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DEPARTMENT OF COMMERCE
RESEARCH PERFORMANCE PROGRESS REPORT (RPPR)

For instructions, please visit
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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	
6. Last Name and Suffix: ,	7. First and Middle Name: ,
8. Title:	
9. Email:	10. Phone Number:
AUTHORIZING OFFICIAL	
11. Last Name and Suffix: Cirelli , null	12. First and Middle Name: Franca , null
13. Title:	
14. Email: franca@ds.uri.edu	15. Phone Number: 401-874-5891
REPORTING INFORMATION	
Signature of Submitting Official: Franca Cirelli	
16. Submission Date and Time Stamp: 05/17/2023	17. Reporting Period End Date: 03/31/2023
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 RD RM 103, 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 four of the OECI saw a continuation of accomplishments in support of OECI goals and objectives. The OECI institutional partners conducted six expeditions in the reporting period (May 2022 - May 2023) with an additional two planned to be conducted before the end of the current award period (July 2023). These expeditions mapped nearly 200,000 sq. Km of seafloor within the US EEZ, including portions of the Papahanamokuakea Marine National Monument and Pacific Remote Islands Marine National Monument in the central Pacific, portions of the Aleutian arc, and areas within the Gulf of Mexico. One expedition covered during this reporting period was a multi-month deployment of the Saildrone Surveyor, a 72 foot uncrewed surface vehicle that transited from California to Alaska to conduct mapping surveys of priority areas identified by NOAA Ocean Exploration, Office of Coast Survey, and the Deep Sea Coral Research and Technology Project, as well as BOEM, and USGS. During this expedition, eDNA sampling was conducted autonomously with a system developed by partners at MBARI. Additional surveys were conducted in this mission off the coast of California. This project was an excellent example of a mutually beneficial public-private partnership that yielded both improvements and advances for the commercial technology and valuable exploration data for NOAA and the ocean science community. The ship-based expeditions for the reporting period enabled 59 deployments of uncrewed systems including 24 ROV deployments, 20 autonomous underwater vehicle deployments, and 15 uncrewed surface vessel deployments. Through these expeditions, we collected over 1300 hours of deep sea video, over 550 deep sea samples of biology, fluids, and geological materials. The expedition live streams were viewed more than 1.5 million times and video highlights from the expeditions were viewed over 3 million times. Additional details on these and other accomplishments from the reporting period will be provided in the Year 4 OECI report in Summer 2024.

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 Community College of Rhode Island 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 most recent 'OECI blue economy career awareness fair' in March 2023 has already yielded a summer internship for an OECI intern with the Naval Undersea Warfare Center. OECI has also supported the training of K-12 educators through the Ocean Exploration Professional Development program. In this reporting period, OECI expeditions provided live stream and ship-to-shore interactions in Olelo Hawaiian for expeditions around Hawaii to further engage with native and indigenous students. Additional details will be provided in Year 4 report in Summer 2023.

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

OECI has disseminated results through a number of different mechanisms. An OECI colloquium is convened monthly to provide project updates across OECI partners and NOAA. Updates on activities and accomplishments have been disseminated through bimonthly newsletters and an Executive Summary of our Annual Report shared with NOAA and more broadly. In addition, OECI has convenes sessions at international conferences (e.g., American Geophysical Union Fall Meeting, Ocean Sciences). 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 participates in panels and at workshops organized by the ocean exploration and research communities to share highlights and accomplishments and to help set the agenda for future ocean priorities (e.g., National Ocean Exploration Forum). OECI members provide seminars at venues from the broadly disseminated NOAA Ocean Science Seminar series to local institutional seminars. This year we shared OECI information a In this reporting period, OECI has initiated a special issue of the journal Frontiers for advances in ocean exploration. 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 4 report in Summer 2023.

ACCOMPLISHMENTS *(cont'd)*

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

Plans for the next reporting period are in development in consultation with the NOAA Ocean Exploration and other NOAA line offices.

PRODUCTS

29. Publications, conference papers, and presentations

Ciravolo, A.E., Konrad, K. (2022) The Origin of Seamounts around Jarvis Island — Preliminary Insights from ROV Expeditions, V11A-02, Fall AGU.

Dalpe, A. J., Suman, S., Jakuba, M. V., & Bowen, A. (2022, October). Teleoperation of Remotely Operated Vehicles: Development, Challenges, and Future Directions. In /OCEANS 2022, Hampton Roads/ (pp. 1-7). IEEE.

Mayer, L. (2023) Uncrewed surface systems facilitating a new era of global ocean exploration. The International Hydrographic Review, pp 1-54, https://doi.org/10.58440/ihr-29-a05.

Flores, P. C. R., & Schnabel, K. E. (2023). New records and species of deep-sea squat lobsters (Galatheoidea, Munidopsidae) from the Hawaiian Archipelago: an integrative approach using micro-CT and barcodes. /PeerJ/, /11/, e14956.

Ferrini, V., Morton, J., Gee, L., Heffron, E., Drennon, H., Raineault, N., & Carbotte, S. (2022). Initial Efforts Toward Coordinated Community Data Processing to Accelerate the Growth of Publicly Available Bathymetric Data Products. /Authorea Preprints/.

Wishnak, S. (2022). New frontiers in ocean exploration: The Ocean Exploration Trust, NOAA Ocean Exploration, and Schmidt Ocean Institute 2021 field season.

Gee, L., Heffron, E., Kelley, C., Petruncio, E., von Krusenstiern, K., Baechler, N., … & Raineault, N. (2022). E/V Nautilus 2021 Mapping: US West Coast to Papahanaumokuakea Marine National Monument. /OCEANOGRAPHY/, /35/(1), 24-25.

Cook, M., Wishnak, S., Moran, K., Fiely, J., Zaccaria, J., Ottaviani, J., … & Ballard, E. (2022). Building Community from Ship to Shore Through Ocean Exploration. /OCEANOGRAPHY/, /35/(1), 18-21.

PRODUCTS *(cont'd)*

30. Technologies or techniques

In OECI Year 4 we advanced the readiness levels of both the DriX UxS and Mesobot AUV as well as improved and adapted those vehicles for cooperative operations. The combination of these vehicles led to a novel 'verified directed sampling' approach wherein the submerged asset is guided to the region of interest—in this case a biologically dense deep scattering layer—and collected samples once its position was confirmed. Notably, we were able to integrate a new sonar into the DriX vehicle to expand its mapping capabilities from several hundred meters of water to more than 2000 meters of water. This required adaptation of the sonar by the manufacturer Kongsberg, modifications to the vehicle by the manufacturer eXail, and testing and integration by the operators UNH. The successful integration is a significant accomplishment for this system and will likely be widely adopted. New technologies for processing data in the cloud were developed. New technologies for automated analysis of subsea video were advanced to field trials in this reporting period, and a novel subsea Raman spectrometer for in situ chemical analysis was deployed on a mobile platform for the first time. Further details will be provided in Year 4 report in Summer 2023.

31. Inventions, patent applications, and/or licenses

Nothing to Report

PRODUCTS *(cont'd)*

32. Other products

Data products and physical samples collected during Year 4 activities are either delivered or in the process of delivery to the archives and repositories of record. Details of data and samples, their repositories, and availability will be shared in the Year 4 report in Summer 2023.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

33. What individuals have worked on this project?

Dr. Adam Soule URI (PI, Executive Director)
Dr. Rick Murray WHOI (Co-PI)
Dr. Leila Hamdan USM (Co-PI)
Dr. Larry Mayer UNH (Co-PI)
Allison Fundis OET(Co-PI)

Andrew Bowen WHOI
Leonardo Macelloni USM
Jason Fahy URI
Daniel Wagner OET
Brian Calder UNH

Jessie Kastler USM
Rae Quedara USM
Dwight Coleman URI
Chris Roman URI
Holly Morin URI
Alex Decicio URI
Brenda Moyer URI
Lori Jacolucci URI
Brian Calder UNH
Val Schmidt UNH
Dana Yoerger WHOI
Annette Govindrajan WHOI
Julie Huber WHOI
Megan Cook OET

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
eXail, France, Collaboration
Tuskegee University, Tuskegee, AL, Collaboration
NOAA Fisheries, Collaboration
NOAA Marine Sanctuaries Program, Collaboration
NOAA Deep Sea Coral Research and Technology Project, Collaboration
BOEM, Collaboration
University of Hawaii, Collaboration
Kongsberg, 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 novel 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, 4) advances in our understanding of the distribution of deep sea sponge and coral communities in the Central Pacific, 5) advances in our understanding of the best uses of cloud computing for ocean exploration data processing, 6) improvements in our understanding of long-range uncrewed systems for ocean exploration. Further details will be provided in Year 4 report in Summer 2023.

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 five graduate students either directly through tuition and stipend or indirectly through participation in research and development projects. 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 maintained an Ocean Exploration 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 the Community College of Rhode Island to apply their technical skills to ocean-related problems. This program held a Blue Economy Career Awareness symposium for students from undergraduate and graduate institutions. The OECI sponsored the SeaPerch International Competition that engages middle school through college students in the development of small remotely operated vehicles. 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 URI Inner Space Center continues to work with the NOAA Ocean Exploration education office to create professionally-produced educator professional development webinars. The approach has proven 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?

The OECI projects have supported the acquisition of hardware and software that becomes part of the infrastructure of the institutional affiliates. In OECI Year 4, the maintenance and improvement of facilities was supported for most of the institutional affiliates including the AUV facilities at USM, USV facilities at UNH, telepresence facilities and URI, and ship facilities at OET.

IMPACT *(cont'd)*

42. What was the impact on technology transfer?

The OECI in Year 4 has continued to enable a range of technology transfers 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. In particular, OECIs work with the DriX USV has helped it to be designated an operational vehicle system by the NOAA National Ocean Service. This knowledge produced by OECI has been integrated into the system and is now available to the ocean science community. Most of the technological developments of OECI are in developmental or early operational stages, but have the potential to transfer to commercial organizations in the coming years, with free-use by NOAA and the federal government assumed as part of the technology transfer.

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. 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. Of note, some of the areas of exploration are currently in discussions for expansion of existing protected areas. The baseline ecosystem, geological, and chemical data and samples we collect are instrumental in these discussions.

IMPACT *(cont'd)*

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

0 , 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

Nothing to Report

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

Nothing to Report

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?

Full details of project outcomes will be provided in the Year 4 OECI Annual Report in Summer 2023.

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.