

**Department of Commerce
Research Performance Progress Report – Grants Online Electronic Template**

1. Award Information: Complete Boxes 1 – 23 with the requested information

Box 1. Federal Agency – Department of Commerce/NOAA

Box 2. Federal Award Number – Assigned Award Number for the project

Box 3. Project Title

Launching WebCOOS: Webcams for Coastal Observations and Operational Support

Box 4. Award Period of Performance Start Date

September 1, 2020

Box 5. Award Period of Performance End Date

August 30, 2023

Box 6. Principal Investigator's Last Name

Hernandez

Box 7. Principal Investigator's (PI) First and Middle Name

Debra

Box 8. PI Job Title

SECOORA Executive Director

Box 9. PI's Email

debra@secoora.org

Box 10. PI's Phone Number

843.906.8686

Box 11. Authorizing Official's (AO) Last Name

Box 12. AO First and Middle Name

Box 13. AO Job Title

Box 14. AO Email

Box 15. Signature of Recipient Authorized Representative – Non Applicable

Box 16. Submission Date and Time Stamp

Box 17. Reporting Period End Date

February 28, 2021

Box 18. Reporting Frequency – Semi-annual

Box 19. Report Type – Not Final or Final

Not final

Box 20. Recipient Name

SECOORA

Box 21. Recipient Address

Post Office Box 13856, Charleston, SC 29422

Box 22. Recipient DUNS

Box 23. Recipient EIN

2. Accomplishments: Boxes 24 – 27 are required the first initial progress report. Subsequent reports will be prepopulated with the information from the previous report and have a limit of 4,000 characters. Comment Box 28 is required but will not be pre-populated in subsequent reports.

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

The goal of this project is to develop a sustained operational webcam coastal observing network for quantitative scientific analysis, public safety, and resource management for coastal municipalities. To accomplish this, standardized data processing and management methodology will be established to provide stakeholders actionable information from webcam video.

The objectives of the project will progress the network and its products to near RL 9 by establishing standards for webcam sensor installation and operations, data management, AI/ML applications to image and video processing, and delivery of training and products to end-users for decision making. The results will have immediate benefits to both partners (e.g. NOAA, USGS, USACE) and end-users (e.g. environmental resource managers, public safety officials, tourism officials, and public health officials), as there will be critical coastal observations where presently very limited or no observations exist. Other benefits include supporting the validation and improvement of the NOAA rip current forecast model; joint USGS-NOAA forecasts of total water level and coastal change; and the development of tools to assess beach usage, beach and surf zone conditions, and water quality for swimmer safety and shellfish harvesting.

Our primary goals and objectives for this project are to:

Goal 1) Engage demonstrated webcam operators and other end-users;

Objective 1.1) Identify and engage Tier 1 and 2 users

Objective 1.2) Develop, assess and disseminate stakeholder appropriate outreach and education materials

Objective 1.3) Identify testers within the network and conduct survey to assess ease-of-use, utility of various analyses and informational products, and willingness to pay for webcam imagery or downstream product access or customization.

Goal 2) Operationalize the WebCAT system to a national webcam data management network;

Objective 2.1) Select camera providers and maintain webcams

Objective 2.2) Develop interactive web portal to access live webcam feeds, historical archive footage, and webcam products

Objective 2.3) Standardize webcam imagery and metadata documentation and delivery

Objective 2.4) Develop end-to-end data management workflow integration

Objective 2.5) Integrate quality assurance and quality control (QA/QC) mechanisms

Goal 3) Automate and validate downstream processing of webcam data;

Objective 3.1) Further develop detection algorithms

Objective 3.2) Develop operational prototype products

Objective 3.3) Validation of prototype

Objective 3.4) Operationalization of approach and resultant output

Goal 4) Package image products into geographically and thematically transferable decision-support tools.

Objective 4.1) Develop, validate and operationalize a 'situational monitoring and reporting' tool

Box 25. What was accomplished under these goals?

Goal 1) Engage demonstrated webcam operators and other end-users

Objective 1.1) Identify and engage Tier 1 and 2 users: 17% Complete

Defined Tier 1 users as project partners that are committed to long-term use and include the following stakeholders: U.S. Army Engineer Research and Development Center, USGS St. Petersburg Coastal and Marine Science Center, NOAA NWS Meteorological Development Laboratory (MDL), co-Directors of the Center for Oceans and Human Health and Climate Change Interactions, and Deputy Director of National Estuarine Research Reserve Central Data Management Office. Conducted individual Tier 1 stakeholder interviews to define needs and requirements. Defined Tier 2 users as end-users who may use the derived products to help inform actionable decisions. These include SC Department of Health and Environmental Control (SCDHEC), City of Folly Beach, Town of Surfside Beach, local weather forecast offices, and North Inlet-Winyah Bay National Estuarine Research Reserve. Defined North Inlet-Winyah Bay National Estuarine Research Reserve needs as monitoring bird activity on their primary pier. Working on developing a citizen science project to annotate training data sets.

Objective 1.2) Develop, assess and disseminate stakeholder appropriate outreach and education materials: 17% Complete

Developed WebCOOS Project Informational flyer for potential cameras of opportunity.

Developed descriptive blueprint of the 'Situational Monitoring and Reporting Tool' prototype.

Objective 1.3) 0% Complete. Nothing to Report.

Goal 2) Operationalize the WebCAT system to a national webcam data management network

Objective 2.1) Select camera providers and maintain webcams: 17% Complete

Identified existing webcams of value to the project team. Initiated contract negotiations with potential camera provider. Developed a list of 160+ cameras of opportunity, organized by placement, positioning, and orientation. Developed project outreach and overview materials and began contacting cameras of opportunity. Identified a homeowner interested in coastal management applications and established a new webcam in Oak Island, NC.

Objective 2.2) Develop interactive web portal to access live webcam feeds, historical archive footage, and webcam products: 17% Complete

- Established links to new webcams for data ingestion and display

Objective 2.3) Standardize webcam imagery and metadata documentation and delivery: 17% Complete

- Development of standard metadata schema for video data

Objective 2.4 and Obj. 2.5: Nothing to Report

Goal 3) Automate and validate downstream processing of webcam data;

Objective 3.1 Further develop detection algorithms: 20% Complete

Engaged two undergrad volunteers to collect training data for rip currents other than bathymetry-controlled rips. Conducted initial investigation of drop-outs to improve ML prediction accuracy. Conducted work on Holland Beach Cam as a testbed for flow-based rip detection. Coordinated with Joshua Rigo (NWS) to apply ML method to identify rips from satellite imagery. Revising a report/paper on flow-based analysis for submission to IEEE ACCESS.

Objective 3.2) Develop operational prototype products: 25% complete

Performed initial porting of rip current ML model to a mobile platform. Investigated alternative lighter weight models to run on mobile platforms. Established a citizen science camera station that allows users to upload snapshots, and algorithms to delineate shoreline water levels. This is an extension of the current WebCOOS network and will combine both webcam stations and citizen science opportunities. The shoreline tracking performed on images from the citizen science camera station is being done by a current UNCW undergraduate student in the Department of Earth and Ocean Sciences.

Objective 3.3 Obj. 3.4: Nothing to Report

Goal 4) Package image products into geographically and thematically transferable decision-support tools.

Objective 4.1) Develop, validate and operationalize a 'situational monitoring and reporting' tool : 17% Complete

- Developed “Situational Monitoring and Reporting Tool” prototype. The tool utilizes web cameras and automated image extraction algorithms to produce a customizable method to monitor, assess, and report beach activities.

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

The project team member from the University of California Santa Cruz provided graduate student research support for Akila de Silva and professional development of Issei Mori. In addition to the involvement of two undergrad volunteers to collect additional training data for other types of rip currents.

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

Members of the project team, from the University of California Santa Cruz, presented “Automated Rip Current Detection with Region based Convolutional Neural Networks” at the University of Utah on February 10th, 2021 . Project team members from Axiom added new data feeds onto the current WebCat interface.

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

Objective 1.1) Identify and engage Tier 1 and 2 users

- Complete all interviews and meetings with Tier 1 and Tier 2 users to identify needs

Objective 2.1) Engage with identified cameras of opportunity

- Identify additional sites for potential new cameras
- Engage with identified cameras of opportunity

Objective 2.2) Develop interactive web portal to access live webcam feeds, historical archive footage, and webcam products

- Create WebCOOS-branded data portal (expanding from the prototype WebCAT portal) to show real-time camera data feeds and archives of raw or processed camera products, indexed by time.

Objective 2.3) Standardize webcam imagery and metadata documentation and delivery

- Leverage the revised IOOS Metadata Profile v1.2 (see: <https://ioos.github.io/ioos-metadata/ioos-metadata-profile-v1-2.html>) standard for structuring web camera metadata. Extend the profile as appropriate in coordination with the standard governance process.
- Provide software engineering and cyberinfrastructure support for the development of operational data management and analysis system.

Objective 2.4) Develop end-to-end data management workflow integration

- Create an ingestion process for web camera data feeds via direct communication with cameras or camera provider systems.

Objective 3.1) Further develop detection algorithms

- Incorporate results from drop-out experiments to improve model accuracy.
- Submit to IEEE ACCESS, and document results of Holland Beach Cam customizations.
- Test existing algorithms to track shoreline water levels on multiple WebCOOS cameras. Explore machine-learning/AI techniques to expand water level tracking.
- Retrain ML model with additional data for other rips, and test new model.

Objective 3.2) Develop operational prototype products

- Work towards a mobile app version of ML and flow-based methods for detecting rip currents.

Objective 4.1) Develop, validate and operationalize a ‘situational monitoring and reporting’ tool

- Continue development of the ‘Situational Monitoring and Reporting Tool’ by integrating Tier 1 and Tier 2 needs

- 3. Products: Comments are required in Boxes 29 – 32 are required the first initial progress report. Subsequent reports will be prepopulated with the information from the previous report and have a limit of 4,000 characters. If the comment is blank, the “Nothing to Report” checkbox must be checked.**

Box 29. Publications, conferences papers and presentations

Project team members from the University of California, Santa Cruz presented the following presentation at the University of Utah, Feb 10, 2021;

Akila de Silva, Issei Mori, Gregory Dusek, James Davis, Alex Pang, “Automated Rip Current Detection with Region based Convolutional Neural Networks” accepted to Coastal Engineering Journal. 2021. Preprint version available from:

<https://arxiv.org/abs/2102.02902>

Box 30. Technologies or techniques

Team members from the University of South Carolina developed a ‘Situational Monitoring and Alerting’ tool prototype. The tool utilizes web cameras and automated image extraction algorithms to produce a customizable method to monitor, assess, and

report beach activities. The tool can count a range of objects in a given area, including swimmers, beachgoers, umbrellas, dogs, and other beach objects. The software can provide timestamped counts in near real-time and derive trends from those collections. The information is presented to the end-user in a simplified, user-friendly format through email, text notifications, or a designated web portal. The tool packages dense scientific data into a clean interface that can immediately be used for decision-making. The tool's ability to extract data from camera feeds can provide a wide range of unique real-time information on environmental parameters defined by the stakeholder. Developed ML and flow-based methods for detecting rip currents.

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

Nothing to Report.

Box 32. Other products

Nothing to Report.

- 4. Participants & Other Collaborating Organizations – Note that all comments boxes are required and the first report will always be blank. For comments boxes 33, 35 & 36 subsequent reports will be pre-populated with the information from the previous report. Comments boxes have a limit of 4,000 characters. For comments boxes 34 – 36, if the comment box is blank, the “Nothing to Report” checkbox must be checked.**

Box 33. What individuals have worked on this project?

PI: Debra Hernandez, SECOORA Executive Director

Lead Science PI: Dwayne Porter, Univ. SC

UofSC Graduate Student/Coordinator: Louisa Schandera

Senior Software Developer: Jeremy Cothran

Co-PI: Joseph Long, Univ. NC Wilmington

UNC Undergraduate Student: Kelsea Edwing

Co-PI: Alex Pang, Univ. California Santa Cruz

UCSC Graduate Students: Akila de Silva and Issei Mori

Co-PI: Kyle Wilcox, Axiom Data Science

Axiom Project Manager: Lauren Showalter

Box 34. Has there been a change in the active other support of the Project Director/Project Investigator(s) or senior/key personnel since the reporting period?

Joseph Long, WebCOOS Project Co-PI, has received a grant from the Department of Defense to study erosion and recovery cycles of barrier islands. *“Beach Berms: The missing link to predicting decadal-scale barrier island evolution?”*, U.S. Coastal Research Program. PIs: Long (lead), Hawkes, November 1, 2020 – September 30, 2023, \$265,549 (UNCW: \$265,549)

Box 35. What other organizations have been involved as partners?

Katherine Brodie and Brittany Bruder, U.S Army Engineer Research and Development Center, Jenna Brown, USGS St. Petersburg Coastal and Marine Science Center, Gregory Dusek, NOAA NOS COOPS, Michael Churma, NOAA NWS Meteorological Development Laboratory (MDL), Geoff Scott and Paul Sandifer, co-Directors of the Center for Oceans and Human Health and Climate Change Interactions (OHHC2I), Melissa Ide, Deputy Director of National Estuarine Research Reserve Central Data Management Office, and National Weather Service: Wilmington WFO, Morehead City WFO.

Box 36. Have other collaborators or contracts been involved?

No other contracts have been issued.

Individuals from the City of Folly Beach, SCDHEC, and North Inlet-Winyah Bay National Estuarine Research Reserve are collaborating with WebCOOS project.

- 5. Impact – Note that all comments boxes are required and the first report will always be blank. For comments boxes 37 - 43 subsequent reports will be pre-populated with the information from the previous report. Comments boxes have a limit of 4,000 characters. For comments boxes 37 - 43, if the comment box is blank, the “Nothing to Report” checkbox must be checked. For comment box 44, only the percent is required (even if it is a zero), the explanation is not required.**

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

As we develop the WebCOOS system, the following fundamental questions will be addressed:

1. Can we increase our understanding of coastal processes and by increased data and understanding that comes from video cameras?
2. Could object recognition be successfully applied to find objects that are both ephemeral and amorphous?
3. Can stakeholder coastal observations data needs be fulfilled by developing personalized operational webcam networks and integrated neural network software applications?

This project, once completed, will contribute to the advancement of environmental monitoring, reporting, and alerting.

Box 38. What was the impact on other disciplines?

The project will provide new understanding and alternative methods for detecting and monitoring environmental conditions, including rip currents, shoreline water levels, dune erosion, and understanding human use of natural resources. In return, the information can help support the progress of research, environmental science, coastal management, and related disciplines. Stakeholders such as NOAA, USGS, state health agencies, academia, and community members may also benefit from this work.

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

Nothing to Report.

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

The project will provide opportunities for undergraduate research in coastal hazards and video remote sensing. The project developments and derived data will provide research and video remote sensing exposure to the general public through citizen science opportunities. The obtained shoreline data will support an undergraduate honors thesis at the University of North Carolina Wilmington related to the tracking of shoreline water levels. The project's developments will provide examples of practical applications of what students learn in class at the University of California Santa Cruz.

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

Nothing to report.

Box 42. What was the impact on technology transfer?

Nothing to Report.

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

The project will be able to provide data and tools that can improve public knowledge about coastal hazards, engage local community members, enable widespread use of camera systems by researchers, managers, and first responders for a growing range of environmental monitoring applications, and provide valuable imagery and products to support scientific research, coastal operations, and decision-making along the coast.

Box 44. What percentage of the award is budget was spent on foreign countries?

Enter Percent: 0%

6. **Changes/Problems** – Note that all comment boxes are required fields and have a limit of 4,000 characters. If the comment box is blank, the “Nothing to Report” checkbox must be checked.

Box 45. Changes in approach and reason for change

Nothing to Report.

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

Nothing to Report.

Box 47. Changes that had a significant impact on expenditures

University of California Santa Cruz: The COVID-19 pandemic impacted/cancelled travel plans. The travel budget was reallocated to support Issei Mori’s work on flow-based analysis. Additionally, the open access cost associated with the publication was higher than originally allocated in the budget.

University of North Carolina Wilmington: UNCW did not establish fund accounts until early 2021 which was past the time to recruit/engage a new Masters student. A student has been identified to start in Fall 2021 but first year student funding has not been spent. Some funds will be expended over the summer for student salary.

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

Not Applicable.

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

Nothing to Report.

7. **Project Outcomes** – Note that the comment box is a required field and has a limit of 4,000 characters

Box 50. What were the outcomes of the award?

Nothing to Report.