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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: NA19OAR4320072
3. Project Title: Ocean Exploration Cooperative Institute (OECI): Discovering the New America	
4. Award Period of Performance Start Date: 07/01/2019	5. Award Period of Performance End Date: 06/30/2024
PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR	
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8. Title: Executive Director of the Ocean Exploration Cooperative Institute	
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REPORTING INFORMATION	
Signature of Submitting Official: Franca Cirelli	
16. Submission Date and Time Stamp: 06/07/2022	17. Reporting Period End Date: 03/31/2022
18. Reporting Frequency: (●) Annual ( ) Semi-Annual ( ) Quarterly	19. Report Type: (●) Not Final ( ) Final
RECIPIENT ORGANIZATION	
20. Recipient Name: UNIVERSITY OF RHODE ISLAND	
21. Recipient Address: 75 LOWER COLLEGE, KINGSTON, RI 02881-1974 USA	
22. Recipient UEI: CJDNG9D14MW7	23. Recipient EIN: 223011455

ACCOMPLISHMENTS

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

The major goals and objectives of the OECI are to conduct ocean exploration, to develop and advance new technologies that enhance ocean exploration, and to engage with and train the next generation of ocean explorers and a diverse blue economy workforce.

25. What was accomplished under these goals?

Year three of the OECI saw many significant accomplishments towards OECI goals and objectives. The OECI partners have conducted 5 ocean exploration expeditions to date in year 3. These expeditions have mapped a total of significant portions of seafloor, filling in gaps within the bathymetric coverage of the US EEZ in the remote Pacific territories. On these expeditions dozens of deployments of uncrewed exploration vehicles encompassing a period of hundreds of hours submerged were completed including ROV dives, USV deployments, and AUV deployments. These deployments resulted in the collection of hundreds of hours of deep sea video, tens of thousands of deep sea digital still photographs, and countless hours of in situ sensor data. Hundreds of physical samples were also collected including geological materials, water, and biological materials. Among the highlights in year three ocean exploration activities were the successful integration of the UNH DriX uncrewed surface vessel with OET's E/V Nautilus; the development and demonstration of intra-vehicle subsea communication between DriX and the WHOI Mesobot and NUI vehicles; demonstration of simultaneous multi-vehicle operations; and demonstration of co-exploration principles that utilize information from multiple vehicles to improve exploration outcomes. OECI projects also produced advancements in machine learning algorithms for video processing, cloud-based tools for bathymetric data analysis, novel sensor developments for subsea light-field measurements, improvements in in-situ eDNA sampling, and advances in tele-operations of uncrewed platforms. Please see Appendix A (attached) for additional information on Year 3 accomplishments. Further details will be provided in Year 3 report in Summer 2022.

ACCOMPLISHMENTS *(cont'd)*

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

OECI activities have provided opportunities for training and development for students through senior researchers. OECI has directly supported the graduate education of multiple students with samples and observations from OECI expeditions and opportunities to gain sea-going experience. In addition, the OECI has provided internship opportunities for students from Tuskegee University and New England Institute of Technology that are exposing students to potential blue career pathways. This has included 10-week on-site intensive internships at OECI partner institutions, paid part-time work opportunities for students pursuing technical degrees, and virtual workshops to pair students with blue economy workers and recruiters. The latter was open to participants from outside of the OECI including NOAAs ocean explorer internship program. OECI has also supported the training of K-12 educators through the Ocean Exploration Professional Development program. Further details will be provided in Year 3 report in Summer 2022.

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

OECI has disseminated results through a number of different mechanisms. A monthly colloquium has been convened to provide project updates across OECI partners and NOAA. Updates on activities and accomplishments have been disseminated through monthly newsletters shared with NOAA and more broadly (see Appendix D - attached). In addition, OECI has convened sessions at international conferences including the American Geophysical Union Fall Meeting and the biennial Ocean Sciences Conference. In these sessions and others and at a variety of ocean-related conferences, OECI members have presented the results of their projects in oral and poster presentations. OECI members have published their results in peer-reviewed journals and provided the data from their projects to public data archives and repositories. Further details will be provided in Year 3 report in Summer 2022.

ACCOMPLISHMENTS *(cont'd)*

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

The next reporting period will see a continuation of many OECI activities and development of new activities. For example, we plan to continue internship opportunities for students, expand training of graduate students and post-docs, and continue to support professional development activities. We also plan to continue ocean exploration expeditions in the Central Pacific utilizing new systems and sensors (e.g., in-situ Raman spectroscopy, deep-water multibeam sonar on DriX), and advance cooperative, multi-vehicle exploration to a more operational level. We will push forward our eDNA program and develop passive acoustic technologies to augment ocean exploration data collection in ways that fill gaps in essential exploration variables. We plan to advance our ability to leverage new telecommunications technologies to increase shore-side participation in ocean exploration activities and ensure that OECI data pipelines meet the highest standards for speed and quality of data delivery to end users.

PRODUCTS

29. Publications, conference papers, and presentations

Suman, S., Jakuba, M., Dalpe, A., Bowen, A. (2021) Towards Teleoperation of Oceanographic Research Vessels, OS12A-08, Fall AGU.

Rodriguez, C., Kelley, K., Ballard, R. (2021) Metal Enrichments as a Function of Water Column Properties in Pacific Ferromanganese Crusts, OS15E-1030, Fall AGU.

Elmore, A., Wang, L., Adams, C., Quadara, R., Machado, C., Rodriguez, C., Suhre, K., Fundis, A., Soule, A. (2021) Suggestions for Supporting Marginalized Group Members at Sea, OS15E-1033, Fall AGU.

Williams, D., Quadara, R., Kastler, J., Macelloni, L., Hamdan, L. (2022) DISCOVERING NEW FRONTIERS: HANDS-ON LEARNING AND SCIENTIFIC COLLABORATION DURING DEEP SEA EXPLORATION, Ocean Sciences Meeting.

Elmore, A. and Soule, A. (2022) Exploring the Nation's Blue Frontier, ECO Environment: Coastal and Offshore, http://digital.ecomagazine.com/publication/?m=9890&i=728343&p= 1&article_id= 4156432&ver=html5

PRODUCTS *(cont'd)*

30. Technologies or techniques

A number of new technologies and techniques were developed or advanced by OECI in Year 3. A partial list includes: New sensor technologies for measuring the light-field in the midwater were advanced. New technologies for collecting material for eDNA analysis in situ were advanced. New technologies for enabling multi-vehicle operations were developed. New technologies for enabling remote (tele-)engineering were developed. New technologies for processing data in the cloud were developed. New technologies for automated analysis of subsea video were developed. Further details will be provided in Year 3 report in Summer 2022.

31. Inventions, patent applications, and/or licenses

Nothing to Report

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

PRODUCTS *(cont'd)*

32. Other products

See attached Appendix B for a description of the data products produced in Year 3 to date and where they are housed.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

33. What individuals have worked on this project?

Dr. Paula Bontempi (PI)
Dr. Adam Soule (Co-PI, Executive Director)
Dr. Robert Ballard (Co-PI)
Dr. Rick Murray (Co-PI)
Dr. Kelly Lucas (Co-PI)
Dr. Larry Mayer (Co-PI)
Andrew Bowen WHOI
Brian Connon USM
Dwight Coleman URI
Jason Fahy URI
Holly Morin URI
Brenda Moyer URI
Leonardo Macelloni USM
Allison Fundis OET
Brian Calder UNH
Val Schmidt UNH
Dana Yoerger WHOI
Tim Shank WHOI

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

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

Nothing to Report

35. What other organizations have been involved as partners?

In addition to partners listed in previous reports:

Saildrone, Alameda, CA, Collaboration
iXblue, France, Collaboration
Tuskegee University, Tuskegee, AL, Collaboration
NOAA Fisheries, Collaboration
NOAA Marine Sanctuaries Program, Collaboration
BOEM, Collaboration
Bigelow Marine Lab, Maine, Collaboration
Consortium for Ocean Leadership, Washington DC, Collaboration

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?

Among the impacts of the principle disciplines from OECI Year 3 activities are 1) development of best practices for exploration of midwater ecosystems, 2) development of coordinated, multi-vehicle operations for ocean exploration, 3) advances in our understanding of fine-scale distribution of rare earth elements in Fe-Mn crusts, and 4) advances in our understanding of the distribution of deep sea sponge and coral communities in the Central Pacific. Further details will be provided in Year 3 report in Summer 2022.

IMPACT *(cont'd)*

38. What was the impact on other disciplines?

Nothing to Report

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

The OECI impacted Human Resources in a variety of ways. First, the ISC-produced professional development webinars exposed teachers to educational materials that will be conveyed to K-12 students and contribute to their interest and retention in STEM fields. In addition, the OECI fully supported one graduate student, Coralie Rodriguez. The OECI expeditions aboard E/V Nautilus reached thousands of people, improving ocean literacy and exciting the next generation of blue economy workers. The ISC supports URI undergraduate students with part-time jobs as watch standers for Nautilus and Okeanos Explorer, exposing students to potential careers in ocean science. USM along with partner insitution Tuskegee University initiated an Ocean Club as well as a summer internship program that offers TU students multiple ways to engage with ocean exploration professionals. The Bridge to Ocean Exploration program provided internship opportunities to undergraduate students from New England Insitute of Technology to apply their technical skills to ocean-related problems. This program held a Blue Economy Career Awareness symposium for students from six undergraduate institutions. Partner institutions maintain robust outreach and education programs that benefit from OECI activities and materials produced by OECI.

IMPACT *(cont'd)*

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

The ISC worked with the NOAA education office to create professionally-produced educator professional development webinars. The approach has proved successful and will be carried forward in the coming years. The materials produced are archived online for later viewing and a process to transition materials into podcast format has been piloted.

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

Nothing to Report

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

IMPACT *(cont'd)*

42. What was the impact on technology transfer?

The OECI has enabled a range of technology transfer from the development and operationalization of vehicle systems to the development of tools to aid in new approaches to ocean exploration involving simultaneous and collaborative operation of multiple autonomous vehicle systems. Of note, the integration of the DriX USV with E/V Nautilus has provided critical information for the adoption of this vehicle system by federal and commercial operators. In addition, the ongoing program with the Saildrone Surveyor is providing insight into the data-as-a-service model of ocean exploration for federal, academic, and commercial investigators and operators.

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

The OECI is committed to communicating the science, practice, and outcomes of ocean exploration to the science community, students, and the public. To that end, cruises on E/V Nautilus live stream video data and commentary to an audience that routinely numbers in the tens of thousands per cruise. We feel that this has a significant impact on the science literacy of the public as well attitudes towards the oceans. In addition, the OECI has made an effort to diversify the ocean science community by providing direct connections with students at Tuskegee University, an HBCU, and providing those students with opportunities to engage in ocean exploration through internships. Given the poor state of diversity within the field, any progress on this front represents a significant impact. As stated above, the ocean exploration data we collect will impact regulatory decision makers in the assessment of marine resources and the need for conservation within the US EEZ.

IMPACT *(cont'd)*

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

6 , Funds were allocated to enable iXblue personnel to participate and aid in integration of the DriX vehicle with E/V Nautilus.

CHANGES/PROBLEMS

45. Changes in approach and reasons for change

Some changes in approach were necessitated by complications from COVID and supply chain disruptions that caused modifications to sea-going schedules. In some instances, vehicles planned for activities on E/V Nautilus were removed due to limitations in deck space or unavailability of sufficient launch and recovery systems and due to conflicting schedules.

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

CHANGES/PROBLEMS *(cont'd)*

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

Nothing to Report

47. Changes that had a significant impact on expenditures

See Appendix C detailing overall OECI expenditures. Note that some unexpended funds relate to activities pre-funded for Year 4 of the OECI and for cruises scheduled to take place during the Year 3 performance period.

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

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

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

PROJECT OUTCOMES

50. What were the outcomes of the award?

Please refer to Appendix A for a summary of outcomes from the Year 3 award.

DEMOGRAPHIC INFORMATION FOR SIGNIFICANT CONTRIBUTORS (VOLUNTARY)

Gender:

- ◯ Male
- ◯ Female
- ◯ Do not wish to provide

Ethnicity:

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

Race:

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

Disability Status:

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

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