Progress Report

Project Title: Sustaining NANOOS, the Pacific Northwest component of the U.S. IOOS
Award Number: NA21NOS0120093
Period of Activity: 01/01/2023 - 06/30/2023
Principal Investigator(s): Jan Newton, NANOOS Executive Director

1) Project Summary

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

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

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

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

During FY23, NANOOS has the following additional tasks funded via IOOS (1-3, 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)

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 four long-range sites in OR, three in WA, one in CA, and two standard-range sites in OR - As resources allow, - 3 Priority 2 standard-range sites covering Heceta Bank, which is a source for HABs and of strong bathymetric flow perturbation, as well as the shelf portion of the OOI Endurance Array - Deliver data via NVS - Bring all data QA/QC to meet Certification standards
	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: Mickett, 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 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 glider:</u> *PIs: Barth, OSU & Seaton, CRITFC* - Maintain the Washington shelf glider at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
	<u>Northern California glider:</u> *Lead PI: Barth, OSU* - Maintain the Trinidad Head, CA, glider, shared with CeNCOOS, at existing levels - Deliver NRT data streams via NVS - Bring all data QA/QC to meet Certification standards
Estuaries	**Maintain multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs:** Sustain observing ability to aid sustainable resource management, water quality assessment, and sub-regional climate change evaluation.
	<u>Puget Sound, WA, profiling buoys:</u> *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,	**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.

Coordination & 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 four long-range sites in OR, three in WA, one in CA, and two standard-range sites in OR [Kosro]*
- *As resources allow, 3 Priority 2 standard-range sites covering Heceta Bank, which is a source for HABs and of strong bathymetric flow perturbation, as well as the shelf portion of the OOI Endurance Array*

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

Status: On track
Summary: During this reporting period, work was completed for the operation and processing of data from the HF sites and their transfer to the IOOS HF data assembly center via our local portal, with CORDC uptime stats of 82% and 90% (#3 and #1 for the system) for Jan-Mar and Apr-Jun respectively. Our MAN1 site, at Manhattan Beach, is down due to a lightning strike and needs to be completely re-installed. The transition to new frequencies requires installation of replacement HF antennas.
Accomplishments/Successes: Operation of HF sites and data delivery. New Washington state site WSP1 provided data to the national system. Purchased new computers for all remote sites to run the latest operating system and acquisition software.
Problems/Delays: Permit applied for at northernmost site KAL1, in the Olympic National Park.

Non-core Task 2: *A one-time HF Radar system add-on [Kosro]*
Status: Completed
Accomplishments/Successes: Updated FCC licenses, computers. Received antennas from Codar (PO funding). In process of installing.
Problems/Delays: Permission from the National Park Service still needed.

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). In April we went to site and replaced the motor brushes on the radar and swapped the backup drives. Everything has been operating as expected. In June, we renewed work to provide public listings of all radar data that may be made available upon request. This work is still ongoing.
Accomplishments/Successes: Continuous operation, data reporting, and archiving. In January, we added several data products on NVS (and our website), these are: time series of peak wavelength, period, and wave direction, and secondary wave components (i.e., non-dominant peak) from the spectral plots. We have also updated our determination of the wave peak period so as it is determined directly from the 3D spectra.
Problems/Delays: Not a problem, per se, but we still need to implement some QC to filter out invalid data for the new data products added this period.

<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 [Mickett]*

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

Status: On track

Summary: The Washington Coast buoy observation program continued the work of maintaining and operating two real-time moorings 13 miles NNW of La Push, Washington. The spring 2023 mooring cruise occurred May 1, 2023 - May 6, 2023 aboard APL's R/V Jack Robertson to recover the Winter Cha'Ba mooring and deploy the Summer Cha'Ba mooring and the newly-upgraded NEMO-subsurface mooring. This cruise was also coordinated with the deployment of the NOAA-MERHAB funded ESP mooring deployment adjacent to the Cha'Ba and NEMO-subsurface moorings.

Although weather was not particularly agreeable, this effort was largely successful with both Cha'Ba and NEMO-subsurface successfully deployed and reporting observations in near real-time. There were challenges with the recovery of the Winter Cha'Ba mooring, however, and although the surface buoy was recovered, the remaining part of the mooring was marked with a surface float to be recovered at a later date from a larger vessel. This surface float and part of the mooring wire with instrumentation subsequently broke free on June 15th and was thankfully recovered by the Sanctuary's R/V Storm Petrel. AIS vessel tracks showed that a southbound fishing vessel may have caught on mooring and parted the wire.

Other work carried out during this period included beginning the significant task of transferring all historical Cha'Ba and NEMO-Subsurface data—going back to 2010—onto the group's ERDDAP server. Where applicable, near-realtime sensor data is being downloaded, processed, and added to the ERDDAP database, providing data accessibility of working sensors with no more than a 1-hour data latency. Presently Cha'Ba wind data and NEMO-subsurface CTD data are available here: https://nwem.apl.washington.edu/erddap

Mickett also processed all 2022 deployment data and presented the observations at the April Puget Sound Marine Waters 2022 Year in Review meeting. Among the key findings were that 2022 had an exceptionally weak and delayed upwelling period.

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.

Accomplishments/Successes: Successful Summer Cha'ba mooring deployment in May 2023, and recovery of winter mooring buoy/tower.

Problems/Delays: Acoustic release of Winter Cha'Ba did not result in mooring release - therefore the surface buoy was recovered but the mooring line/anchor was not recovered due to weather conditions and the lifting limitations of the R/V Robertson. Also, after deployment we discovered the pCO2 system Iridium modem battery was drained so real-time observations would not be possible. Battery swap at sea was not possible.

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

Status: On track

Summary: Carbon measurements are conducted in partnership with PMEL Carbon Programs. The Cha'Ba MapCO2 carbon system operated on the Winter Cha'ba buoy since October 2022, and a refurbished system was deployed on the Summer Cha'ba buoy in May 2023.

Accomplishments/Successes: Continued coordination with the PMEL carbon program to ensure a newly tuned mapco2 carbon system is deployed on each mooring installation - this saves valuable time during cruises and improves system performance outcomes by only using

recently-verified instrumentation systems. Previously, systems were moved from one deployed mooring to another without thorough testing between deployments.
Problems/Delays: We learned that the Iridium antenna on the Summer Cha'Ba mooring was depleted after mooring deployment. This did not allow real-time data transmissions. Mickett and team had a subsequent discussion with PMEL collaborators to ensure that these preventable errors would not happen again. Despite this issue, we are confident that quality pCO2 data are being collected.

Non-core FY21 Task 6: *Support Cha'ba Ship-Time [Mickett, Newton]*
Status: Complete
Summary: Funds were used to cover the spring mooring cruise aboard APL's R/V Robertson. Again, this effort was coordinated with the NOAA-MERHAB supported ESP mooring deployment to leverage vessel costs and personnel resources.
Accomplishments/Successes: Successful spring mooring operations aboard the R/V Robertson.
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 for the season
Summary: Due to constraints caused by the COVID19 pandemic this deployment was delayed from the spring of 2021, as originally planned, to the spring of 2022. The ESP mooring was deployed near the NANOOS NEMO and Cha'ba moorings on May 3rd with regular, real-time measurements of the HAB toxin domoic acid extending until late June as planned. The mooring was recovered on August 3rd.

Reliable, regular, real-time measurements of offshore domoic acid concentrations were made available to stakeholders via the NANOOS Real-time HABs website. The website was updated prior to the spring ESP deployment.
Accomplishments/Successes: This deployment was an unqualified success, with reliable, regular, real-time measurements of offshore domoic acid concentrations distributed to stakeholders via weekly email summaries and the NANOOS Real-time HABs website. The website was successful in providing HAB toxin and valuable contextual data to stakeholders. This information was critical to assessing the risk of HABs on the Washington coast.
Problems/Delays: None

Non-core Task 8: *Support for Monitoring and Event Response for Harmful Algal Blooms (MERHAB) project activities [Mickett]*
Status: Complete (May 3, 2023)
Summary: This effort involved 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 fully-operational system was deployed on May 3rd, 2023 and continues to function well as of the time of this report, providing valuable contextual information for the nearby ESP mooring.
Accomplishments/Successes: The completed and fully-functional upgraded system was deployed on May 3rd.
Problems/Delays: None.

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, needs servicing
Summary: The buoy was last deployed in March 2023, and returned good data with select streams posted to NVS, including solar radiation, eastward and northward currents at multiple depths, near-surface temperature and salinity. Telemetry indicated a charging problem, and the voltage dropped below 12.7v in mid-July. A recovery is being planned. Updated buoy location is being telemetered by two instruments.
Accomplishments/Successes: Good data recovery and display.
Problems/Delays: Telemetry indicated a charging problem, and the power bus voltage dropped below 12.7v in mid-July. Buoy recovery is planned pending personnel and vessel availability. Updated buoy location is being telemetered by two instruments.

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: Solar charging of the main mooring CPU and meteorological station stopped in May. LiFePO4 battery pack maintained operation until early July. Drive-by inspection showed no obvious damage to solar cells or mooring infrastructure. Onboard measurement systems for OA parameters (MApCO2), and in-water systems (CTD, ADCP, and down-tether sensors) are all independently powered and continue to function. Recovery is scheduled for mid August, with redeployment TBD.
Accomplishments/Successes: Persistent deployment and monitoring. Maintained working relationship with Coos Bay vessel service provider.
Problems/Delays: Vessel scheduling for workable ocean conditions continues to be a challenge for the OR coast.

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

Status: 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 recovered in January 2023 and prepared for summer 2023 deployment. CRITFC received permission from the US Coast Guard to deploy an AIS ATON transceiver on SATURN-02, and we are currently waiting on an FCC license, expected in late July. The AIS transceiver will broadcast the position of the buoy to ships, enabling navigation around the buoy and thus protecting it from ship strikes, which is particularly important since the buoy is located near a major shipping lane.

When deployed, SATURN-02 will measure (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, and photosynthetic efficiency/quantum yield. These water property measurements are made through single at-surface sensors and a multi-level pumping system, with the exception of

temperature, which is measured with separate sensors at each depth. Levels measured are 1, 6, 11, 16, 21 and 35m depth.

Real time data from SATURN coastal stations will be 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: Waiting on FCC license for AIS transceiver.

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

Status: On track
Summary: SG236 was re-deployed on 1 June 2023 after an earlier deployment that was aborted due to sensor failure. As of 27 July 2023, the glider has completed 240 dives, for five occupations of the La Push section, with energy remaining for 10-11 more months of sampling.
Accomplishments/Successes: Fabrication of a second NANOOS glider is nearing completion. Data processing and QC have been updated to our current standards, and data is flowing to the DAC.
Problems/Delays: None

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

Status: On track
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 January to June 2023 reporting period, one glider map was made off central Washington in late-May/early-June. The glider was deployed for a total of 14 days, and produced 9 cross-shelf sections over 355 km with 2706 vertical profiles of water properties. Glider data show that the summer upwelling season had just begun and brought near-bottom, low-oxygen, but not hypoxic (DO 1.7-2 ml/l), waters to the midshelf (~50-70 m), but they did not reach inshore of the ~50-m isobath. These data are displayed on NVS.
Accomplishments/Successes: Started the third, summer-season glider work off central Washington; continued operations with a reliable charter boat operator out of Westport, WA; Joe Schumacker (Quinault Indian Nation - QIN) briefed ocean users about oxygen levels in the coastal ocean.
Problems/Delays: None. Awaiting the return of glider 251 that is undergoing upgrade to the latest G3 version, as required by the manufacturer.

Northern California Glider:
- *Maintain the Trinidad Head glider, shared with CeNCOOS, at existing levels [Barth]*
- *Deliver NRT data streams via NVS [Barth]*

- *Bring all data QA/QC to meet Certification standards [Barth]*

Status: On track

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, January to June 2023, a glider was on the TH line for 181 days during two deployments, sampled along 3654 km of track line covering the transect 7 times, and collected about 1553 vertical profiles of ocean properties. Glider uptime during this period was nearly 100%. Data are being sent in near real-time to the IOOS Glider Data Acquisition Center and, simultaneously, to the CeNCOOS and NANOOS data centers.

Accomplishments/Successes: Data from the Trinidad Head glider line are being used to monitor the continuation of the extended 2020-2023 La Niña and will be used to monitor the arrival of the 2023-2024 El Niño. (Figure 1).

Problems/Delays: None. Awaiting delivery of a new Seaglider (sg686), funded by NANOOS/CeNCOOS, for use on the TH line.

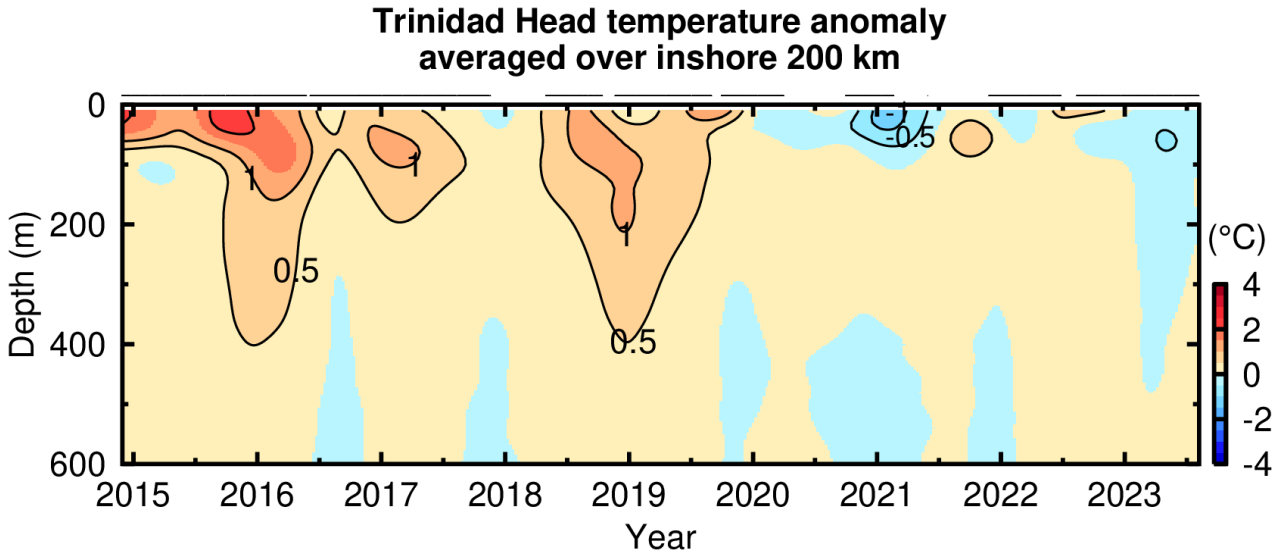

Figure 1: *Temperature anomaly from the Trinidad Head, CA (41° 3.5'N) glider line. Horizontal lines above the panel indicate when the TH-Line glider was in the water.*

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 (UW) to produce the Pacific Northwest Harmful Algal Blooms Bulletin (PNW HAB Bulletin) for coastal shellfish managers. A total of eight PNW HAB Bulletins are typically produced each calendar year, with nominally four Bulletins during spring razor clam digs and another four during fall razor clam digs.
Accomplishments/Successes: McCabe, Hickey, and Trainer produced five PNW HAB Bulletins to support coastal shellfish managers during the reporting period. These included the 02-Apr-2023, 16-Apr-2023, 27-Apr-2023, 16-May-2023, and 31-May-2023 Bulletins. Each of these spring 2023 Bulletins were rated "low" risk. Large size *Pseudo-nitzschia* cells began to appear in higher concentrations (>50,000 cells/L) at southern Washington beaches in late May, but particulate domoic acid concentrations remained low there and at northern Oregon beaches during this period.
The PNW HAB Bulletins are made publically available on both the ORHAB and NANOOS websites.
Problems/Delays: None

Trainer
Status: On track
Summary: During this reporting period, work was completed using $1,254.94 in No Cost Extension (NCE) funds from the previous 5-year award, **f**ully expending the budget funding, In addition there was a $16,000 supplement from APL to the award which was used to purchase equipment for the ONRC Lab which will support tribal needs for AAUV deployments which are anticipated in fall 2023 (see description below). 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 31 December 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, $10,000 a piece was allocated for each of the four tribes. In Years 1 and 2 of the award a total of $20,000 per tribe was awarded. January – June 2023, 100% of award Year 1 funding was expended ($43,604.53: $34,606.76 for equipment, supplies and service contracts and $8,997.77 on University of WA Indirect assessment of 26% on applicable direct expenses). 7.6 % of Year 2 was expended from January 1 – June 30 2023 ($3,839.47: $3047.20 for tribal HAB sampling contract and $792.27 on University of WA Indirect assessment of 26% on applicable direct expenses). The June 30 2023 fund balance for tribal allocation of APL funds through ONRC is $46,560.53. 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. A draft Memorandum of Understanding has been submitted to the University of Washington and the Hoh Tribe for approval, which will allow the Tribe to use the ONRC facility as a laboratory resource. Additionally, the recent introduction of new 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.

Trainer also connected with Oregon coastal caucus members to discuss future possibilities for sustained funding for coastal HAB sampling in Oregon.
Problems/Delays: None

MacCready
Status: On track
Summary: During this reporting period NANOOS support for MacCready's salary allowed for improvements to the reliability of the LiveOcean model system.
Accomplishments/Successes: MacCready runs the LiveOcean daily forecast model that is used as part of the information for the PNW HAB Bulletin. The model continued to run with high reliability during this period, and post-processing particle tracking results used by managers were produced daily. A paper is in review comparing 5 different particle tracking software packages in LiveOcean. Particle tracking is a key analysis technique for the model contribution to the PNW HAB Bulletins.
Problems/Delays: None

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 113 unique individual requests for support from SoundToxins participants relative to monitoring support and phytoplankton identification. We received 90 alerts regarding harmful algal blooms of which 46 of the alerts were provided to the Washington State Department of Health as part of the phytoplankton cell presence alert system. Our team held three virtual training sessions on phytoplankton and procedure review, conducted two site visit training sessions and hosted the annual meeting and training for all participants. Sea Grant staff presented information about SoundToxins and phytoplankton at the Kitsap Beach Naturalist training.
Problems/Delays: No problems or delays to note during this time.

Kavanaugh
Status: On track
Summary: We have embarked on Year 2 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), technician time (to assist with running and annotating samples), and hourly undergraduate assistants.

Accomplishments/Successes: Graduate student Raquel Gilliland has been successful in retaining diverse suite of fishermen (N=7 currently) from the midwater trawl cooperative, Dungeness crab (fishing midwater in Dungeness off-season), charter fishery, as well as researchers associated with NOAA's Northwest Fisheries Science Center. For continuity, Gilliland has also trained research Assistant Kelly George and undergraduate assistants in Oregon coastal waters. These were collected primarily within Oregon waters off Newport, but moving further offshore as the tuna fishing increased. We collect coincident temperature, salinity, and, in the case of NH Line data, particulate domoic acid, however, the latter has experienced delays in part because of expired kits. Salinity protocols have been altered to minimize brine rejection issues, and Gilliland has also coordinated to obtain LiveOcean fields coincident with her sample dates. Plankton samples continue to be run on our imaging flow cytobot. Gilliland has applied an existing classifier to provide cell counts and biovolumes, trained undergraduate assistants Olivia Arvas and Jessica Cedargreen on manual annotations of approximately for a total of >500,000 images for thick and thin P/N, other diatoms, dinoflagellates, ciliates and detritus. We have also created a partial least squares regression model to convert biovolume to counts for both thick and thin morphology types. We, with OSU social scientist Lori Kramer, obtained Institutional Review Board (for human subject research) approval to interview fisherman collaborators to obtain information on what works and costs and benefits related to cooperative fisheries research. Results highlight fishermen motivations and concerns. Gilliland presented her research at several outreach webinars, and is currently editing her MS thesis.
Challenges/Delays: One challenge has been the coordination of pDA and TDA samples for comparisons. There have been some issues with kit availability and/loss of kits. We will network during the NANOOS meeting to iron out a plan for Fall of 2023.

Hunter
Status: Delayed
Summary: The funds from the performance period were used to provide near-shore HAB monitoring capacity in Oregon coastal waters. Funds pay for a phytoplankton specialist and all supplies and services. Funds were used April thru June of this reporting period.
Accomplishments/Successes: ODFW, after some delay, was able to hire a phytoplankton specialist in April of 2023. A total of over 70 near-shore samples were analyzed for HABs from 8 sites along the Oregon outer coast. Of those, 12 were further analyzed for particulate domoic acid (pDA) with all levels below accumulation thresholds. The ODFW phytoplankton project presented a poster at the NANOOS 20th anniversary meeting in Astoria.
Problems/Delays: Previous employee in the ODFW phytoplankton position was hired by WDFW so ODFW had to go through a lengthy hiring process. The late start of the ODFW phytoplankton specialist resulted in a significant gap in data (3-months).

Newton
Status: On Track
Summary: During this reporting period, Newton oversaw all aspects of the NANOOS HABON effort. This included attending ORHAB meetings and discussing progress with each of the HABON PIs in Washington and Oregon. She coordinated with Tanner (UW, NANOOS web) to assure that all PNW HAB Bulletin and other HAB content matched the needs of the community.
Accomplishments/Successes: She met with ORHAB on 19 January to talk about NHABON, NANOOS role in NHABON, and to garner input on PNW needs for the new fiscal year.
Problems/Delays: No continuing funding from Oregon has been identified, as of yet, though this remains a high priority and has been communicated to NOAA IOOS PO.

ESTUARIES

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

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

Status: On track
Summary: Work to maintain Puget Sound Profiling Buoys continued, including regular maintenance conducted at each of six buoy sites. Buoy maintenance includes instrument package swaps, winch repairs, and electrical and mechanical maintenance. Puget Sound profiling buoy data is delivered to NVS. 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 began the transition to a higher-energy density Lithium Iron Phosphate battery chemistry.

Puget Sound Profiling buoy workflow has been standardized to write all data to netCDF-format files using CF conventions for data formatting (seen here: https://cfconventions.org/Data/cf-conventions/cf-conventions-1.9/cf-conventions.html). QA/QC processes have been implemented into the workflow to include IOOS standard QARTOD flags, as well as buoy-specific QC tests, such as checks for density inversions.

To improve options for delivery of data to users and data repositories, an ERDDAP server has been set up to serve the data, increasing accessibility options. This also helps us to standardize the workflow to move data to additional data platforms, such as NVS. Data processing has been streamlined so that all levels of automated processing occur shortly after data acquisition, and thereby reducing data latency, meaning that all data products are typically available within an hour of each buoy cast, with a maximum latency of 6 hours. All data products for the Puget Sound Profiling Buoys can be found here: https://nwem.apl.washington.edu/erddap

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. Successful transition to Lithium Iron Phosphate batteries on all Puget Sound profiling buoys.

All data now includes QA/QC checks and flagging, and is accessible via an ERDDAP server. Derived data products, such as uniform depth gridding, climatologies (when feasible), and climatological anomaly data, have been rebuilt and are also accessible via ERDDAP.

Problems/Delays: Some significant profiling downtime was experienced due to aging systems, and external factors.

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: Thanks to NANOOS continued support of ferry monitoring a larger DOT ferry ADCP dataset has been generated, which allows a unique analysis into the long-term patterns and trends of water exchange across Admiralty Reach. This dataset is valuable providing a physical context to water quality and foodweb related issues in Puget Sound. Albeit slowed by COVID, cross boundary data collection off the Victoria Clipper ferry is a unique asset extending the Alaska and

BC ferry monitoring projects into Puget Sound. Thanks to NANOOS continued support progress has been made.

Accomplishments/Successes: Access to ferries to measure the dynamic of the coast environment is a unique and cost-effective opportunity. Albeit just skimming the surface by ship, Acoustic Doppler Current Profilers (ADCPs) can measure current velocities deep in the water column while operating from moving ships. Such measurements require involved calculations for acoustic signal, position and vector calculations. APL-UW has been providing data flow maintenance from our oceanographic instruments on the M/V Kennewick and the M/V Salish DOT ferries, two ferries covering critical transects of water exchange and renewal for Puget Sound several times per day. Over the years large data volumes have accumulated that can provide a window into the dynamic and response of water exchange to climate forcing factors governing the water exchange across Admiralty Reach. Jim Thomson, senior physical oceanographer at APL, has been working on some example code to harvest long term ADCP data records and began analyzing long-term trends of tidally-driven current velocity and water exchange across Admiralty Reach. Analysis and results will be shared with the public upon completion of the analysis. Back in May, Dr. Thomson noticed that while data posted to our DigitalOcean server collecting all previous data records, the link to NVS was broken and did not show on NANOOS NVS Data Explorer. Consequently, Jim Thomson and his team worked with programmers for NVS and reinstated the dataflow to the NVS Data Explorer!

The Victoria Clipper has been a long-standing collaboration between Victoria Clipper Vacation and the Washington State Department of Ecology allowing us to collect cross-boundary environmental data along a 80 mile transect between Seattle, WA and Victoria BC. The value, scale and low cost of such information and opportunity for collaboration with our Canadian counterparts is unique. However, success also hinges on the company's performance which was severely compromised due to Covid related border closures. After significant restaffing at Clipper Vacation, we have gradually re-established who our contact person and ships engineers allowing us to move forward with installing the pump and other sensor packages onto the new ship. Victoria Clipper's commitment was renewed after modifications were made for us during their recent dry dock in their shipyard and an extra port hole for our system was installed into the hull. Our contractor, GSI Environmental, responsible for the system installation, has made the appropriate technical drawings, preparations and system preassembly for the installation in the hull, Victoria Clipper runs across the border have resumed, and staffing issues at the company have settled so that we are in a position to report that we are again continuing with fabricating remaining aluminum brackets that allow to stall the pre-assembled components into the starboard hull of the vessel. GSI Environmental has also been implementing a basic web app for showcasing our Victoria Clipper data stream live. Currently the app visualizes surface temperature and salinity as time series, on maps and in TS space to explore water masses. Data are also as an interactive table.

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

Columbia River Estuary, OR, Moorings:

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

Status: On track

Summary: TThe 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 estuary stations are displayed on NVS. CMOP also provides access to SATURN long-term datasets via a recently deployed ERDDAP server. Data are subject to QA/QC, which is included in data submitted to NCEI via NANOOS, and included in the ERDDAP server.
Accomplishments/Successes: SATURN-04 has been completely rebuilt at a nearby location. The station is located on a pier in Mott Basin. Ownership of the pier was recently transferred to the US Coast Guard, which plans to demolish the existing pier and replace it with a new pier. In preparation for this, we secured permission from the US Department of Labor to use the neighboring pier for our station. A new pumped station was constructed on the neighboring pier, including near-surface and sea-bed water intakes and an in-situ CTD at the sea bed location. SATURN-07 is on-station after being recovered for servicing in early 2022. The Elliott Point buoy was recovered in 2021 and is scheduled for redeployment in Fall 2023. SATURN-03 sea-bed and mid-water pump intakes were rebuilt in spring 2023. Potential threats from estuarine and coastal hypoxia to Columbia River salmon were presented at multiple events. Work on improving the representation of datasets within the CMOP ERDDAP server, including QA information, occurred in spring 2023.
Problems/Delays: None

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 1/01/23 – 6/30/23. Tom's Creek weather station provides real-time measurements of air temperature, relative humidity, barometric pressure, and wind speed/direction. Telemetry transmissions were continuous for the Winchester Arm water quality and Tom's Creek weather platforms. Water quality data collection was completed at the Valino Island, Charleston Bridge, and Elliot Creek stations, but telemetry status was offline in preparation for replacement with YSI 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 exchanges, maintenance, and data qa/qc and management for all sites were completed for the station network following NOAA NERRS Centralized Data Management Office protocols.
Accomplishments/Successes: Water quality and weather time-series data collected as part of NANOOS/NERRS SWMP programs were incorporated into environmental modeling analyses to characterize drivers of eelgrass declines and understand changes in fish communities.The Margaret A. Davidson Fellow, Lara Breitkreutz, is utilizing water quality data for her research on eelgrass community response to marine heat waves and presented preliminary results in June 2023 at the ASLO conference held in Palma de Mallorca, Spain. The Reserve education team accessed water quality datasets for outreach programs on climate change and are developing a water quality exhibit for the Reserve's Visitor Center. The Reserve is hosting a Summer Research Experience for Undergraduate intern who assists the science program with water quality fieldwork and laboratory sample processing.

Problems/Delays: The Charleston Bridge water quality station continues to have seasonal fouling issues in the spring and summer during monthly instrument exchanges and staff will be replacing the protective instrument housing. Water quality station equipment and telemetry systems ordered from Yellow Springs Instruments were delayed in shipping because of setbacks in product development but some items arrived in June 2023.

BEACHES AND SHORELINES

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

Washington Beach and Shoreline:

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

Status: Complete for the season

Summary: NANOOS funds contribute to the Washington State Department of Ecology Coastal Monitoring & Analysis Program (CMAP) led by G. Kaminsky. CMAP completed winter and spring seasonal beach monitoring surveys in the Columbia River Littoral Cell (CRLC), collecting 50 beach profiles, 5 ATV surface maps, and 57 sediment samples along 12 of the profiles in March and 46 beach profiles and two surface maps in June. Seasonal beach profile data and contour change plots are made available through the NANOOS beach and shoreline portal.

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 March and June, CMAP collected 9 supplemental cross-shore beach profiles in Westport to monitor the dynamic revetment fronting the Westport by the Sea Condominiums, 13 supplemental profiles at the south end of Ocean Shores, and 10 supplemental profiles at the south end of Benson Beach.

CMAP continues to monitor the performance of the dynamic revetment at North Cove. Beach topography surveys were conducted in February and June 2023, where 48 profiles and an ATV 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. The survey in February included digital grainsize sampling and RFID rock tracking to track the movement of RFID tagged rocks along the revetment.

CMAP continues to collect seasonal topographic surveys near Kalaloch at South Beach on the Olympic Peninsula, where 14 cross-shore beach profiles and the cobble berm toe position were collected in January, March, and June of 2023. Monitoring results from Kalaloch will be used for comparison to the North Cove dynamic revetment site, which is intended to mimic functions of a natural composite beach similar to the setting and conditions at Kalaloch. Results may also provide a comparison point for the dynamic revetment at Westport and the planned dynamic revetment on Benson Beach. The survey in March included digital grainsize sampling and RFID rock tracking to help characterize the distribution and movement of cobble at the site. In June, points for photo monitoring were established.

Accomplishments/successes: Data collected by CMAP continue to be used by the USACE and geoconsultants to assess local and regional coastal changes on Washington beaches, particularly at locations with dynamic revetments.

Problems/Delays: CMAP staff continue to work through the backlog of topographic survey data processing. Significant progress has been made this reporting period, with nearly all CRLC survey

locations up to date. We expect this backlog to be resolved by the end of the year. Two of our GNSS receivers are old and no longer repairable and we lack funding to replace them so we have needed to rent this equipment multiple times, which is a relatively high expense. Additional funding is needed to replace this and other old survey equipment.

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 – winter surveys – were successfully collected in the Rockaway littoral cell (25 sites, February/March 2023), along the Clatsop Plains (6 sites, March 2023), along the Neskowin cell (15 sites, March 2023), and the Netarts littoral cell (25 sites, April 2023). In addition to measurements of the transects, datum-based shorelines were also collected along each of the study areas. Beach profile and shoreline data have been processed, QA/QC'd, and archived both locally and remotely. The reduced profile plots, change plots, and trends have been posted to the NANOOS beach and shoreline portal.
Accomplishments/successes: Data collected as part of OBSMAP continue to be used by regional coastal managers (e.g., Oregon State Parks, Oregon Department of Land Conservation and Development agency), geoconsultants and the public to assess local and regional coastal changes taking place on Oregon beaches. Change rates have been used to evaluate future coastal responses on dune backed coastlines for the purposes of determining appropriate sites for landing telecommunication cables. Results from the monitoring were used in recent presentations to the Bandon and Cannon Beach Planning Councils. Monitoring results from adjacent to the south Columbia River jetty were presented at Coastal Sediments'23: Allan, J.C., Gabel, L. and O'Brien, F., 2023. Monitoring the response and efficacy of a dynamic revetment constructed adjacent to the Columbia River South Jetty, Clatsop County, Oregon: 2013-2022, Coastal Sediments' 23, Inclusive coastal science and engineering for resilient communities., New Orleans, Louisiana.
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: P. Ruggiero's group at Oregon State University completed, via collaborations with the USGS and the Washington Department of Ecology, the processing of nearshore bathymetry data collected in summer 2022 along the four sub-cells of the Columbia River littoral cell (CRLC). Over 220 individual cross-shore profiles were collected during summer 2020 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 bringing the data to certification standards. In all cases these nearshore bathymetry measurements have been combined with topographic measurement collected by Ecology developing complete maps of the nearshore planform. Data through 2021 are available via Stevens, A.W., Weiner, H.M., Wood, J.M., Ruggiero, P., Kaminsky, G.M., and Gelfenbaum G.R., 2019, Beach topography and nearshore bathymetry of the Columbia River littoral cell,

Washington and Oregon (ver. 3.0, December 2021): U.S. Geological Survey data release, https://doi.org/10.5066/P9W15JX8.
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. For example, P. Ruggiero co-authored, along with NANOOS investigator George Kaminsky and others, a paper summarizing sediment transport dynamics near the Mouth of the Columbia River (Stevens, A., Moritz, H.R., McMillan, J., Elias, E., Pearson, S., Gelfenbaum, G., Kaminsky, G., Ruggiero, P., 2023. Monitoring and modeling dispersal of a submerged nearshore berm at the Mouth of the Columbia River, Coastal Engineering, https://doi.org/10.1016/j.coastaleng.2023.104285.) During this time period Ruggiero's group also continued developing a new generation Coastal Profiling System with two new Personal Watercraft.
Problems/delays: Our new generation Coastal Profiling System, purchased and built with leveraged funds from the US Army Corps of Engineers, will not be ready for the 2023 field season but should be available by 2024.

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 a significant upgrade of the LiveOcean model system. The model system was transitioned to an up-to-date version of the ROMS community modeling system. The biogeochemical model was completely rewritten, adding ammonium as a tracer in addition to nitrate. Evaporation and precipitation are now included in the forcing. Many small rivers and wastewater treatment plants were added, especially within Puget Sound, increasing the total number of freshwater sources from 45 to 278. The tidal forcing was updated to TPXO9. New sources of model evaluation data were incorporated into the group workflow, including WOAC cruises and Canadian sources, allowing much better testing of water properties in the Strait of Georgia and off Vancouver Island. The transition to the new model in the daily forecast occurred in May 2023, without disruption to model users and stakeholders.
Accomplishments/Successes: A high-resolution nested sub-model of Willapa Bay and Grays Harbor was developed (Figure below), including the effects of wetting and drying of the intertidal. This has been running in test mode as part of the daily forecast since May 2023, and we anticipate it will soon be available in the NANOOS NVS, providing higher quality environmental information to shellfish growers in those coastal estuaries.
Problems/Delays: None

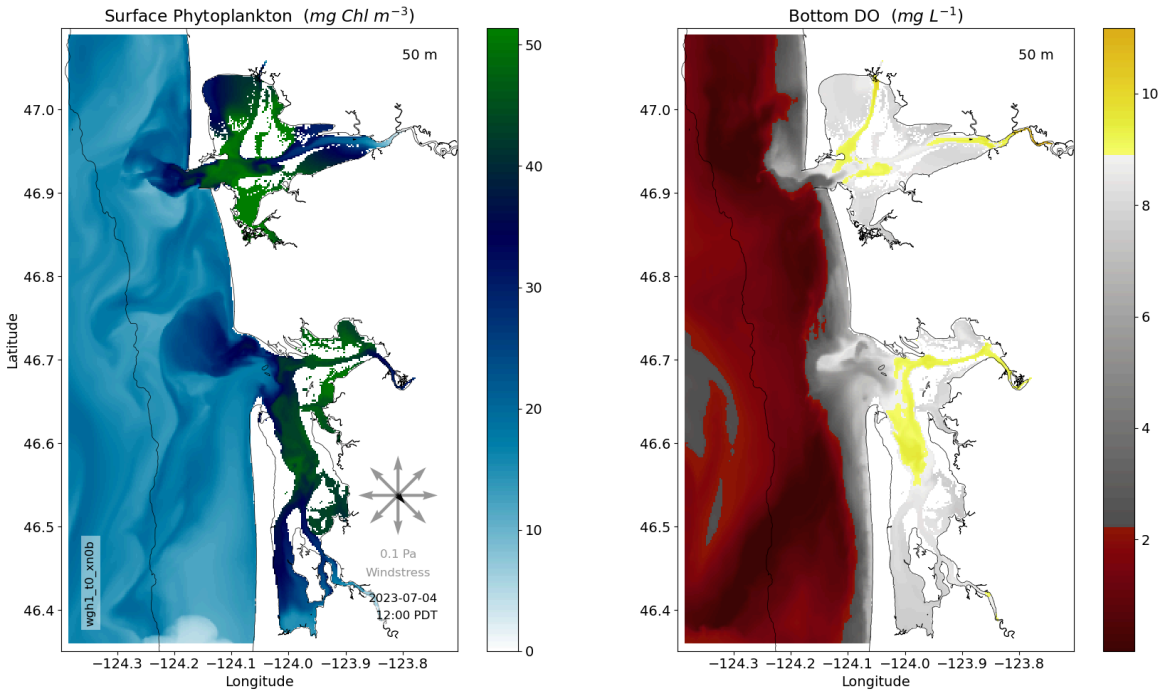

Figure 2: *Surface phytoplankton and bottom Dissolved Oxygen fields from a recent daily forecast of the LiveOcean nested sub-model of Willapa Bay and Grays Harbor. The white areas in the estuaries are intertidal, exposed at low tide.*

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: Complete (February 2023)
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 preparation and presentation of a final report to the NOS chief scientists, and knowledge transfer of model set-up to Virginia Institute of Marine Science (VIMS) staff, for further collaboration with CSDL staff to implement a pre-operational forecast. Transition to operational forecast is planned for 2024. CRITFC involvement in this project, funded through Task 7, is now complete.
Problems/Delays: None

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

Status: On track
Summary: We continued real-time operation and support of our RTDAOW (Real Time Data Assimilation for Oregon and Washington) system on a daily basis. The data delivery is near-real time and stable. At this moment we do not anticipate any substantive changes to the project Scope of Work.
Accomplishments/successes: The data assimilation and modeling system continue to provide real-time forecasts to fishers and the public via the NANOOS Visualization System, e.g., as the Tuna Forecast and SeaCast applications.
Problems/delays: None

C. Data Management & Communications Subsystem:

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

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

Status: On track
Summary: Continued maintenance and development of BlueHarvest, as needed. BlueHarvest is the internal NANOOS DMAC application for harvesting data from a wide range of data providers. The system is robust and maintains flexibility to accommodate a wide range of data providers/sources. It populates the NANOOS internal database in a standardized way so the data

can be easily integrated into the various data products served on NVS. BlueHarvest also provides immediate feedback about data transmission frequency/latency, which enables NANOOS to identify and fix data flow issues more efficiently.
Accomplishments/Success: Consistent, reliable data harvesting.
Problems/Delays: None

Non-core Task 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 completed and submitted NANOOS' application for recertification. This effort included revising the NANOOS Strategic Operational Plan, Build-Out Plan, and Data Management Plan (DMP), as well as working with each NANOOS PI to update their individual DMPs. NANOOS has been notified that our recertification has been approved, and we are awaiting final documentation to sign. All relevant documentation can be found on the NANOOS website on the Documents page, under Certification 2023 heading.
Accomplishments/Successes: NANOOS has been notified that our recertification has been approved, and we are awaiting final documentation to sign.
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, though we expect to engage with a few at our Annual GC/PI Meeting and Community Event on 9-10 August.
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 multiple climatological ranges for OI SST climate products (climate, anomaly) and will update other climate products to use multiple ranges as well. Continued development of new HF Radar overlays. Started development of prototype of NVS Explorer mobile app.
Accomplishments/Success: OI SST climatology overlays now provide two ranges, a fixed baseline from 1983-2012 and a shifting baseline 1993-2022, in alignment with Amaya et al. (2023). Updated cruise data and plots.
Problems/Delays: None

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

Status: On track
Summary: All NANOOS gliders transmit their data to the Glider DAC. All NANOOS HFR transmit their data to the HFR DAC. NDBC harvest in situ buoy data from the NANOOS ERDDAP.

Columbia River Estuary buoys and land-based stations are archived periodically and automatically via an NCEI Data Submission Agreement (set up for PI Seaton). NANOOS will pursue establishing an analogous pathway with NCEI and the Washington Shelf Buoys/Moorings and Puget Sound Profiling Moorings (PIs Manalang and Mickett).
Accomplishments/Success: See updates to ERDDAP data services for the Washington Shelf Buoys/Moorings and Puget Sound Profiling Moorings described above.
Problems/delays: None

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

Status: On track
Summary: NANOOS platforms available via the NANOOS ERDDAP are being included in IOOS datasets.
Accomplishments/Successes: IOOS Sensor Map developers Axiom worked with NANOOS DMAC to resolve problems accurately portraying the NANOOS assets in the IOOS Registry and Sensor Map. These in situ datasets are now transmitted via the NANOOS ERDDAP.
Problems/Delays: None

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

Status: On track
Summary: Tanner and Carini have collaborated with PacIOOS and AOOS DMAC through their NSF-funded Convergence Accelerator Backyard Buoys project.
Accomplishments/Successes: None
Problems/Delays: None

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

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

Status: On track
Summary: Updates slideshow, documents, and other content. Redesigned the NANOOS products page
Accomplishments/Successes: New and updated content.
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 and the annual NANOOS Tri-Comm meeting.
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 updating MODIS climatologies, commenced work on redirecting our OSU access point for HF Radar to HFRnet at CORDC, modified the climatology averaging period to reflect two time periods (1983-2012 and 1993-2022), and began development on a new prototype smartphone NVS Explorer App.
Problems/delays: None

<u>EDUCATION & OUTREACH (E&O)</u>
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 ((fishers and boaters in Washington and Oregon, Sound Water Stewards, Seattle Maritime High School, Technology Access Foundation, Earthlab Internship, Oregon Sea Grant Coastal Haz), published a new curriculum (developed by an Earthlab intern) that brings NVS data into the classroom, maintained content on social media, newsletters, website slideshow, etc., and regularly participated in IOOS Outreach Committee meetings.
Accomplishments/Successes: *"Ocean Acidification: Salmon Race"* middle school curriculum
Problems/Delays: None

Product Co-Development:

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

Status: On track
Summary: Incorporated informal user feedback, collected via engagement activities by Wold and Allan, into enhancing NVS.
Accomplishments/Successes: None
Problems/Delays: None

Non-core Task 9: *Support execution of OceanHackWeek [Mayorga]*
Status: On track
Summary: Planning for OceanHackWeek 2023 (https://oceanhackweek.org/ohw23/) is well underway, with applications opening on May 8 and closing on June 9. OceanHackWeek 2023 will be held as a hybrid event on August 7-11. It will consist of a global virtual event coordinated with an in-person event at the UW and another in-person event in Perth, Australia. There will be about 71 participants. As in previous years, OceanHackWeek brings together oceanographers across disciplines and career stages, from the US and internationally, to advance capabilities in data science focused on oceanographic applications and cultivate an open-science and sharing culture. It is being supported by IOOS, NASA, NSF, the UW eScience Institute, Bigelow Laboratory for Ocean Sciences, Australia CSIRO and a lot of volunteer labor from many individuals in the US and abroad (https://oceanhackweek.org/ohw23/organizers.html), including Emilio Mayorga and Wu-Jung Lee from APL-UW.
Accomplishments/Successes: We continue to sustain a collaboration with individuals in multiple institutions in the US and Australia that enables the organization of OceanHackWeek to benefit from many voices and support participants from across the globe.
Problems/Delays: None

Diversity, Equity, and Inclusion:

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

Status: On track
Summary: During this reporting period, NANOOS Staff and members of the Enabling Change working group met regularly to discuss opportunities to progress DEI efforts.
Accomplishments/Successes: Hosted EarthLab summer interns.
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 Senior Program Manager), and R. Carini (NANOOS Deputy Director) assured progress on the above. Executive Committee meetings were held virtually on 21 February, 25 April, and 27 June, to advise NANOOS on its upcoming GC/PI meeting, Community Event, and 20th Anniversary celebration, as well as to strategize about project ideas for upcoming IRA funds.
Accomplishments/Successes: Plans have been made for the Annual *NANOOS Governing Council* (GC) and *Principal Investigator* (PI) meetings to be held 9-10 August in Astoria, OR. Additionally we are planning a Community Event, open to the public, and a NANOOS 20th Anniversary Reception to celebrate this important milestone for NANOOS. A great element is that the IOOS Association decided to have a Directors’ Retreat following the NANOOS meetings, on 11 August, so most RA directors or their appointee will join not only for that but for many of the NANOOS meetings too. This will aid IRA planning and build community across the nation.
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 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. Newton was invited to a ASOAR working group meeting in Plymouth, England, 28-29 March. Newton presented the PNW approach to co-designed OA vulnerability assessment at the international ASLO meeting in Mallorca, Spain 4-9 June, and co-led the GOA-ON Executive Council meetings 10-11 June there. NANOOS powers the GOA ON web and data portal through funding from NOAA OAP.
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 (Vice Chair) and participated in their teleconferences during the period.
Accomplishments/Successes: Newton, Carini, and Rome attended the *IOOS Spring Meeting* in Washington, D.C. on 20-24 March and did Hill Visits.

At regional meetings, Newton represented NANOOS as a SC member of the *California Current Acidification Network* (C-CAN) and of the *Olympic Ocean Acidification Sentinel Site* (OASES) with NANOOS aiding their development of a website. Newton term-limited out her Research seat for the *Olympic Coast National Marine Sanctuary*, attending her last meeting (20 Jan) in Port Angeles, with a special award of thanks. Dr. Parker MacCready, NANOOS PI and Executive Committee, will replace Jan in the Research seat. She also represented the NANOOS at the ORHAB meeting in Forks (Jan 19) giving a talk about the NHABON and NANOOS funding for the PNW HAB Bulletin.

Newton was invited to give the departmental seminar at the University of British Columbia on Ocean Acidification: Global condition and Local Effects on 26 Jan, and met with Dr. Susan Allen, whose Salish model NANOOS presents on NVS, as well as with her many students. She also gave a lecture to a graduate class at UW School of Marine and Environmental Affairs on "A coastal *ocean observing system to serve science and society" on 12 Jan.*

Newton represented NANOOS and IOOS at the NOAA OAP Stakeholders Workshop on Jan 4-6 giving talks on

- The Olympic Coast as a Sentinel: An Integrated Social-Ecological Regional Vulnerability Assessment to Ocean Acidification &
- Ocean Acidification Research for Sustainability (OARS): Where did it come from; What is it; How can I be involved?

Problems/Delays: None

Project Oversight:

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

Status: On track
Summary: Newton, Carini, and Rome participated in weekly Tri-Comm calls and coordinated with PIs throughout the period. The Annual Tri-Comm meeting, during which the group reflected on the past year's accomplishments and prioritized the next year's developments for Engagement, User Products, and DMAC, was held 11-12 May in Seattle, WA.
Accomplishments/Successes: To grease the wheels for the Annual PI Meeting and increase PI connections, particularly in light of IRA opportunities, calls of various PI subgroups were conducted and attended by Carini and Newton: Gliders, Moorings, HABs, Radar, Modeling, and Beaches & Shorelines.
Problems/Delays: None

Coordination:

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

Status: On track

Summary: Newton, Carini, and Rome engaged in each of these activities over the period, see below.
Accomplishments/Successes: Specific activities included:

- Backyard Buoys (NSF funded) Site Visit with NSF Program Manager Aurali Dade at UW 3-4 April.
- Mar 16 Carini and Newton met with US Marine Mammal Commission Executive Director Peter Thomas, Commissioner Sue Moore, and Commission Chair Frances Gulland, along with their Knauss Fellow Jacquelyn Shaff, about HealthMAP, an effort to assimilate marine mammal stranding and health data and physical, chemical, and biological environmental data to better understand what role changing ocean conditions play in marine mammal health.
- NANOOS provided updates on oceanographic conditions in the Pacific Northwest for the *NOAA WestWatch* webinar series on 21 February, 18 April, and 20 June, along with the other two west coast RAs. NANOOS made contributions to *PSEMP Puget Sound Marine Condition Updates* on 18 January, 15 March, 26 April, and 17 May.
- NANOOS continued work on the development of OA indicators for the *West Coast Ocean Data Portal.*
- Newton presented on two topics, Backyard Buoys and the NANOOS Boaters App, at the CeNCOOS Climate Resilience PI/GC Meeting on 24-25 May.
- Newton stepped down from NOAA's *Ecosystem Sciences and Management Working Group,* having completed her term and submitted the report "*Developing Resilience in the Face of Rapidly Changing Marine Environments*"; 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]*

Summary: Progress report and other requests have been fulfilled during the period. While we are still waiting for the final signed letter, we have been notified that NANOOS is Recertified as a NOAA Data Center. See Non-core Task 3 (below) for 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 and STAC finished a review of their network of marine reserves through 2022.
- Barth was appointed to a National Academy of Sciences, Engineering, and Medicine Standing Committee on Offshore Science and Assessment. The committee provides independent, scientifically credible, and objective information on issues relevant to the Bureau of Ocean Energy Management's environmental studies and assessment activities and supports discussions on relevant issues.
- Newton participated in the "OAH Monitoring Symposium" convened by CeNCOOS and

SCCOOS in Moss Landing, CA, on 6-7 April, giving an invited talk on the OAH indicator, work done with Carini and Drs. MacCready and Hewett (UW), and Sutton (NOAA-PMEL).
- Locally, Newton served on the Steering Committees of C-CAN, OASES, ORHAB, Cascadia CoPes Hub, OCNMS Climate Vulnerability Assessment Working Group, and the Oregon Department of Environmental Quality's OAH Workgroup. Nationally, she informed the NOAA NaMES OA Indicator working group of the west coast OAH indicator work.
- MacCready was elected to the Olympic Coast National Marine Sanctuary's Advisory Council as the primary Research representative (2023-2026). He also joined the SeaGrant Willapa Grays Harbor Estuary Collective Scientific Advisory Committee.

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 a March 2023 workshop to plan a UNDOS project on Basin-Scale Events to Coastal Impacts (BECI), for consideration as a PICES Special Project.
- Trainer participated in PICES as the Science Board chair emeritus, a US delegate to the Section on Harmful Algal Blooms, a member of the Advisory Panels on Early Career Ocean Professionals and Scientific Communications, and as the co-chair of the Study Group on *Generating Recommendations to Encourage Environmentally- Responsible Networking.*
- 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.
- Barth and Newton are on the Advisory Committee of the *UN Ocean Decade Collaborative Center for the Northeast Pacific* and attended meetings during the period, including a scoping workshop on 6-7 March.
- 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

Allan, J. 2023. Beach and Shoreline Dynamics in the Cannon Beach Littoral Cell. *Cannon Beach Planning Council*, Cannon Beach, OR 17 May 2023

Barth, J. A., F. Chan, J. Childress, A. Erofeev, S. D. Pierce, R. K. Shearman and L. Stoltz, 2023. Widespread hypoxia off the Pacific Northwest coast of North America: The role of shelf and shelf-deep ocean exchange processes and climate change. *5th International Symposium on The Effects of Climate Change on the World's Oceans,* Bergen, Norway, April 2023.

Gradoville, et al. 2023. The Past, Present, and Future of the CMOP Observatory at the Columbia River Inter-Tribal Fish Commission (CRITFC). *Columbia River Estuary Conference*, Astoria, OR 16 May 2023.

MacCready, P. et al. 2023. LiveOcean Modeling System. *Washington Ocean Acidification Center Symposium*. Seattle, WA., May 2023.

MacCready, P. 2023. Upwelling in the Northern California Current System. Invited talk, *Pacific County Science Conference*, Willapa Bay, WA.

Newton, J.A. 2023. A coastal ocean observing system to serve science and society. U*W School of Marine and Environmental Affairs graduate class lecture*, Seattle, WA, 12 January 2023.

Newton, J.A. 2023. Ocean Acidification: Global condition and Local Effects. *University of British Columbia departmental seminar*, Vancouver, BC, Canada, 26 January 2023.

Newton, J.A. et al. 2023. The Olympic Coast as a Sentinel: An Integrated Social-Ecological Regional Vulnerability Assessment to Ocean Acidification. *NOAA OAP Stakeholders Workshop*, San Diego, CA, 4 January 2023.

Newton, J.A. 2023. Ocean Acidification Research for Sustainability (OARS): Where did it come from; What is it; How can I be involved? *NOAA OAP Stakeholders Workshop*, San Diego, CA, 5 January 2023.

Newton, J.A. 2023. West Coast Ocean Data Portal Ocean Acidification Indicator Development. *CeNCOOS and SCCOOS OAH Monitoring Symposium*, Moss Landing, CA, 6 April 2023.

Newton, J.A. et al. 2023. The Olympic Coast as a sentinel: An integrated social-ecological regional vulnerability assessment to ocean acidification. *5th International Symposium on The Effects of Climate Change on the World's Oceans,* Bergen, Norway, 18 April 2023.

Newton, J.A. et al. 2023. The Value of Integrating Social and Ecological Science for Regional Vulnerability Assessments of Ocean Acidification. *ASLO Aquatic Sciences Meeting 2023*, Mallorca, Spain, 7 June 2023.

Seaton, et al. 2023. The Columbia River Intertribal Fish Commission (CRITFC)'s CMOP program: modeling the Columbia River from watershed to the Pacific Basin. Columbia River Estuary Conference, Astoria, OR 17 May 2023.

Publications: underline indicates NANOOS PI

Allan, J.C., Gabel, L. and O'Brien, F., 2023. Monitoring the response and efficacy of a dynamic revetment constructed adjacent to the Columbia River South Jetty, Clatsop County, Oregon: 2013-2022, Coastal Sediments' 23, Inclusive coastal science and engineering for resilient communities., New Orleans, Louisiana, April 2023.

Koehlinger J.A., J. Newton, J. Mickett, L. Thompson, and T. Klinger. 2023. Large and transient positive temperature anomalies in Washington's coastal nearshore waters during the 2013–2015 northeast Pacific marine heatwave. PLoS ONE 18(2): e0280646. https://doi.org/10.1371/journal.pone.0280646.

Sutton, A.J., R. Battisti, B. Carter, W. Evans, J. Newton, S. Alin, N. R. Bates, W.-J. Cai, K. Currie, R.A. Feely, C. Sabine, T. Tanhua, B. Tilbrook, and R. Wanninkhof, 2022. Advancing best practices for assessing trends of ocean acidification time series. Front. Mar. Sci., 9:1045667. https://doi:10.3389/fmars.2022.1045667.

Scroccaro, I.; Spitz, Y.H.; Seaton, C.M. Effect of Local Winds on Salinity Intrusion in the Columbia River Estuary. Water 2023, 15, 326. https://doi.org/10.3390/w15020326.