Performance Report for Cooperative Agreement No: NA16SEC4810007
for the Period from September 1, 2019 to February 29, 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: The Center used this reporting period to engage in recruitment activities using various strategies including, but not limited to attending professional meetings and campus events. During this period, recruitment activities focused on recruiting qualified undergraduates from existing student populations at partner institutions as well as outside activities. A selection of those activities includes:

DSU: While doing research in Puerto Rico, and searching on the DSU campus, we recruited students.

HU: Handed out LMRCSC brochures, spoke to individual students with the required GPA, and facilitated summer internship applications at UMES and SSU

OSU: Interviewed 3 students for Cohort 5

RSMAS: Held our annual graduate student recruitment event on Feb 26, 2020 and interviewed 3 potential LMRCSC PhD students

UMES: Dr. Sexton met with interested students at Wor-Wic Community College, a local community college with programs intended to prepare students to transfer to Bachelor of Science programs. We anticipate that UMES will reach an articulation agreement with Wor-Wic in the near future.

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 (September 2019) and four instalments of the Graduate Seminar Series (monthly, November 2019 – February 2020). 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 URMs.

HU: The curriculum at HU is in preparation for careers in marine science. Students are also engaged in semester research.

OSU: Regular meetings among CSC students to discuss research and professional development, such as authorship guidelines, mentoring, CV development

RSMAS: LMRCSC students are encouraged to participate in stock assessment working groups and other training

SSU: Students were recruited at the Georgia Alumni Association of HBCUs (Jan), Univ. of S. Carolina-Beaufort, Georgia Southern University-Armstrong Campus, College of Coastal Georgia, and SSU.

UMES: Graduate students meet monthly and undergraduate students meet twice monthly with Dr. Sexton to discuss professional development topics. Fall topics focused on science communication in preparation for the EPP Forum while spring activities have focused on time management and study skills for undergraduates and job application processes for graduate students. 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.

Scott B. Gudes Public Service Graduate Scholarship in Marine Resource Conservation – Ms. Shadaesha Green (Ph.D. student, UMCES-IMET) is the second Scott B. Gudes Public Service Scholar in Marine Resource Conservation. Applications were solicited during this period for the third Scott B. Gudes Public Service Scholar. A selection will be made during the next reporting period.

Research Goal:

Eight (8) collaborative research projects from the FY19 period and 5 projects from the FY18 were on-going; the titles, names of lead PIs, and the research thematic areas to which they belong are presented in Table 1. These projects are well aligned with NOAA Fisheries research priorities. Three of the lead PIs of the projects are located at LMRCSC MSIs, hence the projects are helping to build sustainable capacities at the Center MSIs; six of the lead PIs are graduate students. Applications for the FY2020 TAB were received and are being reviewed during this period. Awards are currently pending and will be made during the next reporting period.

Table 1. TAB projects funded for FY 2018 and 2019*

Project Number	Principal Investigator	Title	Thematic Research Area
18-01	Brittany King (OSU)	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	Fishery Socio-Economics
18-03	LaTreese Denson (RSMAS)	Indices of abundance for King Mackerel in the Gulf of Mexico and South Atlantic improved by incorporating spatiotemporal and environmental variability	Stock Assessment Support
18-05	Matthew Ramirez (OSU)	Integration of habitat-specific growth variation into assessment models: a case study in the Kemp's ridley sea turtle.	Stock Assessment Support
18-08	Eric A. Lewallen (HU)	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys	Stock Assessment Support
18-11	Enid Munoz Ruiz (UMES)	Assessment of Microplastics in *Placopecten magellanicus* as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic Stock Fisheries	Healthy Habitats
19-01	J. Sook Chung (IMET)	Baseline data on environmental impacts on physiological and molecular parameters determining growth for commercially valuable decapod crustacean management	Stock Assessment Support
19-02	Shanelle Haughton (UMES)	Evaluating physiological and immune responses of snow crabs (*Chionoecetes* sp.) to *Hematodinium* infection	Stock Assessment Support
19-03	Amanda Pappas (DSU)	Bloom dynamics and sediment incubations for a toxic harmful algal bloom species, *Dinophysis acuminata*, in Rehoboth Bay, Delaware, USA	Healthy Habitats
19-04	Rosemary Jagus (IMET)	Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts	Stock Assessment Support
19-05	Keala Pelekai (OSU)	Evaluation of Pacific lamprey (*Entosphenus tridentatus*) statoliths and eye lenses as records of age, natal origin, and trophic history patterns	Stock Assessment Support
19-06	Hillary Thalmann (OSU)	Thermal impacts on juvenile Pacific Cod (*Gadus macrocephalus*) foraging and growth in Gulf of Alaska nursery habitats	Climate and Ecosystems
19-07	Adrianne Wilson (RSMAS)	Population structure and growth of lane snapper, a data limited species	Stock Assessment Support
19-08	Carolina Bonin- Lewallen (HU)	Genetic approaches for monitoring the effects of climate change on leopard seals in the Antarctic Peninsula	Climate and Ecosystems

***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 was offered in Fall 2019. 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 prepared documents and materials for the Independent External Review, submitted those documents to NOAA EPP, and provided an LMRCSC 101 Webinar in preparation for the Fourth Year Review that took place in the first week of the next reporting period.

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 6 Ph.D., 6 M.S., and 11 B.S. Of these Cohort 1 students, nine (9) have graduated, including 1 Ph.D., 3 M.S., and 5 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 8 M.S., and 8 B.S. students. Of the Cohort 2 students, 6 have graduated, including 3 Ph.D., 2 M.S., and 1 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 6 M.S. and 10 B.S. students. One B.S. student from Cohort 3 has graduated. So far, nine (9) students including 1 Ph.D., 5 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, major changes to these plans are anticipated in the next reporting period.

Scott B. Gudes Public Service Graduate Scholarship in Marine Resource Conservation: Ms. Shadaesha Green (Ph.D. student, UMCES) is the Scott B. Gudes Public Service Scholar in Marine Resource Conservation. We accepted applications for the next Gudes Scholar in this reporting period. The selection will be made during the next reporting period.

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 was taught in Fall 2019; and
a) Education Expert Dr. Victoria Young held online forums for LMRCSC students to discuss the center and ask questions about requirements and expectations in September 2019 and to discuss NERTO in January 2020.
b) Four installments of the Graduate Student Seminar Series took place during this period (monthly, November 2019 – February 2020)
c) Professional Development workshop was offered by Dr. Maggie Sexton biweekly for undergraduate students and monthly for graduate students during the academic year at UMES.
d) PIs at HU, OSU, SSU, and UMCES report holding regular lab meetings with Center students.

Research Goals:
Thirteen (13) 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 Board of Visitors meeting was held November 5, 2019 at University of Miami, Rosenstiel School of Marine Science.

4. Key outcomes or other achievements:

a) A total of 76 students (23 in Cohort 1, 24 in Cohort 2, 20 in Cohort 3, 9 in Cohort 4) have been recruited to the Center
b) External Evaluation of the LMRCSC is continuing.
c) New proposals have been submitted to various agencies to leverage funding in order to support additional students.

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

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

- Thirteen (13) students enrolled in the Data Management for Scientists course that was offered in fall 2019.
- Eleven (11) 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 39 presentations of their work at professional conferences including 12 by students.
- Center Scientists produced 27 peer-reviewed publications with 1 student author and also published one book.
- Center Scientists, including the first author who is a student produced a technical report to the North Pacific Anadromous Fish Commission.

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

Education Goals: As examples, the Center will:

a) Continue its efforts to recruit students into the Center; at present 9 students have been recruited into Cohort 4, including 1 Ph.D., 5 M .S. and 3 B.S.
b) Begin planning for the next workshop on Literacy in NOAA related sciences for spring 2021.
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 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 4 degrees during the current funding period including 1 B.S., 2 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
Kleponis	Nicole	DSU	M.S.	2	Dec. 2019	Employed by USGS
Munguia	Angelica	OSU	M.S.	1	12/15/2019	Employed at Oregon Health Sciences University
Ramirez	Matt	OSU	PhD	2	12/15/2019	Postdoc scholar at U of Rhode Island
Ambrose	Alexandria	SSU	B.S.	2	Dec. 2019	Applying to graduate schools

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. Twenty-seven (27) publications (1 student authors identified by *) produced by the Center; LMRCSC scientists are in bold

Publications in journals	Justification	Status
Arai, K. J.E. Graves, and **D.H. Secor**. 2019. Sub-annual cohort representation among young-of-the-year recruits of the western stock of Atlantic bluefin tuna. Fisheries Research 225 https://doi.org/10.1016/j.fishres.2019.105476	Leveraged	Published
Bonin CA, van Wijnen AJ, **Lewallen, EA**. 2019. MicroRNA applications in marine biology. Molecular Biology Reports. DOI 10.1007/s40610-019-00124-w	HU faculty and TAB recipient	Published
Brill RW, **AZ Horodysky**, **AR Place**, AM Watso, R Reimschuessel. 2019. Effects of dietary taurine level on visual function in European sea bass (*Dicentrarchus labrax*). PLoS ONE. 14(6): e0214347	HU Assoc. faculty	Published
Cruz-Marrero*, W, Harms-Tuohy, CA, Appeldoorn, RS, **Stevens, B.G**, Gay, N.C. 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:10.5343/bms.2019.0087	Cohort 3 student	Published
Curran, M.C. and D.H. Wilber. 2019. Seasonal and interannual variability in flatfish assemblages in a southeastern USA estuary. Estuaries and Coasts 42(5):1374-1386.	Leveraged	Published
Curran, M.C. and M.L. Richlen. 2019. Harmful Algal Blooms (HABs): Track them like a scientist. Science Activities. DOI: 10.1080/00368121.2019.1691968.	Leveraged	Published
Curran, M.C., L.S. Sayigh, and K. Patterson. 2019. Eavesdropping on marine mammal conversations: An activity suitable for the visually impaired. Current: The Journal of Marine Education 33(2): 33-42.	Leveraged	Published
Cusick, KD, Polson, S, Durant, G, & **Hill, RT**. 2020. Multiple mega-plasmids confer extremely high metal tolerance in *Alteromonas* strains. Appl. Environ. Microbiol. 86:e01831-19.	Leveraged	Published
Dunn, D.C. **Secor, DH**, & 70 co-authors. 2019. The importance of migratory connectivity for global ocean policy. Proceedings of the Royal Society B http://dx.doi.org/10.1098/rspb.2019.1472	Leveraged	Published
Fucich, D, * Marsan*, D, Sosa, A, & Chen. F 2019. Complete genome sequence of subcluster 5.2 *Synechococcus* sp. strain CB0101, isolated from the Chesapeake Bay. Microbiol Resour Announc 8:e00484-19. https://doi.org/ 10.1128/MRA.00484-19.	LMRCSC	Published
Gonsior, M., Powers, L. C., Williams, E., **Place, A**., Chen, F., Ruf, A. et al. 2019. The chemodiversity of algal dissolved organic matter from lysed *Microcystis aeruginosa* cells and its ability to form disinfection by-products during chlorination. *Water Research*, *155*, 300-309.	Leveraged	Published
Kerr, LA, ZT Whitener, SX Cadrin, MR Morse, **DH Secor,** and W Golet. 2020. Mixed stock origin of Atlantic bluefin tuna in the U.S. rod and reel fishery (Gulf of Maine) and implications for fisheries management. Fisheries Research 224: https://doi.org/10.1016/j.fishres.2019.105461	Leveraged	Published

Lennox RJ, Paukert P, Aarestrup K, Auger-Méthé M, Baumgartner LJ, Birnie-Gauvin K, Bøe K, Brink K, Brownscombe JW, Chen Y, Davidsen JG, Eliason EJ, Filous A, Gillanders BM, Helland IP, **Horodysky AZ,** Januchowski-Hartley SR, Lowerre-Barbieri SK, Lucas MC, Martins ES, Murchie KJ, Pompeu P, Power M, Raghavan R, Rahel FJ, **Secor DH**, Thiem JD, Thorstad EB, Ueda H, Whoriskey FG, Cooke SJ. 2019. 100 pressing questions on the future of global fish migration science, conservation, and policy. *Frontiers in Ecology and Evolution*. 7:286. doi: 10.3389/fevo.2019.00286	HU Assoc. faculty	Published
Pecher, ME, Madadha, A, DasSarma, P, Ekulona, F, **Schott, E.J.**, Crowe, K, **Gut, B.S.** & DasSarma, S. 2019. Effects of road salt on microbial communities: halophiles as biomarkers of road salt pollution. PLoS ONE 14(9): e0221355. https://doi.org/10.1371/journal.pone.0221355 (Sept 2019)	Leveraged	Published
Perryman, H.A., Tarnecki, J.H., **Grüss, A., Babcock, E.A.**, Sagarese, S. R., Ainsworth, C. H., & Gray DiLeone, A. M. 2019. A revised diet matrix to improve the parameterization of a West Florida Shelf Ecopath model for understanding harmful algal bloom impacts. Ecological Modelling 416:108890. doi:10.1016/j.ecolmodel.2019.108890	Leveraged	Published
Pervaiz, A, Aamer, AS, Hassan, F, Hertkorn, N, Gonsior, M, Chen, F. 2019. A Glacier Bacterium Produces High Yield of Cryoprotective Exopolysaccharide. Frontiers in Microbiology, 10, DOI: 10.3389/fmicb.2019.03096.	Leveraged	Published
Rosenberger, A., C. Zimmerman, D. Noakes, R. Taylor, E. Keeley, J. Musick, R. Phillips, **A. Horodysky**, M. Neilson, T. Ray, & J. Neilson. Salmonidae. In: Diversity of North American Freshwater Fishes: Natural History, Ecology, and Conservation, Volume II.	HU Assoc. faculty	Published
Schlenker, L.S, Welch, M. J., Meredith, T. L., Mager, E. M., Lari, E., **Babcock, E.A.**, Pyle, G. G., Munday, P. L. & Grosell, M. 2019. Damsels in Distress: Oil Exposure Modifies Behavior and Olfaction in Bicolor Damselfish (*Stegastes partitus*). Environmental Science and Technology. doi: 10.1021/acs.est.9b03915	Leveraged	Published
Stipek, C., Santos, R., **Babcock, E.A** & Lirman, D. 2020. Modelling the resilience of seagrass communities exposed to pulsed freshwater discharges: A seascape approach. PLoS ONE 15(2): e0229147. doi:10.1371/journal.pone.0229147	Leveraged	Published
Tewfik, A., **Babcock, E.A.** & Phillips, M. 2020. Spiny lobster fisheries status across time and a mosaic of spatial management regimes ICES Journal of Marine Science doi:10.1093/icesjms/fsaa008	Leveraged	Published
Walters, T, **Gibson, D.**, Frischer, M. Cultivation of the Marine Pelagic Tunicate *Dolioletta gegenbauri* (Uljanin 1884) for Experimental Studies. JoVE 59832	HU PI	Published
Walters, T., **Gibson, D.,** Frischer, M. Cultivation of the Marine Pelagic Tunicate, *Dolioletta gegenbauri* (Uljanin 1884) for Experimental Studies. JoVE- Video	HU PI	Published

Wolny, JL, Egerton, TA, Handy, SM, Stutts, WL, Smith, JL, Whereat, EB, Bachvaroff, TR, Henrichs, DW, Campbell, L & Deeds, J.R. 2020. Characterization of *Dinophysis* spp.(Dinophyceae, Dinophysiales) from the mid-Atlantic region of the United States. Journal of Phycology. https://doi.org/10.1111/jpy.12966	Leveraged	Published
Zhang, F, Jonas, L, Lin, H, & **Hill, R.T**. 2019. Microbially mediated nutrient cycles in marine sponges. FEMS Microbiol. Ecol. 95:fiz155.	Leveraged	Published
Zhang, F., Jonas, L, Lin, H, & **Hill, R.T.** 2019. Microbially mediated nutrient cycles in marine sponges. FEMS Microbiol. Ecol. 95:fiz155.	Leveraged	Published
Zhang, H, Peng-Fei Wu, Zhang, SF, Xie, Z, Li, D, Lin, Chen, F & Wang, D. 2019. Comparative metaproteomics reveals functional differences in the blooming phytoplankton *Heterosigma akashiwo* and *Prorocentrum donghaiense.* Applied and Environmental Microbiology. DOI:10.1128/AEM.01425-19.	Leveraged	Published
Zhang, Z, Chen, F, Chu, X, Zhang, H, Luo, H, Qin, L, Zhai, Z, Yang, M, Sun, J, & Zhao, Y. 2019. Diverse, abundant and novel viruses infecting "unculturable" but abundant marine bacteria. mSystem. doi: https://doi.org/10.1101/699256.	Leveraged	Published

Table 3b. Two (2) publications under review or accepted (1 student author identified by*) was produced by the center

Publications under review or accepted	Justification	Status
Hoskins-Brown, D.L. 2020. Tales of Landings and Legacies: African-Americans in Georgia's Coastal Fisheries. Culture, Agriculture, Food and Environment. accepted	Supported student research in 2011 and 2016 awards	accepted for 2020 summer issue
Thalmann*, H.L., Daly, E.A., Brodeur, R.D. *In revision.* 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.	LMRCSC Cohort 1 student	In revision

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

Theses/Dissertations	Justification
Kleponis, N. (2019). Red-throated loon distribution in the Delaware Bay. Master's thesis, Delaware State University.	LMRCSC Cohort 2 student
Hanif, A. (2019). Diet and stomach microbiota of Gulf menhaden, a key filter feeding forage fish species. Ph.D. thesis, Univ. of Maryland Center for Env. Sci.	Cohort 1
Munguia, A. (2019). Feeding Ecology and Food Web Linkages of Yearling Chinook Salmon (*Oncorhynchus tshawytscha*) Emigrating Through the Lower Columbia River and Estuary.	LMRCSC Cohort 1 student
Ramirez, M. (2019). It's in Their Bones: Ecological Drivers of Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) Somatic Growth and Population Dynamics.	LMRCSC Cohort 2 student

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

Table 4a. Thirty (30) oral presentations (12 student presenters); LMRCSC Scientists in bold

Oral presentations at professional meetings	Justification
Chung, J.S., Bachvaroff, TR, & Plough, L. 2019. Cracking the genetic code of the blue crab, *Callinectes sapidus*, IMBC, Shizouka, Japan, September 2019.	Leveraged
Chung, J.S. 2019. Current status of shellfish aquaculture. Mokpo National University, S. Korea: September 2019	Leveraged
Chung, J.S. 2019. Current status of shellfish aquaculture. University of Virginia (Dept. Environmental Science), Charlottesville: Nov. 12, 2019	Leveraged
Cruz-Marrero*, W. & **Stevens, B.G.** 2018. Comparing diver and camera sled surveys: An improvement for fisheries independent data for queen conch in Puerto Rico? Oral presentation; Gulf and Caribbean Fisheries Institute, Colombia.	LMRCSC Cohort 3 student
Curran, M.C. and P. Wilber. 2019. Seasonal and interannual variability in flatfish assemblages in a southeastern USA estuary. Coastal and Estuarine Research Federation Mobile, AL November 2019	Leveraged
Curran, Robertson, and Richlen. 2019. HAB science made easy: Teaching students about the ecology and toxicology of harmful algal blooms. US Harmful Algal Bloom Ocean Beach, AL (Nov 2019)	Leveraged
Curran, Robertson, Richlen. 2019. Invited Presentation: Chemical ecology made easy: Teaching students about the link between toxin chemistry & HABs. Southeastern Regional Meeting of the American Chemical Society (October 2019)	Leveraged
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. Presented in the NOAA EPP session at the AFS & TWS Joint Conference, Reno, NV, September 2019.	LMRCSC Cohort 2 student, TAB
Green*, S., Chung, J.S. 2019. Transcriptomic Analysis of the Red Deep-Sea Crab, *Chaceon quinquedens* throughout Ovarian Development. American Fisheries Society & The Wildlife Society Joint Annual Meeting, Reno, NV, Sept 2019	TAB, one-time
Green*, S, Chung, J.S. 2019. Transcriptomic Analysis of the Red Deep-Sea Crab, *Chaceon quinquedens* throughout Ovarian Development. American Fisheries Society & The Wildlife Society Joint Annual Meeting, Reno, NV, Sept 2019. Oral Presentation.	TAB, one-time
Hanif*, A. 2019. Diet and stomach microbiota of Gulf menhaden, a key filter feeding forage fish species. PhD thesis defense seminar, Oct 24, 2019.	TAB, one-time
Hildebrandt*, S. Spires, J., et. al. 2020. Testing Direct Setting of *Crassostrea virginica* larvae. Presented at the Ocean Sciences meeting, San Diego, CA.	LMRCSC Cohort 2 student
Hoskins-Brown, D.L. 2019. Coastal Resilience and the Gullah Geechee Corridor. U.S. Forest Service Project Team for the International Seminar on Community Resilience. Savannah, GA November 20, 2019	SSU PI
Jonas, L. & **Hill, RT**. 2019. Sponge symbionts and phosphorus cycling in coral reefs.International Marine Biotechnology Conference, Shizuoko, Japan, Sept. 2019.	Leveraged
Kenworthy, M. 2019. Exploring the spatiotemporal factors regulating the success and function of restored oyster reefs in North Carolina Estuaries. LMRCSC Graduate Student Seminar Series. Savannah, GA, November 2019.	LMRCSC Post Doc
Kenworthy, M. 2019. Exploring the spatiotemporal factors regulating the success and function of restored oyster reefs in North Carolina Estuaries. Savannah State University Graduate Student Seminar. Savannah, GA, September 2019.	LMRCSC Post Doc

Lawrence*, A. 2019. Presented at American Fisheries Society 149th Annual Meeting and Joint Conference with the Fish and Wildlife Society for the Diversity and Inclusion Seminar Series, Reno, Nevada, September 29, 2019 - October 03, 2019	Cohort 2
Lawrence*, A., Chung, J.S. and Stevens, B. 2019. Investigating Male Sexual Maturity of the Jonah Crab, *Cancer borealis*. Presented at American Fisheries Society 149th Annual Meeting and Joint Conference with the Fish and Wildlife Society for the Techno-Fish Seminar Series, Reno, Nevada, September 29, 2019 - October 03, 2019.	TAB, one-time
Losee, J., Claiborne A., Dapp, D., Freeman, R. Madel, G., Seamons, T., **Miller, J.A.**, Quinn, T., Hellström, G. and Palm, D. 2020. New insight into the Management and Ecology of Anadromous Cutthroat Trout. 2020 Salmon Ocean Ecology Meeting, Santa Cruz, CA.	Co-PI Miller effort - leveraged
McLean, J. et. al. 2020. The Impact of Marsh Impoundment on Methane Production in a Phragmites Wetland. Presented at the Ocean Sciences meeting, San Diego, CA.	LMRCSC Cohort 2 student
Miller, J. A, Hess, J., Porter, L., Parker, K., Sutton, T., Pelekai*, K. 2019. Understanding Pacific lamprey migration: the potential of statolith structure and chemistry. Lamprey Information Exchange Meeting. Oral.	LMRCSC Cohort 3 student
OFarrell*, H. & **Babcock, E**. 2019. Using generalized linear modeling and quantile regression to produce habitat suitability maps for shortfin mako sharks in the North Atlantic. Presented at the American Fisheries Society Conference, Reno, NV, Oct. 2019.	LMRCSC Cohort 1 student
Ramarui*, K. (2019) Improving *Haematococcus pluvialis* growth and astaxanthin production through chemical mutagenesis. LMRCSC Student Seminar Series, January 15, 2020.	Cohort 4
Ramirez*, M.D., **Miller**, J.A., Shiel, A.E., Avens, L., Goshe, L.R., Snover, M.L. and Heppell, S.S. 2020. Discriminating regional Kemp's ridley sea turtle habitat use through complementary trace element, lead isotope, and growth rate analyses. 2020 Southeast East Regional Sea Turtle Network Meeting.	LMRCSC Cohort 2 student
Ramsden, S. and Curran, M.C. 2019. From graduate to elementary school: Engaging young students can be easy! Coastal and Estuarine Research Federation Mobile, AL November 2019	Leveraged
Secor, D.H. 2019. Before After Gradient Designs to evaluate coastal wind farm impacts to migratory and sedentary fishes. Coastal and Estuarine Research Federation Conferences, Mobile AL.	Leveraged
Secor, D.H. 2019. Fish Movement Ecology and Dynamic Seascapes: Making seascapes dynamic and relevant. Ocean Studies Board, The National Academy of Science, Washington DC.	Leveraged
Secor, D.H. 2019. New York Harbor: High stakes ecological corridor. Surge Barrier Environmental Effects and Empirical Experience. NERRS Workshop, New York, NY.	Leveraged
Tizabi, D, Sosa, A, **Bachvaroff, TR,** Harinantenaina Rakotondraibe, L. & **Hill, RT.** 2019. Bioprospecting marine actinomycetes to combat tuberculosis. IMBC, Shizuoko, Japan, September 2019.	Leveraged
Wilson*, A. 2019. Age and Growth of Lane Snapper in the Gulf of Mexico. Presented at the NOAA EPP session of the annual American Fisheries Society meeting, Reno, NV.	LMRCSC Cohort 2 student

Table 4b. **Posters: 9 (*8 student presenters)**

Poster presentations at professional meetings	Justification
Barry*, T. and **Cox, T.** 2019. Distribution of Non-native Red Lionfish (*Pterois volitans*) and Devil Firefish (*Pterois miles*) Throughout Georgia's Coastal Waters. Ocean Sciences Meeting 16-21Feb 2020, Honolulu, HI	Leveraged
Bender*, A., et. al. 2020.Using Relative Body Measurements of Nassau Grouper to Predict Total Length. Presented at the Ocean Sciences meeting, San Diego, CA.	LMRCSC Cohort 3 student
Layton* J.M., et. al. 2020. Investigating Marine Wildlife Ecotourism In Southern California: A Case Study for La Jolla Cove. Presented at the Ocean Sciences meeting, San Diego, CA.	LMRCSC Cohort 2 student
Milton* I.A., et. al. 2020. The Effects of Feeding Activity on the Bioenergetics of a Pelagic Calanoid Copepod, *Pleuromamma xiphias*. Presented at the Ocean Sciences meeting, San Diego, CA.	LMRCSC Cohort 1 student
Milton, I*, **C. Bonin**, N. Smith, K. Dorsey, O. Stojilovic, J. Layton*, K. Cruz*, **D. Gibson, AZ Horodysky**. MicroRNA isolation from three neurosensory structures in CO2-exposed marine fishes. 149th Ann. Mtg. Am. Fish. Soc. Reno, NV.	Leveraged
Muniz, W., Howard, K., and **Hoskins-Brown, D.L.** 2019. Abundance of the Diamondback Terrapins (*Malaclemys terrapin*) in Coastal Georgia. Ocean Sciences Meeting 16-21Feb20, Honolulu, HI	Leveraged
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. Poster.	CSC Cohort 3 student *Won "People's Choice" for Best Student Poster Award
Pelekai*, K.P., Hess, J., Porter, L., Lampman, R. and **Miller, J**. 2019. Evaluation of Pacific Lamprey statoliths and eye lenses as records of age, natal origin, and trophic history. Lamprey Information Exchange Meeting. Poster.	CSC Cohort 3 student
Thalmann*, H.L., Laurel, B.J., **Miller, J.A.** Few surviving juvenile Pacific Cod are bigger, fatter, and shifting diets in a warm ocean year. Alaska Marine Science Symposium. Anchorage, AK. January 2020. Poster Presentation.	CSC Cohort 1 student

Other Publications:

Other publications	Justification
Thalmann, H.L., Daly, E.A., Brodeur, R.D. 2019. Quantifying thermal impacts on Columbia River Steelhead marine growth using bioenergetics models. North Pacific Anadromous Fish Commission. Technical Report No. 15: 161-163.	CSC Cohort 1 student

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
Grant	Blank	DSU	Participating	15
Christopher	Heckscher	DSU	Advisor	10
Dennis	McIntosh	DSU	Participating	10
Gulni	Ozbay	DSU	Co-advisor	10
Stacy	Smith	DSU	Principal Investigator	80
Kevina	Vulinec	DSU	Co-advisor	10
Deidre	Gibson	HU	PI	40
Carolina	Lewallen	HU	Faculty	80
Jessica	Miller	OSU	PI	45
Elizabeth	Babcock	RSMAS	Principal Investigator	7
David	Die	RSMAS	Faculty	3.5
Tara	Cox	SSU	TAB PI	20
Sue	Ebanks	SSU	Faculty	10
Chris	Hintz	SSU	Faculty	10
Dionne	Hoskins-Brown	SSU	Principal Investigator	40
Victoria	Young	SSU	Education Expert	160
Rosmary	Jagus	UMCES	Principal Investigator, co-advisor, committee member for four LMRCSC graduate students, advisor for one Ph.D. student	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	NE NREC	Dover, DE	Helped students collect samples
Environmental NGO	Wildlife Conservation Society	Belize	Helped Adrianne Wilson collect lane snapper samples in Belize
Non profit	Chesapeake Bay Foundation	Richmond, VA	Helped students with oyster restoration project
LMRCSC partner	Brad Stevens	UMES	Collaborator on TAB
LMRCSC partner	Joe Pitula	UMES	Collaborator on TAB
LMRCSC partner	Stacy Smith	Delaware State University	Collaborator
Tribal government	Columbia River Intertribal Fish Commission	Portland, OR	Advised student, provide 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
North	Heather	Oyster tech, CBF	Helped students with oyster restoration project
Reese	Kimberly	Professor/VIMS	Assisted with HABs identification
Coyne	Kathy	DE Seagrant head/Prof UD	Helping student with DNA analysis/lab space
Hess	Jon	Geneticist	advised student, provide samples

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	PhD committee member and NERTO mentor for Adrianne Wilson
Cortes	Enric	SEFSC	Ph.D. committee member and NERTO mentor for Halie O'Farrell
Walter	John	SEFSC	PhD. Committee member for LaTreese Denson
Thorson	James	AFSC	NERTO mentor for LaTreese Denson
Sharma	Rishi	NWFSC	Collaborator
Leo	Jennifer	SEFSC	NERTO mentor for Juan Cervera
Spires	Jason	NOAA Oxford lab	NERTO advisor
Weitkemp	Laura	NWFSC	NERTO advisor
Deshpande	Ashok	NOAA, NMFS	NOAA/NERTO mentor
Townsend	Howard	NOAA, NMFS	NOAA/NERTO mentor
Baker-Yeboah	Sheekela	NOAA EPP/MSI	NOAA/NERTO mentor
Hill	Ron	SWFSC	NOAA/NERTO mentor
Jensen	Pam	AFSC	NOAA/NERTO mentor
Zamon	Jen	NWFSC	M.S. committee member
Wikfors	Gary	NEFSC	M.S. committee member
McElhany	Paul	Station Chief	NERTO training
Freidland	Kevin	Research Marine Scientist	collaborator
Jacobs	John	Research Fisheries Biologist	Collaborator
Johnson	Ed	Physical Scientist	NERTO mentor
Richards	Anne	Research Fisheries Biologist	NERTO mentor & collaborator
Shank	Burton	Research Fisheries Biologist	NERTO mentor
Vogt	Bruce	Ecosystem Science Manager	NERTO mentor
Weinberg	James	Fishery Biologist	collaborator
Laurel	Ben	AFSC	Committee member for Thalmann
Rogers	Lauren	AFSC	informal mentor for Thalmann
Deary	Alison	AFSC	informal mentor for Thalmann
Weitkamp	Laurie	NWFSC	Committee member for Pelekai

Busch	Shallin	NWFSC	Committee member for Williams
Werner	Kevin	NWFSC	Committee member for King
Fonner	Robby	NWFSC	NERTO mentor for King
Deshpande	Ashok	Res. Chemist, NEFSC	M.S. committee member of Davielle Drayton
Werner	Cisco	Dir. of Scientific Programs and Chief Science Advisor, NMFS	Provided guidance on research development at SSU
Hill	Ron	Acting Branch Chief, SEFSC	Serve on an internal committee to collaborate of the use of UAS for habitat monitoring in the South Atlantic, Gulf, and Caribbean
Caldwell	Phil	GIS Technician, SEFSC	
Merino	Joy	SEFSC	
Roberson	Kim	Research Coordinator, Grays Reef NMS	Served on student committee, collaborated on TAB
Porch	Clay	Director, SEFSC	Convened meeting with Cisco and selected Division chiefs at SEFSC
Gerard	Trika	Chief of Staff, SEFSC	Identified recruitment and engagement strategies

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 6 Ph.D., 6 M.S., and 11 B.S. Of these Cohort 1 students, nine (9) have graduated, including 1 Ph.D., 3 M.S., and 5 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 8 M.S., and 8 B.S. students. Of the Cohort 2 students, 6 have graduated, including 3 Ph.D., 2 M.S., and 1 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 6 M.S. and 10 B.S. students. One B.S. student from Cohort 3 has graduated. So far, nine (9) students including 1 Ph.D., 5 M.S., and 3 B.S. students have been recruited into Cohort 4. Of these 76 students in Cohorts 1-4, at least 65 of them belong to underrepresented minority groups. LMRCSC activities focus on training programs that are preparing students for work on essential fish habitat, marine protected species and ecosystems. The future workforce candidates, our students, are gaining valuable experiences via the cohort experience so they will have colleagues after they graduate. Developing these relationships early will help them in the future. The NOAA mentor experience will prepare students for their first NOAA 'job' experience. Under the tutelage of a mentor, the students will develop work skills, such as co-worker interactions, proper workplace etiquette, etc.

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

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.

SSU: LMRCSC funded Kenworthy's (SSU Post-doctoral fellow) travel to attend the “Concepts and Controversies in Tidal Marsh Ecology Revisited” workshop in Dauphin Island Alabama in fall 2019. Participants in this workshop are working on developing six manuscripts which will be included in a special topics issue in the journal Estuaries and Coasts. Dr. Hoskins-Brown is contributing multiple components for the manuscript being developed by one of the six focus groups on “Novel and emerging applications of technology for advancing estuarine science”.

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. 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 Faculty and students are being invited to give talks, serve on panels, and work with K-12 students on Center related research.

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

UMES UMES NOAA EPP Undergraduate Fellow and NOAA EPP Undergraduate Scholarship recipient India Oliver has been working with the help of her faculty advisor Dr. Sexton during this time period on a community clean-up project to remove litter from campus and the broader Princess Anne community while raising awareness about the impact of plastics in the environment.

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:

HU: Cohort 4 funds were received during the semester and access of funds were granted in late February 2020 in part due to the bureaucracy at HU. This prevented us from recruiting students to Cohort 4.

UMCES: The emphasis of TAB projects is on funding graduate students' research, providing one-time research funds and NERTO expenses. This has affected the amount of funds available to foster research collaborations between faculty at LMRCSC partners.

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

COVID-19 will cause substantial changes in the future. Students are currently not able to complete lab or field work for an indefinite period of time. Telework plans are in development as are remote options for NERTO. Planning for the 2020 Science meeting is underway and will likely be conducted virtually, using any of the electronic webinar platforms.

Changes that have a significant impact on expenditures:

Due to the COVID-19 response, delays in progress are likely to occur. Since there are also limitations to travel, perhaps some travel funds can be shifted to provide additional term(s) of support to students that are in need.

VI. Special Award Conditions

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

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

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

Direct Student Support – Twenty-three (23) students have been identified/recruited to the Center as members of Cohort 1 (2016 – 2017), including 6 Ph.D., 6 M.S., and 11 B.S. Of these Cohort 1 students, nine (9) have graduated, including 1 Ph.D., 3 M.S., and 5 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 8 M.S., and 8 B.S. students. Of the Cohort 2 students, 6 have graduated, including 3 Ph.D., 2 M.S., and 1 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 6 M.S. and 10 B.S. students. One B.S. student from Cohort 3 has graduated. So far, nine (9) students including 1 Ph.D., 5 M.S., and 3 B.S. students have been recruited into Cohort 4. Recruitment for Cohort 4 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
Ileana	Fenwich*	1	B.S.	HU		$5,300.00				
Nylah	McClain*	1	B.S.	UMES	$4,279.00	$1,403.90				
Isaiah	Milton*	1	B.S.	HU		$5,300.00				

India	Oliver*	1	B.S.	UMES						$25.00
Chryston	Best-Otubu*	1	B.S.	UMES	$4,279.00	$2,630.70				$25.00
Amanda	Pappas	1	M.S.	DSU	$5,221.29	$12,115.35		$1,540.00	$200.83	
Shadaesha	Green*	1	Ph.D	UMCES		$4,207.66		$1,319.90	$3,189.89	
Ammar	Hanif*	1	Ph.D	UMCES					$15,100.00	
Halie	O'Farrell*	1	Ph.D	RSMAS	$4,060	$3,556	$1,406.05			
Hillary	Thalmann	1	PhD	OSU		$946.87	$673.78			
Janelle	Layton*	2	B.S.	HU		$5,300.00				
Sierra	Hildebrand	2	M.S.	HU	$11,462.00	$10,500.00				
Amanda	Lawrence*	2	M.S.	UMCES	$4,358.00	$16,595.52	$2,421.58	$5,425.25		
Josette	McLean*	2	M.S.	HU	$11,462.00	$10,500.00				
Kleponis	Nicole	2	M.S.	DSU	$3,185.00	$6,461.52		$1,863.22	$200.83	
Enid	Munoz-Ruiz*	2	M.S.	UMES	$3,336.00	$13,935.06		$1,106.70		$25.00
LaTreese	Denson*	2	Ph.D	RSMAS			$2,457.18			
Adrianne	Wilson*	2	Ph.D	RSMAS	$9,500	$6,082	$517.07			
Kasondra	Rubalcava*	2	Ph.D	UMES	$1,693.00	$15,903.17		$1,732.38		$25.00
Brittany	King*	2	PhD	OSU	$9,744.00	$12,660.74	$4,243.35			
Alexandria	Ambrose	3	B.S.	SSU			$381.60			
Teemer	Barry*	3	B.S.	UMES	$4,279.00	$1,676.61				$25.00
Kathryn	Cruz	3	B.S.	HU		$5,000.00				
Rhyan	Knight*	3	B.S.	UMES	$4,279.00	$2,009.90				
Kiani	Simmons*	3	B.S.	DSU						
Amani	Tolin*	3	B.S.	HU		$1,250.00				
Tyler	Washington*	3	B.S.	UMES	$4,279.00	$1,186.75				
DaQuan	Davis*	3	B.S.	UMES	$4,279.00	$2,656.30				
Semaj	Fielding*	3	B.S.	UMES	$4,279.00	$934.25				
Eunice	Sanvee*	3	B.S.	DSU		$1,740.00				
Joe	Day*	3	BS	SSU	$12,000.00					
Arona	Bender*	3	M.S.	HU	$5,731.00	$3,000.00				
Juan	Cervera*	3	M.S.	RSMAS	$4,060	$17,910				
Davielle	Drayton*	3	M.S.	SSU	$1,864.00	$32,900.00	$3,487.09	$5,000.00		
Benjamin	Frey*	3	M.S.	UMCES		$14,805.33		$2,832.12	$207.00	
Luis	Rodriguez-Sanoguet*	3	M.S.	DSU	$6,811.00	$3,230.76				
Keala	Pelekai*	3	MS	OSU	$11,496.47	$11,930.52	$194.76			
Shanelle	Haughton*	3	Ph.D	UMES		$13,122.48		$1,356.39		$25.00
Wilmelie	Cruz-Marrero*	3	Ph.D	UMES	$834.00	$11,586.73	$83.52	$8,767.64		$25.00
Ashley	Silver*	3	Ph.D	UMES		$1,434.44				
Mya	Rufus*	4	B.S.	UMES	$4,279.00					
Larry	Summer*	4	B.S.	UMES	$4,279.00	$300.98				

Savannah	Geiger*	4	M.S.	SSU		$19,250.00				
Shakira	Goffe*	4	M.S.	UMES	$4,110.00	$3,784.00				
Tahirah	Johnson*	4	M.S.	UMES	$3,114.00	$6,506.85				
Imani	Wilburn*	4	M.S.	UMES	$3,753.00	$3,227.59				
Victoria	Williams	4	MS	OSU	$4,872.00	$3,843.56				
Cristin	Mayes*	4	Ph.D	RSMAS	$2,960	$15,881				
Kyarii	Ramarui*	4	Ph.D	UMCES	$5,117.00	$15,941.06				
Erianna	Hammond*	2	B.S.	SSU	$12,000.00					
Shaneese	Mackey*	3	M.S.	SSU	$3,146.00	$29,300.00	$2,923.00	$(998.50)	$(15.96)	
Chelsea	Spaulding	4	B.S.	SSU	$3,339.62	$960.45				
Sena	Tay*	2	BS	SSU	$6,994.00	$4,000.00	$1,380.00			

**Underrepresented minorities; Data for SSU is incomplete because they have not been provided by SSU*

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
Ileana	Fenwich*	1	B.S.	HU	Fall 17	NA	NA	NA	NA
Nylah	McClain*	1	B.S.	UMES	n/a	n/a	Sum 17	n/a	n/a
Isaiah	Milton*	1	B.S.	HU	Fall 17	NA	NA	NA	NA
India	Oliver*	1	B.S.	UMES	n/a	n/a	Sum 17	n/a	n/a
Chryston	Best-Otubu*	1	B.S.	UMES	n/a	n/a	Sum 17	n/a	n/a
Amanda	Pappas	1	M.S.	DSU	Spr. 19	Fall 19	Fall 19	Fall 18	Y
Shadaesha	Green*	1	Ph.D.	UMCES	Spr. 18	Sum 19	Fall 17	Fall 17	Y
Ammar	Hanif*	1	Ph.D.	UMCES	Spr. 18	Fall 18	Fall 17	Fall 17	Y
Halie	O'Farrell*	1	Ph.D.	RSMAS	Spr 18	Sum 18	Fall 16	Fall 17	Fall 16
Hillary	Thalmann	1	PhD	OSU	Apr.19	Originally Fall 20	Fall 2018	Fall 19	Y
Janelle	Layton*	2	B.S.	HU	Fall 17	NA	NA	NA	NA
Sierra	Hildebrand	2	M.S.	HU	Spr. 21	Sum 20	Sum 20	Fall 19	Y
Amanda	Lawrence*	2	M.S.	UMCES	Spr. 18	Sum 19	Fall 18	Fall 17	Y
Josette	McLean*	2	M.S.	HU	Spr. 21	Sum 20	Sum 20	Fall 19	Y
Kleponis	Nicole	2	M.S.	DSU	Spr. 19	Sum 19	Fall 18	Spr. 18	Y
Enid	Munoz-Ruiz*	2	M.S.	UMES	Spr. 18	Fall 18	Spr. 18	Fall 18	Y
LaTreese	Denson*	2	Ph.D.	RSMAS	Spr. 19	Fall 18	Fall 15	Fall 18	Sum 18
Adrianne	Wilson*	2	Ph.D.	RSMAS	Spr. 18	Sum 18	Fall 17	Fall 18	Sum 18
Kasondra	Rubalcava*	2	Ph.D.	UMES	Spr.18	Sum 19	Fall 18	Fall 18	Y

Brittany	King*	2	PhD	OSU	Mar.18	Originally Spr. 2020	Fall 18	Spr. 20	Y
Alexandria	Ambrose	3	B.S.	SSU	NA	Fall 18	Sum 19	NA	NA
Teemer	Barry*	3	B.S.	UMES	n/a	n/a	Fall 18	n/a	n/a
Kathryn	Cruz	3	B.S.	HU	Fall 17	NA	NA	NA	NA
Rhyan	Knight*	3	B.S.	UMES	n/a	n/a	Spr. 19	n/a	n/a
Kiani	Simmons*	3	B.S.	DSU	n/a	n/a	n/a	n/a	n/a
Amani	Tolin*	3	B.S.	HU	NA	NA	NA	NA	NA
Tyler	Washington*	3	B.S.	UMES	n/a	n/a	Sum 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
Eunice	Sanvee*	3	B.S.	DSU	n/a	n/a	n/a	n/a	n/a
Joe	Day*	3	BS	SSU	NA	Fall 18	NA	NA	NA
Arona	Bender*	3	M.S.	HU	Spr. 21	Sum 21	Sum 21	Fall 20	TBD
Juan	Cervera*	3	M.S.	RSMAS	Spr. 21	Sum 20	Fall 19	Fall 19	Fall 19
Davielle	Drayton*	3	M.S.	SSU	Sum 18	Fall 19	Sum 18		Sum 18
Benjamin	Frey*	3	M.S.	UMCES	Spr. 19	Spr. 19	Fall 19	Fall 19	Y
Luis	Rodriguez-Sanoguet*	3	M.S.	DSU	Spr. 21	TBD	TBD	TBD	TBD
Keala	Pelekai*	3	MS	OSU	Apr.19	Originally Fall 2020	Fall 18	Fall 19	Y
Shanelle	Haughton*	3	Ph.D.	UMES	Spr. 19	Sum 19	Spr. 19	Fall 19	Y
Wilmelie	Cruz-Marrero*	3	Ph.D.	UMES	Spr. 19	Sum 19	Fall 18		Y
Ashley	Silver*	3	Ph.D.	UMES	Spr. 21	TBD	Fall 20	Fall 20	TBD
Mya	Rufus*	4	B.S.	UMES	n/a	n/a	Sum 19	n/a	n/a
Larry	Summer*	4	B.S.	UMES	n/a	n/a	Fall 19	n/a	n/a
Savannah	Geiger*	4	M.S.	SSU	Spr. 21	Sum 20	Sum 20	Fall 19	Fall 19
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
Imani	Wilburn*	4	M.S.	UMES	Spr. 21	Sum 21	Spr. 20	Fall 20	TBD
Victoria	Williams	4	MS	OSU	Spr. 21	TBD	TBD	TBD	Y
Cristin	Mayes*	4	Ph.D.	RSMAS	NA	Sum 21	Fall 19	NA	Sum 20
Kyarii	Ramarui*	4	Ph.D.	UMCES	Spr. 21	TBD	TBD	TBD	TBD
Erianna	Hammond*	2	B.S.	SSU	NA	Fall 18	NA	NA	NA
Shaneese	Mackey*	3	M.S.	SSU	Sum 19	Fall 18	Spr. 19	Fall 19	NA
Chelsea	Spaulding	4	B.S.	SSU	NA	NA	Sum 20	NA	NA
Sena	Tay*	2	BS	SSU	NA	NA	NA	NA	NA

**Underrepresented minorities; Some items that were originally planned for the upcoming reporting period will likely need to be moved or changed due to COVID-19 response. New dates or alternative plans will be communicated as soon as possible.*

Professional Development - Award Recipient Must Report Activities Accomplished for

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

   Erianna Hammond, a B.S. student from SSU participated in the Rising Sophomore Experiential Training Program (RSETP) in summer 2019. She conducted her research at the Pacific Marine Mammals Center, but received mentorship from Drs. Hoskins-Brown and Sexton. She participated in the UMES REU Communications Workshop and presented her research at the UMES REU Symposium. During this period, she continued to analyze data and prepare a manuscript for submission. During this period, recruitment began for the 2020 RSETP.

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

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

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

Student name(s)	Activity name and/or description
LaTreese Denson	Presented talk at American Fisheries Society, Presented talk at LMRCSC Graduate Student Seminar Series
Juan Cervera	Took LMRCSC Data Management Class
LaTreese Denson	Attended Gulf of Maine Research Institute Marine Resource Education Program Southeast Science Workshop
Adrianne Wilson	Presented talk at American Fisheries Society
Halie O'Farrell	Presented talk at American Fisheries Society
Sierra Hildebrandt	Research training in oyster restoration techniques.
Josette McLean	Research training in lamprey genetics
Arona Bender	Research training in marine mammal genetics, accepted to summer internship
Isaiah Milton	Research training in genetics, completing senior thesis, and apply to graduate programs.
Ileana Fenwick	Research training in oyster restoration, completing senior thesis, and accepted to graduate programs.
Amani Tolin	Research training in oyster restoration, accepted to summer internships
Janelle Layton	Research training in marine mammal genetics, EPP scholar, accepted and applying to graduate programs.

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: Dr. Cullen is currently analyzing data and preparing manuscripts for publication in journals and applying to future employment opportunities as his fellowship approaches completion.

SSU: The SSU Post Doctoral Fellow has submitted a TAB proposal.

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	Summer/Fall 2020
HU Students	0	
OSU Faculty	0	
OSU Students	0	
RSMAS Faculty	4	2020
RSMAS Students	6	2020
SSU Faculty	3	6/1/2020
SSU Students	2	6/1/2020
UMCES Faculty	8	Spring and Summer 2020
UMCES Students	4	Spring 2020
UMES Faculty	3	Fall 2020
UMES Students	3	Fall 2020

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

Publications in journals	Justification	Status
Hoskins-Brown, D.L. Tales of Landings and Legacies: African-Americans in Georgia's Coastal Fisheries. Culture, Agriculture, Food and Environment. accepted	Supported student research in 2011 and 2016 awards	Accepted for 2020 summer issue
Thalmann*, H.L., Daly, E.A., Brodeur, R.D. *In revision.* 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.	LMRCSC Cohort 1 student	In revision

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
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 and bull shark fishery sustainability
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
Jennifer Leo	Juan Cerera	RSMAS	3	2019	NERTO mentor	3 month NERTO	NOAA SEFSC	Mangroves as essential fish habitat
John Walter	LaTreese Deson	RSMAS	2	2019	Committee member	Committee member	NOAA SEFSC	King mackerel geostatistical analysis.
Jason Spires	Sierra Hildebrandt	HU	2	1-Sep	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	3	2-Sep	TAB collaborator, committee member, and NERTO mentor	3 years	NWFSC	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys.
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	Development of a Maryland Coastal Bays Ecosystem Model to Assess the Influence of Climatic Factors on Biomass Distributions of Fish and Macroinvertebrates, Food Web Linkages and Community Structure
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.
Ron Hill	Wilmelie Cruz-Marero	UMES	3		NOAA Mentor, NERTO Mentor		SWFSC	Evaluation of fisheries parameters for a commercially important marine mollusk: growth rates and habitat distribution
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
Howard townsend	Brian Galvez	DSU	1	Jan-17	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	Jun-18	Collaborator/ Committee member	3 months	NOAA NEFSC	Ecology of a toxic harmful algal bloom species (*Dinophysis acuminata*) in the Delaware Inland Bays
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
Anne Richards	Benjamin Frey	UMCES-IMET	3	Sep-18	TAB collaborator & NERTO mentor		NMFS	Monkfish Age Validation Using Hardpart Analysis of Known-age Cohorts
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	11/3/2013	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	11/1/2017	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
Laurie Weitkamp	Pelekai	OSU	3					
Ben Laurel	Thalmann	OSU	1					
Kevin Werner	King	OSU	2					
Shallin Busch	Williams	OSU	4	1/1/2020	Committee Member		NWFSC	Operationalization of Adaptive Capacity: An Analysis of Community and Policy Responses to Ocean Acidification and other marine stressors on the West Coast
Ron Hill	Shaneese Mackey	SSU	3	5/26/2019	Committee member, communicating collaborator	~4 mo (incl. NERTO)	NOAA SEFSC	
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
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

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 **50** and graduated **3** in NOAA- mission sciences.
2. **Total number of EPP-funded post-secondary students** who are trained **58** and graduate **4** in NOAA-mission fields relevant to this announcement.
3. **Number of EPP-funded graduates who enter the NOAA mission workforce as hires** by NOAA **0**, NOAA contractors **0**, NOAA partners **0**, resource management agencies **1**, NGO community **0**, academia **1** 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) = **$208,024**

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 6 Ph.D., 6 M.S., and 11 B.S. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 8 M.S., and 8 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 6 M.S. and 10 B.S. students. So far, nine (9) students including 1 Ph.D., 5 M.S., and 3 B.S. students have been recruited into Cohort 4.

Outputs:
(a) Increased quantitative and analytical skills – Students are acquiring quantitative and analytical skills by taking courses such as Data Management for scientists that was offered in fall 2018 and 2019, 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 was held during the previous reporting period and will be held again 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 and 2019 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 6 Ph.D., 6 M.S., and 11 B.S. Of these Cohort 1 students, nine (9) have graduated, including 1 Ph.D., 3 M.S., and 5 B.S. students. Twenty-four (24) students have been identified/recruited as members of Cohort 2 (2017-2018) including 8 Ph.D., 8 M.S., and 8 B.S. students. Of the Cohort 2 students, 6 have graduated, including 3 Ph.D., 2 M.S., and 1 B.S. students. Twenty (20) students have been identified/recruited as members of Cohort 3 (2018-2019) including 4 Ph.D., 6 M.S. and 10 B.S. students. One B.S. student from Cohort 3 has graduated. So far, nine (9) students including 1 Ph.D., 5 M.S., and 3 B.S. students have been recruited into Cohort 4.

(a) **Number of degrees earned annually in NOAA mission-related disciplines** – Four (4) students graduated this period, including 1 Ph.D., 2 M.S., and 1 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**: Eleven (11) students took part in NERTO internships at NOAA facilities under the supervision of NOAA scientists.

Student Engagement with NOAA: Experience at NOAA Facilities			
Student Name	Activity/project title	NOAA personnel involved	Location
Halie O'Farrell	Fisheries independent data collection and harvest control rules for sharks	Enric Cortes	SEFSC Panama City
Adrianne Wilson	Age and growth of Lane Snapper, a data poor species	Robert Allman	SEFSC Panama City
LaTreese Denson	Environmental influences on indices of abundance for King Mackerel in the Gulf of Mexico examined through spatiotemporal geostatistical models	James Thorson	AFSC Seattle
Nicole Kleponis	Seabird lavage/salmon	Zamon	OR
Amanda Pappas	*Dinophysis* growth	Wikfors	NEFSC Milford Lab, CT

Ben Frey	At NEFSC, Woods Hole: Validation of age and growth estimates of New England and Mid-Atlantic demersal fishes using microstructural analysis of hardparts. NEFSC age training workshops	Dr. Anne Richards	NEFSC, Woods Hole, MA
Hillary Thalmann	Pacific Cod Working Group (Meeting with federal, state, and university scientists working with Pacific Cod to discuss current research and plan for future research needs and collaborations at the 2020 Alaska Marine Science Symposium)	Ben Laurel, Lauren Rogers	Anchorage Alaska
Hillary Thalmann	Larval Fish Identification	Alison Deary	NOAA AFSC
Kasondra Rubalcava	Development of a Maryland Coastal Bays Ecosystem Model to Assess the Influence of Climatic Factors on Biomass Distributions of Fish and Macroinvertebrates, Food Web Linkages and Community Structure	Howard Townsend	Oxford Cooperative Lab Oxford, MD
Wilmelie Cruz-Marero	Evaluation of fisheries parameters for a commercially important marine mollusk: growth rates and habitat distribution	Ron Hill	NOAA SEFSC, Galveston, TX
Shanelle Haughton	Understanding *Hematodinium* sp. in Alaskan crabs: new hosts, improved detection and health effects in a changing ocean	Pam Jensen	NOAA AFSC

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

The grant has made it possible for 8 collaborative research projects to be funded/selected for funding during the period of 2019 – 2020, which will enable more Center scientists to be available to mentor and advice undergraduate and graduate students. In addition, 25 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	13
New courses offered	1
New programs developed	0
New degrees offered	0
# of students supported by the LMRCSC	56
Total degrees awarded	4
Degrees awarded to URMs	3

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

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

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

(b) Increased number of URM students who select to pursue higher education in NOAA mission fields = **50** 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 associates 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 eight (8) LMRCSC TAB projects has a NOAA scientist as a collaborator.
(b) **Number of NOAA scientists serving as mentors and advisors for student research**: 34 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** = 12
(d) **Number of uses of NOAA data in research and tool development** = 1. Halie O'Farrell (Ph.D. student at RSMAS) is using the U.S. pelagic longline observer data for her dissertation research. In addition, Kasondra Rubalcava (Ph.D. student at UMES) is using the long-term fish dataset collected by the Maryland Department of Natural Resources for her dissertation research aimed at developing an ecosystem model for the Maryland Coastal Bays.

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

Eight (8) collaborative research projects were funded by the LMRCSC for the period of 2019 – 2020. 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	5	22
# of presentations	23	16
# Tools developed	0	0
Use of LMRCSC research results and tools by NOAA & other stakeholders	0	0
# of instances LMRCSC publications are cited	153	304
# of LMRCSC students, staff or faculty recognized nationally for LMRCSC research	4	4

LMRCSC TAB-funded Projects

In 2018-2019, the LMRCSC funded eight small research projects approved by the Technical Advisory Board (TAB). An additional five projects were continued from the previous year's funding. Abstracts of the projects are presented below; more detailed reports can be found in Appendix II.

TAB projects funded for FY 2018 and 2019*

Project Number	Principal Investigator	Title	Thematic Research Area
18-01	Brittany King (OSU)	Underrepresentation in marine and fisheries science professions: how significant life experiences shape a diverse workforce	Fishery Socio-Economics
18-03	LaTreese Denson (RSMAS)	Indices of abundance for King Mackerel in the Gulf of Mexico and South Atlantic improved by incorporating spatiotemporal and environmental variability	Stock Assessment Support
18-05	Matthew Ramirez (OSU)	Integration of habitat-specific growth variation into assessment models: a case study in the Kemp's ridley sea turtle.	Stock Assessment Support
18-08	Eric A. Lewallen (HU)	Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys	Stock Assessment Support
18-11	Enid Munoz Ruiz (UMES)	Assessment of Microplastics in *Placopecten magellanicus* as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic Stock Fisheries	Healthy Habitats
19-01	J. Sook Chung (IMET)	Baseline data on environmental impacts on physiological and molecular parameters determining growth for commercially valuable decapod crustacean management	Stock Assessment Support
19-02	Shanelle Haughton (UMES)	Evaluating physiological and immune responses of snow crabs (*Chionoecetes* sp.) to *Hematodinium* infection	Stock Assessment Support
19-03	Amanda Pappas (DSU)	Bloom dynamics and sediment incubations for a toxic harmful algal bloom species, *Dinophysis acuminata*, in Rehoboth Bay, Delaware, USA	Healthy Habitats

19-04	Rosemary Jagus (IMET)	Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts	Stock Assessment Support
19-05	Keala Pelekai (OSU)	Evaluation of Pacific lamprey (*Entosphenus tridentatus*) statoliths and eye lenses as records of age, natal origin, and trophic history patterns	Stock Assessment Support
19-06	Hillary Thalmann (OSU)	Thermal impacts on juvenile Pacific Cod (*Gadus macrocephalus*) foraging and growth in Gulf of Alaska nursery habitats	Climate and Ecosystems
19-07	Adrianne Wilson (RSMAS)	Population structure and growth of lane snapper, a data limited species	Stock Assessment Support
19-08	Carolina Bonin- Lewallen (HU)	Genetic approaches for monitoring the effects of climate change on leopard seals in the Antarctic Peninsula	Climate and Ecosystems

***Only currently active projects are included.*

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 Socio-Economics

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. To better understand how to recruit and retain individuals from underrepresented communities, 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 and November 2019, we conducted 43 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. Data obtained from these interviews have yet to be analyzed, however, we expect data collection and analysis to be completed this summer.

Principal Investigator: Brittany King, Oregon State University
Co-PI: Kelly Biedenweg, Oregon State University
NOAA Partner: Kevin Werner, NWFSC: Northwest Fishery Science Center
Students: Brittany King (PhD, OSU)
Keywords: Fisheries; Social science; Diversity

Project Number 18-03

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

Thematic Research Area: Stock Assessment Support

Abstract

The assessment of King mackerel in the Gulf of Mexico uses an index for estimating spawning stock biomass that is developed using a statistical model 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 environmental variables at different time and spatial scales should be considered density drivers while others may be considered as both catchability and density drivers of 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, hoskins@savannahstate.edu

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

Keywords: Fisheries; Marine Biology; Population dynamics

Project Number 18-05

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

Thematic Research Area Stock Assessment Support

Abstract

Spatiotemporal variation in demographic parameters can strongly influence a species' population dynamics but is generally not included in sea turtle populations due in part to lack of sufficient data. For example, Kemp's ridley sea turtles that inhabit the U.S. Atlantic Coast grow slower than conspecifics that inhabit the U.S. Gulf of Mexico (GoM) Coast, which may lead to differences in age at maturation for individuals or whole cohorts. To evaluate the influence of this variation on Kemp's ridley population dynamics, we are developing an improved age- structured population model that incorporates habitat-specific vital rate estimates (growth, survival). Using a ~30 year dataset of somatic growth rates obtained

through skeletochronology, we have developed habitat-specific (Atlantic, GoM) maturation schedules for this species. In addition, ongoing analyses are using 20 years of stranding length frequency data collected through the Sea Turtle Stranding and Salvage Network to estimate habitat- specific survival rates that will be included in the model. Ongoing analyses will examine model sensitivity to changes in stage-and habitat-specific model parameters. This project will help answer critical question about the contribution of somatic growth variation, habitat use, and Atlantic turtles, which have been excluded from all existing population models, to Kemp's ridley population dynamics.
Principal Investigator: Matthew Ramirez, Oregon State University
Co-PI: Selina Heppell, Oregon State University
NOAA Partner: Jeffrey Moore, SWFSC: Southwest Fishery Science Center
Other Partner: Elizabeth Babcock, RSMAS
Students: Matthew Ramirez (PhD, OSU); Tamara Popovska (Undergraduate, OSU)
Keywords: Marine Biology; Protected Species; Population dynamics

Project Number 18-08
Title: Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys
Thematic Research Area Stock Assessment Support
Abstract
The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous species that occurs throughout the Northern Pacific Ocean and is important to humans for at least two key reasons: 1) Indigenous peoples near the Columbia River have a cultural value for them as a ceremonial food item, and 2) during their marine phase, lampreys parasitize many fish species and may reduce commercial harvests (e.g., Pacific hake, walleye pollock). Although culturally important, vulnerable (freshwater modifications reduce larval habitats), and ecologically interesting (parasites can exhibit dramatic fluctuations in abundance), the basic biology of Pacific lamprey in marine waters has not been well documented. The goal of this study is to identify prey items of Pacific lampreys and characterize their feeding ecology in the Northeastern Pacific Ocean, particularly where they overlap with commercially-targeted species (e.g., Pacific hake, shrimps).
Principal Investigator: Eric A. Lewallen, Hampton University
Co-PI: Carolina Bonin Lewallen, Hampton University
NOAA Partner: Laurie Weitkamp, NWFSC: Northwest Fishery Science Center
Other Partner: Linda Park, NWFSC: Northwest Fishery Science Center
Students: Josette McLean (MS, Hampton U); Janelle Layton (Undergraduate, Hampton U)
Keywords: Fisheries; Marine Biology; Ecosystems

Project Number 18-11
Title: Assessment of Microplastics in *Placopecten magellanicus* as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic Stock Fisheries
Thematic Research Area Healthy Habitats
Abstract
Microplastics are plastic fragments, pellets, fibers and cosmetic beads less than 5 mm in size. In recent years, these emerging contaminants have been found in tap water samples all over the world and in a vast array of aquatic organisms with the possibility of toxic effects in them. The objective of my research is to test if the important ecological species and delicious Atlantic Sea Scallops were contaminated with microplastics. Over 200 scallops were dredged aboard the NOAA Scallop Survey Cruise in Georgia's Bank and the Mid-Atlantic Bight for samples. The scallops were dissected with the intention of collecting the gills, digestive tracts and muscle in order to determine bivalve plastic uptake. Briefly, micropolymer assays were conducted using an efficient extraction method consisting of chemical digestion and visual quantification of

microplastics. All microplastics found were fibers and not fragments from larger plastics. There were no significant correlations or differences in microplastic abundance among scallop tissues, sex or size. Since sea scallops are important commercial organisms with fisheries dredging over 50 million pounds annually for seafood consumption, our research directly contributes to NOAA's goal to conserve and manage coastal and marine ecosystems and resources by providing the scientific foundation for understanding further research on the toxicity microplastics can have on important ecological and commercial species.
Principal Investigator: Enid Munoz Ruiz, University of Maryland Eastern Shore
Co-PI: Ali Ishaque, University of Maryland Eastern Shore (UMES)
NOAA Partner: Ashok Deshpande, NEFSC: Northeast Fishery Science Center
Students: Enid Munoz Ruiz (MS, UMES)
Keywords: Toxicology

Project Number 19-01
Title: Baseline data on environmental impacts on physiological and molecular parameters determining growth for commercially valuable decapod crustacean management
Thematic Research Area Stock Assessment Support
Abstract
The crustacean fishery in the US has been challenged due to drastically reduced landings for several decades, including the blue crab (*Callinectes sapidus*) industry in the Chesapeake Bay. Crustacean growth is hormonally regulated while environmental conditions as stress factors often have adverse effects on growth. The vast genetic diversity of *C. sapidus* is reflected in size variation and differential growth rates. This proposal seeks to measure physiological and molecular parameters that define stress impacts on the growth of animals with differential growth rates. Ultimately, the current project seeks to generate a model that will be applied to all commercially important decapod crustaceans for growth prediction under normal and stressful conditions in natural habitats.
Principal Investigator: J. Sook Chung, University of Maryland Center for Environmental Science
Co-PI: Elizabeth A. Babcock, University of Miami - Rosenstiel School of Marine and Atmospheric Science
NOAA Partner: Paul McElhany, NWFSC, Seattle, WA. , NWFSC: Northwest Fishery Science Center
Other Partner:
Students: Anya Byrd (PhD, UMCES); Adjele Wilson (Undergraduate, UMES)
Keywords: Aquaculture; Marine Biology; Habitats

Project Number 19-02
Title: Evaluating physiological and immune responses of snow crabs (*Chionoecetes* sp.) to *Hematodinium* infection
Thematic Research Area Stock Assessment Support
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: Dr. Joseph Pitula, University of Maryland Eastern Shore (UMES)
NOAA Partner: Dr. Pamela Jenson, AFSC: Alaska Fishery Science Center
Students: Shanelle Haughton (PhD, UMES); Reuel Denquah (MS, UMES)
Keywords: Fisheries; Marine Biology; Ecosystems

Project Number 19-03
Title: Bloom dynamics and sediment incubations for a toxic harmful algal bloom species, *Dinophysis acuminata*, in Rehoboth Bay, Delaware, USA
Thematic Research Area Healthy Habitats
Abstract
Members of the dinoflagellate genus *Dinophysis* have been shown to produce toxins that can cause Diarrhetic Shellfish Poisoning (DSP) in humans who consume toxin-contaminated shellfish. The increased and regular presence of toxic harmful algae bloom (HAB) species are of concern to human health and the growing oyster aquaculture industry in the Delaware Inland Bays. The advancing oyster aquaculture industry in the bay requires the development of management practices to protect environment and human health; monitoring for HABs is a necessary component. Torquay Canal is a dead-end canal in northern Rehoboth Bay with a history of *D. acuminata* blooms during the spring and summer. The extent of the *D. acuminata* blooms in Torquay Canal was unknown until this study, which has shown that the bloom is not isolated to the regularly-monitored sampling location at the bulkhead, but extends into the canal, out into Bald Eagle Creek, and in low densities (1,000 cells/L) in northern Rehoboth Bay.

D. acuminata can be toxic even at low concentrations (<1000 cells/L). Potential risk to human health could occur during future bloom events if *D. acuminata* blooms are not isolated to Torquay Canal and extend further into Rehoboth Bay toward oyster aquaculture sites. This study monitored *D. acuminata* at Torquay Canal; the highest cell count from a winter bloom in January 2020 reached 214,000 cells/L. Tests for statistical significance and measures of association between nutrient concentrations (N,P), temperature, and cell densities at Torquay Canal were performed. Toxicity analysis for the winter 2020 bloom event at Torquay Canal is being performed by Juliette Smith at the Virginia Institute of Marine Sciences through a collaboration with Dr. Kathy Coyne and MSc student Amanda Williams at the University of Delaware College of Earth, Ocean, and Environment. The origin of *D. acuminata* blooms at Torquay Canal is unknown. To determine if blooms are seeded by a resident population in the canal, sediment incubation experiments of fall and winter sediments from Torquay Canal were conducted. This study will inform an effective HAB monitoring program in Delaware.
Principal Investigator: Amanda Pappas, Delaware State University
Co-PI: Gulnihal Ozbay, Delaware State University
NOAA Partner: Gary Wikfors, NEFSC: Northeast Fishery Science Center
Other Partner: Dr. Kathy Coyne, University of Delaware
Students: Detbra Rosales (PhD, UMCES); Amanda Williams (MS, UMCES); Raymond Andrews
Keywords: Aquaculture; HABs; Habitats

Project Number 19-04
Title: Validation of Monkfish Age and Growth Using Microconstituent Analysis of Hardparts
Thematic Research Area Stock Assessment Support
Abstract
We propose to develop and validate a novel aging method for monkfish, *Lophius americanus*, to support assessment goals and student training in marine chemistry, and stock assessment. The length modes for the strong 2015 year class (YC) have been clearly delineated through

successive seasonal surveys, thus effectively providing monkfish of known age. Dr. Anne Richards, a stock assessment expert for monkfish at the NEFSC Fisheries Biology Program has collected monthly samples of this YC from 6 mo old. The objective of this study is to analyze seasonal cycles of hardpart microconstituents (Ca, P, and Sr) from this YC at ages 0-3 yr to compare with optical zonation methods. The patterns observed in the known age fish will provide a key to interpreting optical zonation patterns in fish of unknown age, filling a major gap in the data needed for quantitative assessment of monkfish and leading to improved scientific advice to fishery managers.
Principal Investigator: Rosemary Jagus, University of Maryland Center for Environmental Science
Co-PI: David Secor, University of Maryland Center for Environmental Science
NOAA Partner: Anne Richards, NEFSC: Northeast Fishery Science Center
Students: Benjamin Frey (MS, UMCES)
Keywords: Fisheries

Project Number 19-05
Title: Evaluation of Pacific lamprey (*Entosphenus tridentatus*) statoliths and eye lenses as records of age, natal origin, and trophic history patterns
Thematic Research Area Stock Assessment Support
Abstract
The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous species native to the North Pacific Ocean and its adjacent freshwater tributaries. Pacific lamprey is both ecologically and culturally important to the Pacific Northwest of the United States. In the last 50 years, Pacific lamprey have experienced declines in abundance throughout the Columbia River Basin, USA. More information on the biology and ecology of this species is needed for conservation and management. Anatomical structures have been widely used in fisheries science for biological inference. The Pacific lamprey is a cartilaginous fish that lacks the common hard structures used in teleosts to elucidate age and life history patterns. Statoliths, analogous to otoliths in function, are calcium-fluorapatite concretions found in the auditory capsules of lampreys. Statoliths have potential for aging and chemical analysis but require further evaluation to determine if bands represent annual deposition and are chemically reflective of the environment. Eye lenses are another structure with potential for trace element and stable isotope analysis but remain relatively unexplored for lamprey. The goal of this project is to broaden our understanding of lamprey by evaluating the efficacy of different anatomical structures for determining age, natal origin, and trophic history patterns. These objectives will be achieved by evaluating lamprey statoliths and eye lenses taken from known age and origin specimens.
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; Population dynamics; Ageing; Trophic Ecology

Project Number 19-06
Title: Thermal impacts on juvenile Pacific Cod (*Gadus macrocephalus*) foraging and growth in Gulf of Alaska nursery habitats
Thematic Research Area Climate and Ecosystems
Abstract
The Gulf of Alaska is influenced by thermal variation including climatic phenomena and marine heatwaves such as the 2014-2016 and 2019 heatwaves. Warming events are expected to

impact age-0 Pacific Cod (*Gadus macrocephalus*) during summer growth in coastal nurseries and can influence patterns of foraging, selective mortality, and overwinter survival. Understanding thermal impacts on juvenile cod is especially relevant given their recent declines in adult abundance and the closure of the fishery in 2020. I will examine juvenile cod in Kodiak Island nurseries between 2006 and 2019 during representative warm and cold years in order to describe variability in nursery growth, diet composition, and trophic position using otolith increment, stomach content, and stable isotope analysis. Expected results will inform cod recruitment patterns in the face of climate change and contribute to nursery management during future warming.
Principal Investigator: Hillary Thalmann, Oregon State University
Co-PI: Jessica Miller, Oregon State University
NOAA Partner: Ben Laurel, AFSC: Alaska Fishery Science Center
Other Partner: Bradley Stevens, UMES
Students: Hillary Thalmann (MS, OSU); Undetermined Summer Intern (Undergraduate, OSU)
Keywords: Fisheries; Protected Species; Population dynamics; Ecosystems; Habitats

Project Number 19-07
Title: Population structure and growth of lane snapper, a data limited species
Thematic Research Area Stock Assessment Support
Abstract
Lane Snappers (*Lutjanus synagris*) are a data-limited species that range from North Carolina, the Gulf of Mexico (GOM) and south to Brazil. This study will collect 400 sagittal otoliths, fin clips, length/weight measurements from fish caught from East Florida to North Carolina. Otoliths will be processed, aged and two experienced readers will be used to ensure accurate ageing. A variety of growth models will be used to determine best fit. Genotyping by sequencing (GBS) will be used to determine genetic diversity. Results will complement a recent NOAA supported study that examined spatial and temporal variation in the age and growth of Lane Snapper in the GOM and data will be used to support future NOAA stock assessments by providing information on population structure and growth.
Principal Investigator: 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; Social science; Population dynamics

Project Number 19-08

Title: Genetic approaches for monitoring the effects of climate change on leopard seals in the Antarctic Peninsula.
Thematic Research Area: Climate and Ecosystems: Effects on Marine Ecosystems
Abstract
The United States is one of the largest consumers of Antarctic fishery products, and is legally mandated to report on krill and krill-dependent predator abundance, diet and movements. These data have been collected for nearly 30 years in the South Shetland Islands (SSI), through the efforts of the NOAA Antarctic Marine Living Resources program. In the SSI, rapid warming has caused a dramatic decrease in sea-ice with consequences for the entire ecosystem. Interestingly, leopard seal numbers have also increased over this time period;

understanding this intriguing pattern is key for the prediction of future scenarios in the Antarctic. Leopard seals are elusive pack ice breeders, and reliable data on the abundance of this species are lacking. Here we propose to investigate leopard seal abundance using samples archived by AMLR to: i) infer levels of genetic diversity and ii) estimate the number of breeding individuals.

Principal Investigator: Dr. Carolina Bonin-Lewallen, Assistant Professor, Hampton University
Co-PI: Dr. Eric Alexander Lewallen, Assistant Professor, Hampton University
Co-PI: Dr. Felipe Barreto, Assistant Professor, Oregon State University
NOAA Collaborators: Dr. Michael Goebel, Researcher, Antarctic Ecosystem Research Division, Southwest Fisheries Science Center; Dr. Douglas Krause, Researcher, Antarctic Ecosystem Research Division, Southwest Fisheries Science Center;
Students: To be named at a later date; Research Student (Undergraduate): Kathryn Cruz, Hampton University/LMRCSC
Keywords:

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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:	$194,734
Stipend:	$362,768
Travel:	$20,169
NERTO:	$29,945
One-time Research:	$18,883
Professional Development:	$175
Total:	**$626,674**

Collaborative Research:

No new research projects were funded during this period. TAB projects will be funded in the next period.

2. Total leverage funding breakout

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

Postsecondary Student Support:

Source	Type	Start date - end date	Total amount	Current 6 month period	PI	Project title	Contribution to Center
CIMAS	Grant	Sept 2019 to Aug 2018	$49,198	$25,000	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
NSF	Grant	8/1/18 to 7/31/21	$741,820	$247,273	Cuker and Lewallen	Multicultural Diversity in the Aquatic Sciences	Funds are used to support students to ASLO conference.
Aquaculture	Grant	12/1/2019 to 2/28/2020	$4,846	$4,846	Gulnihal Ozbay	Delaware Inland Bays HAB	Funds are used to support a M.S. student Amanda Pappas at DSU

NSF	Grant	5/1/12 to 4/30/20	$627,489	$34,379	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 to 6/30/20	$1,200,000	$81,738	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 to 12/31/20	$ 40,000		Rosemary Jagus	Support IMET Summer Internship	Funding supports IMET Summer Internship, 2020
Anonymous Donor	Award	01/01/20 to 12/31/20	$20,000		Rosemary Jagus	Support IMET Summer Internship	Funding supports IMET Summer Internship, 2020
Alga BT	Contract	5/18/17 to 4/30/20	$381,482	$23,059	Yantao Li	Research Contract with Alga BT	Funds were used to support Kia Ramarui (Cohort 4) flab expenses
NSF	Grant	7/1/17 to 6/30/21	$359,437	$ 48,701	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 to 6/30/20	$8,270		Eric Schott	Determining how variation in life history & connectivity drive pathogen-host dynamics	Supplemental funds for summer intern
OSU	Graduate award	2020 to 2021	$4,000	$2,000	King	Oregon State Thurgood Marshall Graduate Award (Feb. 2020)	
OSU Sea Grant	Graduate award	10/19 to 9/2020	$10,800	$5,400	King	Oregon Sea Grant Robert E. Malouf Marine Studies Award (Sept. 2019)	
USFWS	Award	5/2020 to 4/2021	$20,480		Miller	Natal Origins of Pacific Lamprey	Expand resources and training for Pelekai
NSF	National Research Traineeship	9/2020 to 8/2021	$53,000	$26,500	Ciannelli	Risk and Uncertainty Quantification in Marine Science	Supports Thalmann for 1 full year, stipend and tuition

Ocean Leadership	Grant	Dec. 1, 2018 to Jun. 30, 2019	$10,000	$10,000	Dionne Hoskins, Victoria Young	NOSB Regional Site	Produce the GA-SC NOSB competition
NSF	Grant	9/1/2016 to 8/31/21	$5 million	$500,000	P. Chigbu; M. Sexton; A. Ishaque; S. Parveen	CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics	Funds support PIs salaries, students, research

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 Unversity	Grant	1/1/2020-/30/2020	$16,500	$0	Elizabeth Babcock	Unlocking the global shark meat trade	Provides partial salary support for E. Babcock
NSF	Grant	10/1/17 - 9/30/19	$36,285	$10,388	J. Sook Chung	CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics in the Mid-Atlantic Region	Funds support PI's salary
France Merrick	Grant	5/1/18 - 4/30/21	$71,383	$10,919	Eric Schott	Of Animals and Microbes: A Baltimore Harbor Investigations	Funds support PI's salary
NOAA/NMFS	MOU	Jan. 2000-continuing	$100,000	$50,000	Dionne Hoskins	NOAA CMER	Support a NMFS FTE for a CMER program

Appendices

Appendix I: External Evaluations Report of the LMRCSC

Living Marine Resources Cooperative Science Center
External Evaluation Year 3 Report
(2018-2019)
Prepared by Tina Bishop, Ed.D. and Howard Walters, Ph.D.
(College of Exploration)

Background and Introduction

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

Evaluation Plan

The revised CSC evaluation framework is based on a set of three over-arching questions, focused on the CSC impact on students and graduates, NOAA mission-aligned research, and CSC management and administrative processes. The guiding questions for this framework are:
1. How has the Center award implementation activities increased the number of students and graduates trained in the competencies and skills that align with employability and graduate studies in NOAA mission-aligned areas to advance the effectiveness and impacts of the NOAA Educational Partnership Program with Minority Serving Institutions (EPP/MSI) postsecondary NOAA mission STEM future workforce program?
2. What is the evidence that the Center award implementation activities enhanced the capacity for NOAA mission-aligned research at partner institutions and other MSI's?
3. What is the evidence that the CSC management team and administrative processes enhanced the capacity of lead and partner institutions to meet the goals and objectives of the Center award in advancing the effectiveness and impacts of the NOAA EPP/MSI STEM future workforce program?

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

Year Three Data Collection and Evaluation Focus

For year three of the external evaluation, evidence collection focused on current graduate and undergraduate students, NOAA Scientists who are working with these students or with the LMRCSC in a support position, and project co-PIs. In the fall of 2018, surveys were developed and disseminated to the LMRCSC funded students in the NERTO projects and the TAB projects, as well as to the NOAA and university scientists who were working with these students. A follow-up survey for undergraduate students was disseminated in late Spring 2019.

Additionally, the evaluation effort continued at the Spring 2019 student workshop held at the University of Maryland—Eastern Shore campus. The evaluators attended the workshop again in 2019 to conduct interviews with select students and project leadership, and to administer a post-workshop survey to the student participants.

Finally, the evaluators implemented a series of site visits to interview select project personnel in the spring, 2019, semester. In January of 2019, the evaluators visited the University of Miami, Rosenstiel School of Marine and Atmospheric Science, to interview one of the LMRCSC co-PIs, Dr. Beth Babcock, and two of the graduate students at that location who are funded by LMRCSC. In May 2019, the evaluators visited with Dr. Ashok Deshpande, a researcher at the James J. Howard Marine Sciences Laboratory at Sandy Hook NJ. Dr. Deshpande is an ongoing mentor to LMRCSC students and a member of the technical advisory committee for LMRCSC, who has supervised both TAB and NERTO projects. And finally, in June 2019, the evaluators attended the LMRCSC Science Meeting in Silver Spring, MD, to interact with and interview select students, project personnel, NOAA scientists and NOAA EPP personnel.

The evidence summaries in the following narrative are organized under subheadings to delineate the source of the data. In most cases, the surveys are summarized entirely, but in the interest of space, select items that were not intended to align with the NOAA EPP guiding questions, or which failed to elicit adequate response data were abridged or omitted.

NERTO Student Survey Data and Summaries

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

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

support. The same was observed regarding support for the students' professional careers: students perceived strong, positive support for their professional development from these NOAA scientists. And finally, narrative response data is consistently found to strengthen the value of selected response or ranked response items. These students provided rich affirmations of the role of their mentors/NOAA scientists:

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

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

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

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

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

Item twenty-two asked respondents "what have you learned about the social implications of your science during your NERTO experience?" This item is directly attached to previous interested

expressed by NOAA EPP. The responses were, overall, weak to this item, suggesting that students were not attuned to these social implications. This may be considered in reviewing the programming for the graduate student workshops and webinars moving forward.

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

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

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

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

NERTO Scientist/Mentor Survey

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

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

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

perceived that they were matched well with the students with whom they worked, and that their students were well prepared for the work requirements.

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

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

These skills correlate substantially with expectations for NOAA mission science content areas, and support a conclusion the NERTO projects were well developed for both NOAA EPP goals, and to support the graduate students learning and development for the NOAA science career pipeline.

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

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

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

Item nineteen reversed the previous question's focus, and asked "what were the benefits of the NERTO to you as a researcher?" for the scientists to consider. The responses included networking and capacity building, and the opportunity to get important work completed with student

help. Interestingly, one scientist commented on the enthusiasm of the intern as a help to the scientists, causing them to remember the reason why they were doing their work. One respondent reported he/she advanced her own knowledge because the internship prompted him/her to study an area of science that wasn't familiar prior to launching the project. A second scientist also reported personal learning from the results of the student's project.

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

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

In the closing survey items, when given the opportunity to advise the LMRCSC regarding additional support for interns, no substantive responses emerged. The scientists did offer that they wished personally that they had obtained additional training in analytical programming, statistical analysis, and support developing a generalized ability to continue learning, as employment skills will change over time from graduate school.

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

TAB Project Scientist Data

Similar to the NERTO scientist and student surveys summarized above, the scientists and students who sponsored, led, or participated in TAB projects for the LMRCSC over the previous year were surveyed to obtain descriptive and impact data to describe the implementation of this important element of the LMRCSC. A total of nine scientists responded to the survey, with five responding for multiple projects and four responding for a single TAB project. Seven of the respondents were university faculty members, and two were NOAA scientists. The written descriptions of the TAB projects were clearly aligned with NOAA mission science. These included work with harmful algal blooms, diseases impacting blue crabs, distribution and persistence of HABs, a variety of baseline modeling projects on a number of commercial valuable fin-fish and shell fish species, and a variety of habitat projects. The scientists were asked to assign a content area to their respective projects based on NOAA categories important to EPP for the LMRCSC. The responses indicated 44% were related to ecosystem science, 33% to living resources management, and 22% to stock assessment work. And while the NERTO scientists were ambiguous with regard to the social impacts of those projects, there were clear and distinct social impacts described for the TAB projects, including:

- The impact of land use on HABs and related fisheries;
- Improving sustainability of fisheries and improving management of sea turtles;
- Broader impacts to coastal habitats and species, including impacts on HABs to shellfish aquaculture;
- Some indication of community outreach work associated to TABs;
- Better definitions of habitats for impacting species; and

- The use of data to define fishery target groups, set catch or size limits, and to establish policies and restrict habitats.

Item six asked respondents to "describe any opportunities your students had to learn or practice large data set management or analysis during the project. The responses were clear that this was indeed a significant learning objective or outcome of the TAB projects, and supported this important feature of the LMRCSC. Examples from the substantive narrative responses that are typical of the set of responses included:

- Analyzing deep sequencing results of bacterial populations in oysters;
- A student will work with large data set of stranded sea turtles and produce a large data set of results on growth and isotope rations in sea turtle bones;
- The student learned how to extract water quality information from a Regional Ocean Modeling System (ROMS) model.
- Students collect and analyze their own data. Some use larger data sets collected by NOAA or other agencies. Projects that used such data include Cold-water Corals (NOAA Habitat dataset); Black sea bass food habits (NOAA food habits database); and BSB habitat suitability (Chesapeake Bay ROMS and climate data).

Item seven revealed a range of, typically, 1-3 students per scientist working on TAB projects, although one scientist responded that he/she led a group of 7-8 graduate students and 10-12 undergraduate students, working in teams of 1-2 per project. Eight of the nine scientists reported working approximately 5 hours per week (up to) and one of the respondents reported working more than twenty hours per week. It is presumed this last respondent was also the respondent working with the larger number of students in item seven above. Seven respondents indicated their time allocation for the TAB students/projects was appropriate, with one scientist indicating that the time required was excessive.

Item ten asked scientists to "describe the preparation received to mentor students in a TAB project." While most did not point to preparation specific to the LMRCSC, it was clear that these were experienced scientists, who had mentored numerous students over the years in research settings and felt comfortable extending their prior experience into the LMRCSC work. In a direct probe of this confidence in item eleven, all of the scientists reported their preparation for mentoring students was sufficient for these TAB requirements.

Item twelve revealed all nine scientists perceived that there was a strong and positive match between the students they were assigned or selected, and themselves personally. Item thirteen continued this strong positive assessment, revealing that all the scientists perceived their students were adequately prepared for the projects as assigned. Item fourteen probed more deeply into these work projects, by asking the scientists to describe the work and skills-practices required of the students in these TAB projects. These responses as anticipated reflected a wide range of scientific skills for laboratory, field, and analytic work, including a variety of specific content topic areas related to particular species involved in the projects.

Item fifteen explored the range of time that the scientist had worked with the specific students. It was clear that, for most situations, there was a previous working or academic relationship between the students and the scientists—which would be expected based on the observation most of these TAB projects were coordinated by university scientists where the students were matriculating.

Item sixteen probed into the research on mentoring. Respondents were asked to discuss ways that they provided social and emotional support to their students, as recommended in mentoring research. The responses were rich, and suggested these scientists took seriously the broader needs that students had. Responses included:

- Talking regularly to students;

- Encouraging students to attend meetings, to network with others, and to discuss concerns;
- We have transparent dialogue about issues, thoughts, and plans;
- I ask them about home life and stress levels, and encourage them to work together;
- I pair students and encourage them to work together, take students to lunch and discuss projects, problems, and life in general;
- I try to make them feel like a part of our team of employees, contractors, and students by inviting them to participate in group meetings and social activities;
- Over the years, we have discussed careers, how to manage projects successfully, and how to work with committees; and
- I host gatherings and celebrations for students at my home so they can relate to me socially. I provide emotional support if I feel a student needs it.

Item seventeen asked respondents to describe how they had encouraged or enhanced their student's career development. Responses were, again, rich and demonstrative of the scientists' awareness of early career formation among young colleagues, and their helpfulness in these TAB projects. Responses included: pushing students to present at conferences, assessing their abstracts and posters; encouraging them to publish; encouraging them to apply for NOAA fellowships and internships; CV development, grant writing; working to improve scientific thinking and writing. Clearly, these types of supportive activities are appropriate and have emerged in other research on mentoring success for science disciplines and careers.

Item eighteen asked "in what ways did you introduce your student(s) to your research field. These responses included introducing them to colleagues and encouraging networking opportunities. Other responses described the time invested in the research aspects of the TAB projects that included building awareness of the research field, content enhancement, reading articles and other materials, and communication with team members. One respondent described how he/she networked the students(s) with prior students who had worked on the same project in order to build the network of connected students with awareness of the project and the field of inquiry. It is clear from the range and richness of these responses that career awareness was in the minds of the scientists mentoring the TAB projects. Interestingly, all nine of the respondents reported that they had introduced their students to other colleagues in the field.

Items twenty and twenty-one addressed the benefits of the TAB projects to both the students and the scientists. The benefits that were perceived for the students seemed reasonable given the design of the TAB projects, and included: experience with proposal writing, experience with grants management, opportunities to work with and communicate with NOAA scientists and labs, opportunity to network and to be linked into the NOAA community. Other practical skills included improving writing ability, budget development, experience with teams, setting goals, and attending conferences. The benefits for the scientists included working with diverse students, obtaining some salary support for themselves and for funding students to expand their (scientists) research efforts and agenda. Interesting, several respondents described their own learning from these projects, with one noting that the TAB "expanded or broadened" his/her research interests, and one describing that a student had better hands-on skills than he/she had and so his/her own learning and reputation was enhanced by the student.

Item twenty-two asked respondents to describe specific challenges related to undertaking a TAB project. There was a clear focus in these responses related to funding issues. For some, it was awkward or difficult to execute funding agreements, deal with paperwork, or move funds into accounts. For others, the limitations of funding to leveraging dollars, given difficulties in obtaining these leveraged dollars, is problematic. Restrictions for use of funds, likely a NOAA restriction outside of LMRCSC control, emerged for other respondents.

The closing set of items (twenty-three through twenty seven) elicited responses from scientists that these TAB projects were strongly aligned to NOAA mission science—an observation

also made by the evaluators in reviewing the content descriptions of the TAB projects. Eight of the responding scientists perceive that these students will be good candidates for NOAA's future mission workforce. Item twenty-five sought input on expanded academic support that may be beneficial to students. This item elicited suggestions about the need for post-graduate internships or short-term employment in NOAA labs or with NOAA partners, conference travel funds, and perhaps greater exposure to other, alternative career choices—although this wasn't explained well. A cluster of responses emerged to encourage more training in statistics, computer programming, and writing skills which are consistent with other pipeline research conducted by the evaluation team. And finally, responses related to the overall efficacy of the LMRCSC project and recommendations for improvement overall seemed to focus on enhancing communications opportunities and networks between and among LMRCSC partners and supporting institutions, and NOAA agencies, personnel and laboratories with all of the students involved.

TAB Student Data

The TAB student survey response data were far more limited, with only three students providing responses. It is likely that disruptions in the communications channel as a result of the federal government shut down this year resulted in a disruption in transmitting the surveys to students in a timely manner. Nevertheless, students will be surveyed in early April at the spring workshop at the UMES facility as a part of the LMRCSC student training event, and so there will be additional opportunities to elicit impact data from the perspective of the students themselves. The summary of the current TAB student survey will be limited based on concerns about sample sizes in these responses.

Of the three students responding, two were doctoral students, and one was a masters level student. It was clear, from the content provided and the other related survey items that these students were involved in TAB projects that were related to NOAA mission science, i.e. seafood safety and aquaculture, and habitat assessment. The doctoral students were required to work with large datasets, and all of the students were engaged with projects that had a social implication, and could explain this implication.

The response items four through fifteen, though limited in number, were completely consistent with the responses summarized above by the scientists who supervised these TAB projects, including time on task, relationship with the mentor, time and communication with the mentor, and other benefits and work opportunity provided. When describing the career relationship to their TAB experience, one student wrote: "it immersed me into what life would be like as an academic, or a research scientist. It has demonstrated both the pros and cons of that." Another wrote that "it has helped me to figure out that I would like to have a job as a research scientist in seafood safety." These responses suggest the students "see" the projects much as they were described by the larger number of scientists who responded to this round of seasonal surveys.

Items seventeen through twenty suggest the students were engaged in networking with potential career mentors, met other NOAA scientists and were involved, through these TAB projects, in processes that meaningfully connected them to NOAA research and career pathways. The remaining narrative items didn't produce meaningful clusters of responses to warrant inclusion in this report, but these data will be retained and considered with the April student workshop survey results, which will have similar items.

Undergraduate Student Survey

In spring of 2019, a survey was distributed to undergraduate students who are funded by LMRCSC, as a follow-up to a similar instrument that was used in year one of this current project. As with data collection for the other stakeholder groups, the intent with the undergraduate survey is to obtain evidences to address the EPP guiding questions regarding the STEM pipeline, support for NOAA mission science, and the administrative processes of the LMRCSC systemically.

For this survey implementation, ten students responded collectively from Hampton University, Savannah State University, and the University of Maryland—Eastern Shore. All of these students are pursuing BS degrees currently, either in Marine Science explicitly, or in related fields. All of these students report that they have maintained their major and career goals consistently since coming into relationship with the LMRCSC program.

Items five, six, and seven on the survey related to the respondents' identification and selection of a career field in science. All respondents indicated a desire for a senior researcher or similar level position, which would require graduate preparation. Item six asked respondents how and when they first considered a career in science. Interestingly, eight of the ten indicated this decision was formed very early: in elementary, middle or high school years. This suggests that early identification and recruitment of potential STEM majors and STEM career professionals is a viable and effective activity in and of itself—and as is practiced widely across STEM institutions. This observation could potentially be useful to the overall NOAA EPP interests in minority recruitment as a strategy for consideration for a longer view of the career pipeline. Item seven asked for a rationale for pursuing a STEM career. Six of the ten respondents indicated some value position: helping people, improving the planet, environmental concerns, solving problems, beyond basic interests or dispositions toward science knowledge.

Item eight asked respondents to describe research or field experiences in which they had participated with funding from the LMRCSC. Responses were varied, as anticipated, and included lab work, an internship at a NOAA laboratory, educational outreach at an elementary school and work on a regional site of the National Ocean Sciences Bowl, using lab techniques under supervision of a PI, obtaining their degree (scholarship funds), and an REU at one of the collaborating institutions. The variety of responses is cohesive with the types of funding that are indeed available to support undergraduates, and these responses—beyond the substance of the work—denotes a familiarity with the LMRCSC program and its scope, and supports effective program communications (as an administrative function of the LMRCSC).

Items nine and ten focused on professional mentors, which the respondents might have. There was a common or recurring pattern of responses indicating that students had mentors—or perceived that they did—and that these were most typically influential faculty members with whom the students had taken one or more courses in college. The mentors were characterized as being supportive, passionate and personable, of offering support in both academic and life-related areas of concern. The mentors were described as having offered professional opportunities, or providing links to these opportunities for students: somewhat as clearing houses or network hubs for the students to move into the STEM fields with knowledgeable guides. In item eleven, all ten of the respondents further indicated—in addition to any other information or networking information they had received from mentors—that each had received explicit orientation information to the LMRCSC from a faculty member or LMRCSC representative at their respective home institutions.

There is evidence in STEM educational research that participation in co-curricular STEM related activities is a valuable aspect of formation of early career interests. Based on this evidence, a series of questions were developed and included in the undergraduate survey, to allow a richer understanding of the pool of recruited students. In item twelve, five of the ten students identified a high school level STEM focused program in which they had participated outside of classes. By the post-secondary level, nine of the ten respondents were able to identify multiple co-curricular STEM activities in which they had participated. These post-secondary activities included numerous federally funded initiatives (REUs, HBCU Pathway programs, McNair Scholars) as well as LMRCSC funded efforts and institution specific efforts. And finally, in item fourteen, six of the ten respondents identified STEM related hobbies or community activities in which they engaged, to include various volunteer efforts, and outdoor recreational activities such as hiking, boating, and fishing. These responses, collectively, are supportive of other findings that STEM-interested young adults and early career professionals are developed over time through a variety of formal and non-formal influences that expose these individuals to science through multiple lenses, formal and informal and curricular and extra-curricular. It seems this holistic approach should be considered critically as a

programming strategy.

Item sixteen asked respondents if anyone from their immediate family was employed in a science related career field. Nine of the ten respondents stated *No* to this item. This pattern is meaningful, and suggests the recruitment strategies employed by LMRCSC has extended beyond the cycle of students following familial career patterns and attracted young adults from different backgrounds. In the follow-up item (seventeen), the respondents nevertheless reported that they did receive encouragement by a parent or adult role model. These included mothers, fathers, and others who were interested in these respondents pursuing their passions. Only three respondents responded negatively, that they did not have family support.

Item eighteen asked respondents their view of employment prospects for STEM careers over the next ten years. Perception of employability has been observed to be a motivator for career selection among post-secondary adults. All ten of the respondents view STEM careers as Very Employable to Moderately Employable over the next decade in these responses.

Item nineteen asked respondents to identify sources of federal funding they receive to support their education beyond the LMRCSC funds. One student each responded Pell grant, NSF REU funding, and Hope Scholarship funding. No additional support was reported.

Items twenty and twenty-one asked respondents to identify any additional activities which could be offered through LMRCSC in which they would be interested, and to provide a rationale for these activities. Responses included: coding seminars, REUs, work-study projects, social mixers or other activities for collective social connectivity among LMRCSC students. Other responses included additional conferences, study abroad and community service opportunities. Respondents viewed these types of activities as important for networking and relationship building among peers, but also related to expanding their skill sets and helping them explore interests and build experiences.

Item twenty-two asked respondents to identify the most beneficial university course they had taken in the past year and to explain why that course was beneficial or helpful. Eight respondents identified a science course, either content or lab-based, and explained that these courses were directly related to future employment. Two respondents identified a technical writing course as the most beneficial course, and noted that this course was related to manuscript writing and scientific writing tasks necessary for future careers.

Item twenty-three asked respondents to describe how their knowledge of NOAA mission science and fisheries science had been enhanced over the past year—a direct sub-question from the NOAA EPP question set. Seven of the ten respondents provided some level of positive affirmation and description of enhanced knowledge of NOAA science. One particularly interesting and practical response was that this enhanced knowledge of NOAA fisheries science interests had proven beneficial in writing essays for science-based scholarships, as the respondent was able to discuss personal goals and mission related to NOAA fishery science in the essay. This level of specificity in the response is validating, as is the demonstrated, novel use of this enhanced awareness.

Items twenty-four through twenty-six were simple rating items designed for quick feedback on overall program administration issues. Responses to item twenty-four demonstrate 50% of the ten students rated interaction between LMRCSC institutions as high or medium quality, and 50% rated is as low or non-existent. In item twenty-five, six respondents rated their overall knowledge of the LMRCSC as a NOAA EPP initiative as high or medium level knowledge, with three respondents rating it as low knowledge and one as no knowledge. Overall and in consideration of the fact these are undergraduate students with potentially only a short time in the program, this knowledge level is positive, and likely reflects the orientation to LMRCSC that is provided by the program leadership at the partnering universities. And finally, in item twenty-six, eight of the ten respondents indicated they were very interested or interested in eventually continuing their interaction with LMRCSC through its alumni organization.

Item twenty-seven asked respondents to identify their perceived, greatest challenge moving forward toward completing their career-related education. Responses were nearly unique across all

ten of the students. The responses included: managing the learning curve, finances, finding a job, lack of personal focus and discipline, balancing family needs, passing the GRE, and—again—finding a position or employment.

Item twenty-eight solicited input on additional support structures, resources or information that would be helpful to the respondents in meeting career goals. Again, while no common pattern of responses emerged, the individual responses were interesting and in most cases, would be relatively cost-free: interaction with people in the field, connections and networking; mentorship, information on graduate programs and additional, individual experiences. Two individuals did suggest stipends or other financial support.

Item twenty-nine asked about interactions with LMRCSC graduate students. Five of the ten respondents indicated from a great deal to moderate amounts of contact. The other five respondents reported little (one) to no interaction (four). And finally, in item thirty, nine respondents indicated that it was very likely they would continue in graduate school to study fisheries or a related ocean topic, and the remaining respondent marked likely to occur.

Spring Student Workshop Survey

In late spring 2019 (March 31-April 4), a student workshop was convened at UMES for the cohort 3 students, and a few remaining cohort 2 students who had schedule conflicts in 2018 with the workshop then. This weeklong workshop was designed to build the social and professional network of the students with each other across institutions, and with NOAA scientists and the project leadership. There were extensive workshops aligned to NOAA mission science, career development, and professional skills training. At the conclusion of the workshop, a survey was administered to the graduate students attending (with questions derived from the guidance questions provided by NOAA EPP) and summarized here.

As reflected in items one through three on the survey, each of the twelve respondents are actively pursuing either MS or Ph.D. degrees, and collectively represent each of the seven affiliated schools within the LMRCSC. Their expected major or emphasis areas are all in fisheries science, natural resources or habit conservation areas—and clearly aligned with one of the four mission science content areas described by NOAA EPP and NOAA broadly. Each student is able to name a NOAA scientist and laboratory specifically with whom they are working (these names are omitted to protect student and scientist privacy). Enrollment date within the LMRCSC collected in item six verifies that administrative policy for cohort enrollment and tracking is consistently applied for this program and attendees.

Items seven and eight solicited overall perceptions of the workshop. There were no negative perceptions recorded here, although three respondents perceived the workshop could have been shorter. Select interviews on this point with students suggests that some Ph.D. students prefer not to lose momentum at work in the spring by attending the workshop—but this is simply the nature of the project, which even they acknowledge.

Item nine was an extensive, rating item that listed each implemented area of the workshop content, and asked respondents to rate by most important to least important, each of the areas. There were clear and statistically significant (chi square) differences observed in the ratings when the social/professional items were clustered and compared to the science content elements. It seems the students express confidence that they have other access to the science content, and that they prefer to use the workshop time to expand social networks with peers, scientists, and project leadership; to learn about a variety of career pathways and opportunities; professional skills and community building. Two respondents reiterated this issue of community development and interpersonal relationships in discussing their ratings.

Item ten asked respondents their level of agreement with a statement about their understanding of NOAA and the LMRCSC overall goals and objectives as a result of the workshop. All respondents strongly agreed or agreed that the workshop met the goal of expanding their

understanding of these. In a follow-up question in item eleven, all respondents strongly agreed or agreed that the workshop enhanced their individual understanding of NOAA Mission Science—and the specific content modules used in the workshop, as observed by the evaluation team, confirms this strong content element was addressed.

Items twelve, thirteen, and fourteen provided text boxes for respondents to write open ended narrative around the prompts of most helpful information provided in the workshop, ways the workshop refined academic goals, and ways in which the workshop advanced or refined career goals. The strongest focus in all of the response data centered on how the workshop expanded their understanding of the human dimensions of fisheries science, management, and habitat restoration. This response cut across all three of these items, so clearly impacted the students. Interestingly, the workshop seems to have influenced two of the MS students to apply for doctoral programs.

Items sixteen through eighteen drilled down into the workshop's support for student and faculty collaboration, mentoring or other relationships with NOAA scientists, or other potential benefits from the workshop. Several student responses captures the overall focus of the narrative responses provided by the group and are quoted here:

- *Meeting my peers and fostering science relationships was a great benefit, and may one day lead to collaboration.*
- *Bringing different experts together to talk about professionalism in NOAA fostered collaboration.*
- *The workshop greatly increased my grant writing skills.*
- *Through presentations and social interactions, I learned more about NOAA science and the types of jobs available.*
- *It provided support by introducing us to the NOAA scientists and developing a professional relationship and contact with them.*
- *I learned the importance of integrated science so that scientists from different training expertise should collaborate to address broader questions.*

The strong, positive feedback from the participating students in the 2019 workshop is consistent with the evaluation team's observations from the workshop. There were additional, planned social experiences in 2019 as a result of the feedback from the 2018 workshop, which were reflected in the student evaluations. These, along with the professional skills training, career orientation and networking opportunities matched the desired outcomes for this group of students and demonstrates effective administrative and communications efforts to identify and meet student perceived needs.

Evaluator Site Visits

As in the earlier years of the project, the evaluation team continued in year three to conduct site visits to partnering institutions or with individuals who are among the stakeholders of the LMRCSC. In addition to attending the Spring Student Workshop at UMES in March-April 2019, this year the evaluation team:

- visited with Dr. Beth Babcock and two of her graduate students at the University of Miami;
- visited the James J. Howard Marine Sciences Laboratory in Sandy Hook NJ, to interview Dr. Ashok Deshpande, who participates on a technical advisory committee for LMRCSC and who mentors TAB and NERTO students (he was identified as a mentor by one or more students in the student surveys); and
- attended the LMRCSC Science Meeting in Silver Spring, MD, to both observe and to interact with students, scientists, LMRCSC senior personnel, and NOAA EPP personnel.

These site visits have been highly instrumental in forming a more in-depth view of the scope and impact of the LMRCSC by the evaluation team. While the paper records of the project made available to the evaluators have been very helpful, informative, and have contributed to evaluation reporting, field observations of the senior collaborators and students enhance the credibility of the

evaluator observations by allowing feedback from key stakeholders in their own professional environments. From these observation meetings and interviews, it is clear that the LMRCSC, as one CSC in the broader NOAA EPP portfolio of effort, is a complex organization that is attuned both to its "down stream" stakeholder constituencies, i.e. the students, faculty, and university partners, but also attuned and responsive to its broader NOAA EPP responsibilities. The administrative functions outlined in the operating plan and center policy are realized most directly by the students and faculty at the university and research laboratory sites, through contractual relationships and responsibilities. The evaluators have observed a consistency in administrative policy, in fiscal policy, and in communication strategies—such as student orientations, common courses or skill sets, a common identification of the NOAA mission science categories as the organizing structures for TAB and NERTO projects and course selections for degrees. The LMRCSC, from local site perspectives, is an *executing* entity that contributes to career attainment by minority students at NOAA laboratories.

A number of specific observations were identified or noted at the Science Meeting in Silver Spring, MD, or collected from interactions between the evaluators and NOAA EPP or other NOAA personnel. There are clear interests and generalized concerns expressed by NOAA EPP (some of these will be addressed in the Conclusions) for unified communications, branding and accreditation of project related work—across all of the Centers, not only LMRCSC. Additionally, there was a perception of value in continuing to foster and enhance the interactions between graduate students and NOAA scientists: to enhance both populations' understanding of the work and interest of the other's, and to leverage this enhanced knowledge through communications that can better link students and scientists, and graduating students with laboratories and employment opportunities. This enhanced communications further highlighted NOAA's mission science and mission priorities between NOAA and LMRCSC students and professionals.

Focus Group Discussions with LMRCSC Partners and Staff

At the site visit in March/April (the spring student workshop at UMES), the evaluators further developed observation notes around the NOAA EPP questions 3.2, 3.3 and 3.5 from interviews with the co-PIs from the partnering institutions of higher learning in the LMRCSC. These notes seem particularly valuable to document in this final report and so are included at length as follows:

Response to NOAA EPP Question 3.2:

Interviews with co-PIs demonstrate the CSC funding has increased the capacity of the partnering institutions to recruit and train minority students by providing *student restricted funding* for use with scholarships and expenses for these graduate students. This expansion of the laboratory workforce leverages the capacity of both NOAA labs and partner labs to undertake NOAA mission-aligned and mission-critical research from NOAA science priority areas that would typically exceed the capacities of these labs without the students. "This creates a win-win-win opportunity for NOAA, the partners, and the students." It further introduces the students into the NOAA research community and creates networks for them that have been found to result in employment opportunities following graduation for these CSC students. Robinson et al. (2007) documented that the CSCs had provided a significant proportion of the recently hired minority scientists across NOAA—demonstrating that the CSC networking opportunities for these students had significant impact on eventual employment gains for this key population.

Response to NOAA EPP Questions 3.3 and 3.5:

Ongoing monitoring of project internal communications, documentation, and administrative reports for evidence of project growth and expansion of capacity; individual interviews of each PI/Co-PI annually; semi-structured, guided focus group discussion with project leadership annually.

On Monday, Tuesday, and Wednesday mornings, April 1-3, the project evaluators convened

interview sessions and semi-structured, guided focus group discussions with the Project Director, the co-PIs, administrative staff members (including communications director, the assistant LMRCSC director, the education director, the fiscal and data management director, and the Project Lead Scientist) to ascertain progress toward meeting each element of the project implementation plan. Copies of the implementation plan were available and circulated, as well as the *NOAA EPP Guiding Questions* for evaluation efforts. Discussions considered key accomplishments for the year, as well as opportunities for advancement of goals and objectives, and emerging and previously collected evidences of project goal attainment. Substantive time was given to review for gaps in implementation (none were identified) as well as a focused consideration of available and potential evidences to substantiate program claims. These discussions addressed each of the three primary focus areas of the NOAA EPP guiding questions, i.e. workforce and NOAA mission science objectives, support for NOAA scientists and mission-aligned research, and CSC administrative functions. Several action steps were identified for the evaluation team or project management in the immediate next quarter to half year. These included:

Action Items:

1. Survey for the TAB Committees (see questions 2.3-5)
2. Paragraphs on best practices—1) TAB review process; 2) Mentorship of undergrads and high school students by Grad Students; 3) Mentorship of Grad Students by Scientists and NOAA Scientists.
3. The TAB process is unique to LMRCSC. It provides a simulation of a real world career task, learned in an atmosphere of scaffolded mentoring by scientists. Ideal for building career skills for eventual scientists.
4. Compiling student courses to demonstrate: social science connections, policy and management awareness or preparation, NOAA decision-making (likely observable during NERTO while in the labs). Maggie and/or Victoria need to compile these classes so we can check off where students have classes in any of these areas.

The focus group discussions also raised follow-up questions associated to other elements of the project that require investigation to obtain clarifications related to implementation steps or evidence collection moving forward. These questions include:

Questions:

1. Is the LMRCSC engaged with, or defining correctly, social science integrations as NOAA EPP wants (or social impacts)?
2. Are we at CSCs graduating more minority fisheries graduates than fisheries graduates at other large universities?
3. What is the “value added” of the CSC beyond the student scholarships? One value added piece is observed in the NERTO and TAB survey data: the scientists are benefitting from the ability to get research conducted by students that they cannot otherwise have the time or funding to do themselves?
4. To what extent do the complexities of budget requirements, spending restrictions, and cohort approach to funding creating difficulties for the CSC to best meet students’ needs? Are current interpretations of budget guidance and fiscal policies accurate as intended by NOAA EPP?
5. Have we fully captured all of the dimensions of the Administrative questions provided by NOAA EPP?
6. Are the undergraduate students being effectively supported and challenged in the LMRCSC so as to leverage this critical pool of young students for application into graduate opportunities in the pipeline? It may be that additional social opportunities for these younger students be considered as a means to socialize them into the ocean science and fisheries pipelines.

7. With respect to Question 3, administrative processes, it should be a strong consideration that the co-PIs have a face-to-face team meeting annually at the (alternating) Spring Workshop or NOAA EPP Forum, for general project management discussions and future planning. The evaluators acknowledge that there is a monthly executive committee phone call, which accomplishes much that is positive with respect to project management and work tasks. There would still be value, however, in an annual face-to-face meeting. This meeting would leverage travel funds and annual events, which are already implemented in any event. (The LMRCSC leadership is actively working to schedule this meeting.)

The focus groups also revealed two challenges moving forward that may need additional conversation with NOAA EPP. First, the *Student Tracker* and *Online Individual Student Work Plan* data portals continue to be difficult to use on the front end, and also for extraction of information on the back end. Given the critical need for consistent and thorough documentation of student activities, it is important that these functionality challenges be mitigated (improvements have emerged recently that are helping this situation). Second, the overall complexity of budget utilization suggests a need for continued conversation with NOAA EPP regarding pathways for simplifying the budget management functions so as to best use and leverage funding for student benefit.

Conclusions

These data collection activities were undertaken to consider the overarching NOAA EPP objectives and questions, as these are further sustained in the LMRCSC work with scientists and students.

Primary Finding for Year 3

The data provide evidence that the LMRCSC is *directly supporting scientists to work with diverse students*, in ways that *positively support NOAA mission science*, NOAA's future mission workforce, and *the individual needs of these students for meaningful career mentoring*, science content and skills development, and *recruitment into the career pipeline* through social support, mentoring, networking, and introduction to the discipline by meaningful scientists and faculty members.

Discussion and Recommendations

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

Concerns over paperwork, fiscal constraints, work and project timetables all seem within the typical concerns expressed by these professionals, and are deemed insufficient to elicit response with the exception of fiscal policy, which is discussed below. Large systems' work efforts, through required standardization of work flow and management, typically raise such concerns.

With respect to fiscal policy, it is clear that LMRCSC is administered in a typical institutional oversight and policy environment. Nevertheless, the evaluators perceive a level of concern among senior personnel, and even graduate students, that seems worthy of discussion. The year/cohort model of funding—given the multi-year, dynamic environment of graduate education—seems to be highly problematic in consideration of the balance between use of funds toward authentic, mission needs, and restricting the use of funds within potentially arbitrary accounting parameters.

Recommendation 1) Given the level of concern vocalized by stakeholder members, the LMRCSC leadership is strongly encouraged to schedule and convene a focused *conversation* on balancing fiscal accountability with the need for some degree of financial flexibility in meeting emergent needs of this highly critical group of students. Initially, this conversation should be among LMRCSC PIs, and then, if necessary, result in recommendations from LMRCSC to NOAA EPP.

Recommendation 2) The leadership of LMRCSC is encouraged to consider the expressions of need for enhanced communications among the entire community of stakeholders, and to continue, and highlight, its ongoing efforts in support of NOAA EPP and NOAA mission science evidenced in these NERTO and TAB experiences. It seems clear there are numerous examples of high impact, social impact, and student impact projects among these NERTO and TAB experiences that serve as evidence of the strong, positive impacts of LMRCSC overall, and—importantly—NOAA EPP. The broader science community and public could only benefit from enhanced awareness of these accomplishments. This communications effort would require enhanced networking between and among university and NOAA personnel and project alumni. The activation of these LMRCSC alumni in support of current and future students and project elements could only be a benefit.

Recommendation 3) Based on observations from interactions at the Science Meeting, it is recommended that care be taken to review all documents, presentations, etc. give credit to NOAA EPP and the contract number consistently. This was an expressed concern from NOAA EPP personnel.

Recommendation 4) The LMRCSC center-wide research project should be prioritized and implemented per the project implementation commitments. This issue was raised both at the Science Meeting in Silver Spring, MD, and also by the co-PIs at UMES at the spring workshop meetings. It is noted that project leadership has moved forward with planning a team meeting on the topic of this research project. *The project leadership should prioritize progress on this project during year four. The evaluation team does not yet have insight into the rationale for the delay of this project element.*

Recommendation 5) Compile and document recruitment practices used across the various institutions that have proven successful. It is clear from conversations with project co-PIs, and more so from a variety of literature sources, agency planning documents and concerns, that early identification, support, and scaffolding of minority students with interest in STEM areas is critical. The LMRCSC has enjoyed and documented success in locating and recruiting these gifted young adults, and has leveraged these efforts with other efforts by the partnering institutions to work with even younger secondary youth or pre-adolescent populations to create an even longer pipeline. This work is critical to the nation and documenting the LMRCSC success would benefit many agencies and institutions.

Recommendation 6) LMRCSC leadership have compiled information regarding the Social Science Impacts/Human Dimensions of the various research projects and activities conducted under the Center. It is recommended, given NOAA's broader agency concerns for social science impacts, that these Center efforts continue and that these are communicated broadly to students, center partners and NOAA personnel. It is further recommended that a systematic review of student NERTO an TAB projects be conducted to ascertain these social science and human dimensions impacts.

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 Socio-Economics

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. To better understand how to recruit and retain individuals from underrepresented communities, 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 and November 2019, we conducted 43 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. Data obtained from these interviews has yet to be analyzed, however, we expect data collection and analysis to be completed this summer.

Principal Investigator: Brittany King, Oregon State University
Co-PI: Kelly Biedenweg, Oregon State University
NOAA Partner: Kevin Werner, NWFSC: Northwest Fishery Science Center
Other Partner:
Students: Brittany King (PhD, OSU)

Keywords: Fisheries; Social science; Diversity
Start Date: 9/1/2018 **End Date:** 9/30/2020

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 43 in-person semi-structured interviews across three marine and fisheries related science career levels: undergraduate students (35%), graduate students (40%) and professionals (25%); and different racial and ethnic backgrounds: Black (34%) White (23%) Latino (18 %) mixed race (18%) Asian (4%). Additional interviews are being conducted this quarter to ensure theoretical saturation is being met for each population of interest. Interviews have included questions about participant's 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 prepped for data analysis, which is expected to be completed this summer.

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. The results of this study will be used to inform other components of Brittany's dissertation.

Presentations or Publications
NOAA Living Marine Resources Cooperative Science Center Annual Science Meeting, Silver Spring, MD (June 2019) King, B. Underrepresentation of ethnic and racial groups in marine and fisheries science professions- Marine Science Identity
OSU's Arts and Humanities Graduate Student Conference, Corvallis, OR (May 2019) King, B. Under-representation of ethnic and racial groups in marine and fisheries science professions International Symposium on Society & Resource Management.
Snow Bird, UT. (June 2018) King, B. Underrepresentation of racial and ethnic groups in marine and fisheries science professions.
Performance Measure: 3.4e: Number and percentage of actions ongoing or completed to recover endangered and threatened species
DOC Strategic Plan: 3.1.2: Advance holistic, integrative ecosystem research (NOAA).
NOAA RD Linkage: D1a: Improved understanding of the economic and behavioral elements of coastal resilience
Next Gen Priorities: Diverse and constantly evolving capabilities in NOAA's workforce

Project Number 18-03

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

Thematic Research Area Stock Assessment Support

Abstract
The assessment of King mackerel in the Gulf of Mexico uses an index for estimating spawning stock biomass that is developed using a statistical model 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 environmental variables at different time and spatial scales should be considered density drivers while others may be considered as both catchability and density drivers of 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, hoskins@savannahstate.edu
Students: LaTreese Denson (PhD, RSMAS); Alexandria Ambrose (Undergraduate, RSMAS)
Keywords: Fisheries; Marine Biology; Population dynamics
Start Date: 9/12/2018 **End Date:** 8/31/2019

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 the magnitude of wind and chlorophyll levels should be considered density drivers while others such as sea surface temperature and salinity may be considered as both a catchability and density drivers of larval King mackerel. These factors will be included in the future spatiotemporal index of abundance to further improve model fit and to incorporate ecologically sound hypotheses about the influence of the environment on King Mackerel abundance.

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. 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 18-05

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

Thematic Research Area: Stock Assessment Support

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

Principal Investigator: Matthew Ramirez, Oregon State University
Co-PI: Selina Heppell, Oregon State University
NOAA Partner: Jeffrey Moore, SWFSC: Southwest Fishery Science Center
Other Partner: Elizabeth Babcock, RSMAS
Students: Matthew Ramirez (PhD, OSU); Tamara Popovska (Undergraduate, OSU)
Keywords: Marine Biology; Protected Species; Population dynamics
Start Date: 9/1/2020 **End Date:** 12/31/2019
Results to Date
Matthew interned with Dr. Moore at the SWFSC in La Jolla, CA from 1 October to 21 December 2018. During that time Matthew lead the development of an improved age-structured population model for Kemp's ridley sea turtles. Modeling efforts began with the modification of the existing Kemp's ridley population model used for the species' status assessment (NMFS and USFWS 2015). Major modifications included (1) migration of the base model from Excel to R, (2) separation of Atlantic and GoM juvenile life stages, (3) incorporation of habitat-specific maturation schedules and survival rates, (4) incorporation of variable recruitment from pelagic to benthic life stages (based on stable isotope analyses previously conducted by MDR), and (5) incorporation of variable recruitment from Atlantic to GoM benthic life stages (based on stranding length frequency data). The model uses negative log-likelihood estimation (Equation 1) to predict the number of

nests laid by Kemp's ridley sea turtles on their main nesting beaches in Mexico. The model is deterministic and uses the number of female hatchlings produced each year from the three core nesting beaches, where 100% nest counts are performed, to initiate the model each year. Through a collaboration with Dr. Elizabeth Babcock at RSMAS, we completed a meta-analysis of sea turtle growth rate data. Products of this effort included updated von Bertalanffy growth curves for each sea turtle species. These data were used to develop maturation schedules for Kemp's ridley turtles to be used in the model. Skeletochronology and logistic regression were also used to develop habitat-specific maturation schedules that were included in the model and compared to results from the meta-analysis. Transition probabilities for turtles moving from pelagic (ages 0–1) to small benthic life stages (ages 1 –2) were estimated based on stable isotope data collected from bone tissue. These analyses found a distinct shift in stable nitrogen isotope values when turtle made this habitat shift. Using these data, it was determined that 50% of pelagic turtle transition to benthic habitat at age 1 whereas 50% transition at age 2. Annual estimates of the proportion of pelagic turtles transitioning to benthic habitats in the Atlantic versus the GoM were estimated using ocean circulation models in a collaboration with Dr. Nathan Putman (Ecological Associates, Inc.) (e.g., Putman et al. 2013). Stranding length frequency data obtained in August 2019 were used to estimate survival rates via catch curve analysis for juvenile life stages in both the GoM and Atlantic that were subsequently used in the model. We then evaluated the sensitivity of population growth and recovery time to changes in key transition probabilities that describe the movement of turtles among habitats and life stages within the western North Atlantic Ocean. GoM life stages had the highest elasticity values, indicating they had the strongest proportional contribution to population growth rates. Indeed, estimated population growth and recovery times were relatively insensitive to changes in the proportion of turtles entering Atlantic turtle life stages and the timing of Atlantic turtle recruitment to the GoM over the period evaluated. Across all model simulations, population growth (measured as change in nest counts) differed by<1 % and recovery times (based on nesting female recovery criteria) varied by only four years. These models suggest Atlantic turtles make up > < 5% of first-time nesters (neophytes) annually, even if the proportion of juveniles inhabiting the U.S. eastern seaboard is relatively large (e.g., 35%). Taken together, our results suggest that Atlantic turtles may not have strongly contributed to Kemp's ridley population growth during their recovery, even under the most extreme scenarios evaluated. However, the contribution of Atlantic Kemp's ridleys to population growth may be higher when population growth slows (i.e., since 2010) or when the population reaches carrying capacity. These results, if confirmed through additional independent analyses, may be important to future conservation and management planning for this critically endangered species.

Relevance to NOAA

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

Broader Impacts

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

Presentations or Publications

A manuscript outlining the results of our sea turtle growth rate meta-analysis is in the final stages of preparation and will be submitted to Marine Ecology Progress Series by the end of March. A

manuscript outlining the results of the population model will be submitted to Ecological Modeling by summer.

Performance Measure: 3.4c: Percentage of protected species stocks with adequate population assessments and forecasts 2.0
DOC Strategic Plan: 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources
NOAA RD Linkage: 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 18-08

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

Thematic Research Area: Stock Assessment Support

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

Principal Investigator: Eric A. Lewallen, Hampton University
Co-PI: Carolina Bonin Lewallen, Hampton University
NOAA Partner: Laurie Weitkamp, NWFSC: Northwest Fishery Science Center
Other Partner: Linda Park, NWFSC: Northwest Fishery Science Center
Students: Josette McLean (MS, Hampton U); Janelle Layton (Undergraduate, Hampton U)

Keywords: Fisheries; Marine Biology; Ecosystems

Start Date: 4/1/2019 **End Date:** 8/31/2021

Results to Date

We have weighed, measured and extracted DNA from 20 pacific lamprey and are in the process of fine-tuning the protocols to maximize DNA quality and yield. An additional 200 specimens have been processed by NWFSC collaborators and were shipped to Hampton University. Gut fullness data have been analyzed and presented in the form of a draft senior thesis (Janelle Layton). A manuscript has also been drafted by Josette McLean for May 2020 submission to Current Molecular Biology Reports. We have suspended laboratory activities as per the University mandate in response to COVID-19.

Relevance to NOAA

As stated in the RFP for this funding mechanism: The LMRCSC will conduct research that supports stock assessment of fish, invertebrates, and marine mammals, by describing and understanding population abundance, migration and distribution patterns, predator-prey relationships, habitat use, age structure, growth, mortality, reproductive biology and behavior, and responses to environmental variability. We will specifically provide fundamental data for the direct assessment of Pacific lampreys

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

Broader Impacts

During the first year of this project we finalized specimen collections and sample processing (e.g., voucher preservation, gut dissection, gut content preservation). The master's student (Josette McLean) joins the research team as of August 2019, and is trained in genetic laboratory techniques. Ms. McLean may complete a 3 month internship at the NOAA Northwest Fisheries Science Center during the summer of 2020, yet this plan has not yet been finalized. The second year of this project will focus on collecting genetic data, analysis of genetic and geospatial data, preparation of manuscripts, and presenting the results of our work at a national fisheries research conference (e.g., AFS). The master's student will graduate in May 2021 from the Department of Marine and Environmental Science at Hampton University.

Presentations or Publications

Layton JM, Bonin CA, Pressley N, Park LK, Weitkamp LA, Lewallen EA. Genetic-based methods for assessing prey composition and feeding ecology of Pacific lampreys. American Society of Limnology and Oceanography, San Juan, PR, February 23 - March1st, 2019 (oral).

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

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

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

Performance Measure: 3.4c: Percentage of protected species stocks with adequate population assessments and forecasts 2.0
DOC Strategic Plan: 3.4.1: Strengthen capabilities to assess and monitor fish and, protected resources
NOAA RD Linkage: C4a: Improve survey capabilities to provide more accurate, precise and synoptic information of key marine populations.
Next Gen Priorities: Improved understanding of ecosystems to inform resource management decisions

Project Number 18-11
Title: Assessment of Microplastics in *Placopecten magellanicus* as Possible Indicators of Plastic Pollution from the Georges Bank, Mid-Atlantic Stock Fisheries

Thematic Research Area: Healthy Habitats

Abstract

Microplastics are plastic fragments, pellets, fibers and cosmetic beads less than 5 mm in size. In recent years, these emerging contaminants have been found in tap water samples all over the world and in a vast array of aquatic organisms with the possibility of toxic effects in them. The objective of my research is to test if the important ecological species and delicious Atlantic Sea Scallops were

contaminated with microplastics. Over 200 scallops were dredged aboard the NOAA Scallop Survey Cruise in Georgia's Bank and the Mid-Atlantic Bight for samples. The scallops were dissected with the intention of collecting the gills, digestive tracts and muscle in order to determine bivalve plastic uptake. Briefly, micropolymer assays were conducted using an efficient extraction method consisting of chemical digestion and visual quantification of microplastics. All microplastics found were fibers and not fragments from larger plastics. There were no significant correlations or differences in microplastic abundance among scallop tissues, sex or size. Since sea scallops are important commercial organisms with fisheries dredging over 50 million pounds annually for seafood consumption, our research directly contributes to NOAA's goal to conserve and manage coastal and marine ecosystems and resources by providing the scientific foundation for understanding further research on the toxicity microplastics can have on important ecological commercial species.

Principal Investigator: Enid Muñoz-Ruiz, University of Maryland Eastern Shore
Co-PI: Ali Ishaque, University of Maryland Eastern Shore (UMES)
NOAA Partner: Ashok Deshpande, NEFSC: Northeast Fishery Science Center
Students: Enid Muñoz-Ruiz (MS, UMES)
Keywords: Toxicology

Start Date: 1/30/2018 **End Date:** 5/30/2020

Results to Date: Thesis manuscript in preparation

Relevance to NOAA

It is NOAA's mission to provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems all backed by a sound science and an ecosystem-based approach to the management. This research abides to NOAA Fisheries mission, because it looks into the effects these emerging contaminants with the potential to carry toxicants can have on organisms and ecosystems. Specifically, the outcomes are: (1) Find out if Atlantic sea scallops, a very important commercial species, are contaminated with microplastics, (2) if plastics are present, would they be potentially available for trophic transfer or consumption by humans.

Broader Impacts

With this extensive and arduous research, we hope that Enid Muñoz-Ruiz will obtain the experience, knowledge and requirements to fulfill her Masters degree in Aquatic Toxicology at the University of Maryland Eastern Shore and furthermore, open many doors in her career. The course work, field and research experience, in addition, with the many meetings and collaborations will instill in her a sense of networking and interdisciplinary approach in the scientific community when it comes to developing ideas for projects she pursues in the future. Enid hopes to achieve completion of this project and graduation towards the Spring of 2020.

Presentations or Publications: None to date

Performance Measure: 3.4e: Number and percentage of actions ongoing or completed to recover endangered and threatened species
DOC Strategic Plan: 3.4.2: Improve recovery of listed species through innovative partnerships
NOAA RD Linkage: D2a: Determine combined effects of environmental stressors on coastal species and ecosystems.
Next Gen Priorities: Recovered and healthy marine and coastal species

Project Number 19-01

Title: Baseline data on environmental impacts on physiological and molecular parameters determining growth for commercially valuable decapod crustacean management

Thematic Research Area: Stock Assessment Support

Abstract

The crustacean fishery in the US has been challenged due to drastically reduced landings for several decades, including the blue crab (*Callinectes sapidus*) industry in the Chesapeake Bay. Crustacean growth is hormonally regulated while environmental conditions as stress factors often have adverse effects on growth. The vast genetic diversity of *C. sapidus* is reflected in size variation and differential growth rates. This proposal seeks to measure physiological and molecular parameters that define stress impacts on the growth of animals with differential growth rates. Ultimately, the current project seeks to generate a model that will be applied to all commercially important decapod crustaceans for growth prediction under normal and stressful conditions in natural habitats.

Principal Investigator: J. Sook Chung, University of Maryland Center for Environmental Science
Co-PI: Elizabeth A. Babcock, University of Miami - Rosenstiel School of Marine and Atmospheric Science
NOAA Partner: Paul McElhany, NWFSC, Seattle, WA. , NWFSC: Northwest Fishery Science
Students: Anya Byrd (PhD, UMCES); Adjele Wilson (Undergraduate, UMES)
Keywords: Aquaculture; Marine Biology; Habitats
Start Date: 8/1/2019 **End Date:** 7/31/2020

Results to Date
1. The full-length of mTOR sequence is confirmed using PCR cloning and sequencing. 2. The following genes involved in mTOR pathway at both upstream and downstream are searched, identified and sequenced: TSC1 and 2; SGK; S6K; AKT; Redd 1 and 2; Rictor; Rehb and Rho1. 3. Tissues are collected from the animals with different growth rates and will be processed for expression analysis.

Relevance to NOAA
This project seeks to understand the physiological and molecular parameters that define stress impacts on the growth of animals with differential growth rates using omics tools.

Broader Impacts
Ultimately, the current project seeks to generate a model that will be applied to all commercially important decapod crustaceans for growth prediction under normal and stressful conditions in natural habitats.

Presentations or Publications: None to date

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

Project Number 19-02

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

Thematic Research Area: Stock Assessment Support

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: Dr. Joseph Pitula, University of Maryland Eastern Shore (UMES)
NOAA Partner: Dr. Pamela Jenson, AFSC: Alaska Fishery Science Center
Students: Shanelle Haughton (PhD, UMES); Reuel Denquah (MS, UMES)

Keywords: Fisheries; Marine Biology; Ecosystems
Start Date: 5/1/2019 **End Date:** 5/1/2020

Results to Date

Thus far, samples have been collected and processed for further application. A total of 200 Immature Tanner crabs were collected (115 females and 85 males), physiological observations recorded, and blood and tissue samples from each individual were collected. RNA has been extracted from hepatopancreas tissue of all individuals, with RNA yielded from 94 of the 200 samples. DNA extractions have also been completed for all 200 individuals, with yields from 50 samples. Next, DNA quantification will be completed and used 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* 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. At monitoring sites setup for *Hematodinium* sp. in *Chionoecetes*, infection rates have steadily and annually climbed from 2014 to 2017 from single digit infection rates to all-time highs of 54% & 49% in immature snow crabs, respectively (Pam Jensen, personal communication). This increase is thought to be linked to climate change, and has important implications for the impact on the fishery and dependent communities in Alaska.

Presentations or Publications: 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: 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 19-03

Title: Bloom dynamics and sediment incubations for a toxic harmful algal bloom species, *Dinophysis acuminata*, in Rehoboth Bay, Delaware, USA

Thematic Research Area Healthy Habitats

Abstract

Members of the dinoflagellate genus *Dinophysis* have been shown to produce toxins that can cause Diarrhetic Shellfish Poisoning (DSP) in humans who consume toxin-contaminated shellfish. The increased and regular presence of toxic harmful algae bloom (HAB) species are of concern to human health and the growing oyster aquaculture industry in the Delaware Inland Bays. The advancing oyster aquaculture industry in the bay requires the development of management practices to protect environment and human health; monitoring for HABs is a necessary component. Torquay Canal is a dead-end canal in northern Rehoboth Bay with a history of *D. acuminata* blooms during the spring and summer. The extent of the *D. acuminata* blooms in Torquay Canal was unknown until this study, which has shown that the bloom is not isolated to the regularly-monitored sampling location at the bulkhead, but extends into the canal, out into Bald Eagle Creek, and in low densities (1,000 cells/L) in northern Rehoboth Bay.

D. acuminata can be toxic even at low concentrations (<1000 cells/L). Potential risk to human health could occur during future bloom events if *D. acuminata* blooms are not isolated to Torquay Canal and extend further into Rehoboth Bay toward oyster aquaculture sites. This study monitored *D. acuminata* at Torquay Canal; the highest cell count from a winter bloom in January 2020 reached 214,000 cells/L. Tests for statistical significance and measures of association between nutrient concentrations (N,P), temperature, and cell densities at Torquay Canal were performed. Toxicity analysis for the winter 2020 bloom event at Torquay Canal is being performed by Juliette Smith at the Virginia Institute of Marine Sciences through a collaboration with Dr. Kathy Coyne and MSc student Amanda Williams at the University of Delaware College of Earth, Ocean, and Environment. The origin of *D. acuminata* blooms at Torquay Canal is unknown. To determine if blooms are seeded by a resident population in the canal, sediment incubation experiments of fall and winter sediments from Torquay Canal were conducted. This study will inform an effective HAB monitoring program in Delaware.

Principal Investigator: Amanda Pappas, Delaware State University
Co-PI: Gulnihal Ozbay, Delaware State University
NOAA Partner: Gary Wikfors, NEFSC: Northeast Fishery Science Center
Other Partner: Dr. Kathy Coyne, University of Delaware
Students: Detbra Rosales (PhD, UMCES); Amanda Williams (MS, UMCES); Raymond Andrews
Keywords: Aquaculture; HABs; Habitats
Start Date: 6/1/2018 **End Date:**

Results to Date

The study showed that the winter 2020 bloom at site TQB was not isolated to TQB, but extended further into Torquay Canal and Bald Eagle Creek. *D. acuminata* cell densities peaked on 1/6/2020 at site TQBay at 214,000 cells/L. *D. acuminata* cells were present at site TQ Bay in north Rehoboth Bay

at low density (1000 cells/L).

Relevance to NOAA
This project directly aligns with the NOAA mission to protect and conserve coastal resources.

Broader Impacts
The advancement of the oyster aquaculture industry in Rehoboth Bay will require the development of management strategies to protect environmental and human health; a thorough plan for monitoring harmful algae bloom (HAB) species will be a necessary component. This study has informed management decisions and the methods developed to protect human health and economic resources in Delaware could be translated to other states.

Presentations or Publications
January 29, 2020 - Delaware Wetlands Conference (Poster)

January 15, 2020 - NOAA Graduate Series Seminar (Oral, web based, 35 min)

April 19, 2019 - Delaware State University Research Day (Oral, 15 min)

December 7, 2018 - University of Delaware Citizens Monitoring Quality Assurance Meeting (Oral, 15min)

Performance Measure: 3.3j: Percent of all coastal communities susceptible to harmful algal blooms verifying use of accurate HAB forecasts
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: Healthy habitats that sustain resilient and thriving marine resources and communities

Project Number: 19-04

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

Thematic Research Area Stock Assessment Support

Abstract

We propose to develop and validate a novel aging method for monkfish, *Lophius americanus*, to support assessment goals and student training in marine chemistry, and stock assessment. The length modes for the strong 2015 year class (YC) have been clearly delineated through successive seasonal surveys, thus effectively providing monkfish of known age. Dr. Anne Richards, a stock assessment expert for monkfish at the NEFSC Fisheries Biology Program has collected monthly samples of this YC from 6 mo old. The objective of this study is to analyze seasonal cycles of hardpart microconstituents (Ca, P, and Sr) from this YC at ages 0-3 yr to compare with optical zonation methods. The patterns observed in the known age fish will provide a key to interpreting optical zonation patterns in fish of unknown age, filling a major gap in the data needed for quantitative assessment of monkfish and leading to improved scientific advice to fishery managers.

Principal Investigator: Rosemary Jagus, University of Maryland Center for Environmental Science
Co-PI: David Secor, University of Maryland Center for Environmental Science
NOAA Partner: Anne Richards, NEFSC: Northeast Fishery Science Center
Students: Benjamin Frey (MS, UMCES)
Keywords: Fisheries
Start Date: 9/1/2019 **End Date:** 8/31/2021

Results to Date
Confirmed unreliability of traditional aging methods for monkfish. Developed mounting method for Monkfish hard parts. Successfully analyzed otoliths of control species (black sea bass) with microprobe, establishing feasibility of method.

Relevance to NOAA
Age data is the foundation of stock assessments.

Broader Impacts
Without accurate age data on fish stock, fisheries management is not effective. Reliable, accurate age-structured assessment of stock will allow fisheries managers to make well- informed assessments of stock status and from this build sound management practices.

Presentations or Publications
Frey, B.A., Secor, D., Richards, A., & Jagus, R. Monkfish Age Validation Using Hardpart Analysis of Known-age Cohorts. LMRCSC Science Meeting, NOAA HQ, June 2019. Lightning Talk

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

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: C4a: Improve survey capabilities to provide more accurate, precise and synoptic information of key marine populations.
Next Gen Priorities: Sustainable fisheries and safe seafood for healthy populations and vibrant communities

Project Number 19-05

Title: Evaluation of Pacific lamprey (*Entosphenus tridentatus*) statoliths and eye lenses as records of age, natal origin, and trophic history patterns

Thematic Research Area: Stock Assessment Support

Abstract

The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous species native to the North Pacific Ocean and its adjacent freshwater tributaries. Pacific lamprey is both ecologically and culturally important to the Pacific Northwest of the United States. In the last 50 years, Pacific lamprey have experienced declines in abundance throughout the Columbia River Basin, USA. More information on the biology and ecology of this species is needed for conservation and management. Anatomical structures have been widely used in fisheries science for biological inference. The Pacific lamprey is a cartilaginous fish that lacks the common hard structures used in teleosts to elucidate age and life history patterns. Statoliths, analogous to otoliths in function, are calcium-fluorapatite concretions found in the auditory capsules of lampreys.

Statoliths have potential for aging and chemical analysis but require further evaluation to determine if bands represent annual deposition and are chemically reflective of the environment. Eye lenses are another structure with potential for trace element and stable isotope analysis but remain relatively unexplored for lamprey. The goal of this project is to broaden our understanding of lamprey by evaluating the efficacy of different anatomical structures for determining age, natal origin, and trophic history patterns. These objectives will be achieved by evaluating lamprey statoliths and eye lenses taken from known age and origin specimens.

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; Population dynamics; Anadromous, Natal Origins, Cultural Food, Ageing, Trophic History
Start Date: 10/1/2018 **End Date:** 3/31/2020

Results to Date

Statolith Ageing: Age readings of known-age larval lamprey statoliths have 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. Ageing accuracy was low (4% to 60%) per reader when relying solely on band interpretation. The addition of a linear regression model of statolith height as a function of age, as well as average statolith heights for each age group, yielded a higher ageing accuracy (53% to 63%) per reader. Readers have reported increasing difficulty in band interpretation with each additional annuli. The samples used in this study were reared in stable hatchery conditions with ample resources. Natural samples would likely have more variable growth due to numerous external factors. The low accuracy of the known-age hatchery samples suggests that statolith ageing may not be viable for unknown-age natural samples.
Statolith Structure: Ongoing research is focused on evaluating statolith morphology (height, area, longest/shortest axis) in relation to lamprey total length, with preliminary data suggesting the structure may stop growing at metamorphosis. Statoliths from a range of lamprey lengths (2 cm to 70 cm) are currently being evaluated for any trends.
Eye Lens Stable Isotope Analysis: Pilot study results suggest lamprey eye lenses may be promising structures for trophic inferences via stable isotope analysis (SIA). SIA analysis of incrementally delaminated lens layers shows lower $\delta^{15}N$ in the core of the lens that forms during the filter-feeding stage, with a steady increase that begins approximately 0.5 mm from the lens center that could be related to the onset of parasitic feeding. The increasing $\delta^{15}N$ of the structure (~3 to 18°C) from the nucleus to the outer edge shows potential for retrospective analysis of SIA. Current research is focused on increasing the sample size and determining the relationship between lamprey size and eye lens $\delta^{15}N$.

Relevance to NOAA
NOAA has agreed 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. Methods developed in our research may also have 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 could assist in understanding the health of the population, which effects 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., 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 19-06

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

Thematic Research Area Climate and Ecosystems

Abstract

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

Principal Investigator: Hillary Thalmann, Oregon State University
Co-PI: Jessica Miller, Oregon State University
NOAA Partner: Ben Laurel, AFSC: Alaska Fishery Science Center
Other Partner: Bradley Stevens, UMES
Students: Hillary Thalmann (MS, OSU); Undetermined Summer Intern (Undergraduate, OSU)
Keywords: Fisheries; Protected Species; Population dynamics; Ecosystems; Habitats
Start Date: 9/16/2018 **End Date:** 6/30/2021

Results to Date

We have completed diet analyses for August fish from 2008 (a cool year); 2015 (a heatwave year); 2018 (a post-heatwave cool year), with the goal of these analyses to determine if prey community structure varied in relation to environment and to identify which prey taxa differed. These preliminary results, using non-metric multidimensional scaling (NMS), Multiple Response Permutation Procedure (MRPP), and Indicator Species Analysis, represent about a third of the total diet analyses planned for this experiment. Based on patterns from these preliminary results, the community composition of juvenile Pacific Cod prey is strongly related to thermal regime. The pre-heatwave cool year in this study, 2008, overlapped very little in prey community composition with a heatwave year, 2015. A post-heatwave cool year, 2018, included shared prey species from both 2008 and 2015. These shared characteristics suggest that diet composition of juvenile Pacific Cod may return to a pre-heatwave community composition if the system were allowed to recover without additional thermal disturbances. In addition to temperature, juvenile Pacific Cod length and weight played an important role in community composition across years. In warmer years, juvenile Pacific Cod were, on average, longer and heavier than in cooler years, potentially due to size-selective mortality and competition over scarce resources that is likely to occur in heatwave conditions. Size of Pacific cod prey is proportional to the gape width of the predator's mouth, which is positively correlated to body size. During the marine heatwave in 2015, juvenile Pacific Cod fed on larger polychaete worms and crangonid shrimps compared to their pre-heatwave diet of small copepods and gammarid amphipods. While observed diet shifts may be related to changes in the Gulf of Alaska zooplankton community composition, increased size of juvenile Pacific Cod and their consequent ability to feed on larger and potentially more nutritious prey may be a more important driver for shifting diet composition in marine heatwave conditions.

Detailed Results: The NMS on log-transformed data stabilized on a 3-dimensional solution after 88 iterations, with a final stress of 12.0616 and a final instability of 0.0001. The cumulative variance explained by the three axes was 86.2%. Axis 1 explained 45.3% of the variation and exhibited strong positive correlations with regional temperature, fish standard length, and whole fish weight, and a weaker positive correlation with stomach weight. Axis 2 explained 19.7% of the variation, with weakly negative relationships with fish standard length, weight, and stomach weight. Axis 3 explained 21.2% of the variation with weakly negative relationships to all four environmental variables. Community composition of juvenile Pacific Cod prey varied at both a spatial and a temporal scale, with differences in prey composition evident between the pre-heatwave, heatwave, and post-heatwave years (MRPP; $A = 0.2248$, $p < 0.0001$). In 2008, smaller prey items including *Acartia* spp., Cladocera, Cirrepede larvae, and Isopoda were eaten in higher amount, and in 2015, larger prey including Caprellidae, Polychaeta, Nematoda, and Crangonidae were strongly associated with diet. Gammaridae and Microsetella were common in both 2008 and 2018, while Mysidae were common in both 2015 and 2018. Mysidae was the dominant prey item in both 2015 and 2018, while *Acartia* spp. was the dominant prey item in 2008.

Relevance to NOAA

Living marine resources such as Pacific Cod are critical for Alaska's commercial, subsistence, and recreational fishing industries and represent an important economic and nutritional resource at both a regional and national scale. This TAB project complements and expands ongoing Pacific Cod research within the NOAA Alaska Fisheries Science Center, including efforts to identify overwintering processes during the first year of life and the validation of an individual-based transport model for Pacific Cod. Quantifying trends in Pacific Cod growth and foraging within essential nursery habitat can illuminate changes in a nursery's ability to support a stenothermic species like Pacific Cod and lead to more effective precautionary management for long-term sustainability. For example, the North Pacific Fisheries Management Council sets an annual specific total catch for Gulf of Alaska Pacific Cod based on population- and ecosystem-level risk metrics. Growth patterns, condition, and diet composition of juveniles settling in coastal nurseries can be important metrics that indicate

changes in the population and inform management decisions. Metrics such as these were used to help inform the 2020 closure of the fishery in response to unprecedented low biomass. In addition, climate-mediated declines in Pacific Cod have important ecosystem implications, with effects cascading up the food web to top predators such as salmon, marine mammals, and sea birds. The Kodiak Island beach seine time series is identified as a valuable dataset for the “ecosystem indicators” section of NOAA AFSC's Assessment of the Pacific Cod stock in the Gulf of Alaska because it is the only dataset for nursery-age Gulf of Alaska Pacific Cod that spans multiple thermal regimes and includes data from the 2014-2016 and 2019 marine heatwaves. Trends from these archived specimens can illustrate climate-mediated shifts in growth and production of juvenile Pacific Cod and aide in recovery efforts for the species.

Broader Impacts

Stakeholders, fishermen, and related industry participants in Southeast Alaska are directly impacted by declines in Pacific Cod. To connect with other Pacific Cod scientists, I will work with Dr. Ben Laurel to help organize and participate in events connected to the Alaska Marine Science Symposium in Anchorage, with the purpose of connecting Pacific Cod scientists and stakeholders across the region to discuss current and future Pacific Cod research and potential collaborations. The first of these meetings was successfully implemented at the 2020 Alaska Marine Science Symposium. I anticipated participating in events such as "Dock Talks", which are monthly events run by the University of Alaska Fairbanks Marine Advisory Program and the Alaska Sea Grant and hosted at the Kodiak Seafood and Marine Science Center. These events are opportunities for Kodiak fishermen to connect and network with scientists on community-based fisheries issues. I will explore options with Dock Talks program coordinators to host an event to communicate my research findings and discuss future goals with the fisheries community. However, I envision that this may be virtual due to COVID-19 modifications of work plans.

Presentations or Publications

Thalmann, H.L., Laurel, B.J., Miller, J.A. Few surviving juvenile Pacific Cod are bigger, fatter, and shifting diets in a warm ocean year. Alaska Marine Science Symposium. Anchorage, AK. January 2020. Poster Presentation.

Thalmann, H.L., Miller, J.A., Laurel, B. 2019. Thermal effects on juvenile Pacific Cod phenology, growth, and foraging in Gulf of Alaska nursery habitats. Pacific Estuarine Research Society Meeting, Anacortes, WA. April 2019. Poster Presentation.

Thalmann, H.L., Miller, J.A., Laurel, B. 2019. Quantifying impacts of warm years on juvenile Pacific Cod growth and foraging patterns. Oregon State University's Research Advances in Fisheries, Wildlife, and Ecology Symposium. Corvallis, OR. April, 2019. Oral Presentation.

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

Performance Measure: 3.4e: Number and percentage of actions ongoing or completed to recover endangered and threatened species
DOC Strategic Plan: 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources
NOAA RD Linkage: C1b: Increase our knowledge and understanding of the mechanisms and impacts of environmental changes on marine species and ecosystems.
Next Gen Priorities: Recovered and healthy marine and coastal species

Project Number 19-07

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

Thematic Research Area Stock Assessment Support

Abstract

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

Principal Investigator: 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, Savannah State University
Students: Adrianne Wilson (PhD, RSMAS); Intern (Undergraduate, RSMAS)
Keywords: Fisheries; Marine Biology; Social science; Population dynamics
Start Date: 9/23/2019 **End Date:** 1/1/2021

Results to Date: None to date.

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: None to date

Performance Measure: 3.4a1: Fish Stock Sustainability Index (FSSI) (cumulative)
DOC Strategic Plan: 3.4.1: Strengthen capabilities to assess and monitor fish and protected resources
NOAA RD Linkage: C4c: Develop integrated models that take advantage of synoptic data at various scales, to inform ecosystem-based management approach.
Next Gen Priorities: Improved understanding of ecosystems to inform resource management decisions

Appendix III: Contingency Plan for the LMRCSC Science Meeting

The LMRCSC has begun planning for the 2020 Science meeting that will be held in mid-April. In previous years, the Science meetings were held at NOAA Facilities. Because of the Covid-19 situation, the plan is to hold a virtual Science meeting in 2020. We have held a conference call with Dr. Cisco Werner (LMRCSC Technical Monitor), Bradley Stevens (LMRCSC Distinguished Scientist), and Paulinus Chigbu (LMRCSC Director) to discuss plans for the meeting. Planning is continuing.