



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

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AWARD INFORMATION	
1. Federal Agency: Department of Commerce / NOAA	2. Federal Award Number: NA19OAR4320074
3. Project Title: CINAR: A Cooperative Institute for the North Atlantic Region	
4. Award Period of Performance Start Date: 07/01/2019	5. Award Period of Performance End Date: 06/30/2024
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REPORTING INFORMATION	
Signature of Submitting Official:  Susan Ferreira	
16. Submission Date and Time Stamp: 06/29/2020	17. Reporting Period End Date: 03/31/2020
18. Reporting Frequency:  <input checked="" type="radio"/> Annual <input type="radio"/> Semi-Annual <input type="radio"/> Quarterly	19. Report Type:  <input checked="" type="radio"/> Not Final <input type="radio"/> Final
RECIPIENT ORGANIZATION	
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## ACCOMPLISHMENTS

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

The Cooperative Institute for the North Atlantic Region (CINAR) is a regional CI that focuses on the Northeast U.S. Shelf Large Marine Ecosystem (NEUS LME), a critical region within the North Atlantic that spans from Cape Hatteras to Nova Scotia, encompassing the continental shelf from the continental slope to the northern wall of the Gulf Stream. The CINAR consortium is led by the Woods Hole Oceanographic Institution (WHOI), and includes the Gulf of Maine Research Institute (GMRI), Rutgers University (Rutgers), University of Maryland Center for Environmental Science (UMCES), University of Maryland Eastern Shore (UMES), University of Massachusetts Dartmouth - School for Marine Science and Technology (SMASST), University of Maine (UMaine), and University of Rhode Island (URI). Through our NOAA and academic partnerships, the CINAR consortium provides a mechanism for NOAA scientists to easily and rapidly obtain research assistance and facilities or infrastructure support for projects, and respond to technical needs through the development of instruments, models, and approaches that contribute to management decisions. This CI was established in 2019, and is completing the first year of a five-year award.

CINAR projects are carried out under five research themes: (1) Sustained Ocean Observations and Climate Research; (2) Ecosystem Research, Observation, and Modeling; (3) Stock Assessment Research; (4) Protected Species Research and Recovery; and (5) Ecosystem-Based Fisheries Management. Research carried out by CINAR investigators over the past year encompassed a variety of activities and programs under these five themes to address NOAA research and management needs in the Northeast region and beyond.

In addition to these activities, an important goal of CINAR is to promote education and outreach among member institutions and within the broader scientific community. To achieve this goal, we have provided traineeships and fellowships at a variety of academic levels, including undergraduate internship programs, CINAR Minority Traineeships, and faculty fellowships to help train future generations of NOAA marine scientists. Student participation in CINAR research is further facilitated through the NOAA Living Marine Resources Cooperative Sciences Center at the University of Maryland Eastern Shore. Our outreach programs span a diversity of topics, and include activities to foster better management of harmful algal blooms in the U.S., as well as a series of science and management workshops for commercial and recreational fishermen to foster improved cooperation and trust among fishermen, scientists, and managers.

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

Select research accomplishments are highlighted below, organized under CINAR's five major research themes. (See also comment field #26.)

Theme I – Sustained Ocean Observations and Climate Research. CINAR activities developed and improved data sets quantifying Atlantic basin climate forcing, and used these data sets to examine the projection of climate models onto the NEUS LME, including efforts to: 1) improve the biogeochemical sensor array of the global fleet of Argo floats, which collect systematic observations of subsurface ocean temperature, salinity, and circulation; 2) maintaining the Atlantic Argo array, including the deployment of 73 Argo new floats and operation of a fleet of 389 floats (See Appendix 6, Fig. 1); 3) support and redeploy Ocean Reference Stations (ORS) to provide sustained, climate-quality observing of the trade wind region; and 4) use autonomous underwater gliders to monitor upper ocean heat as a forecasting method for hurricanes in the Gulf Stream (See Appendix 6, Fig. 2).

Theme II – Ecosystem Research. CINAR projects used data from CINAR's ocean observing programs to understand and describe ecological parameters and processes in the NEUS LME, and developed tools and techniques to improve regional ecosystem forecasting, management, and policy decisions. Highlights included: 1) deployment of acoustic tags on Atlantic cod in Southern New England to track the spawning population and assess their thermal habitats and connectivity with other cod populations (See Appendix 6, Fig. 3); 2) expanded development and deployment of Habcam, a stereo optical and acoustic imaging system used by NOAA to survey demersal fish and scallops along the northeast continental shelf; and 3) development of an accurate estimate of the economic value generated by NOAA investments in improved ocean observation, forecasting, and research.

Theme III – Stock Assessment. CINAR research is working to improve stock assessments of species found in the NEUS LME through the development and refinement of technologies and techniques for data collection, and the development of new modeling and forecasting approaches. These activities support better management of fisheries and decision making in the region. Research highlights included: 1) modeling the environmental drivers of change in golden tilefish fishery production and catch-per-effort for both northern and southern populations (See Appendix 6, Fig. 4); 2) comparison of acoustic estimates of Atlantic herring to environmental DNA (eDNA) concentration as a method to assess populations in the open ocean; and 3) development of three-dimensional models to estimate the performance of optical sampling techniques commonly used in stock assessment surveys (See Appendix 6, Fig. 5).

Theme IV – Protected Species. CINAR researchers developed new technologies, research tools, and approaches for the assessment and recovery of protected species in the NEUS LME, including the critically endangered North Atlantic right whale (NARW), Atlantic salmon, and other species. These efforts contribute to improvements in defining, protecting, and restoring essential habitat for these species. Research highlights included: 1) deployment of Slocum gliders to survey the NARW and transmit detections in real time, allowing research flights to perform visual assessments See Appendix 6, Fig. 6; and 2) organizing the NARW Health Assessment workshop and publishing the NARW Health Assessment Research Strategy report (See Appendix 6, Fig. 7).

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

**ACCOMPLISHMENTS (cont'd)**

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

Over the past year, CINAR investigators have provided research, training and professional development opportunities through direct participation of students and postdocs in research, as well as specific programs to connect with local communities. Below we highlight selected achievements and programs:

1. The Marine Resource Education Program (MREP) fishery science and management workshop series: These workshops engage commercial and recreational fishermen, managers, and scientists in discussions about approaches to fisheries management, and help to foster collaboration among these groups. Designed by fishermen for fishermen, MREP workshops include introductory sessions on fisheries science and management, and advanced modules on stock assessments, ecosystem-based management and climate change. Beyond the workshops, informal networking helps build a foundation of mutual respect for improved collaboration between scientists, managers, and fishermen. In 2019, the MREP program offered ten workshops and events.
2. North Atlantic Right Whale (NARW) Health Assessment Workshop: Under the auspices of NOAA Fisheries' Working Group on Marine Mammal Unusual Mortality Events, this workshop met in response to the ongoing NARW Unusual Mortality Event and the endangered status of the species. The main goals of the workshop were to assess current health information data and identify tools for collecting these data, and inform population models to guide recovery of the species. Recommendations were condensed into a workshop report, and used to shape the NARW Health Assessment Research Strategy.
3. Undergraduate summer student fellowships: CINAR sponsors an undergraduate minority traineeship program, which provides funding to each CI partner institution in support of summer fellowships for students from underrepresented communities. These students work on a project selected in collaboration with their sponsor that provides results during a 10 to 12 week period. This highly successful program was established under our prior award, and will continue throughout the duration of our new award.
4. Student and postdoc participation in research: CINAR research programs offer many opportunities to engage graduate students, postdocs, and early career scientists, and provide career training to the next generation of NOAA scientists. Students are introduced to an active and collaborative research environment, interact with scientific leaders in ecosystem research, start building a network of contacts for advanced studies and a career in science or resource management, and gain experience with ecosystem-scale research, proposal writing and presentation skills. Our new consortium includes UMES as an academic partner, which provides an outstanding opportunity to facilitate undergraduate and graduate student participation in research through the NOAA Living Marine Resources Cooperative Science Center (LMRCSC) at UMES, which also participates in NOAA's Education Partnership Program with Minority Serving Institutions, and the NSF Center of Research Excellence – Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics in the Mid-Atlantic Region (CREST-CISCEP). During the first year of our award, CINAR investigators included 6 students and 1 postdoc in their research programs, and we fully expect these numbers to increase going forward.
5. Quantitative Fisheries and Ecosystem Science faculty support: The goal of this program is to engage early career scientists in research to improve and enhance the assessment and management of fisheries resources in the region. With support provided by NOAA's Quantitative Ecology and Socioeconomics Training (QUEST) program, this program will provide support to early career faculty at CINAR partner institutions that conduct research and educational activities related to stock assessment and quantitative fisheries science in the NEUS LME.

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

In addition to the educational and outreach programs described in comment box #26, results were disseminated through the numerous peer-reviewed publications, websites, and public presentations. These are too numerous to list here, but are described and detailed in Appendices 4 and 5, and comment field 32.

**ACCOMPLISHMENTS (cont'd)**

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

Work on all ongoing and new research and educational programs will continue under CINAR's new award. Over the upcoming year, CINAR will also explore opportunities to augment programmatic funding for our education programs, and for expanded engagement of UMES undergraduate and graduate students in research at CINAR consortia via the LMRCSC. In addition, we have initiated a CINAR fellowship program for supporting early career faculty at our partner institutions through funding from QUEST. The call for fellowship applications has been developed and will be issued this summer. Support from these fellowships will enhance research, teaching, and advising activities, and will help to establish programs that can develop and implement new technologies to improve the management of fisheries resources in the NEUS LME.

**PRODUCTS**

29. Publications, conference papers, and presentations

A comprehensive listing of all publications, conference papers, and presentations by CINAR investigators associated with the current reporting period are provided as Appendix 4 and Appendix 5. Please note that DOI numbers are provided for each peer-reviewed publication.

**PRODUCTS (cont'd)**

**30. Technologies or techniques**

Technologies and techniques associated with CINAR research are listed below:

- Anderson (WHOI) Imaging FlowCytobot for unprecedented resolution of the composition and abundance of primary producers in ecosystems.
- Baumgartner (WHOI): Tag detection and passive acoustic monitoring of spawning cod near Stellwagen Bank using WHOI gliders.
- Cadrin (SMAST): Spatiotemporal distribution map of spawning cod in the Southern New England region through data collected from acoustic transmitters deployed on cod in the vicinity of Cox Ledge during two spawning seasons
- Foote (WHOI): Three-dimensional morphometric data derived from CT or MRI scanning of specimens of adult butterfish (*Peprilus triacanthus*) and Atlantic mackerel (*Scomber scombrus*).
- Gallager (WHOI): HabCam for surveying benthic habitats and living resources.
- Jayne (WHOI) Argo floats for physical and biogeochemical sensing.
- Rose (UMCES): 3-D Regional Ocean Modeling System (ROMS) model grid of Gulf of Mexico conditions and particle-tracking bookkeeping to permit simulation of 2-D (horizontal) and 3-D (vertical included) behavioral movement of individual fish and simulate the dragging of optical samplers through the grid.
- Stanley (WHOI): Research sites with active deployed hydrophones and acoustic telemetry receivers.
- Todd (WHOI): Spray gliders deployed to survey the Gulf Stream between Miami, FL and New England during the 2019 Atlantic hurricane season. New post-processed data from Gulf Stream glider missions are routinely added to this publicly available data set: doi: 10.21238/S8SPRAY2675. Plots of real-time and post-processed glider data can be found here: <http://gliders.whoi.edu>.
- Weller (WHOI): The Ocean Climate Observations and Analyses effort supports three Ocean Reference Stations (ORS), which are well-equipped surface moorings, deployed to provide sustained observations of the trade wind region.

**31. Inventions, patent applications, and/or licenses**

Nothing to Report

## PRODUCTS (cont'd)

### 32. Other products

Other products developed by CINAR PIs are listed below:

- Anderson (WHOI): Cyst cruise data supports NOAA harmful algal bloom forecasting and modeling: <https://products.coastalscience.noaa.gov/hab/gomforecast.aspx>.
- Anderson and Richlen (WHOI): Updated and redesigned U.S. National Office for Harmful Algal Blooms website (<https://hab.who.edu/>), which serves as a “clearinghouse” for information related to national and international activities on HAB issues.
- Baumgartner (WHOI): The publicly accessible website <http://robots4whales.who.edu/> is used for displaying near real-time detections of whales from autonomous gliders and buoys.
- Cadrin (SMAST): Acoustic receiver data will be shared with other researchers through the Atlantic Cooperative Telemetry Network (ACT, [www.theactnetwork.com](http://www.theactnetwork.com)).
- Jayne (WHOI): Argo float data and metadata: <http://doi.org/10.17882/42182>
- Kite-Powell (WHOI): Ocean carbon uptake and global climate policy. Draft report, 2019, WHOI Marine Policy Center
- Labaree and O'Brien (GMRI): Fisheries Science and Management Workshops held as part of the Marine Resource Education Program (<https://www.gmri.org/our-work/fisheries-convening>)
- Nesslage (UMCES): Models to identify the effects of environmental drivers on golden tilefish landings and catch-per-unit effort for both the northern and southern stock units.
- Nicholson (WHOI): Floats, equipped with sensors to measure temperature, salinity, oxygen, nitrate, pH and bio-optics, are being deployed in the North Atlantic Ocean and contribute to an eventual global biogeochemical Argo system.
- Pinsky (Rutgers): Created Oceanadapt Website (<http://oceanadapt.rutgers.edu>), which provides information about the impacts of changing climate and other factors on the distribution of marine life to the National Climate Assessment, fisheries communities, policymakers, and to others.
- Stanley (WHOI): Websites describing project activities include:  
(1) Black sea bass and impacts of noise disturbances from pile driving: <https://www.nefsc.noaa.gov/psb/acoustics/psbAcousticsWindEnergyEffects.html>; and (2) SanctSound: Soundscape monitoring program: <https://www.nefsc.noaa.gov/psb/acoustics/psbAcousticsSoundscapeNMS.html>  
<https://sanctuaries.noaa.gov/science/monitoring/sound/>.
- Weller (WHOI): Multi-year time series of surface meteorology and air-sea fluxes, have been merged into the longest possible continuous time Reference Data Sets and are available at <http://uop.who.edu/ReferenceDataSets/index.html>.

## PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

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

The CINAR PIs include Donald M. Anderson, CINAR Director, Woods Hole Oceanographic Institution; Oscar Schofield, Director, Institute of Earth, Ocean, and Atmospheric Science, Rutgers University; Michael Roman, Director, Horn Point Laboratory, University of Maryland Center for Environmental Science; David Townsend, Associate Director of Research and Graduate Studies, University of Maine; Andrew Pershing, Chief Scientific Officer, Gulf of Maine Research Institute; Bruce Corliss, Dean, Graduate School of Oceanography at the University of Rhode Island; Steven Lohrenz, Dean, University of Massachusetts Dartmouth School for Marine Science and Technology, and Paulinus Chigbu, Director, Marine Resources Cooperative Science Center at University of Maryland Eastern Shore. The CINAR PIs meet regularly in person or via conference call to discuss issues and to ensure that partner institutions are updated on CINAR activities. Additional CINAR personnel include Mindy Richlen (CINAR Associate Director) and Claire Anacreon (Administrative Associate). A listing of project investigators is provided in Appendix 1.

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

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

GMRI: In October 2019, GMRI program leadership was assumed by MREP Project Manager, Lauren O'Brien with support from GMRI Chief Community Officer, Jonathan Labaree, and regional MREP Steering Committees.

35. What other organizations have been involved as partners?

Consortium members and subawardees include Woods Hole Oceanographic Institution, University of Maine, Rutgers University, Gulf of Maine Research Institute, University of Maryland Center for Environmental Science, University of Massachusetts Dartmouth School for Marine Science and Technology, University of Rhode Island, University of Massachusetts Dartmouth School for Marine Science and Technology, University of Maryland Eastern Shore and the World Meteorological Organization.

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

36. Have other collaborators or contacts been involved?

Nothing to Report

**IMPACT**

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

Impacts of CINAR research on the principal discipline(s) of this cooperative institute during the first year of our award are summarized below, organized by research theme.

Theme I – Sustained Ocean Observations and Climate Research. CINAR activities under this research theme included supporting the global array of Argo floats, which produce sustained and systematic global observations of subsurface ocean temperature, salinity, biogeochemistry, and circulation (See Appendix 6, Fig. 1). Similarly, the data produced by CINAR-supported Ocean Reference Stations are essential to critical climate assessments worldwide. Regionally, autonomous glider data collected from the Gulf Stream is providing new insights into worsening Atlantic hurricanes (See Appendix 6, Fig. 2). Data generated by these efforts have contributed to our understanding of marine heatwaves and warming trends in the Northeast, and their impact on living marine resources and fisheries.

Theme II – Ecosystem Research, Observation, and Modeling. The NOAA scientific community is using data collected by CINAR's ocean observing assets and programs to understand and describe ecological and environmental parameters and processes in the NEUS LME. State-of-the-art ecological models and data assimilation methods developed by CINAR investigators have been applied to practical problems facing key ecological and commercial species. Examples include mapping the distribution of spawning Atlantic cod (See Appendix 6, Fig. 3) and development of soundscape metrics to monitor effects of anthropogenic sound on black sea bass.

Theme III – Stock Assessment Research. CINAR activities have contributed valuable datasets to advance our understanding of critical species in the NEUS LMS, which are used for effective management and resource stewardship in the region. Examples include analysis of environmental drivers on golden tilefish populations to inform fisheries management strategies (See Appendix 6, Fig. 4), and development of new environmental DNA techniques to accurately assess Atlantic herring populations. These efforts advance knowledge and techniques in the areas of ecosystem research, monitoring, and modeling, and address EBFM implementation by supporting surveys and stock assessment of fisheries resources.

Theme IV – Protected Species Research and Recovery. CINAR activities under this theme are developing new technologies, research tools, and approaches for the assessment and recovery of protected species in the NEUS LME, including, among others, the critically endangered North Atlantic right whale (See Appendix 6, Figs. 6 & 7). These research efforts span the spectrum from basic to applied research on protected species, and are contributing new datasets and approaches to better define, protect, and restore essential habitat. One such project improved detection and monitoring of whales from moored buoys and autonomous gliders in the NEUS LME, which can be applied by investigators elsewhere in the study of endangered migratory species.

Theme V – Ecosystem-Based Fisheries Management. CINAR research is contributing to the development of tools and approaches to

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



**IMPACT (cont'd)**

**38. What was the impact on other disciplines?**

The impact and value of CINAR research extends well beyond the scientific disciplines encompassed by this CI's research themes. Humans are an integral part of approaches to EBFM; therefore, human dimensions research is an important part of support EBFM and other ecosystem-based approaches to management. Data and analyses carried out by CINAR investigators support efforts to integrate human interactions and socioeconomic considerations, thereby promoting sustainable coastal development and community resiliency. In addition, CINAR research is contributing to better management of harmful algal blooms in the region, which contributes to environmental and public health disciplines. Engagement of fisheries stakeholders by CINAR researchers through the MREP program promotes the involvement and participation of the general public and commercial sector in fisheries science and management in a productive way. In addition, CINAR investigators are engaged in developing software and data portals such as the OceanAdapt (<https://oceanadapt.rutgers.edu>; see Appendix 6, Fig. 8) website, which allows fisheries managers and the public to track changes in species distributions. For commercially and recreationally important species, including many species of coastal fish and invertebrates, shifts in species distributions have clear and immediate impacts on coastal communities, economies, and societies. Together, these activities provide a fuller understanding of interactions and interconnections within the NEUS LME, and support efforts to integrate economic, social, and cultural considerations in EBFM.

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

Over the past year, CINAR programs supported 67 research scientists and staff, postdocs, and administrative staff, as well as 6 students. A complete personnel listing is provided in Appendix 3, and additional details regarding the impact of teaching and educational programs is described in comment field #40, below.

**IMPACT (cont'd)**

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

CINAR research programs offer a variety of opportunities to engage graduate students, postdocs, and early career scientists in research programs related to the aforementioned research themes, and provide career training to the next generation of marine scientists. Students are engaged in an active and collaborative research environment, interact with scientific leaders in ecosystem research, start building a network of contacts for advanced studies and a career in science or resource management, and gain experience with ecosystem-scale research, proposal writing, and presentation skills. In the first year of our award, CINAR investigators included 5 students and 1 postdoc in their research programs, and we expect this number to increase in subsequent award years.

Over the past year, CINAR also initiated a fellowship program for supporting early career faculty at our partner institutions through funding from NOAA's Quantitative Ecology and Socioeconomics Training (QUEST) program. An important goal this program is to engage early career scientists in research to improve and enhance the assessment and management of fisheries resources in the region. Two-year fellowships will be funded through competitions held in 2020 and 2022. Multiple fellowships will be offered, with the number of awards and budget guidelines determined by a panel of representatives from each CINAR institution, with guidance from the Director of the Northeast Fisheries Science Center and the QUEST program. Support provided by these fellowships will enhance research, teaching, and advising activities and will help to establish laboratories and programs that can develop and implement new technologies to improve the assessment and management of fisheries resources in the NEUS LME. The call for fellow applications has been developed and will be issued this summer.

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

The Argo float program operated by CINAR investigators at WHOI continues to deploy floats in the Atlantic Basin with an emphasis on expanding coverage of the Intra-Americas seas, and currently operates a fleet of 389 active floats. Contributions to physical, institutional, and information resources included the preparation and deployment of 73 Argo floats over the past year (See Appendix 6, Fig. 1). In addition, data produced by CINAR-supported Ocean Reference Stations are essential to critical climate assessments worldwide. These sites provide benchmark records that anchor fields, such as those of air-sea fluxes, quantify change and variability in ocean state and air-sea coupling, motivate model improvement, and calibrate/validate remote-sensing products. Additional contributions to infrastructure include gliders used for passive acoustic monitoring of cetaceans (See Appendix 6, Fig. 6). CINAR investigators also maintain multiple websites and informational resources, which are listed in comment field #32.

**IMPACT (cont'd)**

**42. What was the impact on technology transfer?**

CINAR investigators are pioneering multiple new tools, models, and approaches to collecting, analyzing, modeling, and disseminating biological and physical data in the NEUS LME. Additional information on some of these products is provided in comment field #30. These include the efforts discussed in comment field #25, such as the development of three-dimensional models to evaluate and improve approaches used in stock assessment surveys (See Appendix 6, Fig. 5). As mentioned above, CINAR investigators maintain multiple websites and informational resources, which are listed in comment field #32.

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

Data and analyses carried out by CINAR investigators are supporting efforts to integrate human interactions and socioeconomic considerations into marine species and ecosystem management, thereby promoting sustainable coastal development and community resiliency. Engagement of fisheries stakeholders by CINAR researchers through the MREP program promotes the involvement and participation of the general public and commercial sector in fisheries science and management in a productive way. In addition, CINAR research is contributing to better management of harmful algal blooms in the region, which contributes to human health disciplines and aquaculture management. These activities support efforts to integrate human interactions and socioeconomic considerations in EBFM, and contribute to a better understanding of interactions and interconnections within the NEUS LME.

**IMPACT (cont'd)**

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

5 , Our estimates indicate that <5% of our budget was spent in foreign countries.

**CHANGES/PROBLEMS**

45. Changes in approach and reasons for change

Several projects experienced significant and ongoing disruptions and delays due to the COVID-19 pandemic. These problems and delays are included in comment field #46.

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

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

All projects that were extended beyond their originally scheduled project end date are listed below. Multiple projects experienced delays due to the COVID-19 pandemic in spring 2020.

- Anderson (WHOI): Project delays due to COVID-19. The state of emergency included a stay-at-home health advisory and an order to cease non-essential in-person operations (<https://www.mass.gov/resource/information-on-the-outbreak-of-coronavirus-disease-2019-covid-19>).
- Baumgartner (WHOI): Project extended due to COVID-19.
- Benway (WHOI): Conference was postponed due to COVID-19.
- Cadrin (SMAST): Fieldwork was suspended in early March to comply with Massachusetts policies for mitigating the outbreak of coronavirus disease 2019 (COVID-19).
- Foote (WHOI): There have been some delays due to the COVID-19, but given that this has occurred early in the life of the project, these may not be significant, excepting the possibility of seasonal limitations in the availability of adult butterfish and Atlantic mackerel.
- Gallagher (WHOI): Project extended due to COVID-19.
- Jayne (WHOI): A no-cost project extension was required due to the long lead time in sourcing floats, then putting them through technical testing and ballasting preparation, with up to a year between acquisition and deployment.
- Kite-Powell (WHOI): A one-year no-cost extension was required to complete project research and reports.
- Mooney (WHOI): Project extended due to COVID-19.
- Nesslage (UMCES): A one-year no-cost extension was granted due to delays in data delivery and collaborative work with federal partners due to COVID-19.
- Nicholson (WHOI): The COVID-19 pandemic caused significant disruptions to this project, including: (1) Delayed delivery of Argo floats as the manufacturer was subject to closures; (2) Cancellation of planned deployment cruises; (3) WHOI closures which have limited progress on in-lab testing. Although these factors have contributed to a significant delay, project goals are expected to be

**47. Changes that had a significant impact on expenditures**

Impacts on expenditures are largely associated with the COVID-19 pandemic, and include cancelled travel reservations and expenditures associated with research cruises and other field work that was suspended (described in comment field #46).

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

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

Nothing to Report

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

Nothing to Report

**PROJECT OUTCOMES**

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

Outcomes of this award are captured in the aforementioned "Accomplishments", "Products", and "Impact" sections, and in Appendices 1-6.

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

<p>Gender:</p> <p><input type="radio"/> Male</p> <p><input type="radio"/> Female</p> <p><input type="radio"/> Do not wish to provide</p>	<p>Ethnicity:</p> <p><input type="radio"/> Hispanic or Latina/o Not</p> <p><input type="radio"/> Hispanic or Latina/o Do not wish to provide</p>
<p>Race:</p> <p><input type="radio"/> American Indian or Alaska Native Asian</p> <p><input type="radio"/> Black or African American</p> <p><input type="radio"/> Native Hawaiian or other Pacific Islander</p> <p><input type="radio"/> White</p> <p><input type="radio"/> Do not wish to provide</p>	<p>Disability Status:</p> <p><input type="radio"/> Yes</p> <p>[ ] Deaf or serious difficulty hearing</p> <p>[ ] Blind or serious difficulty seeing even when wearing glasses</p> <p>[ ] Serious difficulty walking or climbing stairs</p> <p>[ ] Other serious disability related to a physical, mental, or emotional condition</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Do not wish to provide</p>

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