

Progress Report

Project Title: Sustaining NANOOS, the Pacific Northwest component of the U.S. IOOS

Award Number: NA21NOS0120093

Period of Activity: 07/01/2023 - 12/31/2023

Principal Investigator(s): Jan Newton, NANOOS Executive Director

1) Project Summary

Our overall project goal is to sustain the Northwest Association of Networked Ocean Observing Systems, NANOOS, as the Regional Coastal Ocean Observing System for the U.S. Pacific Northwest that serves regional stakeholders in alignment with the vision of the U.S. Integrated Ocean Observing System (IOOS®). NANOOS, with its essential subcomponents (integrated in-water and land-based Observing Systems, Data Management and Communications, Modeling and Analysis, and Education and Outreach) that are closely integrated within the national IOOS® system, provides significant societal benefits across a wide spectrum of users including federal, tribal, state, and local governments, marine industries, scientific researchers, Non-Governmental Organizations (NGOs), educators and the general public.

For FY2023 (= Y2 of the award = Y16 of NANOOS RCOOS) our objectives were to:

- 1) **Maintain NANOOS as the U.S. IOOS PNW Regional Association:** Sustain our proven role for regional coordination, administrative infrastructure, and stakeholder engagement, partnering with federal and non-federal (tribal, academic, state, local, industry, NGO, etc.) entities.
- 2) **Maintain surface current and wave observations:** Maintain existing HF-radar and wave mapping capabilities, providing critical national capacity along coasts and at critical ports.
- 3) **Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs:** Maintain, harden, enhance existing buoys and gliders, with focus on hypoxia, HABs, OA, and climate.
- 4) **Maintain multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs:** Sustain observing ability to aid sustainable resource management, water quality assessment, and sub-regional climate change evaluation.
- 5) **Maintain core elements of beach and shoreline observing:** Measure nearshore bathymetry, topographic beach profiles, and shoreline morphodynamics along OR and WA, contributing to hazard mitigation by providing essential observations and better decision support tools for coastal managers, planners, and engineers.
- 6) **Provide sustained support to a community of complementary regional numerical models:** Contribute to the operation of regional models, and the tools and products they support, covering the head of tide of estuaries to the outer edges of the Exclusive Economic Zone (EEZ) in both OR and WA.
- 7) **Maintain, harden, and enhance NANOOS' Data Management and Cyberinfrastructure (DMAC) system for routine operational distribution of data and information:** Sustain and enhance the DMAC system, including the NANOOS Visualization System (NVS), for dynamic and distributed data access.
- 8) **Continue to deliver existing and, to the extent possible, create innovative and transformative user-defined products and services for PNW stakeholders:** Continue our NVS innovation to succeed in this vital translation for meaningful and informative data products that address user needs and serve society.
- 9) **Sustain and diversify NANOOS engagement to the extent possible:** Continue ongoing engagement with diverse stakeholders and the public, increasing ocean awareness and

literacy; to diversify the ocean and coastal workforce; to improve our ability to provide relevant ocean and coastal data and information to underserved or underrepresented communities; and to facilitate use of NANOOS products for societal objectives, the core task for which NANOOS exists.

During FY23, NANOOS has the following additional tasks funded via IOOS (1-4, 11-12) and the NOAA Ocean Acidification Program (5-10):

1. Further HABs understanding and prediction via a pilot project to support key elements needed to produce the popular Pacific Northwest Harmful Algal Bloom Bulletin including offshore and ESP sampling, beach sampling by tribes and the State of Oregon, analysis, and circulation modeling (Mordy/McCabe (CICOES/NOAA), Trainer (UW ONRC), MacCready (UW Oceanography), Litle (UW Washington Sea Grant), Kavanaugh (OSU), Newton (UW APL))
2. One-time system add-on for HFR system-wide support and replacement for HFR manufactured last century (Kosro, OSU)
3. Expenses associated with SeaSondes for HFR (Kosro, OSU)
4. One year to assist with core needs of the Regional Association in FY23 (Newton, UW)
5. Support for the NANOOS GOA-ON Co-Chair (Newton, UW)
6. Support for the NANOOS GOA-ON Data Portal (Tanner, UW)
7. Support for NOA-ON NANOOS Cha'ba (Mickett/Newton, UW)
8. Support for NOA-ON NANOOS NH-10/CB06 (Hales, UW)
9. OMAO allotment of FY23 resources in support of a vessel charter pool to service Cha'ba (Mickett, UW)
10. Support for NOA-ON NANOOS Cha'ba - Charter Vessel Pool (Mickett, UW)
11. Fabrication of a HAB water sampler for the new Seasats AUV (Mickett, UW)
12. OceanHackWeek sponsorship at UW (Mayorga, UW)

2) Progress and Accomplishments

During the project period, NANOOS accomplished its objectives outlined above. NANOOS maintained the RCOOS subsystems it has developed, implemented, and integrated with NOAA IOOS funding and substantial external leverage. NANOOS remained focused on delivering data-based products and services that are easy to use to diverse stakeholders to address high-priority issues and aid decision making. NANOOS continued its proactive interactions and regional coordination with a wide range of PNW stakeholders, to prioritize and refine our observations, products, and outreach efforts as funding allowed.

NANOOS milestones for this award are provided in Table 1 and reported on in detail throughout this document. Our assessment is that NANOOS has met these milestones for the reporting period. We report here on progress for: a) Governance and Management Subsystem; b) Observing Subsystem (surface currents and waves, shelf buoys/moorings/gliders, estuary buoys/moorings, and beaches and shorelines); c) Modeling and Analysis Subsystem (estuaries and shelves); and d) Data Management and Communications Subsystem (Data Management and Cyberinfrastructure (DMAC), User Products Committee (UPC), and Education and Outreach (E&O)).

Table 1. NANOOS Milestones.

Subsystem / Area	Milestone
Observing Subsystem	
Currents & Waves	Maintain surface current and wave observations: Maintain existing HF-radar and wave mapping capabilities, providing critical national capacity along coasts and at critical ports.
	<u>PNW Coast HF Surface Current Mapping:</u> <i>Lead PI: Kosro, OSU</i> <ul style="list-style-type: none"> - Maintain and operate 10 SeaSonde HF sites designated as Priority 1 sites by the national HF program; these are four long-range sites in OR, three in WA, one in CA, and two standard-range sites in OR - As resources allow, - 3 Priority 2 standard-range sites covering Heceta Bank, which is a source for HABs and of strong bathymetric flow perturbation, as well as the shelf portion of the OOI Endurance Array - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<u>Wave Imaging at Critical PNW Ports:</u> <i>Lead PI: Haller, OSU</i> <ul style="list-style-type: none"> - Sustain the existing marine radar observing station at USCG Station Yaquina Bay - Provide both real-time and historical wave information via NVS; mean and snapshot radar images are real-time viewable for use in environmental characterization - Bring all data QA/QC to meet Certification standards
Shelf	Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs: Maintain, harden, enhance existing buoys and gliders, with focus on hypoxia, HABs, OA, and climate.
	<u>WA shelf buoys/moorings:</u> <i>Lead PI: Mickett, UW</i> <ul style="list-style-type: none"> - Maintain the WA shelf (off La Push) Cha'ba buoy and the NEMO subsurface profiler at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>WA shelf HAB buoy/mooring:</u> <i>Lead PI: Mickett, UW</i> <ul style="list-style-type: none"> - Support for the HAB ESP deployment on NEMO mooring - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>WA La Push glider:</u> <i>Lead PI: Lee, UW</i> <ul style="list-style-type: none"> - Maintain the La Push line glider at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>OR shelf buoy:</u> <i>Lead PI: Kosro, OSU</i>

	<ul style="list-style-type: none"> - Maintain the CB-06 buoy off Coos Bay at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>Columbia shelf mooring:</u> <i>Lead PI: Seaton, CRITFC</i> <ul style="list-style-type: none"> - Maintain the CMOP shelf mooring at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>Washington shelf glider:</u> <i>PIs: Barth, OSU & Seaton, CRITFC</i> <ul style="list-style-type: none"> - Maintain the Washington shelf glider at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>Northern California glider:</u> <i>Lead PI: Barth, OSU</i> <ul style="list-style-type: none"> - Maintain the Trinidad Head, CA, glider, shared with CeNCOOS, at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
Estuaries	Maintain multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs: Sustain observing ability to aid sustainable resource management, water quality assessment, and sub-regional climate change evaluation.
	<u>Puget Sound, WA, profiling buoys:</u> <i>Lead PI: Manalang, UW</i> <ul style="list-style-type: none"> - Maintain 6 Puget Sound estuarine profiling moorings at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<u>Puget Sound, WA, US ferry-box:</u> <i>Lead PI: Krembs, WDOE</i> <ul style="list-style-type: none"> - Maintain US-Canada ferry-box at existing levels, assuming COVID-19 does not preclude its operation - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<u>Columbia River estuary, OR, moorings:</u> <i>Lead PI: Seaton, CRITFC</i> <ul style="list-style-type: none"> - Maintain CMOP estuarine moorings at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<u>South Slough/Coos Bay, OR, moorings:</u> <i>Lead PI: Helms, ODSL</i> <ul style="list-style-type: none"> - Maintain South Slough/Coos Bay estuarine moorings for the NERRS at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards

Beaches & Shorelines	<p>Maintain core elements of beach and shoreline observing: Measure nearshore bathymetry, topographic beach profiles, and shoreline morphodynamics along OR and WA, contributing to hazard mitigation by providing essential observations and better decision support tools for coastal managers, planners, and engineers.</p>
	<p><u>WA beach and shoreline:</u> <i>Lead PI: Kaminsky, WDOE</i></p> <ul style="list-style-type: none"> - Maintain shoreline observations in WA at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<p><u>OR beach and shoreline:</u> <i>Lead PI: Allan, DOGAMI</i></p> <ul style="list-style-type: none"> - Maintain shoreline observations in OR at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<p><u>WA and OR bathymetry:</u> <i>Lead PI: Ruggiero, OSU</i></p> <ul style="list-style-type: none"> - Maintain nearshore bathymetric observations of beach and shoreline morphodynamics in WA and OR at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
Modeling & Analysis Subsystem	
WA & OR Estuaries & Coast Models	<p>Provide sustained support to a community of complementary regional numerical models: Contribute to the operation of regional models, and the tools and products they support, covering the head of tide of estuaries to the outer edges of the Exclusive Economic Zone (EEZ) in both OR and WA.</p>
	<p><u>NE Pacific and Salish Sea:</u> <i>Lead PI: MacCready, UW</i></p> <ul style="list-style-type: none"> - Support, at existing levels, the daily forecast model, LiveOcean, which simulates ocean circulation and bio-geochemistry in the Salish Sea and in coastal waters of the NE Pacific, including Oregon, Washington, and British Columbia - Deliver model output via NVS - Model verification and validation
	<p><u>Columbia River estuary and plume:</u> <i>Lead PI: Seaton, CRITFC</i></p> <ul style="list-style-type: none"> - Support, at existing levels, the CRITFC circulation modeling and forecasting system, which covers the Columbia River estuary and plume - Deliver model output via NVS - Model verification and validation
	<p><u>PNW Coastal Waters:</u> <i>Lead PI: Zaron, OSU</i></p> <ul style="list-style-type: none"> - Support, at existing levels, the OSU real-time coastal ocean forecast model, which covers the coastal waters off OR and WA - Deliver model output via NVS - Model verification and validation

Data Management & Communications Subsystem	
Data Management & Cyberinfrastructure (DMAC)	<p>Maintain, harden, and enhance NANOOS' Data Management and Cyberinfrastructure (DMAC) system for routine operational distribution of data and information: Sustain and enhance the DMAC system, including the NANOOS Visualization System (NVS), for dynamic and distributed data access.</p>
	<p><u>Mature Regional DAC Operations:</u> <i>Lead PI: Tanner, UW</i></p> <ul style="list-style-type: none"> - Sustain, refresh, and enhance a highly available, robust, distributed hardware and software environment; maintain appropriate staffing and team coordination; maintain up-to-date operations and system documentation to ensure transparent and clear descriptions of DAC architecture - Engage new local providers (not NANOOS funded), integrate their data into NVS and IOOS DMAC services; strengthen DAC capabilities and resources through regional and thematic partnerships
	<p><u>NVS Support and Development:</u> <i>PIs: Tanner & Carini, UW</i></p> <ul style="list-style-type: none"> - Maintain NVS support leveraging regional user needs, feedback, and data reviews to continually improve the relevance and quality of metadata for observing and modeling data assets integrated and served by NANOOS - Sustain & enhance existing data streams, IOOS web services, GTS submission; implement NCEI data archiving, NDBC data archiving, Glider DAC submission, QARTOD; maintain and expand ERDDAP to leverage web services, serve NANOOS applications and users; evaluate where new tech (e.g., cloud, AI, etc.) may afford NANOOS better efficiencies and robustness
	<p><u>Engagement in National and Cross-regional DMAC Efforts:</u> <i>PIs: Tanner & Carini, UW</i></p> <ul style="list-style-type: none"> - Sustain participation in IOOS DMAC community activities, including QARTOD development, semantic mapping, OGC WMS/WFS support, climatology data development, UGRID support, and shared code development and testing - Extend to other areas via pan regional products with sister IOOS RAs; engage and leverage NSF-funded OOI, international GOA-ON activities, and Canadian collaborations; engage with other West Coast and Pacific efforts, including WCGA and IPACOA
User Products Committee (UPC)	<p>Continue to deliver existing and, to the extent possible, create innovative and transformative user-defined products and services for PNW stakeholders: Continue our NVS innovation to succeed in this vital translation for meaningful and informative data products that address user needs and serve society.</p>
	<p><u>Web Site:</u> <i>Lead PI: Tanner, UW</i></p> <ul style="list-style-type: none"> - Continue to evaluate and update web content relevant to stakeholder issues, especially those related to Maritime Operations, Ecosystem Assessment, Fisheries & Biodiversity, Coastal Hazards, and Climate; improve ease of usability and user tracking capabilities
	<p><u>Tailored Products Development:</u> <i>Lead PI: Allan, DOGAMI</i></p>

	<ul style="list-style-type: none"> - Annually evaluate priorities for products at the Tri-Com meeting (DMAC, UPS, and E&O), based on outreach feedback, regional issues, and GC input, and will implement new tailored products to the extent possible
Education & Outreach (E&O)	<p>Sustain and diversify NANOOS engagement to the extent possible: Continue ongoing engagement with diverse stakeholders and the public, increasing ocean awareness and literacy; to diversify the ocean and coastal workforce; to improve our ability to provide relevant ocean and coastal data and information to underserved or underrepresented communities; and to facilitate use of NANOOS products for societal objectives, the core task for which NANOOS exists.</p> <p><u>Communication:</u> <i>Lead PIs: Wold & Newton, UW</i></p> <ul style="list-style-type: none"> - Maintain up-to-date success stories, employing effective use of social media and newsletters - Support national communication through IOOS Program Office and IOOS Association collaborations - Be responsive to regional and local events (e.g., harmful algal blooms, fish kills, marine heat waves, hypoxia, floods, etc.) to enhance relevancy to public and highlight regional stories with NANOOS members and partners - Maintain existing and build new relationships to stakeholder user groups and the education community enabling NANOOS to achieve effective education and outreach <p><u>Product Co-Development:</u> <i>Lead PIs: Wold, UW & Allan, DOGAMI</i></p> <ul style="list-style-type: none"> - Engage users in product co-development through focus groups; use targeted interviews or surveys to garner feedback and input on products as they are developed; gain feedback and conduct self-assessment after product release - Conduct trainings to broader user groups and evaluate trainings to optimize NANOOS functionality - Engage with regional formal education communities to use ocean observing and NANOOS products to support STEM education, and with regional non-formal education communities to facilitate the use of NANOOS products to foster community ocean literacy <p><u>Diversity, Equity, and Inclusion:</u> <i>Lead PIs: Newton & Wold, UW</i></p> <ul style="list-style-type: none"> - Work with the other IOOS regions and the Program Office on workforce development initiatives to expand and diversify the ocean, coastal, and Great Lake workforces and to improve our ability to provide relevant ocean and coastal data and information to underserved or underrepresented communities. - On a more immediate and local scale, the NANOOS “Enabling Change” working group, made up of NANOOS staff and partners (currently federal, university, and state agency) will move forward with actions that match NANOOS’ commitment ability.
Governance & Management Subsystem	
Governance, Representation, Oversight,	<p>Maintain NANOOS as the U.S. IOOS PNW Regional Association: Sustain our proven role for regional coordination, administrative infrastructure, and stakeholder engagement, partnering with federal and non-federal (tribal, academic, state, local, industry, NGO, etc.) entities.</p>

Coordination & Accountability	<p><u>Governance:</u> <i>PIs: Newton, Rome & Carini, UW</i></p> <ul style="list-style-type: none"> - Assure that NANOOS has transparent, effective, and representational governance via its Governing Council and the NANOOS Executive Committee composed of its elected Board and its functional committee chairs - Assure these bodies are engaged in NANOOS prioritization of regional needs, work effort, and product development - Assure balance of stakeholders represented in NANOOS reflects the diversity found in PNW - Conduct annual GC meeting
	<p><u>Representation:</u> <i>PIs: Newton, Rome & Carini, UW</i></p> <ul style="list-style-type: none"> - Represent NANOOS at IOOS Program Office and IOOS Association meetings, and at national meetings of significance - Engage at a regional level at meetings and workshops affecting PNW stakeholders and NANOOS
	<p><u>Project Oversight:</u> <i>PIs: Newton, Rome & Carini, UW</i></p> <ul style="list-style-type: none"> - Conduct annual all-PI meetings and Tri-Committee meetings, providing clear feedback and direction - Share project evaluation at the annual PI meeting
	<p><u>Coordination:</u> <i>PIs: Newton, Rome & Carini, UW</i></p> <ul style="list-style-type: none"> - Coordinate with West Coast RAs and other RAs to optimize and leverage capabilities and assure consistencies - Engage in sub-regional and user-group specific workshops to aid coordination and optimization of effort - Coordinate with Canada (CIOOS, MEOPAR, etc.)
	<p><u>Accountability:</u> <i>PIs: Newton, Rome & Carini, UW</i></p> <ul style="list-style-type: none"> - Submit required IOOS progress reports and respond to other requests - Attain recertification in 2023 as the Regional Information Coordination Entity of US IOOS for the PNW

A. Observing Subsystem:

Data from all assets reported here are served via [NVS](#).

CURRENTS AND WAVES

Maintain surface current and wave observations: Maintain existing HF-radar and wave mapping capabilities, providing critical national capacity along coasts and at critical ports.

PNW Coastal HF Surface Current Mapping:

- *Maintain and operate 10 SeaSonde HF sites designated as Priority 1 sites by the national HF program; these are four long-range sites in OR, three in WA, one in CA, and two standard-range sites in OR [Kosro]*
- *As resources allow, 3 Priority 2 standard-range sites covering Heceta Bank, which is a source for HABs and of strong bathymetric flow perturbation, as well as the shelf portion of the OOI Endurance Array*

- *Deliver data via NVS [Kosro]*
- *Bring all data QA/QC to meet Certification standards [Kosro]*

Status: On track

Summary: During this reporting period, work was completed for the operation and processing of data from the HF sites and their transfer to the IOOS HF data assembly center via our local portal, with CORDC uptime stats of 89% and 95% (#2 and #1 for the system) for Jul-Sep and Oct-Dec respectively. Our MAN1 site, at Manhattan Beach, is down due to a lightning strike and needs to be completely re-installed. The transition to new frequencies requires installation of replacement HF antennas.

Accomplishments/Successes: Operation of HF sites and data delivery. New Washington state site WSP1 provided data to the national system. Purchased new computers for all remote sites to run the latest operating system and acquisition software.

Problems/Delays: Permit applied for at northernmost site KAL1, in the Olympic National Park.

Non-core Task 2: *One-time system add-on for HFR system-wide support and replacement for HFR manufactured last century [Kosro]*

Status: Completed

Summary: See "Accomplishments/Successes"

Accomplishments/Successes: Updated FCC licenses, computers. Received antennas from Codar (PO funding). In process of installing.

Problems/Delays: Permission from the National Park Service still needed.

Non-core Task 3: *Expenses associated with SeaSondes for HFR [Kosro]*

Status: In Progress

Summary: Installed several new antennas and new receivers/transmitters.

Accomplishments/Successes: Updated SEA1 and several long-range systems.

Problems/Delays: Negotiating for permissions to install new equipment at PSG1, MAN1.

Wave Imaging at Critical PNW Ports:

- *Sustain the existing marine radar observing station at USCG Station Yaquina Bay [Haller]*
- *Provide both real-time and historical wave information via NVS; mean and snapshot radar images are real-time viewable for use in environmental characterization [Haller]*
- *Bring all data QA/QC to meet Certification standards [Haller]*

Status: On track

Summary: The radar station on the USCG Yaquina Bay watchtower at Newport, OR, was operated continuously through this reporting period. The data acquisition and processing system generated imagery and reported wave parameters and wave spectra from nearshore locations in near-real-time. These were published to NVS and a comprehensive Oregon State University website (linked to from NVS).

Accomplishments/Successes: A listing of recorded radar data is available via the OSU website, and work continues to make a searchable database of radar recordings. Data recorded by the radar system during this period will be used to inform and validate coastal storm model development in collaboration with the US Army Corps of Engineers. In addition, the wave-averaged images are being used to plan a rip current drifter experiment to measure currents over the Yaquina reef.

Problems/Delays: N/A

SHELF

Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs: Maintain, harden, enhance existing buoys and gliders, with focus on hypoxia, HABs, OA, and climate.

Washington Shelf Buoys/Moorings:

- *Maintain the WA shelf (off La Push) Cha'ba buoy and the NEMO subsurface profiler at existing levels [Mickett]*
- *Deliver NRT data streams via NVS [Mickett]*
- *Bring all data QA/QC to meet Certification standards [Mickett]*

Status: On track

Summary: The Washington Coast buoy observation program continued the work of maintaining and operating two real-time moorings 13 miles NNW of La Push, Washington. The fall 2023 mooring servicing cruise occurred Sep 22-27 aboard the R/V Thompson, recovering the Summer Cha'Ba mooring and the NEMO-subsurface moorings, deploying the Winter Cha'Ba mooring. This cruise was a success despite weather constraints forcing all work to be completed within a short two-day window. Plans to recover gear remaining from the winter 2022/23 deploy that was not recovered on the spring cruise had to be delayed. Additionally, upon recovering the Summer Cha'Ba mooring we discovered that the SAMI pH instrument, which is mounted under the buoy and connected to the PMEL MAPCO2 system, was missing. Damage to instrument cables under the buoy suggested that either a vessel strike or fishing gear entanglement could have caused this loss. A comprehensive analysis of AIS ship tracks provided by the Sanctuary unfortunately did not shed light on the root cause of this damage/loss. Data return from the summer Cha'Ba deploy was poor— with a cable failure on the WQM (shallow CTD) resulting in no data after late June and power issues (depleted Iridium battery) with the pCO2 system resulting in no real-time data after mid-June. Although we do not know the root cause of this damage, we will take steps to harden the mooring in an attempt to prevent this for future deployments, including casing all subsurface cables in protective sheathing. Data coverage on nearby NEMO-Subsurface mooring, however, was excellent, with 100% data return for the two ADCPs, CTD and McLane profiler over the deployment (May-Sept). As of the reporting period the pCO2 system on the winter Cha'Ba mooring was reporting. We are also pleased that upgrades to the winter mooring design seem to be effective, with the mooring surviving several storms with waves in excess of 20'.

The process of transferring all historical Cha'Ba and NEMO-Subsurface data—going back to 2010—onto the group's ERDDAP server continues. In addition to the Cha'Ba wind data, WQM CTD data, and NEMO-subsurface CTD data, developmental work on the inclusion of historical ADCP data has begun. All data currently available on the ERDDAP server can be found here: <https://nwem.apl.washington.edu/erddap>.

The team continued collaboration with Jennifer Hagen, Marine Policy Advisor for Quileute Natural Resources, who participated in our September operations. The team also continued collaboration with Sea-Bird Electronics, which refurbished and renewed the loan of a Sea-Bird SeapHOX instrument that was deployed on the winter Cha'Ba mooring to collect deep (84 m) measurements of conductivity, temperature, depth, dissolved oxygen, salinity, and pH.

Accomplishments/Successes: Successful Winter Cha'ba mooring deployment in September 2023, and recovery of summer mooring, NEMO-Subsurface. Excellent data return on NEMO-Subsurface with new buoy controller. With the exception of the pCO2 system (as noted above), real-time data transfer worked flawlessly for both moorings.

Problems/Delays: Weather conditions prevented the recovery of the mooring line/anchor that was not recovered during the spring 2023 cruise. Additionally, we had several meetings to resolve issues with preparations and checks of the pCO2 system and now have a formal checklist that will hopefully prevent a repeat of this year's mistakes.

Non-core Task 7: Support efforts for OA observing on NANOOS NOA-ON Cha'ba on the WA shelf [Mickett, Newton]

Status: On track

Summary: Carbon measurements are conducted in partnership with PMEL Carbon Programs. The Cha'Ba MapCO2 carbon system is operated on both the summer and winter Cha'Ba buoys, with instruments swapped every 6-8 months in the spring and fall.

Accomplishments/Successes: Continued coordination with the PMEL carbon program to ensure a newly tuned MAPCO2 carbon system is deployed on each mooring installation - this saves valuable time during cruises and improves system performance outcomes by only using recently-verified instrumentation systems. Previously, systems were moved from one deployed mooring to another without thorough testing between deployments.

Problems/Delays: We learned that the Iridium antenna battery on the Summer Cha'Ba mooring was depleted after mooring deployment. This did not allow real-time data transmissions for the summer deployment. Mickett and team had a subsequent discussion with PMEL collaborators to ensure that these preventable errors would not happen again. Additionally, due to physical damage to the Cha'Ba base, the SAMI pH instrument was lost over the summer deployment (see above section). This was the first time in 14 years of deployments (since 2010) that this has happened. FY 23 funding yet to be received by PI.

Non-core Task 9: Support for OMAO allotment of FY23 resources in support of a vessel charter pool to service Cha'ba [Mickett]

Status: On track

Summary: These funds are to augment NCCOS MERHAB funds to deploy the ESP HAB-monitoring mooring adjacent to the Cha'Ba mooring.

Accomplishments/Successes: Part of these funds were used to support an ESP mooring swap that occurred in August 2023. Remaining funds will be used to support the spring 2024 and August 2024 mooring operations.

Problems/Delays: Funding yet to be received by PI.

Non-core Task 10: Support NOA-ON NANOOS Cha'ba - Charter Vessel Pool [Mickett]

Status: On track

Summary: Funding to support Cha'ba mooring servicing cruises will be used to cover the fall 2024 cruise aboard the R/V Pacific Storm.

Accomplishments/Successes: Booked the R/V Pacific Storm for 6 days in October 2024.

Problems/Delays: Funding yet to be received by PI.

Washington Shelf HAB Buoy/Mooring:

- *Support for the HAB ESP deployment on NEMO mooring [Mickett]*
- *Deliver NRT data streams via NVS [Mickett]*
- *Bring all data QA/QC to meet Certification standards [Mickett]*

Status: Complete for the season

Summary: Due to constraints caused by the COVID19 pandemic this deployment was delayed from the spring of 2021, as originally planned, to the spring of 2022. The ESP mooring was deployed near the NANOOS NEMO and Cha'ba moorings on May 3rd with regular, real-time measurements of the HAB toxin domoic acid extending until late June as planned. The mooring was recovered on August 3rd.

Reliable, regular, real-time measurements of offshore domoic acid concentrations were made available to stakeholders via the NANOOS Real-time HABs website. The website was updated prior to the spring ESP deployment.

Accomplishments/Successes: This deployment was an unqualified success, with reliable, regular, real-time measurements of offshore domoic acid concentrations distributed to stakeholders via weekly email summaries and the [NANOOS Real-time HABs website](#). The website was successful in providing HAB toxin and valuable contextual data to stakeholders. This information was critical to assessing the risk of HABs on the Washington coast.

Problems/Delays: None

Non-core Task 11: *Support for fabrication of a HAB water sampler for the new Seasats AUV [Mickett]*

Status: Delayed

Summary: Funding will support the fabrication of a custom, APL-designed Water Sampling System (WSS) that will be fitted in the Seasats Lightfish Autonomous Surface Vehicle (ASV). This supports an IOOS OTT project that was delayed/set back due to the switch to a more capable ASV.

Accomplishments/Successes: N/A

Problems/Delays: Funding has not yet been received by PI Mickett due to delays in grant/funding processing within UW.

Oregon Shelf Buoy:

- *Maintain the CB-06 buoy off Coos Bay at existing levels [Kosro]*
- *Deliver NRT data streams via NVS [Kosro]*
- *Bring all data QA/QC to meet Certification standards [Kosro]*

Status: On track, with redeployment of mooring needed

Summary: The mooring system was recovered in September 2023, although a failure of a piece of recovery hardware meant that the tether, anchor and some of the down-tether thermistors were lost. The mooring has been rebuilt and ready for re-deployment since November, but ocean conditions and vessel availability have prevented re-deployment. We currently have a long window of vessel availability, and are waiting on a suitable weather window.

Accomplishments/Successes: Persistent deployment and monitoring. Maintained working relationship with Coos Bay vessel service provider.

Problems/Delays: Vessel scheduling for workable ocean conditions continues to be a challenge for the OR coast.

Non-core Task 8: *Support efforts for OA observing on NANOOS NOA-ON CB-06 off the OR shelf [Hales]*

Status: On track, with redeployment of mooring needed

Summary: The mooring system was recovered in September 2023, although a failure of a piece of recovery hardware meant that the tether, anchor and some of the down-tether thermistors were lost. The mooring has been rebuilt and ready for re-deployment since November, but ocean conditions and vessel availability have prevented re-deployment. We currently have a long window of vessel availability, and are waiting on a suitable weather window.

Accomplishments/Successes: Persistent deployment and monitoring. Maintained working relationship with Coos Bay vessel service provider.

Problems/Delays: Vessel scheduling for workable ocean conditions continues to be a challenge for the OR coast.

Columbia River Shelf Mooring:

- *Maintain the CMOP shelf mooring at existing levels [Seaton/Gradoville]*
- *Deliver NRT data streams via NVS [Seaton/Gradoville]*
- *Bring all data QA/QC to meet Certification standards [Seaton/Gradoville]*

Status: Delayed in 2023, on track for 2024

Summary: The CRITFC Columbia River Shelf Mooring (SATURN-02) is a multi-depth inter-disciplinary buoy, with real-time telemetry, which is deployed seasonally off the mouth of the Columbia River at ~35m depth. SATURN-02 was successfully recovered in January 2023 and was prepared for a summer 2023 deployment. In fall 2022, CRITFC received permission from the US Coast Guard to deploy an AIS ATON transceiver on SATURN-02. The transceiver will broadcast the buoy's position to ships, enabling navigation around the buoy and thus protecting it from ship strikes which are common in this location. In May 2023, CRITFC applied for an FCC license for the AIS ATON transceiver, which was expected in 4-6 weeks, but did not arrive in 2023 despite contracting with an experienced FCC licensing service. Due to the delayed FCC license arrival, the full SATURN-02 buoy could not be deployed in 2023. As a backup measure, in early fall 2023 CRITFC constructed a smaller plume buoy that would not require an FCC license and planned to deploy it at the typical SATURN-02 location but were unable to deploy due to a combination of poor weather and field staff transition issues. Looking to the future, CRITFC expects the FCC license to arrive in time to allow an on-time deployment in spring 2024. CRITFC navigated through a major field staff transition in the second half of 2023 as the contractor who had led the field team for the past 20+ years retired from fieldwork and a field subcontractor likewise retired. CRITFC hired and trained two new field technicians in 2023 and is currently working to ensure that they receive the additional training needed to deploy and recover SATURN-02 in 2024. Real-time data from SATURN-02 will be displayed on NVS while the station is deployed. CRITFC also provides access to SATURN long-term datasets via a newly established ERDDAP data server, including QA flagging. CRITFC stations are expected to be the next batch of NANOOS stations integrated into the NANOOS centralized ERDDAP server for delivery to NDBC.

Accomplishments/Successes: CRITFC is progressing towards acquiring an FCC license for an AIS ATON transceiver, which will protect the buoy from ship strikes in future deployments. Successfully worked through intense field staff transition period, including handling the retirement of the previous field lead, continuing to train technician Andrés Salazar (hired April 2023) and transitioning him to the role of Lead Oceanographic Technician, hiring (November 2023) and training a new Oceanographic Instrumentation Technician, Dan Feldman, and PI Gradoville becoming science lead for the observatory.

Problems/Delays: Delay in receiving FCC license for AIS transceiver resulted in no buoy deployment during 2023.

Washington La Push Glider:

- *Maintain the La Push line glider at existing levels [Lee]*
- *Deliver NRT data streams via NVS [Lee]*
- *Bring all data QA/QC to meet Certification standards [Lee]*

Status: Operations paused

Glider IDs serving this line:

Summary: SG236 suffered a pitch mass failure in late August 2023. This prevented the glider from raising its antenna out of the water, permanently cutting off GPS and severely degrading Iridium communications. Communication has been extremely sporadic, with no positions reported and last contact on 2 December 2023. Although the glider may still be drifting on the surface, it is effectively lost.

As this was the only NANOOS glider supporting the LaPush line, operations are paused until fabrication of the second (now only) glider is completed. Fabrication of this vehicle has been

delayed by supply chain issues, but we currently anticipate finishing in April 2024, after which La Push glider operations will resume.

Accomplishments/Successes: Fabrication of a second NANOOS glider delayed due to supply chain issues. Data processing and QC have been updated to our current standards, and data is flowing to the DAC.

Problems/Delays: None

Washington Shelf Glider:

- *Maintain the Washington shelf glider at existing levels [Barth in collaboration with Seaton and Schumacker]*
- *Deliver NRT data streams via NVS [Barth]*
- *Bring all data QA/QC to meet Certification standards [Barth]*

Status: On track

Glider IDs serving this line:

Summary: Through a collaboration with the Columbia River Inter-Tribal Fish Commission (CRITFC), the OSU Glider Research group is conducting the NANOOS-funded glider sampling on the central Washington shelf. The program is designed to fly gliders off the central Washington coast, centered off Grays Harbor, WA, and south toward the Columbia River. The glider flies a mapping grid, from roughly the 30-m isobath, offshore to approximately the shelfbreak (~200 m). The mapping is done in consultation with the Quinault Indian Nation via Joe Schumacker, NANOOS Governing Council Representative and Executive Committee Representative for Tribes.

During the July to December 2023 reporting period, two glider maps were made off central Washington in the second half of July and September. The glider was deployed for a total of 29 days, and produced 12 cross-shelf sections over 747 km with about 5750 vertical profiles of water properties. Glider data show that the summer upwelling season brought near-bottom, hypoxic ($\text{DO} < 1.4 \text{ ml/l}$) waters to at least the 30-m isobath. These data are [displayed on NVS](#).

Accomplishments/Successes: Completed the third, summer-season glider work off central Washington; continued operations with a reliable charter boat operator out of Westport, WA; Joe Schumacker (Quinault Indian Nation - QIN) briefed ocean users about oxygen levels in the coastal ocean. The OSU glider team visited the Taholah School of the Quinault Indian Nation to demonstrate an underwater glider to students from grades 8-12.

Problems/Delays: None. Upgraded glider 251, now S/N 1138, was returned to OSU in late 2023 and is being readied for use in 2024.

Northern California Glider:

- *Maintain the Trinidad Head glider, shared with CeNCOOS, at existing levels [Barth]*
- *Deliver NRT data streams via NVS [Barth]*
- *Bring all data QA/QC to meet Certification standards [Barth]*

Status: On track

Glider IDs serving this line:

Summary: Starting in early December 2014, the Oregon State University glider research group has been obtaining vertical sections of ocean properties off Trinidad Head, CA ($41^{\circ} 3.5' \text{N}$) using an underwater glider. We use a 1000-m capable Seaglider equipped with the following sensors: CTD, dissolved oxygen (Aanderaa 4831 optode), light backscatter (700 nm), chlorophyll fluorescence and Colored Dissolved Organic Matter (CDOM) fluorescence (WET Labs Ecopuck). The gliders also measure depth-averaged velocity, which can be combined with geostrophic estimates of relative velocity to get absolute velocity and hence transport. The glider samples from approximately the 100-m isobath (~10km offshore) to 130W (~500 km offshore), repeating the line every 30 days. We collaborated with Dr. Eric Bjorkstedt (NOAA Southwest Fisheries Science Center, Humboldt State University) to facilitate fieldwork off Trinidad Head. We used two of our

Seagliders in order to “hot swap” them on the line when their batteries ran low. During this reporting period, this effort was jointly funded by NANOOS and CeNCOOS.

For the reporting period, July to December 2023, a glider was on the TH line for 127 days during two deployments, sampled along 1165 km of track line covering the transect 9 times, and collected about 712 vertical profiles of ocean properties. Glider uptime during this period was 70% due to a gap created by a faulty new Seaglider (see below). Data are being sent in near real-time to the IOOS Glider Data Acquisition Center and, simultaneously, to the CeNCOOS and NANOOS data centers.

Accomplishments/Successes: Data from the Trinidad Head glider line are being used to monitor the continuation of the extended 2020-2023 La Niña and the arrival of the 2023-2024 El Niño.

Problems/Delays: We had a 2-month gap in the time series when a new Seaglider (sg686) failed on its first deployment and had to undergo repair. We refurbished the existing sg685 and redeployed it on the TH line. We are still awaiting delivery of the repaired Seaglider (sg686), funded by NANOOS/CeNCOOS, for use on the TH line.

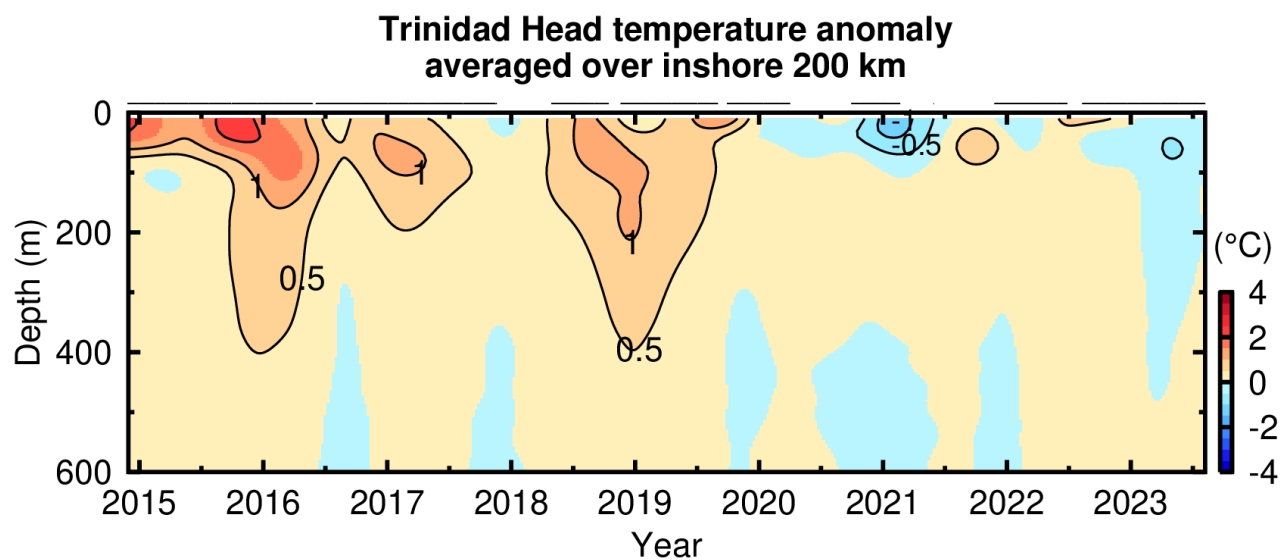


Figure 1: Temperature anomaly from the Trinidad Head, CA ($41^{\circ} 3.5'N$) glider line. Horizontal lines above the panel indicate when the TH-Line glider was in the water.

Non-core Task 1: Further HABs understanding and prediction to be distributed to tribes, UW, WA Sea Grant, OSU, and for data services relevant to HABs in service of the PNW HAB Bulletin for WA and OR and other PNW HAB observing [Mordy/McCabe (CICOES/NOAA), Trainer (UW ONRC), MacCready (UW Oceanography), Litle (UW Washington Sea Grant), Kavanaugh (OSU), Newton (UW APL)]

Mordy/McCabe

Status: On track

Summary: PI McCabe has continued to collaborate with Barbara Hickey (UW School of Oceanography) and Vera Trainer (UW) to produce the Pacific Northwest Harmful Algal Blooms Bulletin (PNW HAB Bulletin) for coastal shellfish managers. A total of eight PNW HAB Bulletins are typically produced each calendar year, with nominally four Bulletins during spring razor clam digs and another four during fall razor clam digs.

Accomplishments/Successes: McCabe, Hickey, and Trainer produced five PNW HAB Bulletins to support coastal shellfish managers during the reporting period. These included the

25-Sep-2023, 09-Oct-2023, 23-Oct-2023, 06-Nov-2023, and 20-Nov-2023 Bulletins. Risk of a toxic *Pseudo-nitzschia* bloom started off generally low but increased slowly throughout the season to medium risk. Large size *Pseudo-nitzschia* cells began to appear in higher concentrations in early November, but strong storms and coastal waves helped to dissipate cells near the coast. Elevated shellfish toxins were encountered briefly in southern Oregon and likely originated from Northern California. The PNW HAB Bulletins are made publically available on both the [ORHAB](#) and [NANOOS](#) websites.

Problems/Delays: None

Trainer

Status: On track

Summary: The funds from the current performance period were distributed to each tribe partnering in the ORHAB program to improve off-shore HAB monitoring capacity over-and-above the weekly shore-side sampling undertaken as part of ORHAB's state-funded monitoring program. Funds remaining after the current reporting period will be spent following the onboarding of our new UW Olympic Natural Resources Center (UW ONRC) administrative assistant in late January 2024.

Accomplishments/Successes: UW ONRC in collaboration with ORHAB (Olympic Region Harmful Algae Bloom Partnership), serves as a primary data source for state and tribal shellfish managers and the PNW HAB Bulletin on Washington's outer coast. The four Coastal Treaty Tribes (Hoh, Quileute, Makah, and the Quinault Indian Nation) are members along with state, federal and academic partners. Core funding for ORHAB's shore-based monitoring is provided by the Washington State Legislature from a percentage of recreational shellfish license fees but off-shore monitoring is not mandated.

The December 2023 fund balance for tribal allocation of APL funds through ONRC is \$33,773.31. No additional funds were spent during the current reporting period due to the retirement of our current administrative assistant and hiring of a new administrative assistant, who will come onboard on 29 January 2024. Spending will commence at this time. The funds will allow each tribe to address individual capacity issues necessary for participating in offshore sampling over-and-above their weekly shore-side sampling. This included equipment upgrades necessary to process the higher volumes of samples including new activities, such as the planned spring 2024 deployments of the Lightfish, an Autonomous Surface Vehicle (ASV). Some tribes have already initiated offshore sampling operations this year that are drawing on their allocations, others are still working on the staffing to bring them up to independent sampling and laboratory operation, which will be the focus for the remaining funds for Hoh Tribe. A draft Memorandum of Understanding has been submitted to the University of Washington and the Hoh Tribe for approval, which will allow the Tribe to use the ONRC facility as a laboratory resource. Additionally, the recent introduction of new ASV technology for off-shore monitoring in the region has exposed the pivotal role existing tribal labs are playing in processing samples and hosting the launching and retrieval for remote vehicle missions. The funds provided here are proving important in helping each tribe meet that new challenge.

Trainer also connected with the Washington State Department of Health and PI, Kavanaugh, to discuss future possibilities to expand ORHAB sampling to help manage Dungeness crab. In addition, she has been instrumental in assisting Maria Kavanaugh's project, by making available new enzyme-linked immunoassay (ELISA) kits for the detection of domoic acid. Trainer worked extensively with a new company, Beacon Analytical, to develop new kits for both ORHAB and our Oregon partners.

Problems/Delays: Spending was paused during the current reporting period due to the transition of the University of Washington financial system to a new platform and the retirement of the ONRC administrative assistant. Purchasing will restart in Feb 2024.

MacCready

Status: On track

Summary: During this reporting period NANOOS support for MacCready's salary allowed for improvements to the reliability of the LiveOcean model system.

Accomplishments/Successes: MacCready runs the LiveOcean daily forecast model that is used as part of the information for the PNW HAB Bulletin. The model continued to run with high reliability during this period, and post-processing particle tracking results used by managers were produced daily. A paper is in review comparing 5 different particle tracking software packages in LiveOcean. Particle tracking is a key analysis technique for the model contribution to the PNW HAB Bulletins. The review process for this paper has taken longer than expected due to delays at the journal.

Problems/Delays: None

Litle

Status: On Track

Summary: The SoundToxins program continues to provide support for phytoplankton monitoring throughout Puget Sound.

Accomplishments/Successes: For this reporting period we received and resolved 116 unique individual requests for support from SoundToxins participants relative to monitoring support and phytoplankton identification. We received 72 alerts regarding harmful algal blooms of which 38 of the alerts were provided to the Washington State Department of Health as part of the phytoplankton cell presence alert system. We conducted 5 site visits including in person training sessions for two new sites and two sites restarting sampling after temporary breaks due to COVID and staffing reasons. We also held two virtual training sessions for providing technical support for monitors. During this time, we presented information about SoundToxins and phytoplankton at 2 educational events, one for NOAA Science Camp and one for the Seattle Aquarium Marine Science Club. Additionally, we met with a phytoplankton monitoring group and several food safety health officials from British Columbia to share information.

Problems/Delays: The previous PI, Teri King, left the program for a new position in September 2023. The SoundToxins program continued the essential functions of providing support for phytoplankton monitoring in Puget Sound, but the transition in leadership has resulted in reduced capacity and delays for lower priority tasks.

Kavanaugh

Status: On track

Summary: We have transitioned to Year 3 of Cooperative Fisheries Plankton Research project to target plankton taxa, in particular the domoic-acid producing species *Pseudo-nitzschia* sp (P/N). Commercial fishermen, including charter boats, have been trained to collect seawater samples which are preserved and/or frozen for analyses in the lab. In the lab, we utilize imaging flow cytometry, to rapidly assess plankton community composition, P/N abundance, dominant morphology (thick, thin), and environmental correlates. A regular exchange of new sampling kits and collected samples was tested, and successfully implemented at a central location, Hatfield Marine Science Center in Newport, Oregon. The project funds graduate student stipend (for project coordination), technician time (to assist with running and annotating samples), and hourly undergraduate assistants.

Accomplishments/Successes: Graduate student Raquel Gilliland has been successful in retaining diverse suite of fishermen (N=7 currently) from the midwater trawl cooperative, Dungeness crab (fishing midwater in Dungeness off-season), charter fishery, as well as researchers associated with NOAA's Northwest Fisheries Science Center. We collect coincident

temperature, salinity, and, in the case of NH Line data, particulate domoic acid, however, the latter has experienced delays in part because of expired kits. Salinity protocols have been altered to minimize brine rejection issues, and Gilliland has also coordinated to obtain LiveOcean fields coincident with her sample dates, although comparisons need to be completed. Gilliland utilized manual annotations of >500,000 images for thick and thin P/N, other diatoms, dinoflagellates, ciliates and detritus. She conducted a partial least squares regression model to convert biovolume to counts for both thick and thin morphology types which yielded strong predictive potential ($R^2=0.80$). Her interviews with fisherman collaborators highlighted motivations related to general environmental concerns; financial compensation to participate was not a motivating factor. Gilliland defended her MS in October of 2023, accepted a position as a Knauss Fellow starting in February 2024. Spring-summer transition will be coordinated by Kelly George, who was trained last year.

Gilliland has presented her research at the annual PISCES meeting and the Society for Advancement of Chicanos/Hispanics and Native Americans in Science meeting– both in the Fall of 2023. Kavanaugh has presented this project to the annual NANOOS PI meeting, and to ORHAB as part of an extension of this project to the coast of Washington state.

Challenges/Delays: One challenge has been the coordination of pDA and TDA samples for comparisons. There have been some issues with kit availability and/loss of kits. We will network through NANOOS and ORHAB to include pDA pilot for Spring of 2024-Fall of 2024.

Newton

Status: On Track

Summary: During this reporting period, Newton oversaw all aspects of the NANOOS HABON effort. This included attending ORHAB meetings and discussing progress with each of the HABON PIs in Washington and Oregon. She coordinated with Tanner (UW, NANOOS web) to assure that all PNW HAB Bulletin and other HAB content matched the needs of the community.

Accomplishments/Successes: She with ORHAB PIs to scope PNW needs that NANOOS could help address through the IRA proposal opportunity.

Problems/Delays: No continuing funding from Oregon has been identified, as of yet, though this remains a high priority and has been communicated to NOAA IOOS PO.

Hunter

Status: On Track

Summary: The funds from the performance period were used to provide near-shore HAB monitoring capacity in Oregon coastal waters. Funds pay for a phytoplankton specialist and all supplies and services.

Accomplishments/Successes: A total of 132 near-shore samples were analyzed for HABs from 8 sites along the Oregon outer coast. Of those, 48 were further analyzed for particulate domoic acid (pDA) where levels on the northern coast sites exceeding accumulation levels in July and the southern coast exceeded accumulation levels in November. The ODFW phytoplankton specialist participated in a NOAA cruise aboard the R/V Bell Shimada in September, collecting and analyzing another 15 offshore samples for HABs. ODFW was able to collect more samples from the commercial Dungeness crab market test project from the north and central coast in October and November. A total of 8 samples from these vessels were collected and analyzed. All data collected was summarized and used in the PNW HAB bulletin. The ODFW phytoplankton specialist was selected to attend the IOC identification of harmful marine microalgae in November 2023.

Problems/Delays: None

ESTUARIES

Maintain multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs: Sustain observing ability to aid sustainable resource management, water quality assessment, and sub-regional climate change evaluation.

Puget Sound, WA, Profiling Buoys:

- *Maintain 6 Puget Sound estuarine profiling moorings at existing levels [Manalang]*
- *Deliver data via NVS [Manalang]*
- *Bring all data QA/QC to meet Certification standards [Manalang]*

Status: On track

Summary: Work to maintain Puget Sound Profiling Buoys continued, including regular maintenance conducted at each of six buoy sites. Buoy maintenance includes instrument package swaps, winch repairs, and electrical and mechanical maintenance. Puget Sound profiling buoy data is delivered to NVS.

All Puget Sound Profiling buoy data products can be found on the team ERDDAP server (found here: <https://nwem.apl.washington.edu/erddap>), revised visualization products have been developed to take advantage of the ease of data access that ERDDAP provides, while also streamlining product creation into a uniform workflow.

Accomplishments/Successes: Multiple successful maintenance operations, and continued troubleshooting to identify root causes of rapid failure modes.

In November 2023, a webinar was held to announce the deployment of the team's ERDDAP server and the release of the revised data products, as well as to detail the methods used to create the revised data products and all of the QA/QC checks performed.

Problems/Delays: Continued profiling downtime was experienced due to aging systems, and external factors. Long lead times have caused challenges in keeping sensor calibrations recent. Emerging problems with cellular coverage resulted in intermittent data harvesting from the profiling mooring at Twanoh.

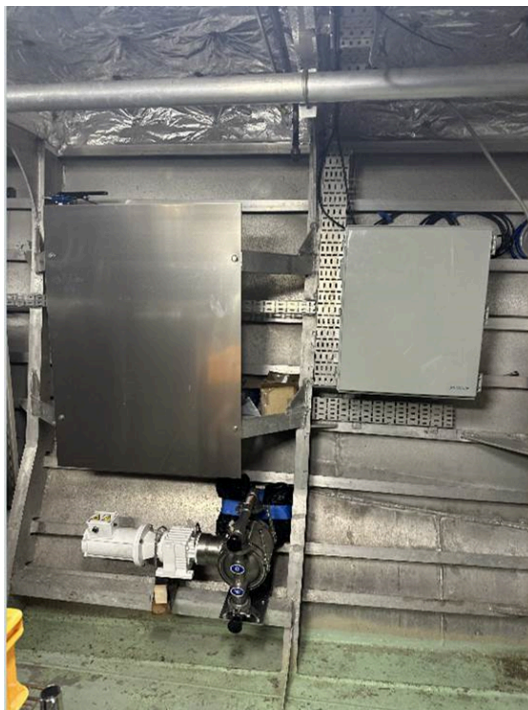
Puget Sound, WA, US-Canada ferry-box:

- *Maintain US-Canada ferry-box at existing levels following COVID-19 and the companies struggle to regain profitability [Krembs]*
- *Deliver data via NVS [Krembs]*
- *Bring all data QA/QC to meet Certification standards [Krembs]*

Status: Regaining momentum

Summary: Ecology has maintained its en route ferry monitoring system by relying on the support of Victoria Clipper engineering staff. Engineering staff were tasked to install the new pumped on-board system on their new larger ferry vessel. The installation has been slow, but we have seen recent concrete activities by the engineers illustrating renewed commitment and progress on critical installations of the pump, water line and electric supply that make us hopeful.

Accomplishments/Successes: Since COVID Victoria Clipper Vacations has been struggling while trying to honor our long-standing work relationship. Critical progress is being made while the ship currently is in dry dock. Brackets for the pump have been built and are welded into place, the electronic compartments have been installed and plumbing lines have been adapted. The completion of this critical bottle neck paves the way for our GSI contractor to install the remaining system.



With the critical installation of the pump and electric lines being done, GSI is now poised to continue with the remaining installations of

- Pump controller setup/testing
- Sensor and pump controller integration/testing
- Data logging and post-processing workflow finalization
- Plumbing manifold design
- Sensor, pump controller, and plumbing manifold installation
- Final system testing
- QAQC web app development

Problems/Delays: Victoria Clipper Vacation staff has been recently responsive again after we sent several letters to the company's mid management addressing the lack of progress and communication with the installation of our equipment.

Columbia River Estuary, OR, Moorings:

- *Maintain CMOP estuarine moorings at existing levels [Seaton/Gradoville]*
- *Deliver data via NVS [Seaton/Gradoville]*
- *Bring all data QA/QC to meet Certification standards [Seaton/Gradoville]*

Status: On track

Summary: CRITFC continued to maintain NANOOS-supported stations in the Columbia River estuary. The Tongue Point (SATURN-04) pier-based, pumped station was moved to a neighboring pier since the US Coast Guard is demolishing the previous pier. A new pumped station was constructed, including near-surface and sea-bed water intakes and an in-situ CTD at the seabed location. A shed to house instruments and pumps was moved to the new pier, and improvements are currently being implemented (e.g., moving instruments to shed, rebuilding and modernizing circuit boards, installing heating so that instruments do not freeze). During the station transition period, problems with circuit boards and charge controllers have caused some data gaps; these issues will be resolved by building new circuit boards and rewiring instruments when they are moved to the shed. The Point Adams (SATURN-03) pier-based, pumped station has been maintained, albeit with some small data gaps due to routine pump replacement. The Point Adams

station was also improved by adding a continuous ocean acidification analysis system, leveraging existing NANOOS infrastructure to install externally funded pCO₂/TCO₂ instrumentation in collaboration with NANOOS PI Hales. This system was installed fall 2023 and is currently being optimized. The Baker Bay (SATURN-07) buoy was recovered for servicing in October 2023 and re-deployed in November 2023, where it is currently on station. Likewise, the Cathlamet Bay (CBNC3) buoy was recovered for servicing in October 2023 and re-deployed later that month, where it remains on station. The Youngs Bay (SATURN-09) buoy was recovered for servicing December 2023 and is expected to be re-deployed in February 2024. Extensive training of the new field staff occurred during this period, and by the end of 2023, all fieldwork and maintenance of instruments and stations was being led by the new Lead Oceanographic Technician (hired April 2023) and Oceanographic Instrumentation Technician (hired November 2023). The field team also updated discrete sample processing protocols (for weekly sampling at pier-based stations) as part of staff transitioning. All stations except for CBNC3 (Cathlamet Bay) are real-time, and data are displayed on NVS. Data are subject to QA/QC, which is included in data submitted to NCEI via NANOOS and to the recently deployed ERDDAP server. Work on improving the representation of datasets within the CMOP ERDDAP server, including QA information, continued during this period. Staff also began setting up the server for real-time and QC'd ocean acidification data, which are expected to be available through NVS and the ERDDAP server by summer 2024.

Accomplishments/Successes: Estuary stations were maintained, including several buoy deployments/recoveries and moving the Tongue Point station to an adjacent pier. A new ocean acidification analyzer was installed at Point Adams. The CMOP field team successfully worked through a challenging personnel transition period, ending 2024 on a high note with two new field technicians who are nearly trained to independently lead all field and instrumentation work. Improvements to servers and QA representation were implemented. PIs Seaton and Gradoville both gave oral presentations on the Columbia River estuary stations, including potential threats to Columbia River salmon from estuarine and coastal hypoxia, at the Coastal and Estuarine Research Federation conference in Portland, Oregon, November 2023.

Problems/Delays: Overall on track with small data gaps due to pump replacement (Point Adams), station pier transition (Tongue Point), and buoy servicing.

South Slough/Coos Bay, OR, Moorings:

- *Maintain South Slough/Coos Bay estuarine moorings for the NERRS at existing levels [Helms]*
- *Deliver data via NVS [Helms]*
- *Bring all data QA/QC to meet Certification standards [Helms]*

Status: On track

Summary: South Slough Reserve continued operation of a network of moored estuarine water quality observing stations as part of the NERRS System-Wide Monitoring Program with additional support provided by NANOOS that includes four real-time water quality stations in the South Slough estuary with continuous water temperature, salinity, dissolved oxygen, pH, turbidity, and water level measurements every 15 minutes over the period 7/01/23 – 12/31/23. Tom's Creek weather station provides real-time measurements of air temperature, relative humidity, barometric pressure, and wind speed/direction. Telemetry transmissions were continuous for the Winchester Arm water quality and Tom's Creek weather platforms. In November 2023, a YSI Storm 3 telemetry system and new enclosure were installed to replace the inoperable data collection platform hardware at the Elliot Creek station telemetry equipment. Telemetry transmissions resumed to NOAA NVS, HADS and NERRS CDMO via GOES West at the end of November (11/28/23). Water quality data collection was completed at the Charleston Bridge and Valino Island stations, but telemetry status has been offline while planning for replacement of the station platforms with steel pilings due to aged wood infrastructure and heavy biofouling, before upgrading to YSI Storm 3 telemetry systems. In collaboration with the Confederated Tribes of the Coos, Lower Umpqua

and Siuslaw Indians (CTCLUSI), SSNERR maintains telemetry for the North Spit BLM water quality station, located in the lower Coos estuary with data available through NVS. Monthly instrument exchanges, maintenance, and data qa/qc and management for all sites were completed for the station network following NOAA NERRS Centralized Data Management Office protocols.

Accomplishments/Successes: Water quality and weather time-series data collected as part of NANOOS/NERRS SWMP programs were incorporated into various research and education programs at the Reserve. Two projects included a NERRS Science Collaborative Hydrodynamic Model project to understand sediment and temperature effects on native species restoration in the Coos estuary and an Oregon Ocean Science Trust biophysical modeling project evaluating the interaction of water quality and eelgrass in the Coos estuary with 4 presentations from the projects delivered at the Coastal and Estuarine Research Federation (CERF) conference in Portland, OR November 2023 on 1) Changes in sediment transport and accumulation in Coos Bay over the past 100-150 years, 2) Remote and local influences on temperature variability in the Coos estuary, 3) Estuarine sediment dynamics and the importance of storms in moving mud, and 4) Biophysical modeling of the interaction between eelgrass and water quality in Coos Bay estuary, OR. The Reserve's Margaret A. Davidson Fellow, Lara Breitreutz, is utilizing water quality data for her research on eelgrass community response to marine heat waves and presented results at the Oregon State of the Coast (Newport, OR), CERF, and NERRA (Galloway, NJ) conferences in November 2023. The Reserve education team accessed water quality datasets for a Teachers on the Estuary training workshop in October 2023, as well as for programs on climate change and developing exhibits for the Reserve's Visitor Center. The Reserve hosted a part-time Fall water quality intern October-December 2023, funded through NANOOS that assisted the science program with water quality fieldwork and laboratory sample processing.

Problems/Delays: The Charleston Bridge water quality station continues to have seasonal fouling issues in the summer and fall during monthly instrument exchanges and the protective instrument housing will be replaced in the short term with a new steel piling installation planned to replace the wood pile. The Valino Island station aged wood pile is too unstable to support new telemetry equipment and will be upgraded to a steel pile, with partial funding requests submitted November 2023 through the NERRS IRA non-competitive Resilience funds.

BEACHES AND SHORELINES

Maintain core elements of beach and shoreline observing: Measure nearshore bathymetry, topographic beach profiles, and shoreline morphodynamics along OR and WA, contributing to hazard mitigation by providing essential observations and better decision support tools for coastal managers, planners, and engineers.

Washington Beach and Shoreline:

- *Maintain shoreline observations in WA at existing levels [Kaminsky]*
- *Deliver data via NVS [Kaminsky]*
- *Bring all data QA/QC to meet Certification standards [Kaminsky]*

Status: Complete for the season

Summary: NANOOS funds contribute to the Washington State Department of Ecology Coastal Monitoring & Analysis Program (CMAP) led by G. Kaminsky. CMAP staff completed summer and fall seasonal beach monitoring surveys along the 4 subcells of the Columbia River Littoral Cell (CRLC), collecting 50 beach profiles, 14 ATV surface maps, and 57 sediment samples along 12 of the profiles in August-September and 46 beach profiles and two surface maps in December. In addition, over 200 beach profiles were collected throughout the CRLC in August 2023 to extend the nearshore bathymetry profiles collected by the USGS and OSU using personal watercraft.

Seasonal beach profile data and contour change plots through June 2023 are available through the [NANOOS beach and shoreline portal](#).

In September, CMAP staff collected beach profile and an ATV surface map north of the Columbia River South Jetty along Clatsop Spit and along the jetty to capture the ridge-runnel morphology for the U.S. Army Corps of Engineers. CMAP continues to conduct detailed topographic surveys in Westport, Ocean Shores, and at Benson Beach, three locations that have ongoing erosion concerns threatening coastal properties and public beach accesses. In both September and December, CMAP collected 9 supplemental cross-shore beach profiles in Westport to monitor the dynamic revetment fronting the Westport by the Sea Condominiums and 10 supplemental profiles at the south end of Benson Beach. At each of these locations, CMAP staff also collects detailed alongshore elevation data to create a local digital elevation model. At the south end of Ocean Shores, 31 supplemental profiles were collected in August. The Ocean Shores surveys were reduced to twice a year, summer and winter, so these were not collected at the end of the fall season as has been done in previous years.

CMAP continues to monitor the performance of the dynamic revetment at North Cove. Beach topography surveys were conducted in September and December 2023, where 48 profiles and an ATV surface map were collected during each survey. Data are used to create a digital elevation model of the survey area and compared for change over time. CMAP continues to collect seasonal topographic surveys at the South Beach campground in the Kalaloch Area on the Olympic Peninsula, where 14 beach profiles and the cobble berm toe position were collected in October 2023. Monitoring results from Kalaloch will be used for comparison to the North Cove dynamic revetment site, which is intended to mimic functions of a natural composite beach similar to the setting and conditions at Kalaloch. Results may also provide a comparison point for the dynamic revetment at Westport and the planned dynamic revetment on Benson Beach.

Accomplishments/successes: Significant steps have been made to catch up with topographic survey data processing, completing all beach profile data through June 2023. Plots on the NANOOS beach and shoreline portal have been updated accordingly. Data collected by CMAP continue to be used by the U.S. Army Corps of Engineers, Washington State Parks, and geoconsultants to assess local and regional coastal changes on Washington beaches, particularly at locations with dynamic revetments. In October, two CMAP staff presented at the American Shore and Beach Preservation Association conference in Providence, Rhode Island, on results from monitoring the effectiveness of dynamic revetments in North Cove and at the Westport Condos by the Sea, each receiving significant interest from the audience. In December, G. Kaminsky participated in the American Geophysical Union conference in San Francisco, California and was a co-author of a poster on regional-interdecadal scale monitoring of coastal evolution via satellite imagery along dissipative beaches of the Columbia River Littoral Cell.

Problems/Delays: CMAP staff continue to work towards streamlining our efforts to keep up with data processing and deriving products for the NANOOS beach and shoreline portal with which we are now only 4 months behind. We plan to increase our staff over the coming years to help keep up with our data collection and processing workload.

With the growing number of dynamic revetments and cobble berms our staff is monitoring on a seasonal basis, staff safety becomes a higher priority as collecting detailed topographic data by foot over cobbles can be hazardous. We are investigating other methods as an alternative, such as the use of drone imagery to generate elevation models and are conducting an error analysis of a recent drone flight conducted during our North Cove survey in September 2023.

Oregon Beach and Shoreline:

- *Maintain shoreline observations in OR at existing levels [Allan]*
- *Deliver data via NVS [Allan]*
- *Bring all data QA/QC to meet Certification standards [Allan]*

Status: Complete for the season

Summary: The Oregon Beach and Shoreline Mapping Analysis Program (OBSMAP) efforts are led by J. Allan and his team at the Oregon Department of Geology and Mineral Industries (DOGAMI). Beach profile data – summer and fall surveys – were successfully collected in the Rockaway littoral cell (25 sites, October and December 2023), along the Clatsop Plains (6 sites, October and December 2023), and along the Neskowin cell (15 sites, September 2023). In addition to measurements of the transects, datum-based shorelines were also collected along each of the study areas. Beach profile and shoreline data have been processed, QA/QC'd, and archived both locally and remotely. The reduced profile plots, change plots, and trends have been posted to the [NANOOS beach and shoreline portal](#).

Accomplishments/successes: Data collected as part of OBSMAP continue to be used by regional coastal managers (e.g., Oregon State Parks, Oregon Department of Land Conservation and Development agency), geoconsultants (e.g., Integral Corporation's work to evaluate erosion at Cannon Beach) and the public to assess local and regional coastal changes taking place on Oregon beaches. Results from the monitoring were used in recent presentations to the Surfrider Foundation.

Problems/delays: None

Washington and Oregon Bathymetry:

- *Maintain nearshore bathymetric observations of beach and shoreline morphodynamics in WA and OR at existing levels [Ruggiero]*
- *Deliver data via NVS [Ruggiero]*
- *Bring all data QA/QC to meet Certification standards [Ruggiero]*

Status: Complete for the season

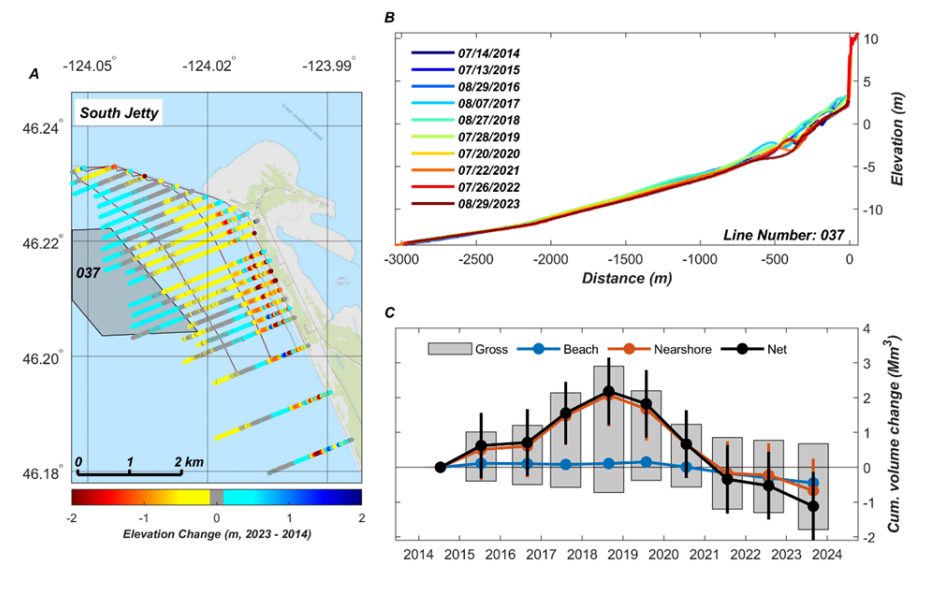
Summary: In collaboration with the Washington State Department of Ecology and the U.S. Geological Survey, P. Ruggiero's group at Oregon State University collected nearshore bathymetry data along the four sub-cells of the Columbia River littoral cell (CRLC). Over 220 individual cross-shore profiles were collected during summer 2022 extending from the lower inter-tidal to ~12 m of water depth (~2000 m from the shoreline). Approximately 400 kilometers of nearshore mapping took place within ~6 days of field data collection. These data have been processed from their raw format into deliverable text files and have passed a rigorous quality assurance process. In all cases, these nearshore bathymetry measurements have been combined with topographic measurement collected by Ecology developing complete maps of the nearshore planform. Ruggiero's group also collected nearshore bathymetry along the Newport littoral cell in Oregon to support a pilot field experiment focused on the influence of the region's basalt reef on wave propagation. This collaborative field campaign is benefiting the US Army Corps of Engineers and other regional stakeholders.

Accomplishments/successes: These data continue to provide a critical source of information for improving coastal hazard mitigation along the coastlines of the CRLC and for understanding the morphodynamics of high-energy beaches. During this time period Ruggiero's group has almost finalized the development of a new generation Coastal Profiling System with two new Personal Watercraft. This new equipment will be ready for summer 2024.

Figure 1. A Map showing cumulative elevation changes between 2014 and 2023 for the South Jetty of the Columbia River region within the Clatsop Plains subcell; depth contours (5-m interval between -10 and 0 m) based on 2014 survey. **B**, Example profile showing changes in beach and nearshore morphology along survey line 037 (location shown in A). **C**, Time-series plot of volume

changes calculated for the South Jetty region; net volume changes are provided for beach and nearshore depth zones, as well as net volume changes integrated over the entire region.

Problems/delays: None



B. Modeling & Analysis Subsystem:

WA & OR ESTUARIES & COAST MODELS

Provide sustained support to a community of complementary regional numerical models:

Contribute to the operation of regional models, and the tools and products they support, covering the head of tide of estuaries to the outer edges of the Exclusive Economic Zone (EEZ) in both OR and WA.

NE Pacific and Salish Sea:

- Support, at existing levels, the daily forecast model, LiveOcean, which simulates ocean circulation and bio-geochemistry in the Salish Sea and in coastal waters of the NE Pacific, including Oregon, Washington, and British Columbia [MacCready]
- Deliver model output via NVS [MacCready]
- Model verification and validation [MacCready]

Status: On track

Summary: During this reporting period NANOOS support for MacCready's salary allowed for continued upgrades of the LiveOcean model system. Daily forecasts from the large NE Pacific domain and the nested Willapa Bay-Grays Harbor domain were reliably produced during this period and distributed to the public and stakeholders through the NANOOS NVS, the LiveOcean website, and a NANOOS server.

Accomplishments/Successes: A new version of the main model grid was developed with improvements to channels within the Salish Sea. A lower resolution (2 km) version of the regional grid was also developed and tested. This is being used in two climate downscaling projects. A bug

in the ROMS treatment of point sources needed for the inclusion of Wastewater Treatment Plants was successfully corrected and the fix was implemented in the official version of ROMS. We initiated a new long hindcast (October 2012 - present) that will allow better scientific understanding of interannual variability and marine heat waves. It has currently run through 2015. Negotiations are underway with NOAA to port this long hindcast to their Cloud Sandbox. This will greatly improve public access to LiveOcean output.

Problems/Delays: None

Columbia River Estuary and Plume:

- *Support, at existing levels, the CRITFC circulation modeling and forecasting system, which covers the Columbia River estuary and plume [Seaton]*
- *Deliver model output via NVS [Seaton]*
- *Model verification and validation [Seaton]*

Status: On track

Summary: CRITFC has maintained an extensive modeling system for the Columbia River coastal margin, denoted Virtual Columbia River (VCR). The VCR has evolved from multi-institutional collaborations involving modelers and non-modelers, in academia and across regional, federal, and tribal agencies. The modeling capabilities of the VCR has assisted the region in the study of salmon life cycle, habitat, estuarine pathways, and status under the Endangered Species Act and in relation to hydropower management and climate change.

Anchoring the system are simulations of circulation, conducted in four distinct forms: (1) daily forecasts, (2) multi-year simulation databases, currently 1999-2018, (3) scenario simulations, and (4) process simulations. Of these, daily forecasts are displayed on NVS. To meet the challenges that the highly energetic and strongly stratified Columbia River estuary and plume pose to numerical models, we have experimented with—and contrasted among—multiple codes (Thetis, SLIM, SELFE and SCHISM) representing different classes of unstructured-grid finite element methods.

Accomplishments/Successes: Maintained forecasts, with forecast overlays provided through CMAP website and NVS. During this reporting period we have continued evaluating the implications of the Pacific model developed under task 12 with the next generation SCHISM model for a new multi-year simulation database and eventual updated forecast.

Problems/Delays: None

PNW Coastal Waters:

- *Support, at existing levels, the OSU real-time coastal ocean forecast model, which covers the coastal waters off OR and WA [Zaron]*
- *Deliver model output via NVS [Zaron]*
- *Model verification and validation [Zaron]*

Status: On track

Summary: We continued real-time operation and support of our RTDAOW (Real Time Data Assimilation for Oregon and Washington) system on a daily basis. The data delivery is near-real time and stable. At this moment we do not anticipate any substantive changes to the project Scope of Work.

Accomplishments/successes: The data assimilation and modeling system continue to provide real-time forecasts to fishers and the public via the NANOOS Visualization System, e.g., as the Tuna Forecast and SeaCast applications.

Problems/delays: None

C. Data Management & Communications Subsystem:

DATA MANAGEMENT & CYBERINFRASTRUCTURE (DMAC)

Maintain, harden, and enhance NANOOS' Data Management and Cyberinfrastructure (DMAC) system for routine operational distribution of data and information: Sustain and enhance the DMAC system, including the NANOOS Visualization System (NVS), for dynamic and distributed data access.

Mature Regional DAC Operations:

- *Sustain, refresh, and enhance a highly available, robust, distributed hardware and software environment; maintain appropriate staffing and team coordination; maintain up-to-date operations and system documentation to ensure transparent and clear descriptions of DAC architecture [Tanner]*

Status: On track

Summary: Continued maintenance and development of BlueHarvest, as needed. BlueHarvest is the internal NANOOS DMAC application for harvesting data from a wide range of data providers. The system is robust and maintains flexibility to accommodate a wide range of data providers/sources. It populates the NANOOS internal database in a standardized way so the data can be easily integrated into the various data products served on NVS. BlueHarvest also provides immediate feedback about data transmission frequency/latency, which enables NANOOS to identify and fix data flow issues more efficiently.

Accomplishments/Success: Consistent, reliable data harvesting.

Problems/Delays: None

Non-core Task 4: A one-time increase for core needs [Newton]

Status: On track

Summary: This one-time increase is being used to support NANOOS fiscal and administrative needs. Hana Sawanobori was hired in November 2023 as NANOOS Grants and Contracts Manager. Sawanobori serves as fiscal lead for NANOOS, assisting with proposals, grants administration, as well as reporting on work completed.

Accomplishments/Successes: Sawanobori has increased NANOOS capacity at a critical time, leading into the IRA proposal opportunity.

Problems/Delays: None

- *Engage new local providers (not NANOOS funded), integrate their data into NVS and IOOS DMAC services; strengthen DAC capabilities and resources through regional and thematic partnerships [Tanner]*

Status: On track

Summary: Met with several data providers at Annual GC/PI Meeting and Community Event on 9-10 August. Discussed options for expanding NVS data ingestion to include additional datasets.

Accomplishments/Successes: Started discussions with South Slough Reserve and other groups about including some of their data in NVS.

Problems/Delays: None

NVS Support and Development:

- *Maintain NVS support leveraging regional user needs, feedback, and data reviews to continually improve the relevance and quality of metadata for observing and modeling data assets integrated and served by NANOOS [Tanner, Carini]*

Status: On track

Summary: Continued development of new HF Radar overlays. Completed development of initial version of prototype of new NVS Explorer mobile app.

Accomplishments/Success: HF Radar overlay and NVS Explorer mobile app prototype development.

Problems/Delays: None

- *Sustain & enhance existing data streams, IOOS web services, GTS submission; implement NCEI data archiving, NDBC data archiving, Glider DAC submission, QARTOD; maintain and expand ERDDAP to leverage web services, serve NANOOS applications and users; evaluate where new tech (e.g., cloud, AI, etc.) may afford NANOOS better efficiencies and robustness [Tanner, Carini]*

Status: On track

Summary: All NANOOS gliders transmit their data to the Glider DAC. All NANOOS HFR transmit their data to the HFR DAC. NDBC harvest in situ buoy data from the NANOOS ERDDAP. Columbia River Estuary buoys and land-based stations are archived periodically and automatically via an [NCEI Data Submission Agreement](#) (set up for PI Seaton). NANOOS will pursue establishing an analogous pathway with NCEI and the Washington Shelf Buoys/Moorings and Puget Sound Profiling Moorings (Pls Manalang and Mickett).

Accomplishments/Success: As stated for the Puget Sound Profiling Moorings, described above, a webinar was hosted by NANOOS about ERDDAP data server access and setup. See write up and recorded materials [linked here](#).

Problems/delays: None

Engagement in National and Cross-regional DMAC Efforts:

- *Sustain participation in IOOS DMAC community activities, including QARTOD development, semantic mapping, OGC WMS/WFS support, climatology data development, UGRID support, and shared code development and testing [Tanner, Carini]*

Status: On track

Summary: NANOOS platforms available via the NANOOS ERDDAP are being included in IOOS datasets.

Accomplishments/Successes: In situ datasets are now transmitted via the NANOOS ERDDAP.

Problems/Delays: None

- *Extend to other areas via pan regional products with sister IOOS RAs; engage and leverage NSF-funded OOI, international GOA-ON activities, and Canadian collaborations; engage with other West Coast and Pacific efforts, including WCGA and IPACOA [Tanner, Carini]*

Status: On track

Summary: Tanner and Carini continue to collaborate with PacIOOS and AOOS DMAC through their NSF-funded Convergence Accelerator Backyard Buoys project.

Accomplishments/Successes: Development of data services for Backyard Buoys project.

Problems/Delays: None

USER PRODUCTS COMMITTEE (UPC)

Continue to deliver existing and, to the extent possible, create innovative and transformative user-defined products and services for PNW stakeholders: Continue our NVS innovation to succeed in this vital translation for meaningful and informative data products that address user needs and serve society.

Website:

- *Continue to evaluate and update web content relevant to stakeholder issues, especially those related to Maritime Operations, Ecosystem Assessment, Fisheries & Biodiversity, Coastal Hazards, and Climate; improve ease of usability and user tracking capabilities [Tanner]*

Status: On track

Summary: Completed development of prototype of initial version of the new Data Explorer smartphone application to allow for improved functionality, which includes the ability to select favorite sensors and models as well as present all assets in a map view. Addressed various problems associated with data not showing up for various in situ assets. Updated old matlab WWII processing code for downloading and processing WWII climatology overlays and contemporary 7-day forecasts.

Accomplishments/Successes: New and updated content.

Problems/Delays: None.

Non-core Task 6: *Sustain NANOOS' work to develop and maintain the GOA-ON data portal [Tanner]*

Status: On track

Summary: Updated slideshow, webinar, and other content. Created web pages for regional hubs. Started work to update platform harvesting script.

Accomplishments/Successes: Maintained GOA-ON website.

Problems/Delays: None

Tailored Products Development:

- *Annually evaluate priorities for products at the Tri-Com meeting (DMAC, UPS, and E&O), based on outreach feedback, regional issues, and GC input, and will implement new tailored products to the extent possible [Allan]*

Status: On track

Summary: This committee is composed of members from OHSU, UW, OSU, NANOOS E&O, and NOAA. NANOOS UPC chair Allan participates in weekly "tag-up" calls with members from DMAC, UPC, E&O, and Web development to facilitate consistent work efforts, synergy across the committees, and improvements to product development and enhancements. Activities for this period centered around weekly NANOOS meetings.

Accomplishments/Success: Commenced development of a complete rebuild of the DataExplore smartphone application to allow for improved functionality, which includes the ability to select favorite sensors and models as well as present all assets in a map view. Prototype is functional but currently does not include model and remote sensing overlays. Work is ongoing to add these additional capabilities. Performed various updates to the tsunami web app to reflect updated tsunami layers for the Washington coast, including a complete revision of WA state evacuation brochure links. Addressed various problems associated with data not showing up for various in situ assets. Updated old matlab WWII processing code for downloading and processing WWII climatology overlays and contemporary 7-day forecasts.

Problems/delays: Continue to experience product development delays due to blueharvest rebuilds.

EDUCATION & OUTREACH (E&O)

Sustain and diversify NANOOS engagement to the extent possible: Continue ongoing engagement with diverse stakeholders and the public, increasing ocean awareness and literacy; to diversify the ocean and coastal workforce; to improve our ability to provide relevant ocean and coastal data and information to underserved or underrepresented communities; and to facilitate use of NANOOS products for societal objectives, the core task for which NANOOS exists.

Communication:

- *Maintain up-to-date success stories, employing effective use of social media and newsletters [Wold, Newton]*

- *Support national communication through IOOS Program Office and IOOS Association collaborations [Wold, Newton]*
- *Be responsive to regional and local events (e.g., harmful algal blooms, fish kills, marine heat waves, hypoxia, floods, etc.) to enhance relevance to public and highlight regional stories with NANOOS members and partners [Wold, Newton]*
- *Maintain existing and build new relationships to stakeholder user groups and the education community enabling NANOOS to achieve effective education and outreach [Wold, Newton]*

Status: On track

Summary: During this reporting period, NANOOS staff engaged with end users and educational partners (National Marine Educators Association and Northwest Aquatic and Marine Educators, Seattle Maritime High School, Pacific Coast Shellfish Growers Association), mentored 10th graders at the Maritime High School, mentored an undergraduate Earthlab intern to develop a new curriculum that brings NVS data into the classroom, maintained content on social media, newsletters, website slideshow, etc., and regularly participated in IOOS Outreach Committee meetings.

Accomplishments/Successes: None

Problems/Delays: None

Product Co-Development:

- *Engage users in product co-development through focus groups; use targeted interviews or surveys to garner feedback and input on products as they are developed; gain feedback and conduct self-assessment after product release [Wold, Allan]*
- *Conduct trainings to broader user groups and evaluate trainings to optimize NANOOS functionality [Wold]*
- *Engage with regional formal education communities to use ocean observing and NANOOS products to support STEM education, and with regional non-formal education communities to facilitate the use of NANOOS products to foster community ocean literacy [Wold, Allan]*

Status: On track

Summary: Incorporated informal user feedback, collected via engagement activities by Wold and Allan, into enhancing NVS.

Accomplishments/Successes: None

Problems/Delays: None

Non-core Task 12: Support execution of OceanHackWeek [Mayorga]

Status: On track

Summary: OceanHackWeek 2023 (OHw23, <https://oceanhackweek.org/ohw23/>) took place in a hybrid mode on August 7 to 11, with five days of collaborative data exploration, peer learning, and software development. 50 participants from multiple countries gathered in three coordinated sub-events: in person events at the University of Washington in Seattle (16 participants) and near Perth, Australia (15), and a global virtual event (19) spanning time zones from the US West Coast to Europe and South Korea. Participants were joined by 13 organizers and 14 additional tutorial presenters, project mentors and helpers. 9 tutorials or coordinated discussion sessions were organized, and participants advanced a diverse set of 11 projects. The event was co-led by organizers from many institutions (<https://oceanhackweek.org/ohw23/organizers.html>) in multiple countries, including Emilio Mayorga and Wu-Jung Lee from APL-UW. Primary funding support was provided by NASA, US IOOS (to NANOOS), NSF and the UW eScience Institute; and the Australian CSIRO for the Australia event.

Accomplishments/Successes: Tutorials and projects spanned a range of oceanographic topics (AI/ML methods, ocean 'omics analysis, upwelling, etc), data sources (remote sensing, Argo floats, US IOOS, OBIS, Australia IMOS, etc.) and open-source programming languages (Python and R),

which were all supported by a common computational infrastructure on the cloud and coordination that enabled extensive project collaborations across the satellites. Presentations, tutorials, and project presentations are openly accessible from the OHW website as computational notebooks (Jupyter or R Markdown), slides, and video recordings on YouTube.

Problems/Delays: None

Diversity, Equity, and Inclusion:

- *Work with the other IOOS regions and the Program Office on workforce development initiatives to expand and diversify the ocean, coastal, and Great Lake workforces and to improve our ability to provide relevant ocean and coastal data and information to underserved or underrepresented communities [Newton, Wold]*
- *On a more immediate and local scale, the NANOOS “Enabling Change” working group, made up of NANOOS staff and partners (currently federal, university, and state agency) will move forward with actions that match NANOOS’ commitment ability [Newton, Wold]*

Status: On track

Summary: During this reporting period, NANOOS Staff and members of the Enabling Change working group met regularly to discuss opportunities to progress DEI efforts.

Accomplishments/Successes: Hosted EarthLab summer interns, mentored students at the Maritime High School.

Problems/Delays: None

D. Non-Core Funded Activities:

Reported throughout the “Core Funded Activities” sections, wherever thematically relevant. Each activity is labeled as “Non-core Funded Task #”.

E. Governance & Management Subsystem:

Governance:

- *Assure that NANOOS has transparent, effective, and representational governance via its Governing Council and the NANOOS Executive Committee composed of its elected Board and its functional committee chairs [Newton, Rome & Carini, UW]*
- *Assure these bodies are engaged in NANOOS prioritization of regional needs, work effort, and product development [Newton, Rome & Carini, UW]*
- *Assure balance of stakeholders represented in NANOOS reflects the diversity found in PNW [Newton, Rome & Carini, UW]*
- *Conduct annual GC meeting [Newton, Rome & Carini, UW]*

Status: On track

Summary: J. Newton (NANOOS Executive Director), A. Barnard (NANOOS Board Chair), and M. Kosro (NANOOS Board Vice Chair) continued to provide leadership to NANOOS operations and connection to the US IOOS enterprise. Newton, R. Carini (NANOOS Deputy Director), and N. Rome (NANOOS Senior Program Manager) assured progress on the above milestones. Executive Committee meetings were held virtually on 22 August, 24 October, and 12 December, to advise NANOOS on its strategy and priorities for the upcoming IRA fund opportunity.

Accomplishments/Successes: The Annual NANOOS *Governing Council* (GC) and *Principal Investigator* (PI) meetings were held 9-10 August 2023 in Astoria, OR. We also held a Community Event, open to the public with two panels of paired scientist-practitioner speakers. A NANOOS

20th Anniversary Reception followed in the evening to celebrate this important milestone for NANOOS on 10 August. Following the NANOOS meetings, on 11 August, many RA directors were able to join the IOOS Directors' Retreat to conduct IRA planning and build community amongst the RA's.

To assure balance of sectors, NANOOS hosted a spotlight event on 2 August 2023 at the UW Waterfront Activities Center in Seattle on *Bridging Science and Industry for Ocean Observing to Meet Community Needs*. Congresswoman Jayapal was our keynote speaker, with representatives from Senator Murray and Congressman Smith.

Problems/Delays: None

Non-core Task 5: Support for salary for Newton as GOA-ON Co-Chair [Newton]

Status: On track

Summary: Newton continued to serve on several international scale coordination committees during the period. Newton is a co-Chair of *Global Ocean Acidification Observing Network* (GOA-ON), along with Steve Widecombe, Plymouth Marine Labs. She represented IOOS on GOA-ON Executive Committee (EC) calls and activities.

Accomplishments/Successes: Over the period, she aided the following activities: GOA-ON Co-Chair input to calls to establish a GOA-ON hub in the Caribbean, and calls to discuss coordination for a West Africa Hub. On 5 September, she co-led the virtual 2023 GOA-ON EC Meeting. As the GOA-ON co-Chair, Newton was involved in standing up the 2023 version of OA Week on 30 Oct - 3 Nov, where she gave a talk on "OARS: *Ocean Acidification Research for Sustainability*". NANOOS powers the GOA ON web and data portal through funding from NOAA OAP (non-core task 6).

Problems/Delays: None

Representation:

- Represent NANOOS at IOOS Program Office and IOOS Association meetings, and at national meetings of significance [Newton, Rome & Carini, UW]
- Engage at a regional level at meetings and workshops affecting PNW stakeholders and NANOOS [Newton, Rome & Carini, UW]

Status: On track

Summary: Newton participated in IOOS Program Office and IOOS Association calls. Newton is a member of the IOOS Association Executive Committee and participated in their teleconferences during the period.

Accomplishments/Successes: Newton, Carini, and Rome attended the IOOS Fall Meeting in La Jolla, CA on 18 November - 1 December. Newton presented highlights of the Ecosystem Sciences and Management Working Group (ESMWG) Report to the NOAA Science Advisory Board (SAB) "Developing Resilience in the Face of Rapidly Changing Marine Environments, which she previously had co-chaired, at the NOAA SAB meeting on 26 July (virtual). She participated in discussions highlighting a role for coordination with IOOS.

Throughout the period, Newton continued representing NANOOS and IOOS at CLIVAR Steering Committee meetings to plan the workshop Optimizing Ocean Observation Networks to be held in Boulder, CO, in early April.

Newton participated in the *North Pacific Marine Science Organization* (PICES) annual meeting in Seattle, WA on 23-27 October. She was invited by NOAA's Dr. Cisco Werner to speak in his workshop on *Science Advances Needed to Understand Our New Ocean* on 22 October giving a talk on "Modernizing our observational capabilities".

Within the scientific community, Newton was invited to give a talk at the US CLIVAR 2023 Summit Meeting 31 Jul - 2 Aug in Seattle and presented on NANOOS observations on marine heat waves off the Washington coast. Newton joined Mickett and Hales in attending the NOAA Ocean Acidification Program (OAP) Observing Network Buoy PI Workshop 3-5 Oct, where they

presented talks on the Cha'ba and CB-06 buoys in the NANOOS network funded by OAP for ocean acidification observations. Newton also attended the Coastal and Estuarine Research Federation (CERF) 2023 Conference in Portland, Oregon, from 13-16 Nov. At the conference, Newton presented research results from the NOAA-funded Olympic Coast Regional Vulnerability Assessment, which used data and model output from NANOOS partners. The approach taken with four tribal partners emphasized co-design and co-production. She spoke in a session co-chaired by AOOS Director Sheyna Wisdom and former IOOS fellow Ashley Peiffer on "Co-design of Community Science Projects For Coastal Resiliency". In the session, Wisdom presented a talk on Backyard Buoys, which NANOOS is a partner in.

At a public event hosted by the Seattle Aquarium on 19 July in Seattle, Newton was invited to give a Lightning Talk in their series on Snails, speaking about the fragility of pteropods to climate change and ocean acidification. Fostering the next generation, NANOOS engaged with EarthLab to host two interns during the summer of 2023 (see Education & Outreach section). Newton attended the EarthLab Intern Showcase on 18 August in Seattle, where the two interns cited NANOOS products that facilitated their work.

Problems/Delays: None

Project Oversight:

- *Conduct annual all-PI meetings and Tri-Committee meetings, providing clear feedback and direction [Newton, Rome & Carini, UW]*
- *Share project evaluation at the annual PI meeting [Newton, Rome & Carini, UW]*

Status: On track

Summary: Newton, Carini, and Rome participated in weekly Tri-Comm calls and coordinated with PIs throughout the period. The Annual NANOOS Principal Investigator meetings were held in association with the GC meeting in Astoria, Oregon on 9-11 August. All PIs were in attendance, except for a few who sent reports due to field conflicts, etc.

Accomplishments/Successes: To grease the wheels for the Annual PI Meeting and increase PI connections, particularly in light of IRA opportunities, on-line zoom sessions of various PI subgroups were conducted and attended by Carini and Newton. These discussions included: Gliders, Moorings, HABs, Radar, Modeling, and Beaches & Shorelines.

Problems/Delays: None

Coordination:

- *Coordinate with West Coast RAs and other RAs to optimize and leverage capabilities and assure consistencies [Newton, Rome & Carini, UW]*
- *Engage in sub-regional and user-group specific workshops to aid coordination and optimization of effort [Newton, Rome & Carini, UW]*
- *Coordinate with Canada (CIOOS, MEOPAR, etc.) [Newton, Rome & Carini, UW]*

Status: On track

Summary: Newton, Carini, and Rome engaged activities over the period with regional and local entities in a variety of venues and opportunities.

Accomplishments/Successes: See below for notable activities.

Problems/Delays: None

Accountability:

- *Submit required IOOS progress reports and respond to other requests [Newton, Rome & Carini, UW]*
- *Attain recertification in 2023 as the Regional Information Coordination Entity of US IOOS for the PNW [Newton, Rome & Carini, UW]*

Status: On track

Summary: Progress report and other requests have been fulfilled during the period. NANOOS was successfully recertified, with a [new MOA enacted](#) between the U.S. IOOS Program Office and NANOOS upon the signature of both parties on 28 August 2023.

Accomplishments/Successes: While Progress Reports in the IOOS requested format have been filed on time, a more readable format is produced and these reports maintained publicly available at https://www.nanoos.org/about_nanoos/documents.php

Problems/Delays: None

Additional NANOOS coordination and representation included:

- Newton led the Backyard Buoys National Science Foundation panel review on 18 July 2023 (virtual) that included NANOOS, AOOS, and PacIOOS. Tiffany Vance (IOOS Program Office) was one of the reviewers. Reviews were very positive, with constructive advice about managing expectations and timelines.
- In coordination with Washington state agencies, tribes, industry, and others, Newton represented NANOOS at the Marine Resources Advisory Council meetings on 25 July in Olympia, WA, and 19 October (virtual).
- Enhancing diversification of workforce in ocean observing, Newton brought staff from the Quileute Tribe and the Makah Tribe as well as students from Western Washington University and University of Washington on the R/V Thomas G. Thompson research cruise from Newport to Seattle over 23-27 September.
- NANOOS provided updates on oceanographic conditions in the Pacific Northwest for the NOAA *WestWatch* webinar series on 15 August, 19 September, and 17 October, along with the other two west coast RAs. NANOOS made contributions to *PSEMP Puget Sound Marine Condition Updates* on 19 July, 20 September, and 6 December.
- NANOOS continued work on the development of OA indicators for the *West Coast Ocean Data Portal* and is supporting a project in collaboration with Oregon State University and NOAA PMEL on Multi-Stressors off the Pacific Northwest Coast.
- Locally, Newton served on the Steering Committees of C-CAN, OASES, ORHAB, Cascadia CoPes Hub, OCNMS Climate Vulnerability Assessment Working Group and the Puget Sound Environmental Monitoring Program. She informed regional and national groups about the west coast OAH indicator work.
- Carini and Newton attended the USGS National Storm Tide Monitoring Program meeting on 4 December (virtually).
- Carini and Newton represented NANOOS at the National WebCOOS Kickoff Meeting on 11 December (virtually).

Keeping the goals and capabilities of NANOOS and IOOS represented internationally, NANOOS Administration and Pls made several important contributions:

- Newton served as a member of the *Canadian IOOS (CIOOS) Pacific* Regional Oversight Committee and maintained communication over the period. Also in Canada, Newton chaired the *Marine Environmental Observation, Prediction, and Response Network*, a Canadian Center of Excellence (MEOPAR) International Science Advisory Committee, which was renewed for funding during the period and will start active meetings in the next period. Newton was invited to attend a virtual meeting to discuss a Bilateral Bulletin for British Columbia, Canada, and the Pacific Northwest USA on 4 December. The Bulletin will include atmospheric and oceanographic information and Newton agreed to help scope the latter.
- Barth and Newton are on the Advisory Committee of the *UN Ocean Decade Collaborative Center for the Northeast Pacific* and attended meetings during the period, including a workshop during the PICES meeting on Indigenous co-production.

- Newton continued as a member of the Science Advisory Team for the *Joint European Research Infrastructure in the Coastal Ocean* (JERICO) along with Henry Ruhl (CeNCOOS) and Clarissa Anderson (SCCOOS).
- Coordination with the Global Ocean Acidification Observing Network (GOA-ON) is described in non-core task 5.
- MacCready continued service on the Olympic Coast National Marine Sanctuary's Advisory Council as the primary Research representative (2023-2026). He also serves on the SeaGrant Willapa Grays Harbor Estuary Collective Scientific Advisory Committee.

F. Presentations & Publications Acknowledging NANOOS Support:

Presentations: underline indicates NANOOS PI

Newton, J. et al. 2023. *The value of integrating social and ecological science for regional vulnerability assessments to ocean acidification*. Coastal and Estuarine Research Federation 27th Biennial Conference. Portland, Oregon. 16 November 2023.

Newton. 2023. *OARS: Ocean Acidification Research for Sustainability*. OA Week. Virtual. 30 October 2023. <http://www.goa-on.org/webinars/OaWeek2023/webinar.php#schedule>

Newton. 2023. *Modernizing Our Ocean Observational Capabilities*. PICES Workshop: Science Advances Needed to Understand Our New Ocean. Seattle, WA. 22 October 2023.

Mickett, Sutton, Alin, Manalang, and Newton. 2023. *Pacific Northwest Observing Node*. NOAA OA Observing Network Buoy PI Workshop. Virtual. 3 (3-5) October 2023.

Newton. 2023. [Understanding marine heatwaves in the Pacific Northwest](#). US CLIVAR 2023 Summit Meeting. Seattle, WA. 1 August 2023.

Newton, J. 2023. *Developing Resilience in the Face of Rapidly Changing Marine Environments*. A summary of the report to the NOAA Science Advisory Board Meeting, Virtual. 26 July 2023.

Gradoville, M.R., Riseman, S., Estrada, A.E.S., Needoba, J., Seaton, C. 2023. Repeated patterns and interannual variability in low oxygen events in the lower Columbia River Estuary. *Coastal and Estuarine Research Federation*, Portland, OR November 2023.

MacCready, P. and J. Blalock 2023. Invited presentation for Panel Session “Pairing a User and Scientist: Willapa Bay Modeling” at NANOOS Meeting, Astoria, Or 8/10/2023.

MacCready, P. 2023: Invited talk for NANOOS public meeting, LiveOcean Daily Forecast” 8/2023.

MacCready, P. and W. R. Geyer 2023. Poster at Coastal and Estuarine Research Federation Conference: “What Controls the Estuarine Exchange Flow of the Salish Sea?” Portland, OR 11/2023.

MacCready, P. 2023. Invited Talk for Puget Sound Marine Water Work Group Meeting: “Residence Times in the Salish Sea” 12/2023.

Publications: underline indicates NANOOS PI