Progress Report

Project Title: Sustaining NANOOS, the Pacific Northwest component of the U.S. IOOS
Award Number: NA21NOS0120093
Period of Activity: 07/01/2022 - 12/31/2022
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 FY2022 (= 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 FY22, NANOOS has the following additional tasks funded via IOOS (1-3, 9), the NOAA Ocean Acidification Program (4-7), and NOAA NCCOS (8):

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
2) A one-time HFR system add-on (Kosro, OSU)
3) A one-time increase for core needs (Newton, UW)
4) Support for salary for Newton as GOA-ON Co-Chair (Newton, UW)
5) Sustain NANOOS' work to develop and maintain the GOA-ON data portal (Newton/Tanner, UW)
6) Support efforts for OA observing on NANOOS NOA-ON CB-06 off the OR shelf (Hales, OSU)
7) Support efforts for OA observing on NANOOS NOA-ON Cha'ba on the WA shelf (Newton/Manalang, UW)
8) Support for Monitoring and Event Response for Harmful Algal Blooms (MERHAB) project activities (Mickett, UW)
9) Support execution of OceanHackWeek (Mayorga, UW)

Work also continues on the following additional tasks, funded during FY21 (= Y1 of the award):

6) Support Cha'ba Ship-Time (Manalang, UW)
7) NOS funds for "Enhancement of NOS modeling capabilities for the Northern Pacific in support of disaster prevention and safe navigation" (Seaton, CRITFC)
8) NOAA/NOPP funds for the BIO GO-SHIP pilot on US-supported GO-SHIP cruises (Graff, OSU)

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.
	PNW Coast HF Surface Current Mapping: *Lead PI: Kosro, OSU* - Maintain and operate 10 SeaSonde HF sites designated as Priority 1 sites by the national HF program; these are six long-range sites in OR, two in WA, 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
	Wave Imaging at Critical PNW Ports: *Lead PI: Haller, OSU* - 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.
	WA shelf buoys/moorings: *Lead PI: Manalang, UW* - 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
	WA shelf HAB buoy/mooring: *Lead PI: Mickett, UW* - Support for the HAB ESP deployment on NEMO mooring - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	WA shelf La Push glider: *Lead PI: Lee, UW* - Maintain the La Push line glider at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	OR shelf buoy: *Lead PI: Kosro, OSU*

	- 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> *Lead PI: Seaton, CRITFC* - 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 Columbia glider:</u> *PIs: Seaton, CRITFC & Barth, OSU* - Maintain the CMOP Columbia glider at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>N. CA shelf glider:</u> *Lead PI: Barth, OSU* - Maintain the Trinidad Head 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> *Lead PI: Manalang, UW* - 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> *Lead PI: Krembs, WDOE* - 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> *Lead PI: Seaton, CRITFC* - 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> *Lead PI: Helms, ODSL* - 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	**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.
	<u>WA beach and shoreline:</u> *Lead PI: Kaminsky, WDOE* - Maintain shoreline observations in WA at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<u>OR beach and shoreline:</u> *Lead PI: Allan, DOGAMI* - Maintain shoreline observations in OR at existing levels - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	<u>WA and OR bathymetry:</u> *Lead PI: Ruggiero, OSU* - 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	**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.
	<u>NE Pacific and Salish Sea:</u> *Lead PI: MacCready, UW* - 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
	<u>Columbia River estuary and plume:</u> *Lead PI: Seaton, CRITFC* - 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
	<u>PNW Coastal Waters:</u> *Lead PI: Zaron, OSU* - 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)	**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.
	<u>Mature Regional DAC Operations:</u> *Lead PI: Tanner, UW* - 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
	<u>NVS Support and Development:</u> *PIs: Tanner & Carini, UW* - 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
	<u>Engagement in National and Cross-regional DMAC Efforts:</u> *PIs: Tanner & Carini, UW* - 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)	**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.
	<u>Web Site:</u> *Lead PI: Tanner, UW* - 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
	<u>Tailored Products Development:</u> *Lead PI: Allan, DOGAMI*

	- 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)	**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.
	<u>Communication:</u> *Lead PIs: Wold & Newton, UW* - 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
	<u>Product Co-Development:</u> *Lead PIs: Wold, UW & Allan, DOGAMI* - 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
	<u>Diversity, Equity, and Inclusion:</u> *Lead PIs: Newton & Wold, UW* - 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, Coordination &	**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.

Accountability	<u>Governance:</u> *PIs: Newton, Rome & Carini, UW* - 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
	<u>Representation:</u> *PIs: Newton, Rome & Carini, UW* - 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
	<u>Project Oversight:</u> *PIs: Newton, Rome & Carini, UW* - Conduct annual all-PI meetings and Tri-Committee meetings, providing clear feedback and direction - Share project evaluation at the annual PI meeting
	<u>Coordination:</u> *PIs: Newton, Rome & Carini, UW* - 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.)
	<u>Accountability:</u> *PIs: Newton, Rome & Carini, UW* - 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. <u>Observing Subsystem</u>:

Data from all assets reported here are served via NVS.

<u>CURRENTS AND WAVES</u>
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 six long-range sites in OR, two in WA, 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 [Kosro]*

- *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, using current-year funds, 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. 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 modifications to the site HF antennas; those are to be shipped soon by Codar.
Accomplishments/Successes: Operation of HF sites and data delivery. Final installation of new Washington state site WSP1, with data to begin flowing to the IOOS HF data assembly center this month.
Problems/Delays: Need permission for northernmost site KAL1, in the Olympic National Park.

Non-core Task 2: *A one-time HF Radar system add-on [Kosro]*
Status: On track
Summary: Site WSP1, at Westport, WA, is installed and will deliver data later this month. At site KAL1, near Kalaloch in the Olympic National Park, an application must be made for site installation.
Accomplishments/Successes: Completion of WSP1 site. Purchase of equipment for KAL1 site.
Problems/Delays: Permission from National Park Service needed.

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 and published these to NVS and a comprehensive Oregon State University website (linked to from NVS). Backup data drives were swapped in November to ensure continuous archival of recorded radar data. Work is in-progress for providing timeseries data of radar-derived ocean spectral statistics (peak direction, period, and wavelength). We are investigating how best to use spectral SNR calculations to filter this data.
Accomplishments/Successes: Continuous operation, data reporting, and archiving. From September-November 2022 OSU conducted a deployment of four Spotter wave measurement buoys with bottom-mounted pressure sensors approximately 1 km offshore off Nye Beach and within the radar footprint. This deployment was in support of a US Army Corps of Engineers program for developing a high resolution nearshore storm modeling system for the West Coast. The radar was operational during this period and the buoy data will be used as a ground-truth check on the radar-derived data products.
Problems/Delays: None

<u>SHELF</u>
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 [Manalang]*
- *Deliver NRT data streams via NVS [Manalang]*
- *Bring all data QA/QC to meet Certification standards [Manalang]*

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 2022 Coastal Buoy deployment cruise occurred October 8, 2022 - October 15, 2022. Work was conducted aboard the R/V Thompson, during a transit from Newport, OR, to Seattle, WA. Moorings recovered during the cruise include:

- **Summer Cha'ba**: recovered from 100m depth
- **NEMO Subsurface (NEMO-SS)**, including McLane profiler: recovered from 100m depth
- **Environmental Sampling Processor (ESP)** mooring: recovered from 100m depth

Mooring deployed during the cruise:

- **Winter Cha'ba** mooring: deployed in 100m water depth. The winter Cha'ba mooring supports instrumentation for measuring temperature, salinity, dissolved oxygen, and pH at fixed depths along the mooring line in addition to surface water and air pCO2 and meteorological variables.

The cruise also included ROV-aided recovery of the 2020 Winter Cha'ba mooring line and anchor that was previously unable to be recovered due to poor conditions. The SAAB Falcon ROV was operated by Global Diving & Salvage.

The team continued collaboration with Jennifer Hagen, Marine Policy Advisor for Quileute Natural Resources, who participated in our May operations. The team also continued collaboration with Sea-Bird Electronics, which refurbished and renewed the loan of a Sea-Bird SeapHOX instrument to collect integrated measurements of conductivity, temperature, depth, dissolved oxygen, salinity, and pH near the seafloor on the WA coast.

During this period, the Northwest Environmental Moorings (NWEM) team hired a full-time data manager in October 2022, Dr. Seth Travis. Dr. Travis has begun work on improved data flow and QA/QC protocols in coordination with NANOOS.

Accomplishments/Successes: Successful Winter Cha'ba mooring deployment in October 2022, and recovery of summer moorings. NWEM hired a full-time data manager to improve QA/QC and mooring data flow.

Problems/Delays: Real time communications with Summer Cha'ba and NEMO-SS moorings did not function throughout the deployment due to cabling and connector failures; however, all data was recorded and downloaded following recovery.

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

Status: On track

Summary: Carbon measurements are conducted in partnership with PMEL Carbon Programs. The Cha'Ba mapco2 carbon system operated on the Summer Cha'ba buoy in May, and a refurbished system was deployed on the Winter Cha'ba buoy in October.

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: Time setting on one instrument did not allow for real-time data from the Summer Cha'ba deployment.

Non-core FY21 Task 6: *Support Cha'ba Ship-Time [Manalang, Newton]*
Status: On track
Summary: The R/V Thompson, a UNOLS global-class vessel operated by the UW, was successfully used to conduct mooring operations in October 2022. Operating off of the R/V Thompson during a transit leg (Newport, OR, to Seattle, WA) results in an extended cruise and requires trucking support to deliver equipment to Newport, which is supported through this task.
Accomplishments/Successes: Successful mooring operations aboard the R/V Thompson.
Problems/Delays: None

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 (August 3, 2022)
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 8: *Support for Monitoring and Event Response for Harmful Algal Blooms (MERHAB) project activities [Mickett]*
Status: On track
Summary: This effort involves upgrading the aging controller and power systems on the NEMO-Subsurface mooring that provides contextual measurements to both the ESP real-time HAB mooring and the Cha'ba mooring. Specifically, ADCP velocities on this mooring are used to approximate HAB trajectories and profiles from the McLane profiler provide invaluable water column measurements to better understand HAB events. The full system should be ready for bench-testing by the end of January, with instrument and telemetry tests to be conducted from March-April, for system deployment the first week of May 2023.
Accomplishments/Successes: The full mechanical engineering of this project is complete, including a new pressure case and new rechargeable lithium batteries. The upgraded battery capacity will allow for longer deployments and more reliable telemetry.
Problems/Delays: After a hiatus of 8 months on this project due the long-lead time of the delivery of a key system component (the main computer board), we are back on track.

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
Summary: The buoy was last deployed in March 2022, and is returning data with select streams posted to NVS: solar radiation, eastward current, northward current, salinity, and water temperature. The replacement buoy and instruments have been prepared and we are waiting for a weather window to make the turnaround.
Accomplishments/Successes: Good data recovery and display.
Problems/Delays: Replacement of a few instruments for the next turnaround, including the ADCP, will be deferred. The replacement will be purchased from the Infrastructure Funds, which are expected to arrive shortly.

Non-core Task 6: *Support efforts for OA observing on NANOOS NOA-ON CB-06 off the OR shelf [Hales]*
Status: On track, with field service of mooring needed
Summary: Our vessel of opportunity in Coos Bay was at a remote port and unavailable in Fall of 2022. Recent extreme ocean conditions have prevented the deployment of the new buoy and recovery of the old one. Current high-pressure conditions are expected to persist for the next 7-10 days, with dropping sea states. Mooring recovery planned for ~1 February.
Accomplishments/Successes: Persistent deployment for 10 months with modern charging/battery system.
Problems/Delays: Vessel availability and ocean conditions limited fall mooring turnaround.

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

Status: On track
Summary: SATURN-02 is a seasonal inter-disciplinary buoy, with real-time telemetry, located off the mouth of the Columbia River at ~35m depth. SATURN-02 data routinely contributes to model validation, capturing near-field Columbia River plume dynamics. Data also routinely offer local temporal context for specialty buoy deployments and for cruises.
Accomplishments/Successes: SATURN-02 was deployed in May 2022 and maintained on-station past Dec 31, 2022. The deployment was planned for recovery in late October, but the mooring is capable of surviving through winter. Good data was collected through mid-December, with limited data collection after that point due to low battery power. Parameters measured are (a) wind speed, direction and gust, air temperature, barometric pressure and PAR; (b) water velocity profile; and (c) the scalar water parameters: (in-situ) temperature, salinity, dissolved oxygen/oxygen saturation, chlorophyll, turbidity, CDOM, and phytoplankton health/quantum yield. Scalar water measurements (except temperature) are made through single at-surface sensors and a multi-level pumping system. Levels measured are 1, 6, 11, 16, 21 and 35m depth.

Real time data from SATURN coastal stations are displayed on NVS while the station is deployed. CMOP also provides access to SATURN long-term datasets via a newly established ERDDAP data server, including QA flagging. CMOP stations are expected to be the next batch of NANOOS stations integrated into the NANOOS centralized ERDDAP server for delivery to NDBC.
Problems/Delays: None

Washington Shelf 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: On track
Summary: SG249 was deployed on 12 July 2022 and continues to sample as of 24 January 2023, having completed 677 dive for 14 complete sections. Projected recovery is June 2023. The previous mission, also executed by SG249, extended from 26 April 2021 to 24 March 2022, completing 1411 dives, for 22 sections over 11 months. The initial deployments to replace the April 2021 - March 2022 SG249 mission were cut short due to sensor failures in SG236.
Accomplishments / Successes: SG249 is on track to operate into June 2023, at which time it will be replaced by a fresh vehicle. Fabrication of a second NANOOS glider is nearing completion.
Problems / Delays: Data processing and QC have been updated to our current standards, and data is flowing to the DAC. Data display on NVS is lagging due to a disconnect that occurred when NANOOS personnel changed over. This will be rectified during the next reporting period.

Washington Shelf Columbia 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
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 2022 reporting period, one glider map was made off central Washington in September using a glider on loan to OSU from CRITFC. The glider was deployed for a total of 15 days, and produced 8 cross-shelf sections over 416 km with 3102 vertical profiles of water properties. Glider data show that the summer upwelling season had brought near-bottom, low-oxygen (hypoxic, DO <= 1.4 ml/l) waters to the midshelf (~40-70 m), but they did not reach inshore of the ~35-m isobath. These data are displayed on NVS.
Accomplishments/Successes: Started the second, summer-season glider work off central Washington; continued operations with a reliable charter boat operator out of Westport, WA; Jack Barth (OSU) coordinated with Joe Schumacker (Quinault Indian Nation - QIN) to visit the Taholah school, on the central Washington coast, to interact with QIN students. Barth brought the just-recovered glider along, giving an interactive talk on gliders, data, and NANOOS.
Problems/Delays: Slocum glider 551, on loan from CRITFC, leaked during a planned July 2022 Washington shelf mapping exercise. The glider was recovered successfully and temporarily repaired in time for the September 2022 mapping effort. Glider 551 has been sent to Teledyne Webb for a more permanent repair.

Northern California Shelf 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

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° 3.5'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 end of December 2022, the glider was on the TH line for 156 days during one deployment, sampled along 2733 km of track line covering the transect 5 times, and collected about 1406 vertical profiles of ocean properties. Glider uptime during this period was 87%. 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 (Figure 1).

Problems/Delays: None

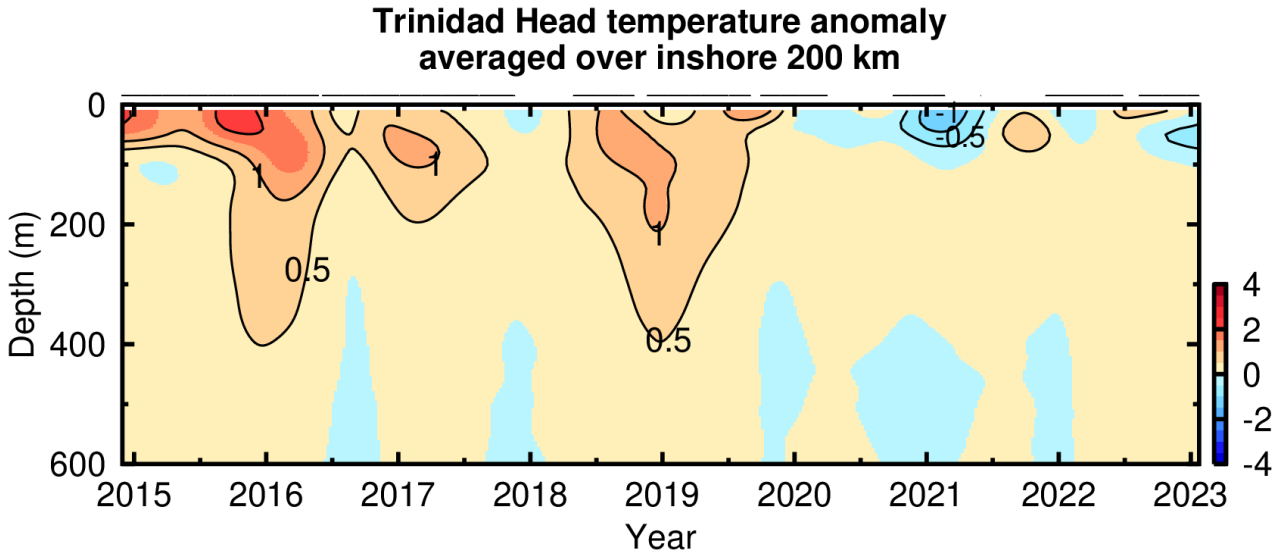

Figure 1: *Temperature anomaly from the Trinidad Head, CA (41° 3.5'N) glider line. Horizontal lines above the panel indicate when the TH-Line glider was in the water.*

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 [McCabe, Bormann/Trainer, MacCready, Callender/King, Kavanaugh, Newton]*

McCabe

Status: On track

Summary: PI McCabe has continued to collaborate with Barbara Hickey (UW School of Oceanography) and Vera Trainer (NOAA NWFSC) 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 four PNW HAB Bulletins to support coastal shellfish managers during the reporting period. These included the 25-Aug-2022, 15-Sep-2022, 03-Oct-2022, and 01-Nov-2022 Bulletins.

The first fall Bulletin on 25-Aug was rated as "moderate" risk, given an uncertain weather forecast and the fact that razor clams were already near regulatory closure limits (a result of domoic acid production by species of *Pseudo-nitzschia* in late July and early August). One month later, in late August and early September, concentrations of seawater particulate domoic acid began increasing again at Oregon beaches. The increasing toxins, variable winds, and reports of *P. australis*-like cells as far north as southern Washington beaches led to a "high" risk rating for the 15-Sep PNW HAB Bulletin. Both remaining Bulletins (03-Oct and 01-Nov) extended the "high" risk rating as a result of elevated toxins and large *Pseudo-nitzschia* cell concentrations at Oregon beaches, coupled with the onset of fall storms. In effect, samples collected by the coastal phytoplankton program at Oregon Department of Fish and Wildlife (ODFW) helped provide a crucial early warning for Washington shellfish beaches. On 02-Nov, the day after the final fall Bulletin, Washington Department of Fish and Wildlife postponed razor clam digs indefinitely.

ODFW Shellfish Biologist Matthew Hunter stated that the PNW HAB Bulletin helped delay the reopening of the popular Clatsop Beach razor clam fishery this fall because additional (unscheduled) tissue samples were collected prior to the opening in response to information provided by the Bulletin. Those samples indicated that domoic acid levels had already exceeded the closure threshold.

In addition, McCabe worked with Maria Kavanaugh (OSU) and colleagues to incorporate offshore samples collected by an Imaging Flow CytoBot (IFCB) into the 03-Oct Bulletin. Results from the ESP mooring off La Push, WA, also continue to be incorporated into the temporally overlapping Bulletins. The PNW HAB Bulletins are made publically available on both the ORHAB and NANOOS websites.
Problems/Delays: None

Bormann/Trainer
Status: On track
Summary: Trainer has been hired as the new Aquatic Science Director of ONRC. During this reporting period, work was completed using $9,834.39 in No Cost Extension (NCE) funds from the previous 5-year award, leaving an award balance of 2.5% of the NCE funds. These funds and 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. Most of that work was reported in the NCE progress report submitted 30 June 2022.
Accomplishments/Successes: UW Olympic Natural Resources Center, 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.

During this reporting period with $10,000 a piece for each of the four tribes, 87% of funding that remains on the current award was allocated (having spent $5,174.76 from January 1 – June 30 2022 and $1,620.71 from July 1 – December 2022). The funds have allowed each tribe to address individual capacity issues necessary for participating in offshore sampling over-and-above their weekly shore-side sampling. This included new microscopes that allow fluorescent analysis

for enhanced taxonomic identification of off-shore species, and equipment upgrades necessary to process the higher volumes of samples these new activities require. 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. Additionally, the recent introduction of new AAUV 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 reported on here are proving important in helping each tribe meet that new challenge.
Problems/Delays: The unique locations and existing capacities of each ORHAB tribal member requires a different strategy to support off-shore monitoring in every case. Some partners already have complimentary monitoring programs and platforms for adding off-shore HAB monitoring, others are struggling to develop the core staff and laboratory capacity to participate. For tribes with existing programs, the supplemental funds were dispersed to fill already identified gaps in capacity. For tribes without those internally funded programs in place, the supplemental funds serve as seed money for developing that capacity with other tribal resources and has led to delays. Delays are primarily COVID-19 related as many tribal partners have not had full access to their laboratories during this reporting period.

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. Dr. Hally Stone, a former grad student, published a paper in the journal Harmful Algae in May 2022 analyzing the forecast skill in relation to past HAB events (see Publications section below). A paper is in preparation 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.
Problems/Delays: None

Callender/King
Status: On Track
Summary: The SoundToxins program continues to provide support for phytoplankton monitoring throughout Puget Sound. Spend down of funds is quicker than anticipated due to increasing costs.
Accomplishments/Successes: For this reporting period we received and resolved 136 unique individual requests for support from SoundToxins participants relative to monitoring support and phytoplankton identification. We received 43 alerts regarding harmful algal blooms of which 33 of the alerts were provided to the Washington State Department of Health as part of the phytoplankton cell presence alert system and one additional alert was provided to let the Department know that a station would be offline due to a closed dock. Our team held six group office hours and conducted two one-on-one online training sessions. Sea Grant staff presented information about SoundToxins and phytoplankton at the DO IT camp for high school students in July and the Pacific Coast Shellfish Growers/National Shellfisheries Association meeting in September.
Problems/Delays: No problems or delays to note during this time other than a dock being closed (for safety reasons) and unavailable for the monitoring team.

Kavanaugh
Status: On track
Summary: We have initiated a 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. We are developing a methodological comparison to determine the utility of total domoic acid collected from frozen seawater samples. The project funds graduate student stipend (for project coordination) and technician time (to assist with running and annotating samples).
Accomplishments/Successes: Graduate student Raquel Gilliland has been successful in coordinating a 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 (Jennifer Fisher, Anna Bolm, Ryan McCabe). While June was relatively slow, a total of 271 samples have been collected from late June to October in Oregon coastal waters. These were collected primarily within Oregon waters off Newport, but moving further offshore as the tuna fishing increased. Gilliland collected coincident temperature, salinity, and, in the case of NH Line data, particulate domoic acid. Samples have been run on our imaging flow cytobot. Gilliland has applied an existing classifier to provide cell counts and biovolumes, and has nearly completed manual annotations of approximately 400,000 images for thick and thin P/N, other diatoms, dinoflagellates, ciliates and detritus. In addition, she is working with CIMERS scientists on a protocol to facilitate collection by fisherman of total domoic acid. Finally, she is working with OSU social scientist Lori Kramer, to obtain Institutional Review Board (for human subject research) to interview fisherman collaborators to obtain information on what works and costs and benefits related to cooperative fisheries research. Gilliland presented research at the State of the Coast conference in November 2022, and is currently writing her MS thesis.

A dashboard has been created to host the data. Next steps will be to automate the IFCb run, metadata ingest, posting of data to the dashboard, and notification of fishermen partners for data visualization. Gilliland was able to contribute P/N counts to the September 2022 HAB bulletin.
Challenges/Delays: Two unavoidable challenges were met with the project. The first was associated with the delayed onset of upwelling favorable winds, which delayed original targeted fishery (Midwater Trawl Cooperative). Those who were going out were following the fish that were distributed away from Heceta Bank off of northern Oregon. However, Gilliland was able to coordinate alternative sampling through the Charter Fishery and Newport Hydrographic Line (which is situated just to the north of Heceta Bank, but within the Heceta/Stonewall complex). The second relates to the idiosyncrasies of P/N toxicity, where counts are useful for presence of the genus, but do not determine species level information or toxicity, which occurs facultatively in only a subset of P/N species. Particulate domoic acid measurements can be taken concurrently, but the feasibility of fishermen collecting these samples is still being determined. pDA analyses were delayed due equipment failure (since fixed) at CIMERS. A future goal would be to develop a likelihood model of pDA abundance and presence above threshold based on morphological indicators, community composition, and environmental factors. The latter would allow prioritization of sample collection or opportunistic sampling when both the environmental conditions and personnel availability are changing.

Hunter
Status: N/A (postponed?)
Summary: No funds were used during this performance period as existing NOAA/MERHAB funds were still available until the beginning of 2023
Accomplishments/Successes: Not applicable as NOAA/MERHAB funding was used.
Problems/Delays: Funds were not used as NOAA/MERHAB funds needed to be extinguished before NANOOS/UW funds were to be used.

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 also reached out to Caren Braby (ODFW) about strategies for continuing funding for the Oregon beach sampling.
Accomplishments/Successes: See summary
Problems/Delays: No continuing funding from Oregon has been identified, as of yet, though this remains a high priority.

Non-core FY21 Task 8: *NOAA/NOPP funds for the Bio-GO-SHIP pilot on US-supported GO-SHIP cruises [Graff]*
Status: Completed
Summary: Funds were fully used to support the Bio-GO-SHIP pilot project field efforts during 2022 and spent prior to 1 July 2022.
Accomplishments/Successes: Bio-GO-SHIP successfully completed the GO-SHP P02 transects from Guam to Hawaii and Hawaii to San Diego. In addition to collecting biological measurements from the underway system and CTD rosette, the team was able to support sampling for calibration of optical instruments on Argo floats deployed during these transects. Sample and data analysis is underway.
Problems/delays: None

<u>ESTUARIES</u>
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. Winter mooring operations have been especially difficult due to poor battery performance in cold weather and reduced solar radiation to recharge batteries. Therefore, the NWEM team has identified and begun transitioning to a higher-energy density Lithium Iron Phosphate battery chemistry.

The NWEM team hired a full time data manager, Dr. Seth Travis, to implement QA/QC and work with NANOOS on implementing improved data flow.

Accomplishments/Successes: Multiple successful maintenance operations, and more in depth troubleshooting to identify root causes behind some rapid failure modes that have been causing extended downtime.

Full time data manager hired in October 2022.

Problems/Delays: Some significant profiling downtime was experienced due to aging systems, and external factors. Identifying and funding a qualified candidate for dedicated QA/QC work has been an ongoing challenge.

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

- *Maintain US-Canada ferry-box at existing levels, assuming COVID-19 does not preclude its operation [Krembs]*
- *Deliver data via NVS [Krembs]*
- *Bring all data QA/QC to meet Certification standards [Krembs]*

Status: On track

Summary: For GSI, we spent a total of $628.27 during the reporting period. For maintaining the DOT ferry instrumentation and data flow with Dr. J Thompson, APL, the total end of the year spending which includes April and June was $10,820.72.

Accomplishments/Successes: The Victoria Clipper is presently in dry dock and we were informed by the ship engineers that an additional hull penetration for the pump effluent is currently being installed above the water line. This port will ensure that pump flows are operating at desired flow rates. This wide effluent that can hold a smaller tube and doubles as a CO2-air intake for the pCO2 sensor and water effluent. The installation of the port hole is a big step forward on a delayed time schedule as it has affected the progress of installation of other plumbing components inside the ferry.

Brandon Sackmann from GSI was tasked to keep the installation moving forward. The hull penetration is an important sign of commitment from Victoria Clipper Navigations in supporting our ferry monitoring project despite economic challenges of the company.

Problems/Delays: The Victoria Clipper has gradually resumed business yet is still very understaffed to adjust to the low passenger volumes following COVID-19. We are finally getting the next important installations accomplished during the dry dock time of the ferry.

Columbia River Estuary, OR, Moorings:

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

Status: On track

Summary: The NANOOS supported estuarine stations that are maintained on a permanent or seasonal basis are SATURN-03, SATURN-04, SATURN-07, SATURN-09, CBNC3, Elliott Point and Woody Island. All stations except CBNC3 have real-time telemetry. All but CBNC3, Elliot Point and Woody Island (which currently only measure salinity and temperature, or only temperature in the case of Woody Island) are interdisciplinary (physics and biogeochemistry). Each of the stations is designed to capture specific features of the estuary. Real time data from SATURN coastal stations are displayed on NVS. CMOP also provides access to SATURN long-term datasets via a recently deployed ERDDAP server. Data is subject to QA/QC, which is included in data submitted to NCEI via NANOOS, and included in the ERDDAP server.

Accomplishments/Successes: SATURN-09 was recovered for servicing in November, 2022. CBNC3 was recovered for data download and redeployed in October, 2022. SATURN-07 is on-station after being recovered for servicing in early 2022. The Elliott Point buoy was recovered in May and will be redeployed in spring 2023. Nitrate observations were successfully restored at

SATURN-03 in early 2022, and calibration of existing nitrate data through laboratory analysis of archived water samples is in progress (water samples have been sent to an external lab for analysis). Potential threat from estuarine and coastal hypoxia to Columbia River salmon presented at multiple events. Work on improving the representation of datasets within the CMOP ERDDAP server, including QA information, occurred in fall 2022.
Problems/Delays: The historical station, SATURN-01, maintained from 2010 to 2017, located on the Astoria-Megler bridge platform, has become impossible to reoccupy due to the relocation of a major cormorant colony to the location, and changes in Oregon Department of Transportation regulations. Extreme cold weather in December 2022 caused power outages within the CMOP radio telemetry system. Remote station batteries are dependent on solar power, and will recover as day length increases.

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 7/01/22 – 12/31/22. Tom's Creek weather station provided 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. Data collection was completed at the Valino Island, Charleston Bridge, and Elliot Creek water quality stations, but telemetry is currently offline in preparation for replacement with Turnkey Storm3 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 deployments, maintenance, and data management were completed for the station network following NOAA NERRS Centralized Data Management Office.
Accomplishments/Successes: Water quality and weather time-series data collected as part of NANOOS/NERRS SWMP programs were incorporated into environmental modeling analyses to characterize drivers of eelgrass declines and understand changes in fish communities. The Reserve's Graduate Fellow (Taylor Dodrill) utilized water quality data for her research on phytoplankton communities and prediction of HABs. The Margaret Davidson Fellow, Lara Breitkreutz, is utilizing water quality data for her research on eelgrass communities. The Reserve education and science programs used water quality datasets for outreach programs on tidal marsh metrics for evaluating wetland resilience to sea level rise and are developing a water quality exhibit for the Reserve's Visitor Center. The Reserve hosted a Fall water quality intern who assisted the science program with water quality fieldwork and laboratory sample processing.
Problems/Delays: The North Spit BLM water quality station telemetry cable was replaced and transmissions resumed. Water quality station equipment and telemetry systems ordered from Yellow Springs Instruments are delayed in shipping because of setbacks in product development.

<u>BEACHES AND SHORELINES</u>
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 completed summer seasonal beach monitoring surveys in the Columbia River Littoral Cell (CRLC) between July and September 2022 collecting 50 beach profiles, 16 surface maps, and 57 sediment samples from multiple cross-shore locations along 12 of the profiles. In addition, over 200 beach profiles were collected to extend the nearshore bathymetry profiles collected by the USGS and OSU using personal watercraft. Seasonal beach profile data and contour change plots are made available through the NANOOS Visualization System.

In addition to the regular CRLC beach monitoring work, CMAP continues to conduct more detailed 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 7 supplemental profiles in Westport to monitor the dynamic revetment fronting the Westport by the Sea Condominiums, 19 supplemental profiles at the south end of Ocean Shores, and 10 supplemental profiles at the south end of Benson Beach.

CMAP also continues to collect seasonal beach profiles near Kalaloch at South Beach on the Olympic Peninsula, where 14 profiles were collected in October of 2022. 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.

CMAP continues to monitor the performance of the dynamic revetment at North Cove. Beach topography surveys were conducted in September and December 2022, where 48 profiles and a surface map were collected during each survey. Data will be used to create a digital elevation model of the survey area and compared for change over time. A storm response survey was conducted in December 2022 following significant high-water levels, which included a subset of topographic beach profiles and mapping of key design features.

Accomplishments/successes: G. Kaminsky co-authored a presentation given by P. Ruggiero at the American Geophysical Union (AGU) Fall Meeting in December (See Presentation section below). The presentation summarized results from twenty-five years of annual topographic and bathymetric surveys completed by CMAP in collaboration with OSU, DOGAMI, and USGS in the CRLC.

Problems/Delays: None

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 & December 2022), along the Clatsop Plains (6 sites, October & December 2022), the Columbia River south jetty dynamic revetment (28 sites,

December 2022), along the Neskowin cell (15 sites, September & December 2022), the Newport littoral cell (58 sites, August 2022) and the Beverly Beach littoral cell (15 sites, August 2022). 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 and the public to assess local and regional coastal changes taking place on Oregon beaches. Change rates are being used to evaluate future coastal responses on dune backed coastlines for the purposes of determining appropriate sites for landing telecommunication cables. Results from monitoring along the Columbia River south jetty dynamic revetment have been summarized in a Coastal Sediments '23 coastal conference proceedings paper.
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 benefitting the US Army Corps of Engineers.

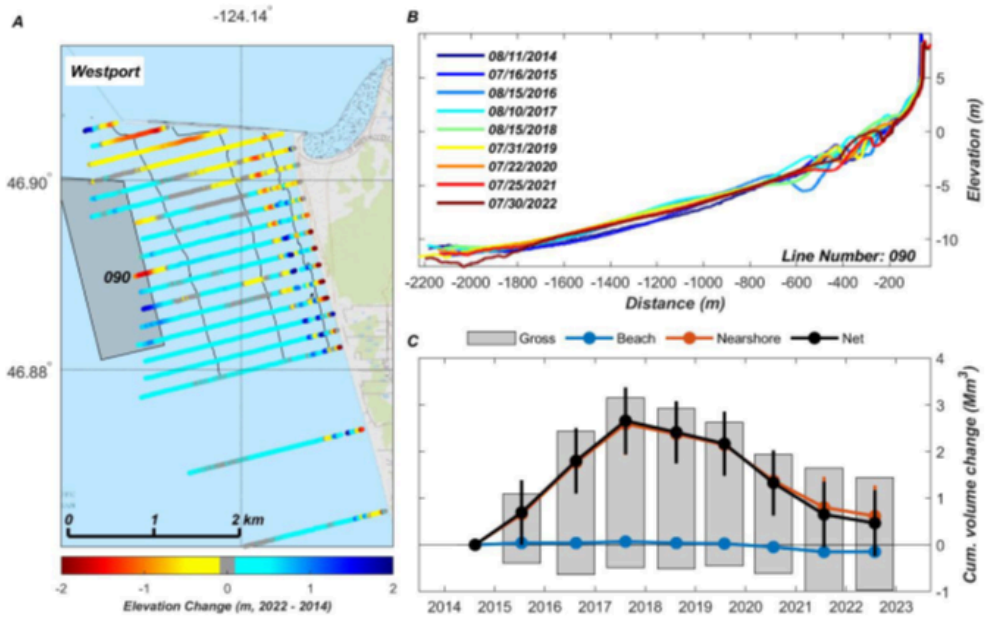

Figure 2. *A Map showing cumulative elevation changes between 2014 and 2022 for the Westport region within the Grayland Plains subcell; depth contours (5-m interval between –10 and 0 m) based on 2014 survey. B, Example profile showing changes in beach and nearshore morphology along survey line 090 (location shown in A). C, Time-series plot of volume changes calculated for the Westport region; net volume changes are provided for beach and nearshore depth zones, as well as net volume changes integrated over the entire region.*

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 started developing a new generation Coastal Profiling System with two new Personal Watercraft. The hope is that the new equipment will be ready for summer 2023. P. Ruggiero delivered a talk at the American Geophysical Union (AGU) Fall Meeting in December co-authored by George Kaminsky and Jonathan Allan. The presentation summarized results from twenty-five years of annual topographic and bathymetric surveys completed by CMAP in collaboration with OSU, DOGAMI, and USGS in the CRLC.
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 improvements to the LiveOcean model system. We are nearly done with validation of a new version of the model using updated source code and revisions to the biogeochemistry. We have also begun testing the effects of adding many small rivers and wastewater treatment plants in a high-resolution nested model of Hood Canal. Initial validation shows significant improvements to the near-surface salinity stratification.
Accomplishments/Successes: Erin Broatch, a current grad student, published a paper evaluating numerical mixing in the LiveOcean model in the Journal of Physical Oceanography.
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 CMOP 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

Non-core FY21 Task 7: *NOS funds for "Enhancement of NOS modeling capabilities for the Northern Pacific in support of disaster prevention and safe navigation" [Seaton]*
Status: On track
Summary: Leveraging the existing modeling system and prior work on implementing SCHISM modeling of the estuary, CMOP worked in collaboration with NOAA/NOS/OCS/Coast Survey Development Lab-Coastal Marine Modeling Branch (with joint funding from OCS, IOOS, NGS and CO-OPS transferred through IOOS/NANOOS, for Task 12) on the development of a new SCHISM model for the northern and tropical Pacific Ocean. After initial work on development of a 2D tide model, the focus of development shifted to 3D model development with the potential for trans-Pacific port-to-port modeling of surface currents in support of navigation.
Accomplishments/Successes: Work during this period included continued skill assessment of a 3-D basin-scale simulation, with a focus on the representation of the Oregon and Washington

coastal shelf and the Salish Sea, and on synthesis and development of final reporting documents. Results of this task were presented at the International Year of the Salmon synthesis symposium. Planning for transition of the model to a pre-operational NOAA-OCS forecast also occurred during this period.
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 SST NPP L3U product that we assimilated into the system for several years was discontinued in summer 2022. Thus instead of assimilating SST NPP L3U (uncollated product coming from a single satellite) the RTDAOW now assimilates the NPP L3S LEO AM/PM product (https://doi.org/10.5067/GHLPM-3SS28), which is a compilation from four VIIRS instruments, providing much better coverage compared to just one satellite. The data delivery is near-real time and rather stable. At this moment we do not anticipate any substantive changes to the project Scope of Work.
Accomplishments/successes: Implementation of new SST data assimilation allowed to essentially improve SST forecast provided 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: Development of BlueHarvest, a new internal NANOOS DMAC application for harvesting data from a wide range of data providers. The new system is more robust and maintains flexibility to accommodate a wide range of data providers/sources. It still 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 more immediate feedback about data transmission frequency/latency, which enables NANOOS to identify and fix data flow issues more efficiently.
Accomplishments/Success: New BlueHarvest assets: CMOP Platforms, USGS Bogachiel Forks, USGS Bogachiel La Push. BlueHarvest assets in process of being updated: OSU CB-06.
Problems/Delays: None

Non-core Task 3: *A one-time increase for core needs [Carini, Newton]*
Status: On track
Summary: This one-time increase is being used to support Carini leading NANOOS efforts for 2023 Recertification as a Data Center. During this reporting period, Carini worked with Biddle in the IOOS Program Office in response to a routine Certification Audit.
Accomplishments/Successes: NANOOS passed its Certification Audit and received a list of actionable items to prepare for Recertification in 2023.
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: No new local providers this reporting period
Accomplishments/Successes: None
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: Added data streams for USGS river gauges near Forks and La Push, WA, based on requests from Jennifer Hagen, Marine Biologist for the Quileute Tribe. Developed new dynamic overlays capability, allowing users to specify colormaps and min/max ranges for overlays. Replaced OI SST climatology overlays with new dynamic capability.
Accomplishments/Success: New dynamic overlay capabilities that provide more customization options for users. Updated OI SST overlays, ensuring automatic updating of the monthly mean and anomaly maps for SST, based on the climatology.
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: Steady progress was made to add assets to NANOOS ERDDAP for NDBC harvest.
Accomplishments/Success: No new assets were added to the NANOOS ERDDAP during this reporting period.
Problems/delays: NCEI queue continues to be the bottleneck for getting relevant data nationally archived. Data providers (typically those with one or two platforms) struggle to make their data available in ways that are straightforward (standardized) to harvest.

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: Carini attended DMAC webinars and met with National Glider DAC managers. Tanner and Carini worked closely with IOOS DMAC staff to attempt to revise the NANOOS assets included in the IOOS Registry and Catalog and to get asset information flowing to the Beta IOOS Sensor Map.
Accomplishments/Successes: None of note
Problems/Delays: Due to the complexity of NANOOS in situ assets and their data structures in the NANOOS ERDDAP, the IOOS Registry and Sensor Map have had problems accurately portraying the NANOOS assets. We are still working on the best way to fix this without having to create redundant ERDDAP datasets for IOOS.

- *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: Though Tanner and Carini have collaborated with PacIOOS and AOOS DMAC through their NSF-funded Convergence Accelerator Backyard Buoys project, they have not done so on core NANOOS funds during this reporting period.
Accomplishments/Successes: None
Problems/Delays: None

<u>USER PRODUCTS COMMITTEE (UPC)</u>
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: Updates slideshow, documents, and other content.
Accomplishments/Successes: Added new USGS river gauge platforms to the NANOOS NVS data explorer. Implemented major updates to several model overlays, including the OSU ROMS overlays, which now include multiple depths and dynamic colorbars; OI SST climatology overlays now include dynamic colorbars. Implemented updates to links to tsunami evacuation brochures.
Problems/Delays: None

Non-core Task 5: *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: Chaired by J. Allan (DOGAMI), 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 DMAC.
Accomplishments/Success: NANOOS continues to modernize its web and data harvesting scripts, centralizing these scripts to the University of Washington. Of note during this period, the NANOOS team was successful in moving the OSU ROMS and OI SST overlays from OSU to UW, and added new capabilities to account for multiple depths and dynamic colorbars.
Problems/delays: None

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 (Seattle Maritime High School, CRITFC Salmon Camp, State of the Coast, Oregon Sea Grant Coastal Haz), developed a video tutorial highlighting a new NVS capability ("*Snapshot*" tool), maintained content on social media, newsletters, website slideshow, etc., and regularly participated in IOOS Outreach Committee meetings.
Accomplishments/Successes: *"Snapshot"* tool video tutorial
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 honing the NVS *"Snapshot"* tool.

Accomplishments/Successes: None
Problems/Delays: None

Non-core Task 9: *Support execution of OceanHackWeek [Mayorga]*
Status: On track
Summary: OceanHackWeek (OHW22, https://oceanhackweek.org/ohw22/) took place in a hybrid mode on August 15 to 19, with five days of collaborative data exploration, peer learning, and software development. It consisted of a global virtual event and six regional, coordinated satellites around the world to accommodate diverse learning environment preferences, as well as to better address the demand for in-person engagement, and support a larger number of participants. 104 participants from multiple countries gathered online and in regional events in the Northeast, Southwest, and Northwest regions of the United States; Australia; Brazil (in Portuguese); and a Spanish language virtual group. The global event spanned time zones from Hawaii to Poland. Participants were joined by many organizers, tutorial instructors, project mentors, and other helpers. The event was co-led by organizers from many institutions (https://oceanhackweek.org/ohw22/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 and NERACOOS) and NSF.
Accomplishments/Successes: Feedback from an OHW22 participant sums up the overall experience: “Participating in OceanHackWeek was a great privilege…. I was able to meet and talk to people from different countries who work in the area of Oceanography and are developing tools and routines to optimize their work and research,” said Paula Marangoni, a Ph.D. student at the Federal University of Rio de Janeiro in Brazil. “I learned a lot of new things with the projects and I was also able to improve my skills in areas that I was already working on, such as data analysis in Python.” Tutorials and projects included oceanographic sub-disciplines (searching for passive acoustic data to unsupervised clustering of flow cytometry data), data sources (remote sensing, ocean and climate models, the Ocean Observatories Initiative, US IOOS, and OBIS) 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 monthly to discuss opportunities to progress DEI efforts.
Accomplishments/Successes: Hosted EarthLab summer interns.
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, N. Rome (NANOOS Program Manager), and R. Carini (NANOOS Associate) assured progress on the above.
Accomplishments/Successes: The Annual *NANOOS Governing Council* (GC) and *Principal Investigator* (PI) meetings were held virtually on 1-2 August. Approximately 50 people attended. Guest speakers included IOOS Deputy Director Krisa Arzayus and IOOS Association Director Josie Quintrell (slides only). The first day included updates on NANOOS, IOOS, IOOS Association, NANOOS Standing Committees (Data, User Products, Engagement), and discussion from the Council. The second day featured PI talks and focused on their shared ideas and needs. The slide deck is on the NANOOS web:
https://www.nanoos.org/documents/general/nanoos_gc_presentations_2022.pdf
Problems/Delays: None

Non-core Task 4: *Support for salary for Newton as GOA-ON Co-Chair [Newton]*
Status: On track
Summary: During the period, Newton performed duties for GOA-ON such as organizing meetings, connecting with the GOA-ON Secretariat to keep activities functional. Newton attended co-chair and Secretariat calls throughout the period.
Accomplishments/Successes: Newton spoke at the *GOA-ON North American Hub* meeting (virtual) on 14 July, co-chaired GOA-ON Executive Committee meetings on 3 August and 3 November, and was interviewed about GOA-ON by the Economist.

Newton represented GOA-ON at the *Oceans in a High CO2 World* in Lima, Peru, 13-16 Sept, with a talk on GOA-ON, as well as attending the GOA-ON Regional Hub Coordination Workshop 10-11 Sept, OARS meeting 11 Sept, and co-chairing the GOA-ON Executive Committee meeting, 17-18 Sept 2022. While an intensive week, there was progress on understanding capacity building, DEI, and ECOP needs and identifying follow-on actions.
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. Newton served on the Search Committee for the IOOS Association Director.
Accomplishments/Successes: Newton, Rome, and Wold attended the *IOOS Fall Meeting* in San Juan, Puerto Rico, 8-11 Nov, and Newton attended the IOOS Directors retreat in St. Thomas, Virgin Islands, 6-7 November.

At regional meetings, Newton represented NANOOS as a SC member of the *California Current Acidification Network* (C-CAN) including a workshop 15-16 Nov, and of the *Olympic Ocean Acidification Sentinel Site* (OASES) with NANOOS aiding their development of a website. Newton holds the Research seat for the *Olympic Coast National Marine Sanctuary* and attended meetings (22 July, 18 Nov). She was asked to speak to the *NW Straits Commission* about NANOOS (28 Oct), to the *UW EarthLab* Advisory Board (27 Oct), and as part of the UW Sparking Climate Connections Showcase (1 Dec). She participated in *Ocean Best Practices* meetings in July and October.

Newton was invited by the *US CLIVAR Phenomena, Observations, and Synthesis* (POS) Panel to speak in their session "Intersection of oceans, sustainability and justice" at their annual meeting 17 Oct in Seattle. Three invited speakers discussed with the panel perspectives on the topic and what can be done by increasing focus. In her talk, "The power of co-designing ocean observations and assessments" Newton stressed IOOS tenets for success.

Newton was interviewed for a local news magazine, *Salish Currents*, regarding ocean acidification and the need for observing data, featuring NANOOS and LiveOcean: https://salish-current.org/2022/11/03/researchers-growers-face-the-challenge-of-acidic-ocean-water/

Newton attended "*Oceans 22"* in Virginia Beach during 19-21 October. She was awarded the Lockheed Martin Award for Ocean Science and Engineering https://mtsociety.memberclicks.net/2022-award-recipients. Newton also participated in the IOOS-led NOAA Town Hall "The New Blue Economy: Application of Ocean and Coastal Data Across Sectors" giving a talk on the Backyard Buoys project, emphasizing co-design and Indigenous autonomy needs.
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, Rome, and Carini participated in weekly Tri-Comm calls. The *Annual NANOOS Principal Investigator* meetings were held in association with the GC meeting virtually on 1-2 August. All PIs were in attendance, except for a few who sent reports due to field conflicts, etc.
Accomplishments/Successes: Newton presented the NANOOS update and evaluation to the PIs and GC members present at the annual NANOOS GC & PI meeting 1 August 2022. The recording was made available and the pdf is posted on the NANOOS web: https://www.nanoos.org/documents/general/nanoos_gc_presentations_2022.pdf
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 engaged in all of these activities over the period, supported by Rome and Carini.
Accomplishments/Successes: Specific activities included:

- Backyard Buoys (NSF funded) activities including the EXPO and a site visit to Utqiagvik, Alaska, 15-17 August.
- Meeting with National Weather Service staff at field offices to share NANOOS products and services 4 August at the invitation of Grant Cooper and Jeff Zimmerman.
- NANOOS provided updates on oceanographic conditions in the Pacific Northwest for the *NOAA WestWatch* webinar series on 9 August and 1 November, along with the other two west coast RAs. NANOOS made contributions to *PSEMP Puget Sound Marine Condition Updates* on 21 Sept and 16 November 2022.
- NANOOS was funded to aid development of OA indicators for the *West Coast Ocean Data Portal.*
- Newton participated in the *Subcommittee on Ocean Science and Technology* (SOST) *Opportunities and Actions in Ocean Science and Technology Roundtable* on 19 July.
- Newton gave opening remarks at the *IOOS Glider Workshop* on 20 September, welcoming attendees to the NANOOS region.
- Newton and Molly McCammon (AOOS), as members of NOAA's *Ecosystem Sciences and Management Working Group,* participated in meetings during the period and served as WG co-chairs. The WG produced a report "*Developing Resilience in the Face of Rapidly Changing Marine Environments*"; the short report was developed at the request of NOAA to provide advice regarding how NOAA's practices will need to evolve over the next decade to keep up with, and anticipate, possible future ocean states and the impact on ocean resources.

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.
Carini will be leading NANOOS Recertification efforts. See Non-core Task 3 (above) for more details.
Accomplishments/Successes: None
Problems/Delays: None

Additional NANOOS coordination and representation included:

- Barth serves on the *Oregon Ocean Policy Advisory Council's* (OPAC) *Scientific and Technical Advisory Committee* (STAC) responsible for providing expertise on ocean issues including the implementation and monitoring of Oregon's marine reserves and ocean acidification monitoring efforts. Oregon is preparing for review of their network of marine reserves due in 2023.
- Barth and Newton participated in the "West Coast Ocean Acidification and Hypoxia Symposium" convened by the *Pacific Coast Collaborative* in Portland, Oregon, on October 13-14, 2022.
- Locally, Newton served on the Steering Committees of *C-CAN*, *OASES*, *ORHAB*, *Cascadia*

CoPes Hub, and the Oregon Department of Environmental Quality's *OAH Workgroup*. Nationally, she served on the *HAB Liaison Advisory Committee*, the *IOOS DEIA Working Group*, and the *NHABON Working Group.*

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

- Barth maintained active participation in the *North Pacific Marine Science Organization* (PICES, pices.int), reporting on US ocean observing efforts through his membership on the MONITOR Committee and the Advisory Panel on North Pacific Ocean Observing Systems. Barth is the US academic representative to the PICES Governing Council. During the reporting period, he attended the 2022 PICES Annual Meeting in Busan, South Korea, from September 24 to October 3, 2022.
- Newton served as a member of the *Canadian IOOS (CIOOS) Pacific* Regional Oversight Committee. Also in Canada, Newton chaired the *Marine Environmental Observation, Prediction, and Response* Network, a Canadian Center of Excellence (MEOPAR) International Science Advisory Committee. She attended meetings during the period.
- 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.
- 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 (11-12 October).
- Newton continued as a member of the Science Advisory Team for the *Joint European Research Infrastructure in the Coastal Ocean* (JERICO).

F. Presentations & Publications Acknowledging NANOOS Support:

Presentations: underline indicates NANOOS PI

Barth, J. A., S. D. Pierce, B. Carter, A. Erofeev, J. Fisher, R. Feely, K. Jacobson, A. Keller, C. A. Morgan, J. Pohl, L. Rasmuson, and V. Simon, 2022. Mapping widespread hypoxia off the Pacific Northwest during the 2021 summer upwelling season: A necessary ingredient to informing sustainable use of the ocean. *PICES Annual Meeting*, Busan, South Korea, September 2022.

Kaminsky, G. M., A. W. Stevens, P. Ruggiero, G. R. Gelfenbaum, J. C. Allan, H. M. Weiner, and J. M. Wood, 2022. A quarter century of nearshore-beach-dune observations: Coastal change in the Columbia River littoral cell, *American Geophysical Union Fall Meeting*, Chicago, IL, December 2022.

Newton, J. A. 2022. Backyard Buoys: Locally owned, globally connected, building resilience, *Oceans 22*, "The New Blue Economy: Application of Ocean and Coastal Data Across Sectors," Virginia Beach, 20 October 2022.

Newton, J. A. 2022. The power of co-designing ocean observations and assessments, Invited speaker: *US CLIVAR Phenomena, Observations, and Synthesis (POS) Panel Workshop;* "Intersection of oceans, sustainability and justice," Seattle. 17 October 2022.

Newton, J. A. 2022. SDG 14.3.1: The global call to collect ocean acidification data, *UN High-Level Policy Forum*, Virtual, New York, 6 July 2022.

Newton, J. A. and S. Widicombe. 2022. The Global Ocean Acidification Observing Network (GOA-ON): Ten years later and one hundred countries strong. *Oceans in a High CO2 World Conference*, Lima, Peru, September 2022.

Seaton, C., et al. 2022. Ocean basin to watershed modeling of the North Pacific provides a new basis for modeling climate change impacts on salmon. I*nternational Year of the Salmon Synthesis Symposium*, Vancouver, BC, 4 October 2022.

Publications: underline indicates NANOOS PI

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Ross, T., A. C. Franco, J. A. Barth, A. Sastri, M. Robert, D. Ianson, C. Hannah, F. Chan, R. Feely, R. Dewey, and A. Peña, 2022. Update on the Northeast Pacific: Summer 2021 low oxygen event on the west coast of North America. *PICES Press*, https://meetings.pices.int/publications/pices-press/volume30/PPJan2022.pdf.

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