Directly Supported with FY 16 Funds	# from Leveraged Projects
# of peer reviewed publications	7	26
# of presentations	9	10
# Tools developed	0	0
Use of LMRCSC research results and tools by NOAA & other stakeholders	0	0
# of instances LMRCSC publications are cited	165	396
# of LMRCSC students, staff or faculty recognized nationally for LMRCSC research	0	0

LMRCSC TAB-funded Projects

In 2019-2020, eleven active TAB projects were investigated by students and scientists at LMRCSC partner institutions. Three of these began in 2018, four in 2019, and four in 2020. Ten new projects were proposed and funded in Fall 2020, but not much research has been done because of the covid-19 pandemic. The following table and list of abstracts describes only those projects that were active in the last year.

TAB Project Titles

Project Number	Principal Investigator	Title	Thematic Research Area
18-01	Brittany King	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	Fishery Economics and Social Science
18-03	LaTreese Denson	Sensitivity of indices of abundance to the specification of environmental covariate in spatiotemporal geostatistical models	Stock Assessment Support Information
18-06	Detbra Rosales	Assessing the impacts of harmful dinoflagellates and *Vibrio* spp. on oyster aquaculture in the Delaware Inland Bays.	Habitats and Biological Systems
19-02	Shanelle Haughton	Evaluating physiological and immune responses of snow crabs (*Chionoecetes* sp.) to *Hematodinium* infection	Stock Assessment Support Information
19-04	David Secor & Rose Jagus	Validation of Monkfish age and growth using microconstituent analysis of hardparts	Stock Assessment Support Information
19-05	Keala Pelekai	Utilizing Pacific Lamprey anatomical structures as records of age, natal origin, & trophic patterns	Stock Assessment Support Information
19-07	Adrianne Wilson	Population structure and growth of lane snapper, a data limited species	Stock Assessment Support Information
20-01	Savannah Geiger	An analysis of distribution and	Habitats and Biological

		abundance of microplastics in selected commercially important species in Northern Georgia coastal waters	Systems
20-02	Sierra Hildebrandt	Investigating the impacts of adult-oyster-conditioned-seawater on the setting efficiency of *Crassostrea virginica* larvae utilizing direct setting in the field	Habitats and Biological Systems
20-05	Matt Kenworthy	Evaluating the effects of landscape scale habitat variability on white shrimp (*Litopenaeus setiferus*) population dynamics in Georgia estuaries.	Habitats and Biological Systems
20-10	Imani Wilburn	The occurrence of microplastics in the Maryland Coastal Bays	Habitats and Biological Systems

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: Fishery-Economics and Social Science

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. Data obtained from these interviews are currently being analyzed to address research questions.
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)

Project Number   **18-03**
Title: Sensitivity of indices of abundance to the specification of environmental covariate in spatiotemporal geostatistical models
Thematic Research Area: Stock Assessment Support Information
Abstract: The assessment of King mackerel in the Gulf of Mexico uses an index for estimating

spawning stock biomass; this index is developed using a statistical model that is parameterized by fitting to larval count data from annual plankton surveys. The model used to make the index does not explicitly consider spatiotemporal variation, which is inherent to the larval count data or environmental variability which can also influence local population density. Biomass trends can be misrepresented by a model that does not explicitly consider changes in spatial distributions (e.g., migration or ontogenetic shifts). This misrepresentation of estimated trends has been shown to lead to incorrect and uncertain estimates of stock status in the stock assessments, which are used to set management regulations which help to achieve NOAA's sustainable fisheries goals. King mackerel spatial distributions vary over time as adults migrate seasonally and change their distribution based on the quality of their environment. Migrations cause shifts in their spawning locations from year to year, and this then impacts the larval stage as their distribution is dependent on the location of spawning, and the local oceanography. We have used geostatistical models to answer the following question: Will accounting for spatiotemporal variation reduce the uncertainty in the estimates of the index, or indicate new biomass trends? We have also used non-spatial negative binomial general additive models to determine environmental factors that have a significant impact on King Mackerel catchability and density. Current results indicate that incorporating spatiotemporal variability produces different trends in abundance. Results also suggest that temperature at the time of sampling should be considered a driver of catchability differences for larval King mackerel. These results support the development of a more ecosystem based index of abundance for use in stock assessments. Further analyses are being conducted to validate these findings.

Principal Investigator: LaTreese Denson, 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: John Walter, SEFSC: Southeast Fishery Science Center

Other Partner: Dionne Hoskins- Brown, Savannah State University

Students: LaTreese Denson (PhD, RSMAS); Alexandria Ambrose (Undergraduate, RSMAS)

Project Number   18-06

Title: Assessing The Impacts of Harmful Dinoflagellates and *Vibrio* spp. On Oyster Aquaculture In The Delaware Inland Bays.

Thematic Research Area: Habitats and Biological Systems

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

predicting changes in oceans and coasts, as HAB species are proliferating due to anthropogenic forces.

Principal Investigator: Detbra Rosales, University of Maryland Eastern Shore
Co-PI: Joseph Pitula, University of Maryland Eastern Shore (UMES)
NOAA Partner: John Jacobs, NCCOS national center for coastal ocean sciences
Other Partner:
Students: Detbra Rosales (PhD, UMES); Rebel Danquah (Undergraduate, UMES)

Project Number   19-02
Title: Evaluating physiological and immune responses of snow crabs (*Chionoecetes* spp.) to *Hematodinium* infection
Thematic Research Area: Stock Assessment Support 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: Pamela Jensen, AFSC: Alaska Fishery Science Center
Other Partner:
Students: Shanelle Haughton (Ph.D., UMES)

Project Number   19-04
Title: Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts
Thematic Research Area: Stock Assessment Support Information
Abstract: Monkfish *Lophius americanus* supports one of the most economically important fisheries of the US Northeast Shelf. Recent fisheries for monkfish have been managed very conservatively because of major uncertainties in the stock assessment, the most significant of which is in interpreting age structure and parameterizing growth in this long-lived species. 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. In 2015, an unusual opportunity to study monkfish growth arose from an exceptionally strong year class (YC). The length modes for this YC have continued to be clearly delineated through successive seasonal surveys to date (to age 2), thus effectively providing monkfish of 'known' age. The NEFSC has collected monthly samples of this YC since it was approximately 6 months old; these will be available to this project. The objective of this study is to use analysis of seasonal cycles of hard part microconstituents (calcium, phosphorous, and strontium) from samples taken from the 2015 YC at ages 0-3 to test whether optical zonation in illicia (first dorsal fin spine), vertebrae, and otoliths conform to expected seasonal periodicity (due to temperature-related uptake of microconstituents). The patterns observed in the 'known age' fish will provide a key to interpreting optical zonation of samples from fish of unknown age, thus potentially leading to estimation of a growth curve and filling a major gap in the data needed for quantitative assessment of monkfish and leading to improved scientific advice to fishery managers. This project will primarily provide support to an

LMRCSC student to work with Dr. Anne Richards, a stock assessment expert and lead scientist for monkfish assessments, and the NEFSC Fisheries Biology Program (Age and Growth Unit).
Principal Investigator: David Secor, University of Maryland Center for Environmental Science
Co-PI: Rose Jagus, University of Maryland Center for Environmental Science
NOAA Partner: Dr. Anne Richards, NEFSC: Northeast Fishery Science Center
Other Partner: Eric Robillard, NEFSC
Students: Benjamin Frey (MS, UMCES)

Project Number   19-05
Title: Utilizing Pacific Lamprey anatomical structures as records of age, natal origin, and trophic patterns
Thematic Research Area: Stock Assessment Support Information
Abstract: The anadromous Pacific Lamprey (*Entosphenus tridentatus*) is a biologically and culturally important species native to the North Pacific Ocean and its adjacent freshwater tributaries. In the last 50 years, Pacific Lamprey have experienced declines in abundance throughout the Columbia River Basin. More research is needed to better inform conservation and management efforts. Lampreys are cartilaginous and lack the common hard structures (i.e. otoliths, scales, and fin rays) used in fisheries science to elucidate age and life history patterns. Lamprey statoliths, analogous to otoliths, have potential for ageing and natal origin assignment through band interpretation and elemental analysis, respectively. Eye lenses have potential for retrospective analysis of stable isotopes, which can be used to infer trophic history. This project aims to increase our knowledge on lamprey by evaluating the efficacy of these anatomical structures for determining age, natal origin, and trophic history patterns by utilizing known age and origin samples.
Principal Investigator: Keala Pelekai, Oregon State University
Co-PI: Dr. Jessica Miller, Oregon State University
NOAA Partner: Dr. Laurie Weitkamp, NWFSC: Northwest Fishery Science Center
Other Partner: Dr. Eric Lewallen, Hampton University
Students: Keala Pelekai (MS, OSU)

Project Number   19-07
Title: Population structure and growth of lane snapper, a data limited species
Thematic Research Area: Stock Assessment Support 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 compliment 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: Adrianne Wilson, University of Miami - Rosenstiel School of Marine and Atmospheric Science
Co-PI: Dr. Elizabeth Babcock, University of Miami - Rosenstiel School of Marine and Atmospheric Science
NOAA Partner: Robert Allman, SEFSC: Southeast Fishery Science Center
Other Partner: Dr. Dionne Hoskins-Brown, Savannah State University
Students: Adrianne Wilson (Ph.D., RSMAS); Intern (Undergraduate, RSMAS)

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: 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 C. Ebanks, Savannah State University

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

Other Partner: Kimberly Roberson, NOS: National Ocean Service

Students: Joe Day (Undergraduate, SSU)

Project Number   20-02

Title: Investigating The Impacts Of Adult-Oyster-Conditioned-Seawater On The Setting Efficiency Of *Crassostrea virginica* Larvae Utilizing Direct Setting In The Field

Thematic Research Area: Habitats and Biological Systems

Abstract: Direct setting is a technique that utilizes eyed oyster larvae to directly seed oyster reefs for restoration purposes. The technique has shown positive results and setting efficiencies comparable to traditional remote setting. However, methods are still needed to increase setting efficiencies. One way to potentially increase setting efficiencies in the field is to induce oyster settlement using waterborne chemical cues released by adult oysters. In this study, we tested the effectiveness of using adult-oyster-conditioned-seawater (OCW) to increase oyster larvae setting efficiency in the lab and field. This will be the first study to compare the impacts of OCW on the larval settlement on an artificial oyster reef in the field.

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 U); N/A (Hampton U); N/A

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: 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); Cameron Atkinson (MS, SSU)

Project Number   **20-10**
Title: The Occurrence of Microplastics in the Maryland Coastal Bays
Thematic Research Area: Habitats and Biological Systems

Abstract: A major problem in the world is plastic in the ocean with 8 million tons of plastic from coastal nations entering the ocean every year. Microplastics are tiny pieces of plastic, 5 mm or smaller, that originate from the breakdown of larger pieces of plastic. Because they are so small, it is easy for organisms to ingest them and considerably harder to remove them from the environment, making plastics a huge threat to marine life. The Maryland Coastal Bays are important sources of commercial and recreational activities as well as home to over one hundred fish species, but their health is declining, more specifically their water quality. For my master's research, I am proposing to examine the amount of microplastics found in Maryland Coastal Bay fishes in comparison to the same species found in Delaware's Inland bays. 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, UMES
Students Imani Wilburn (MS, UMES)

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VII. Financial Information

1. Total NOAA funding breakout

FY 16 Award Center base funds: Indicate how funds were used for the reporting period, using award budget categories to provide detailed information for reporting period.

Unobligated balances will be compared with SF 425 reporting.

Postsecondary Direct Student Support (Data do not include information from SSU):

Tuition:	$232,257
Stipend:	$288,515
Travel:	$5,951
NERTO:	$0
One-time Research:	$14,154
Professional Development:	$584
Total:	**$551,461**

Collaborative Research:

Ten (10) new research projects were funded during this period in the amount of $386,318.77.

Total leveraged funding breakout

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

Postsecondary Student Support:

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
Aquaculture	Grant	12/1/2019 - 2/28/2020	$11,307.14	$6,461.52	Gulnihal Ozbay	Delaware Inland Bays HAB	Funds are used to support a M.S. student Amanda Pappas at DSU
NSF	National Research Traineeship	9/2020 to 8/2021	$53,000	$26,500.00	Ciannelli	Risk & Uncertainty Quantification in Marine Science	Supports Thalmann for 1 full year, stipend and tuition

OSU	Graduate award	2020-2021	$4,000	$2,000.00	King	Oregon State Thurgood Marshall Graduate Award	Help support research of King
OSU Sea Grant	Graduate award	10/19 to 9/2020	$10,800	$5,400.00	King	Oregon Sea Grant Robert E. Malouf Marine Studies Award (Sept. 2019)	Provide support for King
CIMAS	Grant	Sept 2019-Aug 2018	$49,198	$24,198.00	Elizabeth Babcock	Evaluation of Management Strategies for Fisheries Ecosystems, additional funds	Funding supports one PhD student from LMRCSC and partial salary support for E. Babcock
GA Dept. of Natural Resources	Georgia DNR Coastal Incentive Grant Program	8/1/2016-7/31/2017	$95,574	n/a, just awarded	Matt Kenworthy, Dionne Hoskins-Brown	Evaluating the use of a biodegradable hardscape for oyster reef habitat restoration applications in Georgia estuaries	Funds are used to support a M.S. student; also provides research support for Matt Kenworthy
NSF	Grant	5/1/12 - 4/30/21	$627,489	$16,742.91	J. Sook Chung	Functional Roles of a Novel Crustacean Female Sex Hormone in Sex Differentiation and Developing Secondary Sex Features of Crustaceans	Funds support PI's salary and Shadaesha Green (Cohort 1) research

Ratcliffe Foundation	Award	7/1/14 - 6/30/21	$1,200,000	$73,288.45	Russell Hill/Nina Lamba	Award to cultivate the leadership and business skills necessary to bring their research into commercial markets and to provide students with an enhanced appreciation of the potential business implications of their research.	Funds support graduate student stipends
Bunting Foundation	Award	01/01/20-12/31/20	$40,000	$40,000.00	Rose Jagus	Support IMET Summer Internship	Funding supports IMET Summer Internship, 2020
Anonymous Donor	Award	01/01/20-12/31/20	$20,000	$20,000.00	Rosemary Jagus	Support IMET Summer Internship	Funding supports IMET Summer Internship, 2020
MIPS	Grant	2/1/20 - 1/31/21	$100,000	$40,234.18	Yantao Li	*In situ* astaxanthin production in microalgae	Funding supports Kia Ramarui research
NSF	Grant	7/1/17 - 6/30/21	$362,497	$62,708.01	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	$3,546.22	Eric Schott	Determining how variation in life history & connectivity drive pathogen-host dynamics	Supplemental funds for summer intern
NSF	Grant	9/1/2016 – 8/31/21	$5,000,000	$500,000.00	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

Collaborative Research:

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
Shark Conservation Fund via Dalhousie University	Grant	1/1/2020-/30/2020	$16,500	$16,500.00	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	$10,000.00	Dionne Hoskins, Victoria Young	NOSB Regional Site	Produce the GA-SC NOSB competition
MIPS	Grant	2/1/20 - 1/31/21	$178,973	$4,925.98	Feng Chen	Microbial dynamics in anaerobic digesters	
MIPS	Grant	2/1/20 - 1/31/21	$100,000	$17,586.17	Feng Chen	Algae in Livestock and Aqua Feed	
NSF	Grant	2/1/19 - 1/31/22	$300,281	$44,523.03	Feng Chen	Fate of lysis products of picocyanobacteria contributes to marine humic-like chromophoric dissolved organic matter	
KIMST	Grant	1/1/19 - 12/31/22	$115,011	$19,993.05	J. Sook Chung	Agreement on International Collaborative Research on Oceans and Fisheries	
MIPS	Grant	8/1/19 - 7/31/21	$100,000	$13,455.99	J. Sook Chung	Non-invasive assessment of shrimp biomass	
NSF	Grant	10/1/17 - 5/31/21	$109,949	$6,779.32	J. Sook Chung	CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics in the	Funds support PI's salary

						Mid-Atlantic Region	
Various Donors	Award	7/1/16 - 7/30/20	$215,079	$10,071.73	J. Sook Chung	Blue Crab Genome Initiative	Funds provide data for work in the lab
MIPS	Grant	8/1/18 - 7/31/21	$250,000	$20,461.66	Russell Hill/Yantao Li	Improving algal growth via probiotic bacteria	
Bailey Wildlife Foundation	Grant	1/1/19 - 12/31/20	$189,751	$51,112.92	Yantao Li/Allen Place	A Global Defense for Coral Reef Wildlife: Creating Carbon Negative Habitat	
Mote Marine Laboratory	Grant	5/1/20 - 4/30/21	$136,259	$9,969.88	Allen Place	Pushing *Karenia* over the edge with Nature Derived Flavenoids	
France Merrick	Grant	5/1/18 - 4/30/21	$71,383	$3,988.04	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	$1,673.61	Eric Schott	Molecular Screening for Microbes in Baltimore's Harbor 2019/2020	Funds support PI's salary and former summer intern's salary

Appendices

**Living Marine Resources Cooperative Science
Center External Evaluation Year 4 Report
(2019-2020)
Prepared by Tina Bishop, Ed.D. and Howard
Walters, Ph.D. (College of Exploration)**

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

Among the significant programs implemented under LMRCSC are the *NERTO*, a research program for graduate students to conduct original research under the cooperative supervision of a NOAA scientist in a NOAA laboratory, and a university mentor; the *TAB* research project (Technical Advisory Board, in reference to the primary review process embedded in project approval for students or related faculty); and a *Data Management for Scientists* graduate course taught online as a requirement for all students in the program. This current annual report provides summaries and observations for evaluation efforts conducted at the end of project year four for these three programs of the LMRCSC, as well as a brief synopsis of two additional evaluation efforts in this year, i.e. a site visit to Savannah State University, and development and implementation of a student recruitment planning survey (which emerged from the IERT Panel Review). Additionally, the external evaluation team made significant time commitments to preparing for and responding to the IERT Panel during year four, which is also summarized at the end of this report. This final, written report consolidates all of the annual evidence into an overarching report with recommendations and findings at the end of the project year, as has been done in the earlier years, although in light of the IERT process in year four, these recommendations and conclusions are couched or contextualized within the IERT Panel Final Report.

NERTO Report

In fall 2019, the students conducting NERTO projects during this academic year were surveyed to collect formal response data to allow the evaluation team to consider the impacts of the NERTOs overall. In addition to these surveys, the evaluation team has been conducting site visits at the LMRCSC partner institutions to also conduct interviews with graduate students, NOAA scientists, and university mentor faculty members associated with the project and to conduct field observations of the contexts in which these students are working. These data are also contributing to an understanding of the impacts of the NERTO efforts. The summary sections as follows will consider first the survey responses from eight graduate students who participated in the NERTO and completed the survey in fall 2019, and then briefly summarize select interview narrative that relates to these NERTO projects.

Items one through four of the survey focused on the content of the NERTO projects. Respondents described their projects (item one) which addressed ecosystem modeling in Maryland, and a variety of commercially important species (Dungeness crabs, shellfish) or other forage fishes related to resource uses. When asked to align their projects with the NOAA mission science research priorities, the responses distributed in 25% equal units with Seafood safety/Aquaculture, Ecosystem Science, Stock Assessment, Living Resource Management. Item three responses note that five of the eight responding students were required to "manage, analyze or manipulate large datasets" while working on their projects. And (item four) three of the respondents indicated that they considered the social science implications of their projects during the NERTO. Particularly with item four (social implications), over a third of the respondents did not associate social science with their project. The responses suggest there may be a gap in the students' conceptions of social impacts of science research. It is noted that in the interviews with the graduate students, this gap did not appear when they were prompted to think through potential social science implications, as the interview methodology allowed for probing questions as the evaluators met with the individual graduate students.

Items five through ten addressed the relationships and roles of the mentors on the projects and students. Five of the eight respondents had worked with their mentor more than a year, with the other respondents less than this. Four of the respondents were working more than eleven hours weekly (two, more than twenty hours weekly). Item seven suggested, counter-intuitively, that direct, in person conversation with the primary method of communications between the students and mentors.

Most had significant support from their academic mentors, although there is one person in the response pool who is disgruntled in some way. In item eight, five of the eight respondents indicated that the mentor has supported their academic work either significantly or quite a bit. In item nine, six of the eight respondents indicated that the mentor has supported their professional careers either significantly or quite a bit.

Item ten followed up the previous questions to ask respondents to describe the ways in which their mentors had provided this support. Except for one student, the respondents indicated networking in the field as a primary mechanism for career support. One select quote that illustrates well the overall essence of these responses is, "By treating me as part of the team, I was expected to fully participate in lab meetings…I was also given an opportunity to present my work in front of other scientists."

From the narrative responses, the participants viewed the primary benefit of NERTO was insight into the NOAA community from working in a NOAA research facility. Other benefits mentioned by students included professional relationships with NOAA scientists, and other collaborations and networking opportunities. Numerous students also mentioned the benefit of a professional association with NOAA several times.

It does seem clear from select response items and narrative descriptions that the NERTO participants perceive the NERTO influenced their career decisions, with seven of the eight students strongly agreeing or agreeing. The narrative responses are helpful in clarifying these perceptions:

- *Interning at a NOAA Lab this summer allowed me to experience what it would be like to work at NOAA and has inspired me to possibly work at NOAA when I graduate;*
- *I learned more in depth how NOAA operates as an organization and the role of science in the government; and,*
- *I got a chance to see what NOAA does in person and be a part of that work. I am more energized about NOAA's mission and seeing what they do first hand, solidified my wanting to work for NOAA one day.*

Continuing this workforce theme of questioning, item sixteen reveals that seven of the eight respondents gained "good insight into the NOAA organizational culture through their NERTO." Item seventeen further revealed that seven of the eight perceived that NERTO

"helped create a network for future success in the workforce." And finally, item nineteen reflects that seven of the eight had a mentor who "introduced them to other colleagues in the field during the NERTO experience." This was reinforced with responses in item twenty-three where six of the eight completed their NERTO with a "sense of belonging to NOAA mission science fields."

TAB Report

Annually, the Technical Advisory Board (TAB) for the project receives proposals for original research from graduate students, and following a technical review, awards funds for these projects, conducted by the students under the supervision of a university mentor. In fall 2019, students in the TAB projects were provided an electronic survey to complete to provide responses aligned to the NOAA EPP guiding questions for the Cooperative Science Centers. Seven students provided responses to the survey, with their responses summarized below.

Items one through five solicited descriptions of the student projects. Item one reflects that three respondents were Ph.D. students, and four were masters level students. In item two, respondents described, briefly, the extent of their projects:

- The objective of my research is to test if Atlantic Sea Scallops are contaminated with microplastics and determine the polymer composition of the plastics found in them.
- The funded project used geostatistical modeling to understand the spatio-temporal distribution of larval King Mackerel in the northern Gulf of Mexico and how it impacts the trends and uncertainty in the index of spawning biomass abundance, used for the stock assessment.
- Exploring underrepresentation in marine and fisheries science professions
- Investigating the reproductive biology of the Jonah crab. Using hormone expression as an indicator of male sexual maturity and determining the size at which these males are becoming mature.
- Develop an improved stage structured population model for Kemp's ridley sea turtles to evaluate the contribution of Atlantic turtles to population growth.
- Validating ageing methods for Goosefish (*Lophius Americanus*) using microconstituent analysis.
- Determining the reach of spring blooms of HAB species *Dinophysis acuminata* and overwintering strategy.

Item three asked respondents to align their projects with one of the NOAA science content emphasis areas. Students selected aquaculture and seafood safety, stock assessment, living resource management, or social science and economics in their responses. Five of the seven respondents (item four) were required to use, analyze, or manipulate a large data set to complete the requirements of their projects, and four of the students (item five) were required to consider the social science implications of their research as a part of their project work.

Items six through eleven were related to the students work with the academic mentor who oversaw the TAB project. Item six notes that all of the students had worked with the supervising mentor for at least a full academic year, with most having worked multiple years with that mentor. Five of the students (item seven) worked five hours per week on the project, with one student working up to ten hours weekly, and one other student working more than ten hours weekly. Item eight describes the communications process used between students and mentors, with five of the seven meeting face to face, and two additional students using email as the primary mode of communications. All of the respondents (item nine) perceived the mentor as being supportive of their academic work, with four of the students expressing that this support was more than minimal to substantial. A larger proportion of respondents (five of the seven on item ten) perceived stronger support for their career aspirations from these mentors. When asked to describe the nature of this support (item eleven), the respondents listed being

introduced to potential professional colleagues and a network of scientists, being provided opportunities to apply for grants, and being invited to professional meetings and science conferences as primary mechanisms.

Item twelve asked respondents to describe the primary benefit(s) they perceive from participating in a TAB project. Their responses were unique and seemed to cover a wide but expected range of professional and academic issues:

- The primary benefits obtained from this TAB project are the experience of writing a research proposal and working directly with a NOAA affiliate.
- Networking and geostatistical modeling skills.
- It is contributing to the rest of my dissertation.
- A much better understanding of how fisheries are managed and the data that is needed to produce policies.
- Funding for the last year of my program and establishment of new collaborations.
- Funding for the last year of my program and establishment of new collaborations.
- Funding to continue my project and have samples run.

Items thirteen through sixteen solicited responses regarding career development opportunities which were embedded in the TAB projects and related work. Four of the seven respondents perceived that the TAB project influenced their ultimate career selection. And among the seven responses to this item, the primary skills developed through the TAB projects were communication related skills, grant writing, data modeling, and science process skills. Finally, the respondents indicated that the TAB process increased their awareness of working for a government agency as a scientist.

Items seventeen and eighteen asked respondents about their perception specifically of the NOAA workforce and networks for career advancement. Six of the seven respondents indicated that they agreed or strongly agreed that their experience conducting their TAB project gave them good insight into the NOAA work culture. Four of the seven further concluded that the TAB project had helped them develop a network of contacts that would be important for their careers.

Item nineteen asked the respondents to describe their new or changed perceptions about the workforce based on the TAB experience. The responses were richly descriptive and included:

- I have the experience of managing a budget, writing proposals, abstracts and reports, in addition, to working closely with government affiliates.
- It is a very small community and people hire those that they know even if they are not as competent as the employer may think.
- Who you know or who you are connected to definitely gets you in the door in quantitative fisheries jobs especially on the west coast.
- I gained an in depth understanding of the proposal process and budgeting, which are both transferable skills that can be used in many other jobs or careers in the sciences.
- I have a more thorough understanding of the NOAA organizational structure which is useful to any future job with NOAA.
- This project has revealed a whole new avenue of potential careers I was not even aware of prior. Most of which pertain to NOAA.
- I will look at NOAA jobs as potential opportunities.

Item twenty reflected that all of the respondents were introduced to other colleagues in the field during the TAB project experience. This created an opportunity for networking that could be important for careers down the road.

Items twenty-one through twenty-seven asked respondents to comment on the administrative and process elements of the TAB experience and a selection of potentially informative issues regarding program management and student experiences, to allow the evaluators to consider this programming element in light of the NOAA EPP questions regarding CSC administrative culture and process. Sample size limited the range of responses to these items and preclude the observation of clusters of responses. One exception to this was item twenty-three which asked respondents what they had learned about the Social Implications of their research. These expressions from the students constitute evidence of an enhanced knowledge for the social science integration of their research as per the NOAA EPP guiding questions 1.5:

- I have learned this project has a large societal impact, because plastics are commonly involved in everyday life.
- During my TAB project, I was able to sit in on the groundfish planning team meetings. This meeting included all kinds of people who had a stake in the fishery. It was interesting to learn and witness first had the conflict between what fisherman and scientists want versus what management and funding will allow. There are a great deal of social science decisions that play into the management of a valuable commercial fish stock and they must all be taken into account when trying to set quotas.
- The importance of fisheries management, to keep this resource sustained to continue to keep fisherman employed, I have not learned anything new regarding social implications specific to my project however I was exposed to this topic in the Cohort Experience.
- In the future I plan to explicitly include social science aspects in my research proposals.
- I have seen that Fishery's management is more about managing people and their expectations rather that managing the species in question. Also how my work could greatly impact the lives of those who rely on work with goosefish.
- The importance of being able to communicate your science to people not within science fields and even other scientists outside of your field is one of the most important skills to develop.

It is important to highlight these various descriptions of students' perceptions of the social implications of their research, particularly in light of NOAA EPP question 1.5. This question emphasizes "evidence of enhanced knowledge" of social science integration, not a full or complete understanding of a clearly defined criterion of knowledge. Clearly, there is evidence that LMRCSC students are learning and obtaining enhanced knowledge in this area.

Data Management for Scientists Course Report

Late in the fall semester, the evaluators were contacted by the Project Director and asked to create and implement an evaluation of the Data Management for Scientists online course, which had been developed and implemented as a program element of the LMRCSC. While this specific element had not been sequenced for evaluation during this program year by the evaluators, nevertheless, a survey was quickly formulated and approved by the leadership, and then distributed to course participants.

The following summaries by item are based on responses from six graduate students who took the course, and are clearly bimodal in their positive to negative reactions to the course. The specificity of critique offered by the respondents read as if they are, in two groups,

describing in separate ratings and narratives a course, its instructor, and its requirements and outcomes that are wildly differing. Items two through six, as follows, were essentially demographic or related to the pacing and credit of the course experience and are presented with little explanation:

Item two: five of six respondents rated themselves as average (two) or below average (three) in their understanding of data management prior to taking the course.

Item three: after the course five of the six rated their knowledge as average (four) or above (one) in their understanding.

Item four: four of the respondents had taken more than four credit hours of statistics prior to taking this course, but two had fewer than three hours.

Item five: only one respondent of six indicated that he/she had used the content or skills from the course in a NERTO or TAB project.

Item six: three respondents thought the course was paced too slowly; two thought it was paced well and one thought it was paced too quickly.

Item seven: respondents were asked to rate the amount of work required for the two credit hour course. The responses were equally distributed, two each, in exceeded, met or beneath expectations of work quantity.

Given the small number, relatively, of respondents possible for this survey, there were a few anecdotes observed in the data that seem important to bring to the attention of the LMRCSC leadership. There was a concerning statement in the item seven responses: *We never received a syllabus with weekly homework and due dates. Every week, the course varied between 1-3 hours of class time with 0-2 hours of homework. It was extremely frustrating to go into a class not knowing how much time I needed to budget for the course. In addition, the professor did not make the course accessible for Mac users. The code we needed was somewhat different and it took additional time outside of class to find and incorporate that code into projects.*

Item eight asked respondents if they "considered this course, as they experienced it, was helpful for their future careers." The responses were substantially negative, with five of six respondents indicating a negative response. Descriptive comments included: the course was insufficient to teach database management. Other detailed responses included: every single, three hour class could have been condensed to thirty minutes with no information lost; YouTube was more helpful for learning SQL than this course; I didn't learn anything…that is not an exaggeration; the course was unnecessary for the career-path I'm on; and I'm a first year graduate student without any data to work on so it was unhelpful right now. Item 9 further records that only one of the six respondents perceived that the course was helpful for meeting other LMRCSC students with whom they might eventually work.

Item ten asked respondents to provide an overall quality rating of the course. Two of the responses were positive (one very high, one high quality) and four of the responses were low (two responses) or very low (the final two responses). These evaluations are generally skewed positive by typical respondents in these types of survey contexts, and so this pattern, even for a small sample size, is likely concerning. Nevertheless, in item eleven, as a follow-up, the respondents did identify one consistent benefit to the course: some elemental or basic level instruction in SQL programming.

Item twelve asked the respondents to provide narrative descriptions of some ways that the course could have been improved. Given the negative values expressed by approximately

half of the six respondents across the survey, it seemed prudent to provide the responses to this item in their entirety for the program leadership to review. These included:

- Pre-class prep: rarely did we receive data more than a few hours before the class. 2) Schedule: Every day we went in not knowing what we are covering and if homework would be assigned. 3) Homework Due Dates: Making homework due the day it was assigned was difficult, as we would have to rearrange our schedules to accommodate homework on subjects we had just covered. 4) SQL Program Installation: Spending a 3-hr lecture on something that a piece of paper could accomplish was frustrating.
- Allowed student microphone usage.
- Ask students with Macs to bring a PC in advance. The program doesn't seem to work properly on a MAC, thus much time was spent on the instructor troubleshooting their issues or explaining how to code on their computers.
- Shorter classes meeting multiple times a week instead of one long class. Syllabus more tailored to students and going at a slower pace
- Would have been nice for the professor to have a plan for the lecture prior to the beginning of the lecture. We would have benefited from powerpoints, illustrations, or other learning tools for complex database topics. It would have also been nice for the professor to explain how concepts were linked in this course. Every lecture, and, indeed, the entire structure of the class, felt very disjointed and ill-prepared.

Item fourteen solicited the primary challenge in taking the course from respondents. Two of the respondents provided substantive and negative criticisms of the course quality, organization, and effectiveness. The program leadership are encouraged to review these extensive narratives in the raw data for this item which are provided to the leadership separately. These are not included here as they essentially restate prior negative responses that are already included. Other responses to this item didn't seem essentially out of alignment with typical course struggles when content is new or difficult.

All respondents in item fifteen perceived that the analysis software incorporated in the course was appropriate. Item sixteen indicates that four of the six respondents perceived the course was offered at the most appropriate time to be helpful in their academic courses of study. Two of the respondents perceived it would likely be more helpful later.

Items seventeen and eighteen focused on the quality of instruction and the online format of the course. Again as observed in earlier items, the responses were bimodal: half the respondents were negative in evaluating the instructional quality, and four of the six were negative with respect to the online format, although the narrative explanations for the online format item seemed more pointedly concerns about the instructors capability, for example, pointing to the instructors inability to effectively use the instructional learning system for the course.

Items nineteen and twenty, again dividing into a set of positive and a set of negative responses, suggested half the students had improved their ability to develop a data management plan, and half had improved their ability to manipulate and analyze data, with half responding negative in each item.

Finally, item twenty-two included an opportunity for respondents to provide an open-ended, narrative response to the evaluators about the course. The item specifically informed the respondents that their personal identity would be protected. As with the earlier survey items, the respondents were distributed with fifty percent positive and fifty percent negative in their responses, and again the leadership is encouraged to read the de-identified narrative in

entirety to consider the reasoning and narrative on its own merits. The evaluators' view of these responses is that they are conceptually so far apart as to seemingly be describing two entirely different courses and instructors. In this case, it seems prudent to leave any requisite decision about this course moving forward to the judgment of the larger leadership team.

The evaluators strongly recommend that the results from this course evaluation be provided to the course instructor, with a requirement that revisions to the course be considered in response to these student evaluations. This process will be useful to document the use of evaluation reports for continuous quality improvement of the LMRCSC and its related programming elements.

Additional Evaluation Efforts for Year 4

Site Visit—Savannah State University

In addition to the surveys and data analysis and presentation work summarized above, the evaluation team continued to support the external evaluation of the project in two additional ways during year four. First, as described in the initial evaluation plan and as implemented in prior years, the team selected one institutional site partner location to conduct a site visit. This year in January 2020, the evaluation team visited Savannah State University. On location, the evaluators interviewed undergraduate students who obtain LMRCSC funding; SSU faculty members, a NOAA researcher housed at SSU, and a post-doctoral researcher, as well as extensive conversations with the LMRCSC Education Director, who is housed for the project at SSU. This site visit, as with those undertaken in earlier years, is funded from the evaluation budget to The College of Exploration (the external evaluators) and has been added to allow the evaluators to obtain direct observational evidence of the reach of the LMRSC at the institutional partner campuses, and with the students, faculty, and staff at those locations. This context facilitates the richer understanding of the Center by the external evaluators in terms of analyzing the collected data elsewhere in this report, and advising, on a month to month basis, the project leadership team when the need arises. The evaluators typed field notes from interviews and observations from the site visit, which are summarized as follows:

The External Evaluators traveled to Savannah, GA, to conduct a site visit at Savannah State University on January 17-18, 2020. During the visit, evaluators visited classrooms and laboratory facilities used by graduate and undergraduate students. In addition, evaluators conducted structured and semi-structured interviews with a nearly encompassing set of individuals associated with the LMRCSC: the institutional Co-PI, faculty members from the academic department, undergraduate and graduate students, the department chair, the LMRCSC Post-Doctoral Researcher who is housed at SSU, and the LMRCSC Education Director (who is also housed at SSU). A conference room was reserved for uses by the evaluators to meet with the different individuals or groups of individuals delineated above.

Field notes from the evaluator interviews, as well as embedded observations by the evaluators, suggest a strong program at the campus level. All of the individuals had an operational awareness of the LMRCSC, although the undergraduate students were less aware of the breadth of the program.

The faculty had been engaged for multiple years, although they expressed concerns with the relative difficulty of using LMRCSC funds due to restrictions on the use of the funds. These restrictions had curtailed the interest of the faculty in applying for funding, with one expressing that she was required to write the proposal and manage the funds, but was unable to use funds for her own contract time. These funding restrictions as issues within the LMRCSC have

emerged before at other partner institutions and from Co-PIs themselves in conversation with the evaluators.

The three graduate students who were interviewed were excited about LMRCSC, and expressed the benefits of the network opportunities, the scholarships, the research experiences, and the social community. Nevertheless, collectively, there was a similar concern which has emerged from other graduate students at other institutions: a lack of communications about the broader NOAA effort and jobs in that agency; a perception of a lack of jobs in higher education as faculty, and living within very tight financial means during their research work experiences.

Student Recruitment Survey Development and Summary Report

An additional evaluation effort emerged in late spring and summer of year four as a result of the IERT panel review of the LMRCSC. The panel concluded that there was a deficiency in the development of a formal recruitment plan for the Center, which necessitated the collection of input data from the stakeholder community on the issues surrounding student recruitment. The evaluation team was tasked to develop, circulate, and revise a survey instrument, and to summarize the respondent data obtained from this survey to support the Center administrative efforts and in compliance with the IERT panel. The survey was kept brief and focused, including thirteen items that focused on several dimensions of the recruitment process and these students' experiences. The following brief narrative summarizes this initial survey effort.

Twenty-eight students from all partner institutions completed the survey. The survey was completed by six undergraduate students, ten Masters students, and twelve doctoral students. Six of these respondents had prior LMRCSC awards; but for twenty-two respondents, this was their first award.

Items four and five explored reasons for applying to or participating in the LMRCSC. The primary reasons for participation in LMRCSC fell into several main areas. For many of the respondents, the main motivator was funding. Several students mentioned the connection or mentorship with NOAA and building a connection with a scientific or marine community, while other respondents listed the motivation of a potential career field or employer. Several students expressed interest in marine sciences and the opportunity to gain research and lab experience and networking connections. In this vein, one student highlighted the diversity of LMRCSC, stating "I wanted to be surrounded by a community that looked like me."

The respondents were asked how they first learned about LMRCSC. There responses included:
- internships at partner institutions;
- from one of the PIs, a counselor or advisors, or a faculty member;
- from an REU;
- from a campus communication or source;
- on a job board at campus;
- upon university application/acceptance; or
- from a TAB RFP.

In addition to these communications channels, several students listed, by name, specific individuals from whom they were informed about LMRCSC. These names are not included here in the interest of privacy, but are included in the raw data provided to the LMRCSC leadership. Prior to starting LMRCSC, 92% of respondents were already interested in fisheries or ocean sciences. The responses mentioned experiences in early life, through recent research. The impetus for their interest in fisheries or ocean sciences included:
- Early life on an island; experiencing the beach or lake; love of the ocean as a child; reading about fishing and documentaries;
- Sea World, or going to an aquarium as a child;

- Shark week on television, documentaries;
- Through high school classes, high school summer program;
- Interactions on campus, undergraduate research experiences, scholars' programs, coursework in ecology-based biology, or undergraduate degrees in Marine Biology; or
- Previous research experiences, environmental work with MPAs.

When asked (Question 9) about other information they wished they had concerning the LMRCSC and its opportunities, several main themes emerged. Many expressed the desire to have a clear list of requirements, with consistent and solid updates about the requirements, including timelines and the NERTO requirements (the creation of this resource is the subject of a separate IERT Panel Recommendation). Also mentioned was a desire to know about "heavily encouraged events," such as conferences or training. Several respondents mentioned project, research, internship, or mentorship opportunities, as well as opportunities after graduation. One respondent mentioned "It was difficult, as a freshman, to seek out research opportunities." One suggestion for enhanced communication was "a quick overview about finding a good mentor, and how to be a reliable student in a mentor-mentee relationship."
Other respondent suggestions included:
- Realistic assessment of the number of years for funding,
- More university information about graduate life,
- Awareness of availability for undergraduates, and
- Support for science content development.

When asked (Question 10) about ideas for recruiting students into LMRCSC, the respondents offered several compelling suggestions, to showcase the LMRCSC to other students:
- Several mentioned having students or alumni speak with incoming students. Direct connection was important. Experience fairs were suggested. *"Current students and alumni are a great tool. If they are happy with the program, they can help bring many new students."*
- Have mentors available to incoming students (better definition of mentorship is an additional IERT Panel Recommendation).
- Target students doing internships and other marine science research opportunities at other minority institutions.
- Emphasize the potential of LMRCSC to provide good connections for students (to others and to NOAA), "promote the network," highlight post-graduation options, make the full portfolio of the LMRCSC program visible to students (again, an additional IERT Panel Recommendation addresses this communication need).
- Highlight that a strong background in statistics is helpful.
- Advertise in as many places as possible for deeper community outreach.
- Visit other HBCUs to recruit students, and consider visiting high schools.
- Provide clear timelines and expectations regarding programs at each partnering university.

When asked about recommending LMRCSC to other students, the respondents were nearly all very positive and enthusiastic, offering a resounding "yes," using words like *grateful*, *valuable*, *special*, *supportive*, and *opportunities*. One enthusiastic response was "absolutely, best experience ever!" And one respondent exclaimed, "The metaphorical door has opened up so many research opportunities." "It is a fantastic pathway to connections in marine science, internships and scholarships. It is incredibly applicable to young scientists at HCBUs and other minority-serving institutions" was an additional, positive affirmation about the CSC.
Aside from the primarily positive comments, there were several negative comments

which should be considered. One respondent felt that better recognition was needed by NOAA of LMRCSC. One respondent would not recommend LMRCSC to second year masters students due to the difficulty of accomplishing the requirements. A final respondent would not recommend the program due to the requirements and the "toxic environment." There was no further explanation from the student of what this comment might point towards.

When queried about other advertisements or announcements about the LMRCSC which respondents recalled seeing, most could not remember seeing any. Some respondents said they saw pamphlets or notices posted on a jobs board on their campuses, or the TAB RFP announcement. Two respondents mentioned direct communications with faculty or one of the co-PIs.

A final question addressed retaining students and asked the respondents to identify the greatest challenges in moving forward through their institution's degree programs while participating in LMRCSC. Specific challenges which were provided included:

- Distance between the other partner institutions,
- UMES lack of broad choice of classes,
- Professors having to handle several students for research projects,
- Disconnect between LMRCSC, the School of Graduate Studies, the department of Natural Sciences and the Office of the Registrar (UMES),
- Meeting deadlines, "Handling business within a reasonable timeframe was difficult,"
- "Requirements to remain a part of LMRCSC are confusing,"
- Keeping up with LMRCSC activities while doing classes, and
- COVID challenges.

Suggestions related to program or experience improvements provided by respondents included:

- Do things to engage students across the partner institutions. Helpful to meet other LMRCSC students at conferences,
- Boost morale of students and faculty (UMES),
- Acknowledge individual differences and challenges for each student, and
- Hold additional seminars on professional development skills.

One student remarked "It was challenging to continue meeting my research requirements, but having a supportive mentor makes that much easier."

And finally, one negative comment related to LMRCSC administration. This respondent indicated (without any explicit or actionable description) "the director does not listen to student concerns: student struggles are dismissed" with a parallel concern about the lack of a way to register complaints. While this comment is isolated and doesn't provide sufficient context to even allow investigation, it may point to a need to define mechanisms generally for participants to register concerns, issues or complaints in a neutral manner during their program experiences.

External Evaluation Support for IERT Panel Review and Response

An additional, substantial effort for the external evaluation team in year four (from a time commitment) was support for the LMRCSC Panel Review, conducted in March 2020, followed by substantive efforts to address recommendations and suggestions from that panel report which interfaced with the external evaluation. Efforts to support the review included development of Center responses for select sections of the preliminary briefing document in the center report narrative; creation of a custom Power Point presentation and delivering this to the Review Panel during the review; creation of a hard copy notebook which included all external evaluation written reports, survey instruments, and guiding documents for the Center Director and the IERT Panel members; and meeting privately with the Review Panel for additional questioning by the panel.

After the final report was received from the IERT Panel, the external evaluators developed the following responses to each of the recommendations and suggestions included in the report, as well as supplemental draft surveys as indicated in the responses. These supplemental documents, i.e. a stakeholder survey for post-assessment of the TAB projects, the recruitment planning survey summarized in the above narrative, and a draft conceptual rubric and instrumentation to monitor Student Core Competency attainment have also been attached to this annual report, as these will be the beginning efforts in year five of the external evaluation support for LMRCSC.

Evaluation Team Responses to IERT Recommendations and Suggestions

The IERT Panel Report provided a group of three Recommendations and three additional Suggestions for the CSC External Evaluators to refine or extend their activities with respect to the LMRCSC. Those have been excerpted from the Final Report of the IERT Panel and copied below. Under each of these, the External Evaluators have provided narrative explaining how their efforts are or have already been revised to accommodate this report from the Panel. In select cases, additional documents are attached where noted to new data collection instruments, or previously development and implemented instruments, to document these efforts.

Recommendation 1: Develop a clearer and more transparent strategy for the evaluation of LMRCSC students in both the attainment of core competencies and the evolution of professional development skills.

The evaluation team coordinated with the LMRCSC leadership in identifying the core competencies that have been embraced in the project for students, as well as professional development skills. The evaluators have developed an Assessment Rubric as a scale of measurement for attainment of these competencies and skills which will be used by the LMRCSC leadership, distributed to select Co-PIs, faculty mentors, and instructional faculty who interact with the students, to directly measure and obtain evidence for attainment and evolution of these competencies and skills. The current draft Assessment Rubric is attached and will be piloted in fall 2020; revised in late fall/early winter 2020-2021, and then fully implemented in spring 2021. In addition, an overview sheet for the Assessment Rubric and a Master Scoring Sheet to be used for each student has been included in the attachments.

Recommendation 2: Develop a Center standardized process for monitoring results when Center incorporates the recommendations from external evaluation process to track – with data – impacts for continuous improvement.

Recommendation 2, while included in the IERT Panel Report for the External Evaluation, points appropriately to the use of the evaluation results, through a standardized process, by the Center to track continuous improvement. The response to this Recommendation will come from the Center Leadership, as the work effort required for this Recommendation cannot be undertaken by the evaluators, but only by center leadership.

Recommendation 3: Develop evaluation criteria for the TAB mini grant projects to evaluate the impact of the TAB on student research interests, and to capture the quality of the project, dissemination of results, and student professional development through performance in the TAB project.

Working with the LMRCSC leadership, the evaluation team has created a new

assessment tool to measure and collect evidence for the quality of the TAB projects, the dissemination of results, student professional development, and (emerging from Suggestion 1 below) the integration of social science in the TAB projects. This assessment tool will be used by LMRCSC leadership to collect evidence from TAB project faculty and student principal investigators, and from the project science director who chairs the TAB processes. The draft survey is attached to this report, and will be piloted this fall semester for the 2019-2020 TAB awards.

Suggestion 1: Assess how well the TAB projects incorporate social science integration.

This current Annual Report (see above) already includes student descriptive data of the incorporation of social science integration into both TAB and NERTO projects. The evaluators have included these response items in annual surveys of both students and faculty/scientists since the project's inception. These raw data, blank surveys, and evaluation written reports were provided to the IERT Panel and previously to the LMRCSC Director and Co-PIs. As noted under Recommendation 3 above, the new assessment tool for the TAB post-project assessment includes two items explicitly related to social science integration (items 8 and 13). Item 8 is an open-ended narrative response item to obtain a rich description of the integration of social sciences. Item 13 is a numeric rating scale to metric the final work of each project for comparison to a comparable rating scale used in initial review and award decisions at the front-end of the TAB project. These qualitative and quantitative data will be provided to both the TAB review panel, the LMRCSC Director and Science Director, and reported to the full leadership team by the Evaluators at a monthly team phone meeting. The assessment tool is included in the attachments.

Suggestion 2: Assess how LMRCSC students and their research fit within the thematic areas.

Each year, students, faculty, and science mentors are surveyed to identify the match between student research and academic experiences fit within NOAA's four, science areas incorporated in the CSCs. The response data are analyzed for patterns and reported to the leadership team, and included in a written annual report. The student completed survey data for both TAB and NERTO projects as summarized earlier in this report demonstrates that the external evaluation has been collecting these data since the project inception.

Suggestion 3: Assess the LMRCSC recruitment strategies for fellows – at all postsecondary levels and alumni including Center post-doctoral fellows – along with how the fellow's research advance the award objectives within the Center and the solicitation requirements.

Working with the LMRCSC leadership team, the Evaluators have created an additional assessment tool to identify, summarize, and assess the recruitment strategies used for undergraduate, graduate, and post-graduate participants in the CSC. This survey has been piloted already (in July 2020) and a summary report has been provided to the LMRCSC leadership, and attached to this document along with a copy of the survey itself.

Conclusions and Recommendations for the Annual Report

The conclusions and recommendations for the LMRCSC emerging from the annual report of the external evaluation team are of necessity couched within the year four report of the IERT Panel. The Panel provided substantive and significant input to the leadership of the

LMRCSC through numerous recommendations and suggestions. The LMRCSC, by the time of submission of this annual evaluation report, will have most certainly submitted its responses to the IERT recommendations and suggestions. The External Evaluation team has not yet analyzed this response document submitted to NOAA EPP by LMRCSC Leadership with a view toward year five evaluation efforts, but will address its (the external evaluation team) efforts in year five to evidence collection in support of these project revisions, as well as the new TAB, Student Core Competency, and Student Recruitment evidence collection.

Appendix II: TAB Funded Research Projects in 2017-2019

Project Number   18-01

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

Thematic Research Area   Fishery-Economics and Social Science

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. Data obtained from these interviews are currently being analyzed to address research questions.

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

Start Date: 9/1/2020   **End Date:**   12/31/2020

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 are being analyzed for themes and trends, related to our research questions.

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 LMRCSC missions to prepare a diverse student body for careers in marine and fisheries sciences through exemplary academic and research collaborations, by examining drivers that influence a diverse marine and fisheries science workforce. The project provides the LMRCSC student researcher, Brittany King, the opportunity to integrate social science research into the LMRCSC program to help better understand underrepresentation in marine and fisheries science professions

Presentations or Publications

King, B. Underrepresentation in marine and fisheries science professions: How social identities influence career experiences. Research Advances in Fisheries, Wildlife, and Ecology Symposium (RAFWE), Corvallis, OR (May 2020) - Presentation

King, B. Utilizing Cloud-Based Services in a Time of Uncertainty: Perceptions of Natural Marine Resource Management. NOAA Living Marine Resources Cooperative Science Center Annual Science Meeting, Silver Spring, MD (April 2020) - Presentation

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) - Presentation

King, B. Underrepresentation of ethnic and racial groups in marine and fisheries science professions. OSU's Arts and Humanities Graduate Student Conference, Corvallis, OR (May 2019) - Presentation

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

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   **18-03**

Title: Sensitivity of indices of abundance to the specification of environmental covariate in spatiotemporal geostatistical models

Thematic Research Area   Stock Assessment Support Information

Abstract

The assessment of King mackerel in the Gulf of Mexico uses an index for estimating spawning stock biomass; this index is developed using a statistical model that is parameterized by fitting to larval count data from annual plankton surveys. The model used to make the index does not explicitly consider spatiotemporal variation, which is inherent to the larval count data or environmental variability which can also influence local population density. Biomass trends can be misrepresented by a model that does not explicitly consider changes in spatial distributions (e.g., migration or ontogenetic shifts). This misrepresentation of estimated trends has been shown to lead to incorrect and uncertain estimates of stock status in the stock assessments, which are used to set management regulations which help to achieve NOAA's sustainable fisheries goals. King mackerel spatial distributions vary over time as adults migrate seasonally and change their distribution based on the quality of their environment. Migrations cause shifts in their spawning locations from year to year, and this then impacts the larval stage as their distribution is dependent on the location of spawning, and the local oceanography. We have used geostatistical models to answer the following question: Will accounting for spatiotemporal variation reduce the uncertainty in the estimates of the index, or indicate new biomass trends? We have also used non spatial negative binomial general additive models to determine environmental factors that have a significant impact on King Mackerel catchability and density. Current results indicate that incorporating spatiotemporal variability produces different trends in abundance. Results also suggest that temperature at the time of sampling should be considered a driver of catchability differences for larval King mackerel. These results support the development of a more ecosystem based index of abundance for use in stock assessments. Further analyses are being conducted to validate these findings.

Principal Investigator: LaTreese Denson, 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: John Walter, SEFSC: Southeast Fishery Science Center

Other Partner: Dionne Hoskins - Brown, Savannah State University

Students: LaTreese Denson (PhD, RSMAS); Alexandria Ambrose (Undergraduate, RSMAS)

Keywords: Fisheries; Marine Biology; Population dynamics; larval surveys, spatiotemporal models

Start Date: 9/12/2018   **End Date:**   12/1/2020

Results to Date

When developing the index of abundance for King Mackerel larvae, model results indicated that both of the indices, the original non-spatiotemporal and the spatiotemporal model identify many of the same trends in the early years but in the later years, 1999 and beyond, there is a slightly lower estimate of density in the spatiotemporal index. Results also indicated spatial variation has been more informative than spatiotemporal variation to the development of the index of abundance. Analysis of the environmental impact on larval King mackerel density and catchability indicate that sea surface temperature may be considered a catchability driver of larval King mackerel. These factors will be included in the future spatiotemporal index of abundance to test the sensitivity of the index trends to decisions regarding environmental variable inclusion.

Relevance to NOAA

This project contributes to NOAA's long-term goal of Healthy Oceans by improving the understanding of the Gulf of Mexico and South Atlantic ecosystems and its effects on important living marine resources such as King mackerel, to inform management decisions. This advancement is particularly important to implement ecosystem based fisheries management. Explicitly accounting for how this stock will be affected by ecosystem changes allows for management that more readily adapts to ecosystem dynamics and is trusted by its stakeholders.

Broader Impacts

Conducting this project has facilitated the training of underrepresented minorities in NOAA related sciences at multiple levels of education. This increases and diversifies the pool of applicants who are trained and ready to join the NOAA workforce.

Presentations or Publications

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

Ambrose A., Denson L.S., Babcock E. A. (2019). The effect of the environment on the distribution and density of King Mackerel in the Gulf of Mexico. Oral presentation, University of Miami RSMAS Internship Seminar in Miami, FL.

Denson L. S., Babcock E. A., Walter J. F. (2019). Incorporating Spatial and Spatiotemporal Variation into Indices of Abundance for King Mackerel in the Gulf of Mexico. To be presented at the AFS Annual Conference in Reno, Nevada in October 2019.

Denson, L. S., Babcock E. A. (2019). The effects of spatio-temporal variation on indices of abundance used for King mackerel in the Northern Gulf of Mexico. NOAA Headquarters, Silver Spring, MD.

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: C1c: Incorporate environmental change information into operational marine resource assessments and decision-making.

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

Project Number   18-06

Title: Assessing the Impacts of Harmful Dinoflagellates and *Vibrio* spp. On Oyster Aquaculture In The Delaware Inland Bays.

Thematic Research Area   Habitats and Biological Systems

Abstract

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

Principal Investigator: Detbra Rosales, University of Maryland Eastern Shore

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

NOAA Partner: John Jacobs, NCCOS national center for coastal ocean sciences

Other Partner:

Students: Detbra Rosales (PhD, UMES); Rebel Danquah (Undergraduate, UMES)

Keywords: Plankton; HABs; Ecosystems; Habitats

Start Date: 5/1/2018   **End Date:**   5/30/2019

Results to Date

From April-October 2018 we have collected water and oyster samples from the Delaware Inland bays. We have worked with John Jacobs to identify the impacts okadaic acid has on oyster health. Detbra Rosales, our Ph.D. LMRCSC research assistant has processed water and oyster samples for the identification and enumeration of harmful algae and pathogenic Vibrio spp. She was able to identify the presence of many harmful algal species such as *Karlodinium veneficum*, *Dinophysis* spp., *Heterosigma akashiwo* and *Chattonella subsalsa* in the DIBs. We identified the presence of *V. parahaemolyticus* and *V. vulnificus* virulent genes in both of our study areas (Sloan Cove and Torquay Canal). However we found a higher abundance of the virulent genes at Torquay Canal a highly anthropogenic area. She has also exposed oysters to Okadaic acid and *V. parahaemolyticus* to understand the influence of okadaic acid on gene expression and bacterial susceptibility. As of now okadaic acid has no effect on *V. parahaemolyticus* growth with in oysters, however okadaic acid has decreased *V. parahaemolyticus* growth in media. She re- ran the experiment to understand why okadaic acid decreased *V. parahaemolyticus* growth. However she ran into method development issues and the pandemic has caused a halt on the project at NOAA facility. Reuel Danquah, our LMRCSC undergraduate research assistant has been testing 2018 oysters and water samples for the presence of bacteria and Dinoflagellates. These samples were sent out for metagenomics to determine the eukaryotic and microbial community in the Delaware Inland Bays oysters. In 2019-2020 we completed the analysis of the microbial community following the qime2 pathway. Unfortunately because of poor miseq chemistry we were not able to analyze the oyster microbial community. Overall in a 2018 study we compared bacterial communities at a highly anthropogenic-impacted site (Torquay Canal) to a less impacted site (Sloan Cove). The most abundant phyla found in April and June were Proteobacteria and Bacteroidetes, which are the most abundant bacteria phyla in marine environments. In the month of October Rhodospirillales and Rickettsiales emerged as significant components to the microbial communities at both Torquay Canal and Sloan Cove. Of particular interest is Rickettsiales, of which little is known concerning the potential hosts of this intracellular parasite in marine environments. When directly comparing communities in October 2018, Torquay Canal and Sloan Cove water samples clustered together suggesting a generally similar composition between sites. However, we also found a low percentage of Lentisphaerae, Parvarchaeota, Chlorobi, and Deferribacteres in our Sloan Cove sample, which were not present at Torquay Canal. These preliminary results provide supporting evidence that even in areas that are nutrient rich, such as at Torquay Canal, this comes at the expense of microbial diversity. Nutrients seem to drive the capacity for individual groups to dominate populations, and add further credence to our observation that nutrient rich environments promote unhealthy microbial assemblages.

Relevance to NOAA

Oysters are harvested for human consumption, and studies have shown that dinoflagellate (HABs) can increase bacterial loads in oysters. HABs can also produce toxins that accumulate in our shellfish and cause human sickness. Therefore, understanding the relationship between the factors that promotes both HAB development and pathogenic bacterial proliferation is imperative. Our results will support NOAA's long-term goal of 'healthy habitats' by 1)

Evaluating the community structure of harmful dinoflagellates and *Vibrio* spp. in the Delaware Inland Bays. 2) Comparing the seasonal succession of harmful dinoflagellates and microbial community in the water 3) Determining the impacts of okadaic acid on oysters health and Vibrio spp. growth we are fulfilling NOAA's mission of understanding and predicting changes in oceans and coasts, as HAB species are increasing due to anthropogenic forces.

Broader Impacts

A major component of completing our project is to provide both our Graduate (Detbra) and Undergraduate (Reuel) students with an opportunity to collaborative with NOAA mentors, UMES and DSU faculty, DNREC, and stakeholders. With our findings we will be able to better inform local government, stakeholders, and scientists on the areas in the Delaware inland Bays that are safe for oyster aquaculture and how we, as a community, can decrease factors that lead to the presence of HABs. Detbra Rosales' dissertation defense is scheduled for Sept 25th 2020. Reuel has gained research experience that motivated him to pursue a graduate degree in marine science. Reuel has completed his undergraduate degree in Biology and is currently, a LSTAMP graduate student in the Toxicology program at UMES.

Presentations or Publications

Henesy Josh, Mullican John, Wolny L. Jennifer, Rosales, S. Detbra and Pitula S. Joseph (2020). Cyanobacteria distributions and potential effects to macroinvertebrate communities in the Potomac River MD. Journal of Plankton and Benthos Research. Manuscript under review .

Rosales, D., Parveen S., Ozbay, G., Jacobs, J., and Pitula, J. (2019). Harmful algal species and Vibrio spp. in the Delaware Inland Bays. UD Citizen Monitoring Program Fall 2019 Quality Assurance Workshop, November 2019 Oral presentation.

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

Performance Measure: 3.3j: Percent of all coastal communities susceptible to harmful algal blooms verifying use of accurate HAB forecasts
DOC Strategic Plan: 3.1.2: Advance holistic, integrative ecosystem research (NOAA).
NOAA RD Linkage: D2a: Determine combined effects of environmental stressors on coastal species and ecosystems.
Next Gen Priorities: Improved coastal water quality supporting human health and coastal ecosystem services

Project Number 19-02

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

Thematic Research Area Stock Assessment Support 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: Pamela Jensen, AFSC: Alaska Fishery Science Center

Other Partner:

Students: Shanelle Haughton (PhD, UMES)

Keywords: Fisheries; Marine Biology

Start Date: 5/1/2019 **End Date:** 5/1/2020

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 individuals 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. DNA quantifications have been completed and DNA was yielded from 171 of 200. *Hematodinium* qPCR were delayed due to denied access to the lab in response to COVID-19. Preparation has begun to use extracted DNA for qPCR to determine *Hematodinium* infection status of all 200 individuals.

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* spp. and *Callinectes sapidus*.

Broader Impacts

Chionoecetes sp. crustaceans 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% and 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. Evaluating physiological and immune responses of Tanner crab (*Chionoecetes bairdi*) to *Hematodinium* sp. infection . LMRCSC 2020 Virtual Science Meeting. April 2020.

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

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: C1a: How do environmental changes affect marine ecosystems?

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

Project Number 19-04

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

Thematic Research Area Stock Assessment Support Information

Abstract

Monkfish *Lophius americanus* supports one of the most economically important fisheries of the US Northeast Shelf. Recent fisheries for monkfish have been managed very conservatively because of major uncertainties in the stock assessment, the most significant of which is in interpreting age structure and parameterizing growth in this long-lived species. 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. In 2015, an unusual opportunity to study monkfish growth arose from an exceptionally strong year class (YC). The length modes for this YC have continued to be clearly delineated through successive seasonal surveys to date (to age 2), thus effectively providing monkfish of 'known' age. The NEFSC has collected monthly samples of this YC since it was approximately 6 months old; these will be available to this project. The objective of this study is to use analysis of seasonal cycles of hard part microconstituents (calcium, phosphorous, and strontium) from samples taken from the 2015 YC at ages 0-3 to test whether optical zonation in illicia (first dorsal fin spine), vertebrae, and otoliths conform to expected seasonal periodicity (due to temperature-related uptake of microconstituents). The patterns observed in the 'known age' fish will provide a key to interpreting optical zonation of samples from fish of unknown age, thus potentially leading to estimation of a growth curve and filling a major gap in the data needed for quantitative assessment of monkfish and leading to improved scientific advice to fishery managers. This project will primarily provide support to an LMRCSC student to work with Dr. Anne Richards, a stock assessment expert and lead scientist for monkfish assessments, and the NEFSC Fisheries Biology Program (Age and Growth Unit).

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

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

NOAA Partner: Dr. Anne Richards, NEFSC: Northeast Fishery Science Center

Other Partner: Eric Robillard, NEFSC

Students: Benjamin Frey (MS, UMCES)

Keywords: Fisheries; Population dynamics

Start Date: 5/1/2019   **End Date:** 8/31/2021

Results to Date

The project goal was to test for seasonal chemical cycles in hard part 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 graduate student Ben Frey 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 betterunderstand the assessment process and obtain samples of monkfish,

Frey participated in leg 3 of the Fall Bottom Trawl Survey aboard the NOAA Ship, Henry B Bigelow. 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 returned 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 Secor 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 120 black sea bass otoliths, 87 monkfish illicia, and 42 monkfish otoliths, and 10 monkfish vertebrae have been processed for age interpretation and microprobe analysis. In four visits to the microprobe facility during July 2020, 35 black sea bass otoliths and 5 monkfish illicia were analyzed for Ca, Sr, and Mg. Hardpart profiles are being analyzed for periodicity and alignment with annular optical zones.

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 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 the initial recruitment of an LMRCSC student to the Chesapeake Biological Laboratory campus, which houses UMCES expertise in fisheries assessment science.

Presentations or Publications

Frey, B.A., Secor, D., Richards, A. and Jagus, R. Monkfish Age Validation Using Hardpart Analysis of Known-age Cohorts. American Fisheries Society Tidewater Chapter Annual Meeting, Salisbury, MD, February 2019.

Frey, B.A., Secor, D., Richards, A. and Jagus, R. Monkfish Age Validation Using Hardpart Analysis of Known-age Cohorts. NOAA LMRCSC 2020 Virtual Science Meeting, MD, April 2020.

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: C4c: Develop integrated models that take advantage of synoptic data at various scales, to inform ecosystem-based management approach.

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

Project Number 19-05

Title: Utilizing Pacific Lamprey anatomical structures as records of age, natal origin, and trophic patterns

Thematic Research Area Stock Assessment Support Information

Abstract

The anadromous Pacific Lamprey (*Entosphenus tridentatus*) is a biologically and culturally important species native to the North Pacific Ocean and its adjacent freshwater tributaries. In the last 50 years, Pacific Lamprey have experienced declines in abundance throughout the Columbia River Basin. More research is needed to better inform conservation and management efforts. Lampreys are cartilaginous and lack the common hard structures (i.e. otoliths, scales, and fin rays) used in fisheries science to elucidate age and life history patterns. Lamprey statoliths, analogous to otoliths, have potential for ageing and natal origin assignment through band interpretation and elemental analysis, respectively. Eye lenses have potential for retrospective analysis of stable isotopes, which can be used to infer trophic history. This project aims to increase our knowledge on lamprey by evaluating the efficacy of these anatomical structures for determining age, natal origin, and trophic history patterns by utilizing known age and origin samples.

Principal Investigator: Keala Pelekai, Oregon State University

Co-PI: Dr. Jessica Miller, Oregon State University

NOAA Partner: Dr. Laurie Weitkamp, NWFSC: Northwest Fishery Science Center

Other Partner: Dr. Eric Lewallen, Hampton University

Students: Keala Pelekai (MS, OSU)

Keywords: Fisheries; Marine Biology; Protected Species; Anadromous, Natal Origins, Cultural Food, Trophic History

Start Date: 10/1/2019 **End Date:** 3/15/2021

Results to Date

Statolith Ageing Interpretation of statolith banding patterns yielded mixed success for utilizing the structure for age determination. Banding patterns on the structure appear to be similar to those found in teleost otoliths, with alternating light and dark bands visible when the structure is viewed from the side. However, aging accuracy was low (4% to 60%) per reader when relying

solely on band interpretation. Providing readers with a linear regression model of statolith height as a function of age (R2=0.79) and a table of average statolith heights for each age group resulted in higher ageing accuracies (53% to 63%) per reader. Readers have reported increasing difficulty in band interpretation with each additional annuli. The known-age samples used in this study were reared in stable hatchery conditions with ample prey resources. Natural samples would likely have more variable growth due to numerous external factors. The relatively low aging accuracy of the known-age hatchery samples suggests that statolith band interpretation may not be a viable technique for age determination in unknown-age natural samples. ***Statolith Structure***: Ongoing research is focused on evaluating statolith morphology (height, area, longest/shortest axis, mean radii, mass, base length) as a means of age determination. Preliminary analysis using four variables (statolith area, statolith height, fish total length, and natural/hatchery origin as a binary variable) and six age classes (1, 4, 6, 7, 8, and 9 year olds) in a classification random forest model yielded an 84.6% classification accuracy when training the model and a 75.9% accuracy when testing the model on non-training data, though further analysis is needed. An additional 30+ samples are being added to the total known-age samples so that our range encompasses a more complete range in age (1, 2, 4, 5, 6, 7, 8, and 9 year olds). Evaluation of statolith morphometrics in relation to lamprey total length suggests a possibility that the structure may stop growing around metamorphosis. Statoliths from a range of lamprey lengths (2cm to 70cm) show this trend in statolith metrics, wherein growth appears to plateau in out-migrating juvenile samples. Eye Lens Stable Isotope Analysis Pilot study results indicated lamprey eye lenses may be promising structures for trophic inferences via stable isotope analysis (SIA). SIA analysis of incrementally delaminated lens layers, which are primarily protein, shows a trend of lower d15N in the core of the lens that forms during the filter-feeding stage, with a steady increase from the lens center to the edge that could be related to the onset of parasitic feeding. The increase in d15N of the structure from the nucleus to the outer edge (~3 to 18) shows potential for retrospective analysis of SIA to infer trophic history of individuals. One academic quarter was dedicated to the delamination, desiccation, and SIA prep for analysis. Approximately 100 samples were submitted to the OSU Stable Isotope Lab for analysis, and the results were recently obtained and analysis is ongoing ***COVID Complications***: The ongoing COVID-19 pandemic has resulted in delays in progress. Originally, we (OSU LMRCSC) had intended to host a Hampton University graduate student during the 2020 summer to help facilitate collaboration, but the trip was canceled due to concerns surrounding the virus. While we have been communicating with HU collaborators, laboratory access for data analysis has delayed our planned comparisons of eye lens trophic history and genetically identified stomach contents. We have also been delayed in the collection of statolith chemistry data due to lab closures and campus restrictions.

Relevance to NOAA

NOAA has acceded to assist in the conservation of Pacific Lamprey under the Pacific Lamprey Conservation Agreement. The Pacific Lamprey Conservation Agreement represents a cooperative effort among natural resource agencies and tribal entities to promote scientific research and conservation measures for Pacific Lamprey in Alaska, Washington, Oregon, Idaho, and California. Our research goal is to expand our knowledge of Pacific Lamprey biology and ecology through the development of new methods of assessing age, natal origins, and trophic

histories. Currently, we have evaluated statoliths for age determination through annular band interpretation and morphometric-based models. Statolith chemical analysis is ongoing for natal origin assignment. Stable isotope analysis results for incrementally delaminated Pacific Lamprey eye lenses have been obtained with analysis also ongoing. Methods developed in our research may have the potential for other species of native lamprey across the west coast of the USA as well as the invasive sea lamprey (*Petromyzon marinus*) in the Laurentian Great Lakes. Furthermore, many of the species parasitized by Pacific Lamprey in the marine environment are commercial species regulated by NOAA Fisheries. These commercial species include hake, flatfishes (halibut), round fishes (rockfish, lingcod), salmon, and more. Improving assessment methods for lamprey would assist in understanding the health of the population, which affects the predator-prey dynamic of lamprey and these commercial stocks.

Broader Impacts

Increasing our understanding of Pacific Lamprey biology and ecology would help with the conservation of the species. Knowledge of population age structure is important for fisheries assessment and tracking cohort survival. Natal origin determination is useful to assess recovery efforts and monitor hatchery supplementation projects. A better understanding of host trophic position is useful to understand diet and prey selection, which ties into the predator-prey dynamics of lamprey and commercially important species.

Presentations or Publications

Pelekai, K.P. 2020. Utilizing Pacific Lamprey anatomical structures as records of age, natal origin, & trophic patterns. NOAA LMRCSC EPP Virtual Forum.

Pelekai, K.P., Hess, J., Porter, L., Lampman, R., and J. Miller. 2019. Evaluation of Pacific Lamprey statoliths and eye lenses as records of age, natal origin, and trophic history. Lamprey Information Exchange Meeting.

Pelekai, K.P., Hess, J., Porter, L., and J. Miller. 2019. Evaluation of Pacific Lamprey statoliths and eye lenses as records of age, natal origin, and trophic history. State of the Coast Conference.*Won 'People's Choice'•for Best Student Poster Award

Pelekai, K.P., Miller, J., Hess, J., and L. Porter. 2019. Determination of age, natal origin, and trophic history of Pacific Lamprey (*Entosphenus tridentatus*). Oregon Chapter of the American Fisheries Society Annual Meeting. *Won Runner-Up for Best Student Poster Award

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: Improved understanding of ecosystems to inform resource management decisions

Project Number   19-07

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

Thematic Research Area   Stock Assessment Support 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 compliment 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: Adrianne Wilson, University of Miami - Rosenstiel School of Marine and Atmospheric Science

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

NOAA Partner: Robert Allman, SEFSC: Southeast Fishery Science Center

Other Partner: Dr. Dionne Hoskins-Brown, Savannah State University

Students: Adrianne Wilson (PhD, RSMAS); Intern (Undergraduate, RSMAS)

Keywords: Fisheries; Marine Biology; Population dynamics

Start Date: 9/23/2019 **End Date:**   12/31/2021

Results to Date

N/A

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 and 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 is 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

Wilson, A. (2019). Age and Growth of Lane Snapper in the Gulf of Mexico. Oral session presented at the annual American Fisheries Society meeting, Reno, NV.

Wilson, A. (2019). Age and Growth of Lane Snapper in the Gulf of Mexico. Oral session presented at the University of Miami Institute for Advanced Study of the Americas Annual

Graduate Symposium and Field Research Grant Workshop, Miami, FL.

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 approach.

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 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 C. Ebanks, Savannah State University

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

Other Partner: Ms. Kimberly Roberson, NOS: National Ocean Service

Students: Joe Day (Undergraduate, SSU)

Keywords: Marine Biology; Ecosystems; Habitats

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

Results to Date

Funding was not received until September 2020, so no results are available at this time.

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

Co-PI Ebanks has applied to be a partner on a collaborative research project involving K-12 teacher training with a group from UGA's Marine Extension and Aquarium (MECA), Georgia SeaGrant, Georgia Aquarium, Museum of Arts and Sciences, and Northeast Georgia Regional Educational Service Agency for a proposed project entitled, 'Georgia Resilience and Innovation Training (GRIT).' Additionally, she is developing a module on microplastics to be included in K-12 teacher summer intensive training, which is a component of an HBCU collaborative NSF project 'GP-IMPACT: Expanding HBCU Pathways for Geoscience Education.' Each of these efforts will be an extension of the work of this project, impacting K-12 education by providing professional development resources to K-12 educators.

Presentations or Publications

None to date

Performance Measure: 3.4f: Number of habitat acres restored
DOC Strategic Plan: 3.1.2: Advance holistic, integrative ecosystem research (NOAA).
NOAA RD Linkage: C1a: How do environmental changes affect marine ecosystems?
Next Gen Priorities: Improved understanding of ecosystems to inform resource management decisions

Project Number 20-02

Title: Investigating The Impacts Of Adult-Oyster-Conditioned-Seawater On The Setting Efficiency Of *Crassostrea virginica* Larvae Utilizing Direct Setting In The Field

Thematic Research Area Habitats and Biological Systems

Abstract

Direct setting is a technique that utilizes eyed oyster larvae to directly seed oyster reefs for restoration purposes. The technique has shown positive results and setting efficiencies comparable to traditional remote setting. However, methods are still needed to increase setting efficiencies. One way to potentially increase setting efficiencies in the field is to induce oyster settlement using waterborne chemical cues released by adult oysters. In this study, we tested the effectiveness of using adult-oyster-conditioned-seawater (OCW) to increase oyster

larvae setting efficiency in the lab and field. This will be the first study to compare the impacts of OCW on the larval settlement on an artificial oyster reef in the field.

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 U); N/A (Hampton U); N/A.

Keywords: Habitats

Start Date: 4/1/2020   **End Date:**   10/30/2020

Results to Date

No results are available at this time because of covid-19 disruption of research activities.

Relevance to NOAA

The mission of NOAA Fisheries is 'stewardship of living marine resources through science-based conservation and management and the protection and restoration of healthy ecosystems'. The overall goal of this project is to enhance oyster population recovery while minimizing cost. Specifically, this project will investigate the use of natural chemical cues to increase direct setting efficiencies in the field. Additionally, this project will provide an opportunity for under-represented students to learn concepts in marine ecology and management while gaining hands on experience in oyster restoration research.

Broader Impacts

This project provides a number of socio-economic benefits: (1) Direct setting has the potential to reduce cost associated with oyster restoration by reducing steps and cost in current remote setting techniques. For example, reduction of substrate, removal of barge transportation, and removal of additional grow out stages. (2) Provide K-12 students and teachers the opportunity at Hampton University and local schools to learn about oyster restoration and ways to get involved. (3) Provide educational presentations to the Hampton Clean City Commission, Hampton Roads Oyster Gardeners, and the Chesapeake Bay Foundation.

Presentations or Publications

None to date

Performance Measure: 3.4f: Number of habitat acres restored
DOC Strategic Plan: 3.4.2: Improve recovery of listed species through innovative partnerships
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* mutant 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 (UMCES)

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

NOAA Partner: Dr. Gary Wikfors

Other Partner: Dr. Allen Place (UMCES), Dr. Joseph Pitula (UMES)

Students: Kyarii Ramarui; PhD (UMCES)

Keywords:

Start Date: 9/01/2020   **End Date:**   8/31/2021

Results to Date

Funding was not received until September 2020, so no results are available at this time.

Relevance to NOAA   Not identified.

Broader Impacts   Not identified.

Presentations or Publications

Performance Measure: Not identified.
DOC Strategic Plan: Not identified.
NOAA RD Linkage: Not identified.
Next Gen Priorities: Not identified.

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   Stock Assessment Support Information

Abstract

The blue crab, *Callinectes sapidus*, supports fisheries that define a way of life in coastal communities from New Jersey to Texas. Across their range, crabs display life history variation: overwintering in the north and year-round activity in the subtropics. They also inhabit true tropics, where there is a lack of data on crab biology. In Puerto Rico, crabs are harvested in an artisanal fishery that may grow as conch and lobster fisheries decline. If so, crucial data, (size at maturity, sex ratio, habitat use) will be needed for management, and have value for under standing Puerto Rico estuaries. Across their range, blue crabs are infected by viruses and protozoa that may interact with environmental and anthropogenic stressors to limit abundance. This project will enable a graduate student to gather blue crab life history and pathogen data in Puerto Rico and learn how life history data is applied to management by NOAA.

Principal Investigator: Eric Schott, University of Maryland Center for Environmental Science (UMCES)

Co-PI: Bradley Stevens, University of Maryland Eastern Shore

NOAA Partner: Bruce Vogt, NOAA Chesapeake Bay Office

Other Partner:

Students: Olivia Pares (MS, UMCES)

Keywords:

Start Date: 9/01/2020   **End Date:**   8/31/2021

Results to Date

Funding was not received until September 2020, so no results are available at this time.

Relevance to NOAA   Not identified.

Broader Impacts   Not identified.

Presentations or Publications

Performance Measure: Not identified.
DOC Strategic Plan: Not identified.
NOAA RD Linkage: Not identified.
Next Gen Priorities: Not identified.

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 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 tropic 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); Cameron Atkinson (MS, SSU)

Keywords: Fisheries

Start Date: 6/15/2020 **End Date:** 6/15/2020

Results to Date

We have successfully conducted 4 sampling events in each of the 9 creek sites we are monitoring. Regular sampling includes quantification of white shrimp relative abundance and biomass via trawl and cast net surveys. Additionally we have collected specimens for stable isotope analysis within each of the primary 9 creeks as well as two additional creek locations. Finally, we are continuously working through samples to quantify condition indices from individuals collected at our target creek sites.

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

assessment 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

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: C1a: How do environmental changes affect marine ecosystems?
Next Gen Priorities: Healthy habitats that sustain resilient and thriving marine resources and communities

Project Number   20-10

Title: The Occurrence of Microplastics in the Maryland Coastal Bays

Thematic Research Area   Habitats and Biological Systems

Abstract

A major problem in the world is plastic in the ocean with 8 million tons of plastic from coastal nations entering the ocean every year. Microplastics are tiny pieces of plastic, 5 mm or smaller, that originate from the breakdown of larger pieces of plastic. Because they are so small, it is easy for organisms to ingest them and considerably harder to remove them from the environment, making plastics a huge threat to marine life. The Maryland Coastal Bays are important sources of commercial and recreational activities as well as home to over one hundred fish species, but their health is declining, more specifically their water quality. For my master's research, I am proposing to examine the amount of microplastics found in Maryland Coastal Bay fishes in comparison to the same species found in Delaware's Inland bays. 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, UMES

Students: N/A (Undergraduate, UMES)

Keywords: Fisheries; Marine Biology; Ecosystems; Habitats

Start Date: 6/1/2020   **End Date:**   8/31/2022

Results to Date

No results are available at this time because of covid-19 disruption of research activities.

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. The 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 material for the public so they can learn more about microplastics. I plan to develop flyers and make hands-on activities for K-12 students so they may learn about microplastics and their effects. These materials would be disseminated during outreach events done 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.

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: D4d: Improved understanding of emerging water quality issues, including the sources, environmental fate and ecological consequences of nanoparticles and microplastics
Next Gen Priorities: Healthy habitats that sustain resilient and thriving marine resources and communities