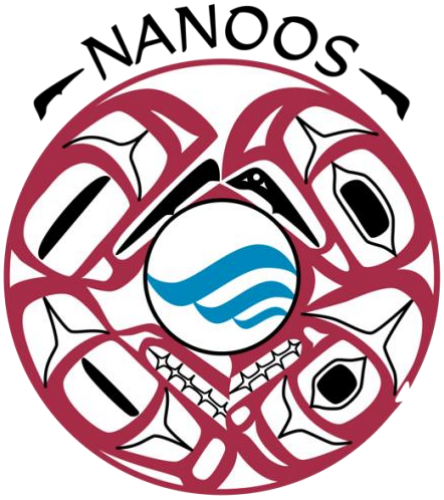

Revised for NANOOS Recertification: 15 April 2023

§ 997.23 Strategic operational plan.

a) –

1) To become certified, an RCOS must:
    i. Develop and operate under a strategic operational plan that will ensure the efficient and effective administration of programs and assets to support daily data observations for integration into the System, pursuant to the standards approved by the Council; and
    ii. Work cooperatively with governmental and non-governmental entities to identify and provide information products of the System for multiple users within the service area of the regional information coordination entities.
2) The application must contain a Strategic Operational Plan, which is a high-level document that outlines how an RCOS manages and operates an integrated regional observing system. This Plan should evolve as an RCOS matures, new technologies become available, regional priorities change, and new users and stakeholders are identified. The Plan may be responsive to changing funding levels, and shall contain sections that each address the requirements in paragraphs (b) through (g) of this section, referencing other plans directly when applicable.

The NANOOS Strategic Operational Plan (SOP) comprises the information provided below and the current NANOOS 5-year proposal (FY21-25, appended) to satisfy the IOOS Certification requirements per §997.23. The NANOOS SOP heavily references and is supported by:

- NANOOS Charter
- NANOOS Memorandum of Agreement (MOA)
- NANOOS Data Management Plan (DMP)
- Individual observing asset DMPs

- NANOOS FY21-25 Award Letter from NOAA IOOS
- Most recent NANOOS Descope for its 5-year NOAA IOOS award
- NANOOS Build-out Plan
- NANOOS Business Plan

All these documents can be found on the NANOOS Documents webpage.

b) Background and Context. The Strategic Operational Plan shall contain a Background and Context section that describes:

1) The role of the RCOS in furthering the development of the regional component of the System;

The Northwest Association of Networked Ocean Observing Systems (NANOOS) was assembled by charter in 2003 and formally established by Memorandum of Agreement (MOA) in 2005 to serve citizenry of the PNW. NANOOS has engaged representatives from a diverse set of stakeholders who are directly involved in the definition and execution of NANOOS within the region and as part of the U.S. IOOS effort. Since 2004, NANOOS has received NOAA funds to build the PNW IOOS Regional Association (RA) and its Regional Coastal Ocean Observing System (RCOOS). NANOOS has been executed with substantial stakeholder involvement in every aspect: defining NANOOS, its governance structure, regional coordination, and prioritization. Stakeholders contribute to and help define our NANOOS subsystems: observations; modeling; data management and cyberinfrastructure (including user products); and engagement.

NANOOS' development was guided by many years of meetings and stakeholder input that NANOOS continues to collect. Key developmental factors have been a balanced focus on coastal ocean, estuarine, and shoreline observations and on product development to meet user needs. Ongoing outreach and engagement have shaped the five high-priority, PNW stakeholder-defined topical areas for NANOOS: a) maritime operations; b) ecosystem assessment including PNW hypoxia, ocean acidification (OA), and Harmful Algal Blooms (HABs); c) fisheries and biodiversity; d) mitigation of coastal hazards; and e) climate and weather.

Prioritization for activities and products continues to be advised by our regional engagement and active stakeholder involvement within NANOOS governance and committees. The NANOOS GC proposes to sustain and enhance NANOOS: to maintain NANOOS as the PNW regional arm of U.S. IOOS; to strengthen existing infrastructure, capacity, and diversity, assuring reliability and inclusion; and to make selective increases in our capabilities in strategic topical areas dictated by our stakeholders. These guiding principles serve PNW coastal and ocean resiliency, intelligence, and the blue economy.

2) The process by which the RCOS updates the Strategic Operational Plan at least once every five years and how the RICE seeks inputs from the broader user community; and

The Strategic Operational Plan (SOP) will be updated at least once every five years as part of our development of the new 5-year funding request. Any content outside of that proposal that changes will be updated in the NANOOS SOP. The Governing Council, Governing Council Board, Executive Committee, PIs, as well as user input we have received over the year from other stakeholders (e.g., from outreach activities and our "Comments" form on our website), will provide guidance in the development of the SOP. Such revisions will be reviewed prior to and discussed at each annual Governing Council Meeting and all-PI Meeting.

3) The RCOS's primary partners and any contributing observing systems. For the purposes of § 997.23, NOAA defines a primary partner as any organization or individual that contributes significant staff time, funding or other resources to project activities. This is not an exhaustive list of all RCOS partners but the primary partners the RICE is working with on a given project.

Partnering is strong within NANOOS, through our PIs, through our regional prominence as a coordinating body, and through our governance. The proposed efforts will be conducted in partnership by PIs at several NANOOS membership organizations who have maintained NANOOS to date: University of Washington (UW); Oregon State University (OSU); Columbia River Inter-Tribal Fish Commission (CRITFC); Oregon Department of Geology and Mineral Industries (DOGAMI); Oregon Department State Lands (ODSL); Washington Department of Ecology (WDOE). Additional collaborative partners in this proposed work are: National Park Service (NPS), Berring Data Collective (BDC), and partners through NOAA collaborations.

NANOOS coordinates specific PNW efforts with or receives funding from several federal and local entities, including the NOAA Ocean Acidification Program, NOAA Pacific Marine Environmental Laboratory (PMEL), National Estuarine Research Reserve System (NERRS), West Coast Ocean Alliance (WCOA), and Washington Ocean Acidification Center. Additionally, NANOOS has coordinated with the National Science Foundation, which, through its Ocean Observing Initiative (OOI), has PNW observing assets. NANOOS and OOI PIs coordinated a single design that optimizes spatial coverage and will serve data jointly when OOI data are available. NANOOS plays an important role in the PNW, as attested by letters from eleven diverse entities, including the California Current Integrated Ecosystem Assessment Team, Canadian IOOS-Pacific, Columbia River Bar Pilots, Emergency Volunteer Corps of Nehalem Bay, NOAA PMEL, National Marine Sanctuary Foundation, Olympic Coast National Marine Sanctuary, Oregon Coastal Management Program, Pacific Coast Shellfish Growers Association, Quinault Indian Nation, and West Coast Ocean Data Portal, that articulate how NANOOS makes a difference to their work and coastal ocean decisions.

The 73-member NANOOS Governing Council, the guiding body for this work, reflects a balanced composition of academic and research institutions (22%), tribal governments and tribal organizations (8%), federal, state, and local governments (22%), industries (22%), and non-

governmental organizations (26%). That partnership offers this proposal for submission.

c) Goals and Objectives. The Strategic Operational Plan shall contain a Goals and Objective section that describe:
    1) How the RCOS addresses marine operations; coastal hazards; ecosystems, fisheries and water quality; and climate variability and change; and

NANOOS' goal is to sustain and enhance NANOOS to continue as the regional association for the PNW serving our stakeholders in alignment with the vision and operations of IOOS. By coordinating existing assets and placing strategic focus on new investments, NANOOS has produced a distributed observing system yielding informative and decision-relevant data products serving PNW stakeholders and society in five areas of concern (maritime operations, ecosystem assessment, coastal hazards, biodiversity, climate) across three spatial domains (coastal ocean, estuaries, shorelines).

1) Maritime Operations: NANOOS provides water, wave and weather observations and forecasts to ship and boat operators for safe operations and planning

2) Ecosystem Assessment: NANOOS provides time-series and real-time observations and data products used to evaluate, and in some cases forecast, HABs, hypoxia, ocean acidification, and water quality.

3) Fisheries and Biodiversity: NANOOS's forecasts and data on the biophysical environment permit better-informed management decisions by fishers (from tuna fishers to shellfish growers) and regional managers.

4) Mitigation of Coastal Hazards: NANOOS provides observations and analysis of topographic beach profiles, shoreline change, nearshore bathymetry, sea level change, and waves to improve planning and response to coastal hazards, to assist with engineering design, to enhance coastal resiliency, and to track local shoreline change in coastal communities.

5) Climate: NANOOS provides climatology and anomaly products from regional buoy and satellite time series to improve understanding of climate variation and change.

    2) The major objectives that guide the RCOS's priorities for data collection and management, development of products and services, research and development, and education and outreach.

NANOOS Objectives are as follows:

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 nonfederal (tribal, academic, state, local, industry, NGO, etc.) entities.

2) Maintain and enhance surface current and wave observations: Maintain existing HF-radar and wave mapping capabilities and extend these to unserved and underserved areas in the region, providing critical national capacity along coasts and at critical ports. Utilize drifters to expand spatial coverage. Use observations to support wave forecasting capability.

3) Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs and deploy new observing assets to expand spatial scope and increase our focus on biology: Maintain, harden, enhance existing buoys and gliders, and engage new assets to provide broad regional observations, with focus on hypoxia, HABs, OA, and climate. Develop biological observations via tracking and acoustic networks, as part of West Coast wide efforts.

4) Maintain and expand multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs: Sustain and enhance observing ability including new investments in hypoxia, OA, and biological observations to aid sustainable resource management, water quality assessment, and sub-regional climate change evaluation.

5) Maintain and enhance 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, with strategic improvements to capabilities and scope, including new forecasts for waves.

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 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, diversify, and strengthen NANOOS engagement: Continue ongoing engagement with

diverse stakeholders and the public; to engage more audiences in observations, increasing ocean awareness and literacy; to expand and 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.

d) Operational Plan for the Observing System. The Strategic Operational Plan shall include or reference an Operational Plan for the Observing System that:
    1) Describes the desired outcomes of the observing system;

Section D (Work Plan) of the NANOOS FY21-25 Proposal outlines NANOOS' desired Strategic Operational Plan for the current year period. For each FY during the current 5-year period, NANOOS goes through a descope process, once the funding level has been communicated, and submits a revised Work Plan that guides the fiscal year.

For FY 2022, NANOOS is implementing a revised Work Plan as outlined in the NANOOS Descope Package from October 2022. The desired outcomes for NANOOS observing/modeling system for each observing/modeling subsystem objective are as follows:

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.

    2) Describes the elements of the operational integrated observing system that will deliver those outcomes;

The elements of the observing/modeling system that will deliver the outcomes for NANOOS observing system objectives are summarized below, pulled directly from Section D (Work Plan) of the NANOOS FY21-25 proposal.

2) Maintain surface current and wave observations:
- PNW Coast HF Surface Current Mapping
- Wave Imaging at Critical PNW Ports

3) Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs:
- WA shelf buoys
- WA shelf glider
- OR shelf buoy
- Columbia River shelf mooring
- Columbia River shelf glider
- N. CA shelf glider

4) Maintain multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs:
- Puget Sound, WA, profiling buoys
- Puget Sound, WA, US ferry-box
- Columbia River, OR and WA estuary moorings
- South Slough/Coos Bay, OR estuary moorings

5) Maintain core elements of beach and shoreline observing:
- WA and OR beach monitoring
- WA and OR nearshore bathymetry

6) Provide sustained support to a community of complementary regional numerical models:
- NE Pacific and Salish Sea
- Columbia River estuary and plume
- PNW Coastal Waters

3) Documents to NOAA's satisfaction that the individual(s) responsible for RCOS operations has the necessary qualifications and possesses relevant professional education and work experience to deliver observations successfully. At a minimum the Strategic Operational Plan shall:
    i. Identify the individual(s) responsible for overall RCOS management;

Overall NANOOS Management:
Jan Newton, NANOOS Executive Director

Leads the NANOOS enterprise. The Executive Director of NANOOS reports to and receives guidance from the Governing Council. Specific duties of the Executive Director include: management and execution of the NANOOS enterprise; organization of NANOOS planning workshops, as needed, and service as Presiding Officer at these workshops; coordination of all official NANOOS correspondence; preparation or cause the preparation of plans and policy documents for NANOOS including the Memorandum of Agreement, Strategic Operational Plan, Build-out Plan, etc.; and performance of other functions, as directed by the Governing Council Board.

Roxanne Carini, NANOOS Deputy Director
Assists the NANOOS Executive Director in their duties and participates in NANOOS strategic planning with the Executive Director and Governing Council. Provides additional, specialized support of the Data Management and Cyberinfrastructure (DMAC) component of the NANOOS enterprise through regular communication and coordination with: the IOOS Program Office DMAC team; NANOOS Principal Investigators (PIs) to ensure data flows from PIs to NANOOS according to the NANOOS Data Management Plan (DMP); national databases and archives (e.g, NDBC, NCEI, etc.).

Nick Rome, NANOOS Senior Program Manager
Assists the NANOOS Executive Director in their duties and participates in NANOOS strategic planning with the Executive Director and Governing Council. Provides additional, specialized support for the development of the NANOOS enterprise through: visioning and planning stakeholder workshops and events; exploring new partnerships with PNW NANOOS-relevant industry representatives; identifying funding opportunities and writing proposals for NANOOS priority areas.

Andrew Barnard, NANOOS Governing Council Board Chair
Assists the Executive Director in direction of the NANOOS enterprise, including the tasks above. The Board Chair shall exercise such authority as to: act as meeting chair; execute any instruments the Council authorizes, except in cases where signing and execution thereof is expressly delegated by the Council to another representative or agent of NANOOS. Actively promote NANOOS within and outside of the region.

Mike Kosro, NANOOS Board Vice Chair
Assists the Executive Director in direction of the NANOOS enterprise, including the tasks above. The Board Vice Chair shall be responsible to the Board Chair and shall exercise such authority as may be delegated by the Chair, including to: act as meeting chair in the absence of the Chair; execute any instruments the Council authorizes, except in cases where signing and execution thereof is expressly delegated by the Council to another representative or agent of NANOOS. Actively promote NANOOS within and outside of the region.

ii. Identify, as applicable, the individual(s) responsible for observations system management across the region;

Observations/Modeling System Management:
NANOOS necessarily utilizes distributed operational observing leadership over the three domains (coastal ocean, estuaries, and shorelines) and two states (WA and OR) that we operate in across our region, with a lead expert for each observing arena. State agency participation and regional oceanographic variation necessitates the distributed system NANOOS employs.

Surface current and wave observing lead: Mike Kosro (WA/OR)
Leads implementation, operation, and maintenance of HF radars for the NANOOS system. Performs data QC and dissemination tasks as needed to assure coherency with IOOS Program standards.

Coastal shelf buoy observing co-leads: John Mickett (WA) and Mike Kosro (OR)
Each lead maintains and operates a coastal ecosystem mooring in their local waters, utilizing their knowledge of local oceanographic and weather conditions, ability to leverage local assets, and contributions to local stakeholder needs to provide NANOOS with cost-effective and targeted coastal buoy ecosystem observations from WA and OR. Performs data QC and dissemination tasks as needed to assure coherency with IOOS Program standards.

Coastal shelf glider observing co-leads: Jack Barth (OR) and Charles Seaton (WA/OR)
Each lead maintains and operates a coastal glider in their local waters, utilizing their knowledge of local oceanographic and weather conditions, ability to leverage local assets, and contributions to local stakeholder needs to provide NANOOS with cost-effective and targeted glider observations from WA and OR. Performs data QC and dissemination tasks as needed to assure coherency with IOOS Program standards.

Estuarine observing co-leads: Dana Manalang (WA) and Charles Seaton (OR)
Each lead maintains and operates estuarine ecosystem moorings in their local waters, utilizing their knowledge of local oceanographic and weather conditions, ability to leverage local assets, and contributions to local stakeholder needs to provide NANOOS with cost-effective and targeted estuarine buoy ecosystem observations from WA and OR. Performs data QC and dissemination tasks as needed to assure coherency with IOOS Program standards.

Beach and shoreline observing co-leads: Jonathan Allan (OR) and George Kaminsky (WA)
Each lead, situated at their respective state agency, maintains and operates beach and shoreline observations for areas where their state has legal jurisdiction, utilizing their knowledge of conditions, ability to leverage local assets, and contributions to local stakeholder needs to provide NANOOS with cost-effective and targeted beach and shoreline observations from WA and OR. Performs data QC and dissemination tasks as needed to assure coherency with IOOS Program standards.

Regional numerical modeling co-leads*: Ed Zaron (Coastal PNW Ocean), Parker MacCready (Estuarine WA: Salish Sea and Nearshore WA), and Charles Seaton (Estuarine OR: Columbia River Estuary and Plume)
Each lead maintains and operates a numerical forecast model displayed on the NANOOS Visualization System (NVS) for their respective domain that is tailored to capture the key features of the domain (e.g., river plumes, fjord circulation, etc.). These experts actively utilize observing data for validation, highlight areas where new observations are needed, and provide critical model output used by myriad stakeholders in the PNW for a diversity of uses.
* Information about the numerical modeling systems is provided for context. As these are not observing assets, no further documentation (i.e., CVs, DMPs) is provided.

iii. Provide the curriculum vitae for each identified individual; and

CVs for the above individuals are available at:
https://www.nanoos.org/documents/certification/NANOOS-CVs-2023.pdf

iv. Identify the procedures used to evaluate the capability of the individual(s) identified in §997.23(d)(3) to conduct the assigned duties responsibly;

NANOOS selected these individual leads to implement discrete functions of our observing system based on their achievements, qualifications, and regional knowledge, as detailed in their CVs. All are known experts in their respective fields. Each of these NANOOS leads provides a detailed performance report every six months to the Executive Director, which are reviewed by the Director, posted publicly, and are part of annual NANOOS reviews presented to the Governing Council and its Board. Any corrective actions are identified and discussed with the leads. Additionally, all leads are subjected to the annual review processes of their home institutions. Each institution has a process in place for personnel evaluation.

Every five years, starting a year and a half before the new proposal submission, NANOOS reassesses these existing efforts, the leaders, and any gaps or deficiencies to define its development of the new 5-year proposal. The Executive Director serves at the will of the Governing Council (NANOOS MOA Section 8). At the annual Governing Council meeting the Board Chair gives an assessment of NANOOS and the performance of the Executive Director, inviting comments or written concerns. The Board Chair calls for a vote of confidence for the Director at the start of every 5-year proposal planning process.

For the University of Washington (UW), all staff at the Applied Physics Laboratory (APL) undergo annual performance reviews. Examples of the Performance Review Forms used by UW APL can be found at: https://hr.uw.edu/forms/ (under P: Performance Evaluation – …")

4) Describes how the RCOS manages ongoing regional system operations and maintenance. At a minimum the Strategic Operational Plan shall:
    i. Describe the RCOS's standard operating procedures for calibrating, validating, operating, and maintaining equipment owned and/or operated by the RCOS regularly and in accordance with manufacturer guidance or industry best practice. Equipment is defined in § 997.1; and

NANOOS operators of observing assets follow best practices and manufacturer guidance where applicable, to calibrate, operate, and maintain the equipment used in this effort, and are able to provide documentation of this upon request. All operators have a long track record of maintaining similar equipment in the field in working conditions. Individual Data Management Plans provide these details.

    ii. Describe the RCOS's standard operating procedures for maintaining equipment inventories, shipping logs and instrument history logs for equipment owned and/or operated by the RCOS.

NANOOS operators maintain equipment inventories, shipping logs, and instrument maintenance history logs, as appropriate, that are available upon request. All operators have a long track record of maintaining similar equipment in the field in working conditions. Individual Data Management Plans provide these details.

e) Development of a Strategy to Sustain and Enhance the System. The Strategic Operational Plan shall describe its strategy for balancing changes in regional priorities with the need to maintain established data sets, the primary value of which may be in their long-term records. At a minimum the description shall:
    1) Identify the guiding principles that inform the strategy;

NANOOS' development was guided by years of meetings and stakeholder input that NANOOS continues to collect. Key developmental factors have been a balanced focus on coastal ocean, estuarine, and shoreline observations and on product development to meet user needs. Prioritization for activities and products continues to be advised by our regional engagement and active stakeholder involvement within NANOOS governance and committees. The NANOOS GC proposes to sustain and enhance NANOOS: to maintain NANOOS as the PNW regional arm of U.S. IOOS; to strengthen existing infrastructure, capacity, and diversity, assuring reliability and inclusion; and to make selective increases in our capabilities in strategic topical areas dictated by our stakeholders. These guiding principles serve PNW coastal and ocean resiliency, intelligence, and the blue economy.

    2) Reference and show connections to a long-term (five-to-ten-year) regional Build-out Plan for the full implementation of the regional observing system based on the RCOS's priorities and identified user needs; and

In concert with IOOS, the IOOS Association, and other Regional Associations, NANOOS developed its first Build-Out Plan in 2012 with strong consideration of regional issues and product needs, based on stakeholder input. The NANOOS GC and PIs were involved with the production of the 2012 Build-Out Plan. In subsequent years, we have used this Build-Out Plan to inform and develop our "NANOOS Effort vs. Application" matrix (Table 1 in the NANOOS FY21-25 Proposal), which we have utilized to identify existing gaps for prioritization of our build-out efforts, should funds become available. The NANOOS Build-out Plan was updated in 2023 using an assessment of the NANOOS Descopes from FY21-23 of the current 5-year award to reflect additions to the observing system since 2012, while still highlighting gaps for future development.

3) Relate the annual planning process the RCOS uses to review its priorities in light of funding levels and its plans for system enhancement as outlined in the regional Build-out Plan.

NANOOS engages its Governing Council (GC), with representation from diverse sectors and a regionally equitable distribution, to define and refine its regional priorities. Annual GC meetings are used to identify priorities, new members, and deficiencies of the NANOOS enterprise.

The 17-member GC Board is elected from the GC to represent them. Per the NANOOS MOA, the GC Board has sector representation from academia, state agencies, tribes, tribal support organizations, federal agencies, industry, and non-governmental organizations. The GC Board, along with Chairs from the NANOOS operational Standing Committees (Data Management and Cyberinfrastructure, User Products, and Engagement, Education, and Outreach) and the Executive Director, comprises the Executive Committee (ExCom). The ExCom provides an agile yet still representative advisory body for NANOOS. The ExCom discusses the annual budget prepared by the Executive Director, and the GC Board, with "Conflict of Interest" members abstaining, provides decision-making authority on annual budgets and other prioritization decisions by vote.

With the input from NANOOS PIs, GC, and stakeholders, NANOOS developed its "Effort vs. Application" matrix as part of our current 5-year proposal plan. Gaps for build-out were solicited via a publicly advertised LOI process, with results ranked by our GC Board. NANOOS uses this matrix and the prioritization from the Board to assess where any new funding, should it be available, will be directed as part of our system build-out.

f) Data Management and Communications (DMAC) Plan.

NANOOS Data Management Plan (DMP):
https://www.nanoos.org/documents/certification/DMP/2023/NANOOS-DMP.pdf

Individual DMPs for each observing system: See the "Certification 2023" section on the NANOOS Documents page: https://www.nanoos.org/about_nanoos/documents.php

g) Budget Plan. The Strategic Operational Plan shall include or reference a Budget Plan that:
   1) Identifies who supports the RICE financially;

NANOOS operates primarily via funds from its 5-year award from NOAA's IOOS Program Office. NANOOS coordinates with specific PNW efforts or receives funding from other federal and local entities, including the NOAA Ocean Acidification Program (NOAA OAP), NOAA Pacific Marine Environmental Laboratory (NOAA PMEL), National Estuarine Research Reserve System (NERRS), NOAA National Centers for Coastal Ocean Science (NOAA NCCOS), and the Washington Ocean Acidification Center (WOAC).
From our FY22 Descope Package, non-core funded tasks were:

- $430,000 to 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
- $29,073 for a one-time HFR system add-on
- $35,000 for a one-time increase for core needs
- $35,000 as support for salary for Newton as GOA-ON Co-Chair
- $50,000 to sustain NANOOS' work to develop and maintain the GOA-ON data portal
- $271,455 to support efforts for OA observing on NANOOS NOA-ON CB-06 off the OR shelf
- $102,948 to support efforts for OA observing on NANOOS NOA-ON Cha'ba on the WA shelf
- $32,000 as support for Monitoring and Event Response for Harmful Algal Blooms (MERHAB) project activities
- $7,500 to support execution of OceanHackWeek

Many observing assets are leveraged significantly from the NANOOS partner entities, which has not been tracked in terms of dollars. Some of these sources of leverage are indicated below:

- WA Shelf buoy: NOAA OAP, NOAA PMEL, WOAC
- OR shelf buoy: NOAA OAP, NOAA PMEL
- Puget Sound Profiling buoys: NOAA OAP, NOAA PMEL, WOAC
- Columbia River, OR and WA estuary buoys: US Geological Survey
- South Slough/Coos Bay estuary moorings: NERRS
- Puget Sound estuary ferrybox: WA State Department of Ecology
- WA and OR shoreline monitoring: WA State Department of Ecology, OR Department of Geology and Mineral Industries

   2) Identifies how RCOS priorities guide funding decisions; and

NANOOS' development was guided by years of meetings and stakeholder input that NANOOS continues to collect. Key developmental factors have been a balanced focus on coastal ocean, estuarine, and shoreline observations and on product development to meet user needs. Prioritization for activities and products continues to be advised by our regional engagement and active stakeholder involvement within NANOOS governance and committees. The NANOOS GC proposes to sustain and enhance NANOOS: to maintain NANOOS as the PNW regional arm of U.S. IOOS; to strengthen existing infrastructure, capacity, and diversity, assuring reliability and inclusion; and to make selective increases in our capabilities in strategic topical areas dictated by our stakeholders. These guiding principles serve PNW coastal and ocean resiliency, intelligence, and the blue economy. Funding decisions are guided by NANOOS priorities. The GC has voted that they prioritize sustaining current observations first. New activities were prioritized by the GC Board aided by the "NANOOS Effort vs. Application" matrix.

3) Assesses funding constraints and the associated risks to the observing System that the RCOS must address for the future.

NANOOS is highly constrained by funding, with proposals being funded at about 50% of its need. When NANOOS outlined risks to the system in our NANOOS Business Plan (Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis Section), funding constraints was listed as a considerable risk to the NANOOS enterprise. NANOOS has had the fortune to be relatively level-funded, though we recognize this is a slight reduction each year due to increasing costs. However, this funding level has allowed us to sustain across the years the key observing assets that NANOOS originally invested in. While additions to our observing system are desired, none of these original assets are underperforming, and all have links to stakeholders and applications.

Our Governing Council was solicited as to what to preserve if a major funding cut (e.g., ≥$500k) was made and they considered preservation of existing observations to be the highest priority. However, they also stated that such a cut would require a wholesale evaluation of this system, which would take considerable time and was not advised unless this magnitude of a cut was pending.

In our NANOOS FY21-25 proposal, we stated that: "We discuss two levels of work effort: $3M, which allows NANOOS to maintain current capacity; and $6M, which allows for hardening of our existing capacity and new investments to fill significant gaps. NANOOS has prioritized enhancing all existing operations by 20% and DMAC by 30% to account for rising costs of operation during static funding (NANOOS base funding has been flat-funded since 2015). NANOOS then prioritizes replacing aging infrastructure and enhancing our modeling focus, which is currently only 5% of our base. Finally, NANOOS proposes new endeavors that would enhance our breadth and focus. NANOOS priorities for the two funding scenarios are based on our GC and Executive Committee deliberations, informed by stakeholder input."

We stand by our assertion that if the risk of a major funding cut becomes serious, we will engage our Governing Council and stakeholders to prioritize activities and investments at that time.

Northwest Association of Networked Ocean Observing Systems

15 December 2020

Ms. Oriana Villar
U.S. IOOS Office, NOAA
1315 East-West Highway
Silver Spring, MD 20910

Dear Ms. Villar:
Following the guidance in the FY2021 Implementation of the U.S. Integrated Ocean Observing System (IOOS®) Notice of Federal Funding Opportunity, this title page provides information on our proposal to sustain the Northwest Association of Networked Ocean Observing Systems (NANOOS) for the Pacific Northwest region as part of the US IOOS.

Proposal Title: **Sustaining NANOOS, the Pacific Northwest component of the US IOOS**

Topic Area: 1. **Implementation and Development of Regional Coastal Ocean Observing Systems**

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Duration of proposed project:
Five years, from 01 June 2021 to 30 May 2026

Funding requested:
$29,250,000 to University of Washington (including subawards)
$362,749 NOAA transfer of funds via SCCOOS & CeNCOOS
$387,251 NOAA hold back of funds for ONMS & NMFS

This project complies with the IOOS Programmatic Environmental Assessment (section 2.1.1.3: pg. 2-7– 2-9 and pg. 2-24 – 2-26; section 3.1.5: pg. 3-12; section 3.25: pg. 3-35 – 3-38; section 3.35: pg. 3-65 – 3-66).

Sincerely,

Jan Newton, Ph.D.
NANOOS Executive Director

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2. PROJECT SUMMARY

Project Title: Sustaining NANOOS, the Pacific Northwest component of the US IOOS
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Other Key Investigators: Mike Kosro (OSU), Jonathan Allan (DOGAMI), Parker MacCready (UW)

Project Summary

The Governing Council of the Northwest Association of Networked Ocean Observing Systems (NANOOS), on behalf of its 73 members, presents this proposal to maintain and enhance NANOOS as the U.S. Integrated Ocean Observing System (IOOS) Regional Association for the Pacific Northwest (PNW) and to fund sustained operation of its Regional Coastal Ocean Observing System (RCOOS). The primary mission of the user-driven NANOOS is to provide PNW stakeholders with ocean data, tools, and information they need to make responsive and responsible decisions, appropriate to their individual and collective societal roles. Sustained funding for NANOOS will ensure NANOOS' mission is successful. Established by charter in 2003, NANOOS used results from several years of NOAA-funded efforts and other regional contributions to build regional partnerships in the PNW, coordinate regional activities, and identify high-priority user needs and requirements. Our NANOOS Governing Council, composed of members, who have signed our Memorandum of Agreement (MOA), have identified our 5-y priorities.

Our goal is to sustain and enhance NANOOS as the regional association serving PNW stakeholders in alignment with the vision and operations of U.S. IOOS. By coordinating existing assets and placing strategic focus on new investments, NANOOS has produced a distributed observing system yielding informative and decision-relevant data products serving PNW stakeholders and the broader society in five areas of concern (maritime operations, ecosystem assessment, coastal hazards, biodiversity, climate) across three spatial domains (coastal ocean, estuaries, shorelines). From this system, NANOOS provides significant societal benefits to a wide spectrum of users including federal, tribal, state, and local governments, industries, scientific researchers, non-governmental organizations (NGOs), educators, and the public. NANOOS is PNW-managed and operated, federally certified, and maintains essential subsystems (Governance and Management, Observing, Data Management and Cyberinfrastructure, Modeling and Analysis, and Engagement), in coordination with other regional associations, US IOOS, and Canada. Specific objectives over the next five years are to:

1) **Maintain NANOOS as the U.S. IOOS PNW Regional Association**
2) **Maintain and enhance surface current and wave observations**
3) **Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs and deploy new observing assets to expand spatial scope and increase our focus on biology**
4) **Maintain and expand multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs**
5) **Maintain and enhance core elements of beach and shoreline observing**
6) **Provide sustained support to a community of complementary regional numerical models**
7) **Maintain, harden, and enhance NANOOS' Data Management and Cyberinfrastructure (DMAC) system for routine operational distribution of data and information**
8) **Continue to deliver existing and create innovative and transformative user-defined products and services for PNW stakeholders**

9) Sustain, diversify, and strengthen NANOOS engagement

Our work plan is a composite of existing operations that the NANOOS Governing Council (GC) want to sustain and a slate of new efforts that improve existing data quality and access, expand our operators to include the fishing industry, students, and citizen scientists, and expand NANOOS' focus to include biological observations via west coast networks and the HAB Observing Network. NANOOS will remain focused on delivering data products and services that are easy to use to diverse stakeholders for addressing high-priority issues and aiding decision-making. NANOOS will continue its proactive interactions and regional coordination with a wide range of PNW stakeholders, to prioritize and refine our observations, products, and outreach efforts to serve PNW resiliency, coastal intelligence, and conservation goals.

Benefits of this investment include provision of: water and weather observations and forecasts to ship and boat operators for safe operations and planning; time-series, real-time observations, and data products used to evaluate, and in some cases forecast, HABs, hypoxia, ocean acidification, and water quality; data and forecasts for the biophysical environment to permit better-informed management decisions by fishers (from tuna fishers to shellfish growers) and regional managers; observations and analysis of topographic beach profiles, shoreline change, nearshore bathymetry, sea level change, and waves to improve planning and response to coastal hazards, to assist with engineering design, to enhance coastal resiliency, and to track local shoreline change in coastal communities; and climatology and anomaly products from regional buoy and satellite time series to improve understanding of climate variation and change.

This plan for the PNW region represents collaborative consensus of our stakeholders. The NANOOS GC, the guiding body for this work, approved the content of this proposal for submission.

Partners

Partnering is strong within NANOOS, through our PIs, through our regional prominence as a coordinating body, and through our governance. The proposed efforts will be conducted in partnership by PIs at several NANOOS membership organizations who have maintained NANOOS to date: University of Washington (UW); Oregon State University (OSU); Columbia River Inter-Tribal Fish Commission (CRITFC); Oregon Department of Geology and Mineral Industries (DOGAMI); Oregon Department State Lands (ODSL); Washington Department of Ecology (WDOE). Additional collaborative partners in this proposed work are: National Park Service (NPS), Berring Data Collective (BDC), and partners through NOAA collaborations.

NANOOS coordinates specific PNW efforts with or receives funding from several federal and local entities, including the NOAA Ocean Acidification Program, NOAA Pacific Marine Environmental Laboratory, National Estuarine Research Reserve System (NERRS), West Coast Ocean Alliance (WCOA), and Washington Ocean Acidification Center. Additionally, NANOOS has coordinated with the National Science Foundation which through its Ocean Observing Initiative (OOI) has PNW observing assets. NANOOS and OOI PIs coordinated a single design that optimizes spatial coverage and will serve data jointly, when OOI data are available. NANOOS plays an important role in the PNW, as attested by letters from eleven diverse entities, including the California Current Integrated Ecosystem Assessment Team, Canadian IOOS-Pacific, Columbia River Bar Pilots, Emergency Volunteer Corps of Nehalem Bay, NOAA PMEL, National Marine Sanctuary Foundation, Olympic Coast National Marine Sanctuary, Oregon Coastal Management Program, Pacific Coast Shellfish Growers Association, Quinault Indian Nation, and West Coast Ocean Data Portal (Appendix) that articulate how NANOOS makes a difference to their work and coastal ocean decisions.

The 73-member NANOOS Governing Council, the guiding body for this work, reflects a balanced composition of academic and research institutions (22%), tribal governments and tribal organizations (8%), federal, state and local governments (22%), industries (22%), and non-governmental organizations (26%). That partnership offers this proposal for submission.

3. PROJECT DESCRIPTION

A. Background

The Pacific Northwest (PNW) waters of the United States are critically linked to the societal and ecological health of the region. They modify and moderate regional weather, serve as highways for marine commerce involving the entire Pacific Rim, are part of an oceanic buffer for the Nation's national security, support a productive ecosystem, including significant natural and cultural resources, and provide exceptional recreational opportunities. The PNW states of Washington (WA) and Oregon (OR) need access to coastal ocean data and products. The US Integrated Ocean Observing System (IOOS) was authorized by Congress to fill the gap between the importance of coastal ocean data and its lack of availability to diverse sectors of society; since then, the U.S. IOOS Enterprise has flourished through partnerships.

In response, the Northwest Association of Networked Ocean Observing Systems (NANOOS) was assembled by charter in 2003 and formally established by Memorandum of Agreement (MOA) in 2005 to serve the citizenry of the PNW. NANOOS has engaged representatives from a diverse set of stakeholders who are directly involved in the definition and execution of NANOOS within the region and as part of the U.S. IOOS effort. Since 2004, NANOOS has received NOAA funds to build the PNW IOOS Regional Association (RA) and its Regional Coastal Ocean Observing System (RCOOS). NANOOS has been implemented with substantial stakeholder involvement in every aspect: defining NANOOS, its governance structure, regional coordination, and prioritization. Stakeholders contribute to and help define our NANOOS subsystems: observations; modeling; data management and cyberinfrastructure (including user products); and engagement. NANOOS achieved Certification in 2018, with documented governance practices.

For its governance, NANOOS has an established Governing Council (GC) that is thriving, diverse, and continues to grow. Membership has grown from 25 in 2007 to 73 today. Representation is from many sectors, including local, state, and federal agencies, tribes and tribal organizations, NGO/education organizations, industry, and academic institutions. NANOOS has a demonstrated, effective governance structure, with an elected Board of the GC from designated sectoral representation. The Executive Committee, composed of the Board plus operational chairs, advise NANOOS leadership. PIs from multiple institutions have implemented NANOOS since 2007, authoring 185 NANOOS-supported publications.

NANOOS is an active participant in U.S. IOOS and IOOS Association activities and is well-integrated with other regional observing systems[1]. Within the Pacific, NANOOS collaborates with CeNCOOS, SCCOOS, and AOOS, via our IOOS Partners Across Coasts for Ocean Acidification (OA) (IPACOA) project with shellfish growers, West Coast organizations (letter, West Coast Ocean Data Portal, Appendix), and with PacIOOS via our emerging DMAC coordination activities. NANOOS interacts with Canada through their organizations and universities on our GC, including coordination with Canadian IOOS (CIOOS)-Pacific (letter, Appendix), Ocean Networks Canada, and Hakai. NANOOS' Director sits on the CIOOS Pacific Regional Oversight Committee and is the chair of Canada's Marine Environmental Observation, Prediction, and Response (MEOPAR) International Science Advisory Committee.

NANOOS' development was guided by years of meetings and stakeholder input that NANOOS continues to collect. Key developmental factors have been a balanced focus on coastal ocean, estuarine, and shoreline observations and on product development to meet user needs. A host of data and user-defined products are currently available through NANOOS and the NANOOS Visualization System (NVS, Figure 1, Appendix). Prioritization for activities and products continues to be advised by our regional engagement and active stakeholder involvement within NANOOS governance and committees. NANOOS used an open solicitation process to develop our proposal for the next five years. Based on outcomes of this process, the NANOOS GC proposes to sustain and enhance NANOOS: to maintain NANOOS as the PNW regional arm of U.S. IOOS; to strengthen existing infrastructure, capacity, and diversity, assuring reliability and inclusion; and to make selective increases in our capabilities in strategic topical areas dictated by our stakeholders. These guiding principles serve PNW coastal and ocean resiliency, intelligence, and the blue economy.

B. Goal and Objectives

i. Goal: Our goal is to sustain and enhance NANOOS to continue as the regional association for the PNW serving our stakeholders in alignment with the vision and operations of IOOS. We aim to maintain IOOS program funding and to continue to engage a significant array of leveraged resources. By coordinating existing assets and placing strategic focus on new investments, NANOOS has produced a distributed observing system yielding informative and decision-relevant data products serving PNW stakeholders and society in five areas of concern (maritime operations, ecosystem assessment, coastal hazards, biodiversity, climate) across three spatial domains (coastal ocean, estuaries, shorelines). From this system, NANOOS provides significant societal benefits to a wide spectrum of users including federal, tribal, state and local governments, industries, scientific researchers, non-governmental organizations (NGOs), educators, and the general public. NANOOS is PNW-managed and operated, federally certified, and maintains essential subsystems (Governance and Management, Observing, Data Management and Cyberinfrastructure, Modeling and Analysis, and Engagement) in coordination with IOOS.

ii. Objectives: For the next five-year funding cycle, our objectives annually are 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 and enhance surface current and wave observations:** Maintain existing HF-radar and wave mapping capabilities and extend these to unserved and underserved areas in the region, providing critical national capacity along coasts and at critical ports. Utilize drifters to expand spatial coverage. Use observations to support wave forecasting capability.

3) **Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs and deploy new observing assets to expand spatial scope and increase our focus on biology:** Maintain, harden, enhance existing buoys and gliders, and engage new assets to provide broad regional observations, with focus on hypoxia, HABs, OA, and climate. Develop biological observations via tracking and acoustic networks, as part of West Coast wide efforts.

4) **Maintain and expand multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs:** Sustain and enhance observing ability including new investments in hypoxia, OA, and biological observations to aid sustainable resource management, water quality assessment, and sub-regional climate change evaluation.

5) **Maintain and enhance 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, with strategic improvements to capabilities and scope, including new forecasts for waves.

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 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, diversify, and strengthen NANOOS engagement:** Continue ongoing engagement with diverse stakeholders and the public; to engage more audiences in observations, increasing ocean awareness and literacy; to expand and 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.

Our work plan encompasses existing operations the NANOOS GC wants to sustain and new efforts that improve existing data quality and access, expand our operators to include the fishing industry, students, and citizen scientists, and expand NANOOS' focus to biological observations via west coast networks. Enhancements to existing efforts address aging infrastructure, data QA/QC, expansion of variables or range, and increased focus on modeling and forecasts. NANOOS maintains the flexibility to respond to emergent regional needs and evaluation of products and services to assess needed improvement.

C. Connection to Users/Stakeholders and Benefits

Our targeted audience is PNW user communities that stand to gain real benefit from NANOOS data products. Ongoing outreach and engagement have shaped the five high-priority, PNW stakeholder-defined topical areas for NANOOS: **a) maritime operations; b) ecosystem assessment including PNW hypoxia, ocean acidification (OA), and Harmful Algal Blooms (HABs); c) fisheries and biodiversity; d) mitigation of coastal hazards; and e) climate and weather**. These topics are intimately linked to the economy, health, resiliency, and ecology of the region; hence efforts in these areas benefit society in the PNW, the Pacific Rim, and beyond. We connect to our users and stakeholders to assess requirements, deploy and maintain observations, and deliver products; modeling the Framework for Ocean Observing process[2] to maximize benefits, and maintain connection iteratively[3] as per OceanObs'19 recommendations.

NANOOS established these priorities in its formative years and has regularly sought input to ratify relevancy, user requirements, and assess how well needs are being met. Input is from two main sources: 1) we seek input formally from our GC during our annual in-person meeting; and 2) we interact directly with our stakeholders, users, and collaborators throughout the year via on-going engagement and partnership. Some of our NANOOS implementers are also our users or play vital roles on our operational standing committees thus feedback interactions are direct, frequent, and two-way.

Primary benefits to NANOOS audiences, with examples of tailored NVS products, are provided:

i. Maritime Operations: NANOOS provides water, wave and weather observations and forecasts to ship and boat operators for **safe operations and planning**. Audience: Commercial Port Authority offices in Puget Sound, Columbia River, and along the coast, coast and bar pilots, USCG District 13, regional USCG coastal stations, and boaters of all types. ***NANOOS members engaged in this area include*** the Maritime Exchange of Puget Sound, Ports of Newport, OR and Neah Bay, WA, Council of American Master Mariners, World Ocean Council, and Puget Sound Harbor Safety Committee. Both commercial maritime operations and recreational boaters benefit from NANOOS apps: MaritimeOps and Boaters. New operations we propose would allow accurate wave forecasting at a major shipping conduit (Columbia River), increase surface current observations, and provide biological information for ship strike avoidance.

ii. Ecosystem Assessment: NANOOS provides time-series and real-time observations and data products used **to evaluate, and in some cases forecast, HABs, hypoxia, ocean acidification, and water quality**. Audience: U.S. EPA, Tribes; OR, WA and CA natural resource, environmental quality, and ecology agencies; and local/county resource divisions. ***NANOOS members currently engaged include*** NOAA PMEL, WA Dept. Ecology, WA Dept. Health, OR Dept. State Lands, Hakai Institute, Long Live the Kings, Puget Sound Partnership, Puget Sound Restoration Fund, Columbia River Inter-Tribal Fish Commission, Northwest Indian College, Quileute Tribe, Pt. Gamble S'Klallam Tribe, Quinault Indian Nation, Olympic Coast National Marine Sanctuary, Ocean Aero, Rockland Scientific, Seabird Scientific, Weatherflow, WETLabs, Western Assn Marine Labs, Ocean Blue Corp., Seattle Aquarium, Surfrider Foundation, and Nature Conservancy. Benefits for these stakeholders are from the NVS Explorer (Figure 1, Appendix), a HAB Real-time data app and the PNW HAB Bulletin, a water quality app for Shellfish Growers, and NANOOS theme pages on hypoxia, OA, HABs. New efforts we propose focus on nearshore

definition of OA, oxygen, and temperature for better assessment of that critical environment of wide interest to our engaged audience.

iii. Fisheries and Biodiversity: NANOOS's forecasts and data on the biophysical environment **permit better-informed management decisions by fishers (from tuna fishers to shellfish growers) and regional managers**. Audience: OR, WA, and CA health and natural resource departments; Tribal governments and enterprises; Aquaculture companies, commercial and academic researchers and shellfish trade associations. ***NANOOS Members currently engaged include*** NOAA NWFSC, Quileute Tribe, NW Indian Fisheries Commission, Port Gamble S'Klallam Tribe, Quinault Indian Nation, WA Dept of Fish & Wildlife, OR Dept of Fish & Wildlife, Columbia River Inter-Tribal Fish Commission, Pacific Coast Shellfish Growers Association, Long Live the Kings, PNW Salmon Center, Hakai Institute, Pacific Shellfish Institute, Columbia River Crab Fishermen's Association, Puget Sound Restoration Fund, and the Puget Sound Partnership. NVS apps tailored to Tuna Fishers, Fishers, and Shellfish Growers are used for business decisions that sustain PNW economies. We propose to join west coast-wide networks for acoustics and animal tracking to expand the knowledge of biodiversity and the number of stakeholders involved.

iv. Mitigation of Coastal Hazards: NANOOS provides observations and analysis of topographic beach profiles, shoreline change, nearshore bathymetry, sea level change, and waves **to improve planning and response to coastal hazards, to assist with engineering design, to enhance coastal resiliency, and to track local shoreline change in coastal communities**. Audience: WA and OR natural resource departments, FEMA, USACE, USGS, local government planners, geotechnical engineers, shipping interests and the public-at-large. ***NANOOS Members currently engaged include*** OR Dept of Geology & Mineral Industries, the WA Dept of Ecology, OR Dept State Lands, OSU, Raincoast GeoResearch, and Northwest Research Associates. Focused NANOOS apps include Tsunami Evacuation and Beach Mapping, and a NANOOS info page on Marine Debris. Increased focus on bluff erosion and bathymetry measurements will lead to better modelling of coastal hazards and aid our engaged audience.

v. Climate: NANOOS provides climatology and anomaly products from regional buoy and satellite time series **to improve understanding of climate variation and change**. Audience: WA and OR natural resource, tribes, local government planners, and the public-at-large. ***NANOOS Members currently engaged include*** WA Dept. Ecology, OR Dept State Lands, Puget Sound Partnership, Columbia River Inter-Tribal Fish Commission, Northwest Indian College, Quileute Tribe, Pt Gamble S'Klallam Tribe, Quinault Indian Nation, Olympic Coast National Marine Sanctuary, Surfrider Foundation and Nature Conservancy. Our NVS Climatology app provides context and a greater understanding of current conditions relative to long-term means to interpret the coastal climate signal. New observations of temperature in the nearshore will help our understanding of marine heat waves and their effects in this critical habitat.

D. Work Plan

Our work plan addresses how NANOOS will address all five PNW stakeholder-defined topical areas, which map to the seven IOOS societal benefits (weather and climate; maritime operations; coastal hazards; national security; public health; ecosystem health; natural resources). To illustrate this, we map NANOOS' "Effort versus Application" (Table 1) showing where our **Observing** and **Modeling** efforts are being applied, the balance across our three spatial domains and topical application areas, and to highlight existing gaps NANOOS proposes to fill would fit in our overall effort. Our **DMAC** and **Engagement** subsystems span across and support all these efforts. In this work plan we present how we will achieve our objectives, noting the technical approach, partner roles and responsibilities, user involvement, and Milestones (Table 2).

We discuss two levels of work effort: $3M, which allows NANOOS to maintain current capacity; and $6M, which allows for hardening of our existing capacity and new investments to fill significant gaps. NANOOS has prioritized enhancing all existing operations by 20% and DMAC by 30% to account for rising costs of operation during static funding (NANOOS base funding has been flat-funded since 2015). NANOOS then

prioritizes replacing aging infrastructure and enhancing our modeling focus, which is currently only 5% of our base. Finally, NANOOS proposes new endeavors that would enhance our breadth and focus. NANOOS priorities for the two funding scenarios are based on our GC and Executive Committee deliberations, informed by stakeholder input. Our regional objectives complement and comply with national plans including the U.S. IOOS Strategic Plan, National Operational Wave Observation Plan, National Strategy for a Sustained Network of Coastal Moorings, National Surface Current Mapping Plan, Underwater Glider Workshop Report, ATN Implementation Plan, OA Strategic Plan, QARTOD manuals, MBON and BIO Task Team Strategies and OceanObs Living Action Plan.

i. Governance and Management Subsystem:

Objective 1. Maintain NANOOS as the U.S. IOOS PNW Regional Association. *As the US IOOS Regional Association for the PNW, NANOOS proposes to sustain our proven role for regional coordination, administrative infrastructure, and stakeholder engagement, encompassing federal and non-federal (tribal, academic, state, local, industry, NGO) partners*.

NANOOS has designed and implemented PNW IOOS infrastructure since 2003. We propose to sustain NANOOS, continuing its successful 16-y old governance and management structure comprised of: 1) a Governing Council (GC) of representatives from member (MOA-signatory) institutions; 2) a decision-making Executive Committee (ExCom) composed of a Board of 15 elected GC members from diverse sectors, plus chairs of three NANOOS operational committees: DMAC (Risien, OSU), User Products (Allan, DOGAMI), and Engagement (Wold, UW); 3) a Board Chair (Martin, retired) and Vice Chair (Kosro, OSU) for leadership; 4) an Executive Director (PI Newton, UW) and Program Manager (Rome, UW) for project vision, oversight, and implementation; and 5) distributed partner PIs who execute the subsystems of NANOOS. The CVs for NANOOS PIs and key personnel who will implement this proposed work are in the Appendix. For this and previous proposals, UW acts as the fiscal authority on behalf of NANOOS, entering legally binding agreements, receiving and disbursing funds, and ensuring accountability.

NANOOS engages its GC, with representation from diverse sectors (22% local, state, and federal government, 8% tribes and tribal organizations, 26% NGO/education organizations, 22% industry, and 22% academic institutions) and a regionally equitable distribution, to define and refine its regional priorities. Annual GC meetings are used to identify priorities, potential new members, and deficiencies. In preparation for this NOFO, during the 2019 and 2020 meetings, overviews of the NANOOS enterprise were presented with a request for input on where improvements were needed or costs could be saved. The unanimous consensus each year was to retain all existing efforts, as stakeholder benefits are being realized and support is strong for the continuation of these efforts. NANOOS employed an open solicitation process inviting Expressions of Interest (EOI) for response to this NOFO. The ExCom, with representation from federal, state/local agencies, tribes, academia, industry, and NGOs, and NANOOS' DMAC, User Products, and Engagement committees, provides an agile yet still representative advisory body for NANOOS. They hold decision-making authority on annual budgets and other prioritization decisions. The ExCom reviewed all EOIs for this proposal, scoring and ranking them, and discussing and approving an overall $6M budget.

NANOOS plays a vital regional coordination role, both within the PNW and along the west coast. For the PNW, NVS serves an order of magnitude more data streams than we financially support. NANOOS is turned to for coordination and assistance with key regional issues; see letters from NOAA PMEL and CA Current Integrated Ecosystem Assessment regarding our contributions (Appendix). NANOOS cooperates extensively with west coast and Pacific RAs, co-hosting workshops (e.g., WCOFS, MBON/ATN, Pacific Anomalies), sharing competencies (e.g., IPACOA), and strategic planning.

NANOOS will continue to participate actively with the U.S. IOOS Program Office, regularly attending semi-annual meetings and other IOOS activities. NANOOS is a member of the IOOS Association, on whose Board Martin and Newton sit; Newton also serves on its ExCom. Newton will assure NANOOS submission of required IOOS progress reports. NANOOS will seek re-certification as a Regional

Information Coordination Entity of US IOOS. Our work plan for this subsystem requires salaries and travel in each year for oversight, coordination, and evaluation by the NANOOS ED and Program Manager.

ii. Observing Subsystem: We propose to sustain and enhance observing assets within three observational domains: coastal ocean, estuaries, and shorelines. We use our NANOOS Effort vs. Application Map (Table 1) to show how these collectively address NANOOS' priority topical areas and feed user data product development within these three domains. The NANOOS Conceptual Design (Figure 2, Appendix) shows the distribution of existing and proposed observing assets, which derives from NANOOS' Build-Out Plan, our Certification Strategic Operating Plan, and ongoing stakeholder input as evaluated by the NANOOS Governing Council. IOOS Core Variables are denoted by underline throughout this section.

Objective 2. Maintain and enhance surface current and wave observations. *NANOOS proposes to maintain existing HF-radar and wave mapping capabilities and extend these to unserved and underserved areas in the region, providing critical national capacity along coasts and at critical ports; utilize drifters to expand spatial coverage; and to use observations to support wave forecasting capability.*

PNW Coast HF Surface Current Mapping: Surface currents are fundamental ocean data[4], serving diverse users[5]. We propose to continue to operate a suite of current measurement sites using HF radar in a continuous mapping array in OR and WA. This system produces individual hourly-averaged radial current measurements, which are translated to visualizations and user products. Vector currents are made available to NVS and IOOS, and used by a wide array of stakeholders, including the US Coast Guard for search-and-rescue, NOAA's Office of Response and Restoration for oil spill and pollution response, ecosystem analysts for tracing transport of HABs, fishermen and other ocean users for route planning, the US Weather Service through AWIPS, field scientists for operational planning, ocean modelers for data assimilation to improve their model fidelity, and for assessment of ocean interannual variability due to sustained ops (1997). We will continue improvements for maritime operations (search and rescue, vessel routing), and ecosystem assessment, including analysis and modeling of HAB transport. (PI Kosro, OSU)

Our work plan for this objective element at the $3M budget level is to operate ten SeaSonde HF sites designated as Priority 1 sites by the national HF program; these are six long-range sites in OR, two in WA, and two standard-range sites in OR. As resources allow, three 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. At the $6M level, we propose to fill the final gap in HF coverage.

GAP: *NW WA surface currents:* NANOOS places priority to purchase one additional HF system to extend surface current mapping to the northwesternmost WA coast, thus completing full coverage of the US West coast. Surface currents at this site play a critical role for maritime transport, tracking HAB transport, and for understanding coastal dynamics that affect fisheries and coastal hazards. We also are renewing discussion of collaboration in British Columbia via Canadian IOOS Pacific and Ocean Networks Canada, for the potential of sites in the Strait of Juan de Fuca, a major shipping conduit, if resources allow.

Wave Imaging at a key PNW Port: Because of critical potential pay-off to save lives at dangerous ports, NANOOS has invested in an X-band marine radar wave observing station at the Newport, OR, Yaquina jetty since 2009. Our objective is to provide both real-time and historical surface wave and bathymetry data of use to the USCG, Newport marine industry, and recreational boaters out of Yaquina Bay[6]. There are no other existing sources of wave data local to the area. Also, bathymetry around the inlet is only available yearly, at best, based on USACE dredging. Bathymetry data from nearby beaches are available yearly from ongoing NANOOS activities (see Objective 5; Ruggiero). Our marine radar planned work produces wave directional spectra over three sub-regions near the inlet and supplies mean and snapshot radar images. These data are updated every 15 minutes through NVS Explorer. In addition, the system can estimate bathymetry (not in real-time) with data are supplied as overlays of variable transparency in a Google Earth image. This system offers value to scientific understanding and non-academic stakeholders. Yaquina Bay is important to OR's commercial and recreational fishing industry and is a critical lifeline for shipping and

maritime transportation. Environmental data (such as waves and bathymetry) are important for navigational safety and planning and can save lives. See Letter from Columbia Bar Pilots (Appendix) (PI Haller, OSU)

Our work plan for this objective element at the $3M budget level is to sustain the existing marine radar observing station at USCG Station Yaquina Bay, providing both real-time and historical wave information via NANOOS NVS. Mean and snapshot radar images are real-time viewable for use in environmental characterization. At the $6M level, limited additional funds are requested to verify more extensively and to streamline the operational bathymetric estimation in and around the inlet and neighboring beaches through collaboration with NANOOS shoreline bathymetry observing efforts (Objective 5; Ruggiero) and local wave forecasting efforts (Objective 6; Ozkan-Haller).

Objective 3. Sustain and enhance buoys and gliders in the PNW coastal ocean in coordination with national and regional programs and deploy new observing assets to expand spatial scope and increase our focus on biology. *NANOOS proposes to maintain, harden, and enhance existing buoys and gliders, and engage new assets to provide broad regional observations, with a focus on hypoxia, HABs, OA, and climate; and develop biological observations via West Coast tracking and acoustic networks.*

NANOOS efforts characterizing the coastal ocean cover many core IOOS variables (underlined). Though configurations vary, most gliders and moorings measure temperature, salinity, pressure, chlorophyll, colored dissolved matter, particles, optics, and oxygen; many moorings additionally measure nitrate, pH (acidity), partial pressure CO_2; moorings with surface expression measure wind speed and direction, radiation, and air temperature. Enhancements would include sound, marine mammals, fish, phytoplankton, zooplankton, and HAB toxins. NANOOS collaborates closely with NSF's Ocean Observatory Initiative (OOI) PNW observatory; the assets NANOOS proposes for ongoing support complement OOI assets, maximizing spatial coverage of oceanographic features and user needs. Some NANOOS assets are partially supported by NOAA's OA Program. Collectively, these shelf observing assets provide timely information about OA status, seasonal hypoxia severity and extent, and HAB dynamics, and potentially can be used to predict PNW-wide ocean ecology impacts. All existing assets' data are served via NVS. Data from these shelf assets are assimilated into and used to verify the results of circulation and ecosystem models.

WA shelf buoy and glider: This system, acquired with Murdock Charitable Trust funding and deployed in 2010, is comprised of three components: a surface mooring ("Cha-ba", meaning "whale tail," named for us by the Quileute Tribe) and a sub-surface profiling mooring, and a Seaglider autonomous underwater vehicle. Collectively these yield an unprecedented, synthesized view of WA's coastal processes, which includes 37-m internal waves[7]. Strong support from Makah, Hoh, and Quileute Tribes, Quinault Indian Nation (Letter, Appendix), Olympic Coast National Marine Sanctuary (OCNMS) (Letter, Appendix), and WA State was instrumental in justification and defines ongoing system implementation. Interest in OA, hypoxia, and HABs is high, with impacts on these communities. (PIs Curry, UW, (moorings) & Lee, UW, (glider))

OR shelf buoy: When NSF's OOI established support for the historical NH-10 mooring supported by NANOOS since 2007, NANOOS shifted its support to a new location CB-06, farther south on the OR coast off Coos Bay and part of our NANOOS Buildout Plan. Both of these assets' measurements are used to inform ocean users and managers about the current state of OR coastal waters, supporting investigation to understand the influence of hypoxia on coastal ecosystems, and observations on OA[8]. (PI Kosro, OSU)

Both the Coos Bay and La Push buoys are located at 80m depth to aid intercomparison of coastal dynamics; both are NOAA OA Program buoys receiving federal support for OA monitoring[9].

Columbia shelf mooring and glider: Located between WA and OR is a major driving influence on the coastal waters: the Columbia River[10]. The Coastal Margin Observation and Prediction (CMOP) observatory was developed to study this dynamic[11] with former NSF support and current NANOOS support and is now operated by the Columbia River Inter-tribal Fish Commission (CRITFC), a NANOOS partner. CMOP includes a shelf mooring at 30m just south of the Columbia River on the OR shelf, as well as a Slocum glider on the WA shelf. We will operate the glider in collaboration with CRITFC and the Quinault Indian

Nation (QIN, a NANOOS member, Letter, Appendix) with the primary mission to map subsurface ocean properties including dissolved oxygen in a region near Grays Harbor and extending south toward the Columbia River. Monitoring the evolution and extent of possible hypoxic waters is important especially for QIN who have traditional fishing rights in this region. Both QIN and the member tribes of CRITFC have interest in better understanding ocean conditions, including hypoxia and temperature, as these affect tribal fisheries. QIN advise the glider operators on the desired sampling pattern and provide logistical field support from their boats. We will explore involving an intern from QIN in our at-sea glider operations to engage them in piloting and examining the data. (PIs Seaton, CRITFC, (mooring) & Barth, OSU, (glider))

CA shelf glider: In collaboration with CeNCOOS, NANOOS supports a glider off Trinidad Head, northern CA, coordinated after NSF's OOI glider team took over Newport glider operations. Bounding NANOOS' southern border, this dynamic region with fronts and eddies is known to have concentrated commercial and recreational fish species. The Trinidad Head glider line provides much-needed subsurface data from a region of the California Current that is under sampled, providing key measurements of upper-ocean heat content, along-coast flow, and subsurface dissolved oxygen and chlorophyll fluorescence. The upper-ocean heat content is critical for tracking interannual variability like El Niño/La Niña and marine heat waves. Variations in the properties of deep source water for upwelling influence productivity and hypoxia on the continental shelf. Surveys are coordinated with NOAA NMFS (with Eric Bjorkstedt). (PI Barth, OSU)

Our work plan for this objective at the $3M budget level is to sustain these assets. At the $6M level we will replace aging infrastructure and make enhancements to harden them to withstand the elements for uninterrupted service. New mooring components, sensors, and a second glider will be purchased for the La Push and Trinidad lines. Based on stakeholder input, the NANOOS GC ExCom recommends investments in the following new directions to fill gaps, expand our coastal ocean shelf observations to the nearshore region, and add biological observations in concert with West Coast wide efforts. Some of these proposed investments are relatively small (<$50k) but funding would make a pivotal difference to sustaining high-quality data for better understanding and applications.

GAP: *Biological observations:* NANOOS lacks biological observations, especially on trophic levels above plankton. NANOOS, CeNCOOS, and SCCOOS are jointly proposing collaborative and synergistic projects that advance national priorities for assessing ecosystem viability and advance West Coast and national networks for biological observations; letters National Marine Sanctuary Foundation and OCNMS (Appendix)

1. *West Coast ATN:* Regional marine animal telemetry networks (ATN) have formed *de novo* around the world among researchers using acoustic telemetry to tag and track a wide range of economic and ecologically important marine species[12]. These networks have enabled independent researchers to expand their ability to track their target species across much larger stretches of coastline, leveraging collective data sharing, and enabling networks the ability to share data with the public. There is an obvious need to merge west coast-wide ocean observing systems with marine animal telemetry networks, creating a more comprehensive data serving platform; this project will expand acoustic nearshore receiver arrays and data services as part of a West Coast ATN effort. Working with CeNCOOS, SCCOOS, and their PIs, we propose to unify a west coast acoustic receiver data network, which is currently lacking and to bring it into the IOOS data stream and the ATN. In the NANOOS region, large coastal sharks, regionally under-sampled, will be the focus of our tagging efforts. Acoustic tags can provide information on seasonal residency, escapement, and survival, essential to stakeholders such as NOAA, ODFW, WDFW, and tribal communities for resource management; for generating new models on fishery distributions, behaviors, and abundance to help maintain stocks, preserve biodiversity; and to inform ecosystem-based management efforts of living resources, and for assessing climate change effects on animal movements. (PI Chapple, OSU)

2. *West Coast Ocean Sound:* The Ocean Sound Observation Network (OSON) capitalizes on existing partnerships, infrastructure, and expertise to consistently produce robust, standardized sound metrics that are valuable ecosystem health indicators. The goal is to sustain a critical network of passive sound listening

stations along the West Coast in partnership of NANOOS, CeNCOOS, SCCOOS, with three mooring sites in the NANOOS region in the Olympic Coast region, to monitor the underwater soundscape, understand its composition and measure the variability of sound levels at various frequencies and on different time scales representing geophysical, biological, and anthropogenic sounds[13]. The West Coast OSON will help close the acoustic environment knowledge gap by sustaining strategic long-term sampling and producing standardized time-series ocean sound metrics for federal and state organizations, National Marine Sanctuaries, the U.S. Navy, and NOAA in support of U.S. MBON goals. (PI Peavey-Reeves, NOAA)

3. *National HAB Observing Network:* NANOOS maintains a sharp focus on HABs[14], which affect the PNW economy and ecology, as part of the emerging National HAB Observing Network for which we have received pilot funds. We propose continued support of key elements needed to produce the popular Pacific Northwest Harmful Algal Bloom Bulletin including offshore and ESP sampling, beach sampling by tribes, analysis, and circulation modeling. The Bulletin is used by state and tribal resource managers to protect the health of shellfish harvesters and consumers and NOAA fisheries managers to protect marine mammals. NANOOS acknowledges other un-met HAB needs, including support for Imaging Flow Cyto-Bots.

GAP: *Nearshore hypoxia and acidification:* National attention has been drawn to the outbreak of more intensive and nearer-shore hypoxia off the PNW coast and impact of ocean acidification on shellfish growing and ecosystem integrity[8, 9, 15]. NANOOS proposes to address gaps in our coverage with strategic contributions to regional capability to assess ocean acidification and hypoxia (OAH).

1. Higher resolution coverage: We lack observations with high enough spatial resolution to document the area impacted by seasonal hypoxia on PNW continental shelves. This approach uses crab pots as platforms of opportunity to extend the NANOOS network coverage and engages fisherman directly in ocean observing thereby building support for NANOOS from a key sector of the coastal economy. We will equip up to 80 crab pots, deployed by commercial and tribal fishermen, with second-generation temperature and dissolved oxygen sensors that report observations to the fishermen and back to shore as soon as pots are brought on deck, covering within estuaries to the near-shore (5 m depth) to the mid-shelf (100 m depth) where risks of hypoxia are greatest, yielding unprecedented coverage. This project engages fishermen as 'citizen scientists' and by reducing uncertainty in the location and severity of hypoxic zones, provides fishermen with the information needed to adapt to changing ocean conditions. (PI Shearman, OSU).

2. Intertidal coverage: Lack of observations comparing OAH shelf observations with the fertile intertidal renders our current understanding less complete toward biological impacts in dynamic ecologically important refugia. NANOOS proposes two OAH observing activities in relatively undisturbed areas in OR and WA to provide insights on these stressors absent other anthropogenic disturbance (e.g., harvesting): a) Citizen Science monitoring in OR Marine Reserves via a network of community citizen scientist partners (i.e. Redfish Rocks Community Team, Friends of the Cape Falcon Marine Reserve, Oregon Surfrider, The Nature Conservancy) using Durafet-based pH sensors custom-developed by MBARI for use in open coast rocky benches in all five OR marine reserves. We propose to fold this low-cost, high-impact monitoring partnership into the broader NANOOS network via NANOOS' Citizen Science Data portal (PI Chan, OSU); and b) Intertidal sensors in National Parks off the Olympic Coast and San Juan Island, WA, to determine the status and trends of OA at sentinel sites in low elevation tide-pools that are twice daily inundated by nearshore seawater, co-located with NPS funded long-term biological monitoring sites, enabling the potential linkage of OA and biological community dynamics. (PI Fradkin, ONP)

3. Data coverage in real-time: The OCNMS has maintained seasonal moorings from Cape Flattery to Grays Harbor at a water depth of 35 m, now designated as a NOAA OA Sentinel Site. Data reveal seasonal hypoxia and OA conditions of known impact to biota; however, with much interannual variation. OCNMS mooring data are valuable to the region but can only be accessed **after** the season, upon download. The plan is to refabricate four real-time mooring systems with hourly real-time data from the OCNMS sensors served through NANOOS NVS. See OCNMS letter (Appendix) for their strong support. (PI Mickett, UW)

GAP: *Expanding coverage by expanding the observing community:* Coastal dynamics are incredibly intricate with diversity and dynamics operating on small-, meso-, and large-scales. Effective observations can utilize various strategies to integrate across those scales and can only be sustained by entraining more than the traditional academic or agency efforts.

1. Fishing Vessels: We propose to use fishing vessels of opportunity (FVOP) to expand coverage of physical and chemical measurements off the West Coast. This project, also proposed by CeNCOOS and SCCOOS, would harness the fishing fleet to collect temperature and other data, channeling to NANOOS and IOOS for broader dissemination and use by modelers, managers, and scientists needing coastal data on broader scales than revealed by buoys and gliders. In this pilot project, frameworks and data pathways will be laid to evaluate future scaling up of operational networks, a first step towards integrating fisheries ocean observations into existing ocean observation networks. (PI Van Vranken, Berring Data Collection)

2. Students: Toward a long-term goal of developing a community of high schools and fishers who follow a strict oceanographic standard in building and deploying instruments with the same protocols where the data is documented and stored according to IOOS principles, we propose to work with several schools throughout the PNW, sending them drifter kits and instructional videos, and with various mariners to coordinate deployments. Track data would be processed, visualized, served, and archived, merging new data with historical datasets, performing quality control, getting drifter data into systems such as the Environmental Data Server, Global Telemetry System, ERDDAP, and NCEI so multiple model groups can access data in a standardized way. All tracks would be displayed in real-time on NOAA/NWFSC and NANOOS maps and archived and served according to IOOS standards via ERDDAP. (PI Manning, NOAA)

Objective 4. Maintain and expand multidisciplinary observational capabilities in PNW estuaries and the nearshore, in coordination with local and regional programs. *NANOOS proposes to sustain and enhance these assets, including new investments for hypoxia, OA, and biological observations, to aid sustainable resource management, water quality assessment, and sub-regional climate change evaluation.*

Our estuarine observing effort is concentrated in two PNW estuaries of large economic and ecological footprints (Puget Sound and Columbia River), and in South Slough/Coos Bay, a National Estuarine Research Reserve System (NERRS) site in southern OR. Though configurations vary, most moorings measure (IOOS Core Variables underlined) temperature, salinity, pressure, chlorophyll, colored dissolved matter, particles, optics, and oxygen; many moorings additionally measure nitrate, pH (acidity), partial pressure CO_2; moorings with surface expression measure wind speed and direction, radiation, and air temperature. Enhancements would include contaminants, phytoplankton, and zooplankton.

Puget Sound, WA: Puget Sound has six profiling buoys with physical, chemical, and biological sensors originally constructed through federal (Navy, EPA) and state funding. Puget Sound, covering 2600 km^2 and depth >200m has five diverse basins of differing water quality. Two buoys are in Hood Canal and one each in Admiralty Inlet, Dabob Bay, Puget Sound Main Basin and South Puget Sound, most near shellfish growing areas. Slower water circulation and other factors in Hood Canal and South Sound result in hypoxia and enhanced OA, of strong concern[16, 17]. These buoys, registered with NDBC, provide multiple daily depth profiles and surface weather, allowing assessment of hypoxia, algal blooms, and climate effects, including modulation of salinity that affects circulation. IOOS and NOAA OAP investment enables surface pH and pCO_2 sensors provided by NOAA PMEL (Dabob and Hood Canal), NANOOS member King County (Main Basin) and WOAC (rest). Shellfish growers rely on these data (PCSGA Letter, Appendix). (PI Curry, UW)

Complementing these fixed assets is NANOOS support for a ferry-box between Seattle, WA and Victoria, BC. Through a collaboration with Clipper Navigations, Inc., to collect high frequency, continuous water quality data using sensors on the Victoria Clipper IV, this cost-effective partnership is the only monitoring crossing the US/Canadian border, enabling assessment of dynamic water exchange between Puget Sound and the Strait of Juan de Fuca, for surface water, sediment, and river influences[18]. (PI Krembs, WDOE)

Columbia River, OR and WA: We propose to maintain and strengthen the CMOP observation and prediction infrastructure for science and societal applications in the Columbia River estuary[19, 20]. These interdisciplinary data are used extensively in fisheries, navigation improvements, ecosystem restoration and hydropower management, numerical modeling, and scientific exploration. These data are of utility to diverse stakeholder communities (federal and state agencies, tribes, others) and provide direct support to major regional decisions, including the Columbia River Channel Improvement Project, the Columbia River Treaty Review, and the Bradwood Landing LNG terminal application. (PI Seaton, CRITFC)

South Slough/Coos Bay, OR: NANOOS proposes to help support observations in the South Slough-Coos Bay estuary cluster, including major ecological reserves and oyster and fisheries industries. This links NANOOS' estuarine network with NOAA's NERRS network, co-managed by OR Dept of State Lands (ODSL), a NANOOS participant since our inception. Local shellfish growers use the real-time water quality station data from NVS for several aspects of their business, including nursery tank operations, during grow out, outplant, and monitoring established oyster grounds. The water quality data also serve to document reference conditions for restoration projects such as salt marsh restoration projects[21]. (PI Helms, ODSL)

Our work plan for this objective at the $3M budget level is to sustain estuarine assets. At the $6M level we will replace aging infrastructure and make enhancements. Based on stakeholder input, the NANOOS GC ExCom recommends investments in the following new directions to fill gaps and expand estuarine observations to the central Salish Sea region and add contaminants to Columbia River estuary sampling.

GAP: *Central Salish Sea:* The UW Friday Harbor Laboratories underwater instrument array (Friday Harbor Labs Ocean Observatory, FHLOO), constructed with NSF funding, will soon have data streaming on NVS for policy makers, affected communities, scientists, and the public. Designed to capture daily to inter-annual patterns in oceanographic changes (including OAH), the system continuously monitors micro-plankton using an Imaging Flow CytoBot (IFCB) for species identification, including HAB species. Needed is funding to cover annual costs of keeping the sensors running, calibrated, and the data streaming.

GAP: *Columbia River contaminants:* We propose to expand the established CMOP Columbia River estuary observatory, now integrated into CRITFC, to protect reserved treaty rights through the exercise of the inherent sovereign powers of the tribes. Water quality in the Columbia River estuary is essential to fish and human health. Contaminants from wastewater and potential fuel spills, as well as increasing river and ocean acidity and nutrient levels impact ecosystem health and fisheries. While contaminants are an IOOS core variable, long-term monitoring of contaminants is currently very limited. We propose to enhance selected stations to monitor contaminant-associated parameters (e.g., refined fuels, optical brighteners, and tryptophan-like compounds) relevant to ecosystem health, fisheries, and biological diversity.

Objective 5. Maintain and enhance core elements of beach and shoreline observing. *NANOOS proposes to 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.*

Beaches are an integrated indicator of the effects of climate variability and long-term climate change. This work provides information for mitigation of coastal hazards through observations and analysis of topographic beach profiles, shoreline change, nearshore bathymetry, sea level change, and waves to improve planning and response to coastal hazards, to assist with engineering design, to enhance coastal resiliency, and to track local shoreline change in coastal communities[22]. Our audience is WA and OR natural resource departments, FEMA, USACE, USGS, local government planners, geotechnical engineers, shipping interests and the public. NANOOS' observing effort for this objective is a collaboration between WDOE, DOGAMI, and OSU that focuses on consistent observations between WA and OR for the NVS beach mapping app. These efforts measure bathymetry, topography, bottom character, and sea level.

WA and OR beach and shoreline: These efforts document beach and shoreline morphodynamics, yield an improved awareness of the spatial and temporal response of beaches to major winter storms and

climate events, and provide information being used by state agencies to assist with coastal resource management, coastal geotechnical consultants for a range of projects, federal agencies such as FEMA for coastal flood inundation and erosion mapping, the USACE for regional sand management adjacent to navigable waterways, and the public. Monitoring to-date has yielded a combined 23-year time series (one of the longest in the world) of change information, facilitating many new investigations, including basin-scale comparisons of climate effects with similar beach datasets collected by researchers around the Pacific.

In WA, beach monitoring along the Columbia River littoral cell began in 1997 and was integrated with NANOOS in 2004. This work directly supports NANOOS priorities of coastal hazards and climate change with strong links to maritime operations of navigation through coastal inlets. Monitoring components include geodetic control, topographic beach profiles, sediment size distributions, topographic 3D beach surface maps, and nearshore bathymetry. Beach monitoring is performed using a variety of Real-Time Kinematic Differential Global Positioning System (RTK-DGPS) surveying techniques. (PI Kaminsky, WDOE)

In OR, with funding from NANOOS, DOGAMI implemented a beach monitoring program on the northwest OR coast in 2004 with the goal of documenting seasonal, interannual (storm- and El Niño-induced) and long-term (sea level rise and changes in storm frequency/magnitude due to climate change) responses in beach and shoreline morphodynamics[23]. Measurements are undertaken using RTK-DGPS and consist of cross-sections and datum-based shorelines. These data are used by state and federal coastal resource managers, university researchers, geotechnical consultants, and the public-at-large. (PI Allan, DOGAMI)

Through coordination provided by NANOOS, the OR beach monitoring has used the same techniques as those in WA, an approach that is capable of accurately documenting seasonal, interannual, and long-term changes[24, 25]. With additional NANOOS and other leveraged funding, DOGAMI expanded beach and shoreline monitoring to 178 permanently maintained NANOOS sites, 410 sites established for FEMA coastal flood hazard inundation mapping, and 86 sites observed ad hoc, including monitoring potential effects of wave energy arrays (Oregon Wave Energy Trust), Snowy Plover dune restoration (USFWS), landslide changes (ODOT/FHWA), and erosion control and engineering design at MCR (USACE). See letters by OR Coastal Management Program and Emergency Volunteer Corps of Nehalem Bay (Appendix).

WA and OR nearshore bathymetry: This component of NANOOS will remain focused on maintaining the nearshore bathymetric component of both the WA and OR beach and shoreline monitoring efforts in cooperation with DOGAMI and WA DOE. NANOOS-supported nearshore bathymetric observations document interannual to long-term changes in nearshore morphodynamics and identify coastal hazards information critical to state and federal coastal resource managers, geotechnical consultants, and the public. Annual nearshore bathymetric surveys are conducted using a PWC-based Coastal Profiling System from ~MLLW out to water depths greater than 10 m at selected sites in OR and WA. The purpose of our collective efforts is to document the seasonal-interannual-decadal changes in beach, shoreline, and nearshore morphodynamics and produce coastal hazard products on the NVS beach app, a critical source of information for improving coastal hazard mitigation along PNW coastlines, supporting US Army Corps' Regional Sediment Management; Oregon Wave Energy Trust's ocean wave energy conversion projects; FEMA flood mapping activities; and coastal hazards climate change research. (PI Ruggiero, OSU)

Our work plan at the $3M budget level sustains this bi-state network of beach, shoreline, and bathymetry monitoring efforts in collaboration with the WA and OR state agencies. Based on stakeholder input, the NANOOS GC ExCom recommends additional investments to address the following two gaps.

GAP: *Coastal Bluffs:* Presently, we are unable to adequately account for bluff erosion. At the $6M level we will expand our monitoring to document change on coastal bluffs, using a sophisticated Terrestrial Laser Scanning (TLS) system. Processing of these data will enable us to generate higher resolution change information that would complement existing data products and stakeholder needs.

GAP: *Puget Sound:* We would expand beach monitoring to Puget Sound collecting nearshore bathymetry and beach topography along selected beaches to characterize the temporal and spatial scales of nearshore

processes and morphology change. The results are intended to fill a critical knowledge gap in understanding methods, rates, and patterns of sediment supply to Puget Sound beaches and how these processes affect their physical structure and ecological function. The effect of sea-level rise is expected to significantly vary depending upon the setting and type of human intervention; thus, this enhancement is critical for addressing the regional effects of climate change on beaches and nearshore ecosystems.

iii. Modeling and Analysis Subsystem: NANOOS will focus on numerical modeling and analyses to enable now-cast and forecasting capabilities, with efforts serving NANOOS user applications (Table 1).

Objective 6. Provide sustained support to a community of complementary regional numerical models. *NANOOS proposes to 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 EEZ in both OR and WA, with strategic improvements to capabilities and scope, including new forecasts for waves.*

Currently, NANOOS supports several forecast models with output on NVS with the ability for users to switch between models, as well as to use a built-in "comparator" to compare models with observing data in real-time. NANOOS supports: 1) **LiveOcean** (PI MacCready, UW) in coastal WA, OR, BC, and the Salish Sea; 2) **OSU ROMS** (formerly Alex Kurapov, NOAA; now PI Zaron, OSU) in coastal WA and OR; and 3) **CMOP Columbia** (formerly Antonio Baptista, OHSU; now PI Seaton, CRITFC) in the Columbia River estuary and shelf. These regional-scale models each have output products actively used by stakeholders and together make a comprehensive package for NANOOS. LiveOcean includes biogeochemical fields in addition to circulation, used for investigation of OA, hypoxia, and HABs by shellfish growers and resource managers. CMOP Columbia is used for fish habitat and sediment forecasting in the estuary by CRITFC and other fisheries managers. OSU ROMS is run with data assimilation to resolve currents that are key information for the specialized Tuna Fishers NVS app. NANOOS also serves model output from researchers not supported directly by NANOOS. This includes biogeochemical model output from Canada's **Salish Sea Cast** (Susan Allen, UBC) and seasonal forecast **J-SCOPE** biogeochemical model (Samantha Siedlecki, U Conn). NANOOS will soon be serving PNNL's **Salish Sea** and **Columbia River estuary** models (Tarang Khangaokar, PNNL/UW), developing an oil spill trajectory app for the Salish Sea model.

Our work plan for this objective at the $3M budget level is to support the continued operation of the NANOOS-supported models and maintain serving our partners' model outputs. At the $6M level we will enhance each of the NANOOS-supported models and add coastal wave forecast modeling for the Columbia River bar area, a major regional shipping conduit. NANOOS' suite of forecast models addresses PNW user needs, is responsive to IOOS National Modeling Strategy, fulfills some goals of NOAA's Ecological Forecasting Roadmap, and leverages IOOS COMT and the NOAA West Coast Ocean Forecast System (WCOFS), which involves NANOOS PIs. NANOOS' current ability to compare several models, and between models and data, on NVS advances the analysis of coastal model output, as visioned for IOOS[26].

NE Pacific and Salish Sea (LiveOcean): The daily forecast model, LiveOcean, simulates ocean circulation and biogeochemistry in the Salish Sea and in coastal waters of the NE Pacific, including Oregon, Washington, and British Columbia. The model is used for assessment of ocean acidification and hypoxia (OAH), phytoplankton growth and harmful algal blooms (HABs), and is widely used by public health agencies and tribes. The extensions and improvements NANOOS proposes for the next five years are designed to enhance its utility to our stakeholders. We propose to: Develop new nested forecast products for high-value regions such as Willapa Bay and South Puget Sound, where shellfish growing is most common; Improve the treatment of particle remineralization that influences hypoxia in deep basins such as Hood Canal, where fish kills can happen seasonally, with high interest from tribes and state fisheries; Continue improving web access of the model output and data comparisons, developed in collaboration with stakeholders; Extend the daily forecast from 3 days to 7 days to give users more warning; and Perform hindcasts from 2013-present with the new grid, to yield new understanding of, e.g., the effects of the "Blob" marine heat wave of 2014-2016 on the inland waters of the Salish Sea. (PI MacCready, UW).

PNW Coastal Waters (OSU ROMS): OSU ROMS has been a foundational real-time coastal ocean forecast model serving both OR and WA outer coastal waters since the beginning of NANOOS' effort. This system assimilates observations of surface currents from high-frequency (HF) radars, non-tidal sea level from satellite altimeters, as well as satellite sea surface temperature (SST). The system provides forecast updates once a day. SST from the model is the base of the "Tuna Forecast App" in NVS, very popular among commercial and recreational fishermen and crabbers. The NOAA Office of Response and Restoration uses forecast surface currents in environmental hazard response.

In the next funding period, we propose to upgrade the system by including the newest RADS homogenized multi-satellite altimeter product to improve modeled surface geostrophic velocities. We will also investigate the utility of the multi-satellite Level 3 Super-collated (L3S) SST product based on data from 4 satellites (NPP, NOAA20, and two MetOp's; A. Ignatov, NOAA NESDIS). We also plan to investigate whether utilization of the existing HF radar data stream can be improved through assimilation of the measured radial currents, rather than the pre-processed 2-dimensional current vectors. (PI Zaron, OSU)

Relation of NANOOS modeling to WCOFS: NANOOS PIs Zaron and MacCready are part of the WCOFS project and actively compare modeled and observational fields to WCOFS. When WCOFS is fully online, unless WCOFS yields better forecasts (including the location of the SST front, alongshore currents, the thermocline placement, the near bottom currents) than the OSU ROMS model, NANOOS does not anticipate stopping support of OSU ROMS, rather WCOFS will be another tool that stakeholders will have for new products to be developed that depend on a west coast-scale domain, such as for biota movement. The models are fundamentally different, assimilation is based physically on different codes, HF and altimetry data are treated differently, and OSU ROMS uses a more advanced model error covariance. Sustaining OSU ROMS will also allow the modeling community to learn from these differences and advance the science of data assimilation. The smaller and more modular OSU ROMS may serve as the test ground to further improvements in WCOFS.

Columbia River estuary and shelf (CMOP Columbia): CMOP Columbia is a daily forecast model of river-to-shelf circulation in the Columbia River that includes forecasts of estuarine salmon habitat in support of adaptive management strategies for dam operation and fish releases. We propose to enhance the current modeling capabilities in support of the CRITFC information system (CIS), the tribal tool for modeling multiple scenarios of Columbia River System operations under climate change. Additionally, CMOP Columbia will be transitioned to a newer numerical model, SCHISM, which will allow progressive improvements in multiple aspects of the model. Improvements to the Virtual Columbia River will be applied to both a new operational forecast and to the multi-decadal retrospective simulations, and the Climatological Atlas will be updated to incorporate the retrospective simulations. (PI Charles Seaton, CRITFC)

GAP: *Wave Forecasting:* Large swell waves and strong ebb tidal currents co-exist at the Mouth of the Columbia River (MCR), with especially pronounced navigational hazards. The work proposed will sequentially assemble, validate, and transition ocean forecasting systems for Oregon's most important inlets, starting with the MCR and progressing to Newport and Tillamook. The modeling of waves and circulation near navigational inlets involves a nested approach that takes advantage of the wave forecasts for the waters of the Oregon shelf that are provided by an operational WaveWatch III modeling system (now run by the National Weather Service (NWS) Portland and Medford offices). These wave forecasts will form the outer boundary condition for the nested inlet model domains. As the tidal currents are important for wave forecasting in these areas, we will also utilize either existing circulation model results (e.g., for the MCR) or set up our own ROMS modeling system for the currents, as needed. All forecast results will be made available to the public via the NVS, and specialized products will be produced for stakeholders, e.g., the Columbia River Bar Pilots. Finally, the modeling setup and codes will be made available to the NWS to enable a transfer of the operational forecasting to their local offices. (PI Ozkan-Haller, OSU)

iv. Data Management and Cyberinfrastructure (DMAC) Subsystem: NANOOS will continue its ongoing DMAC work to maintain and extend a system that delivers IOOS compliant data sets, data services, tools, and products to regional, national, and international stakeholders. This system provides the foundation upon which tailored web and user products are developed and distributed. We continue to work closely with partner RA's and the IOOS program office to leverage ongoing work, contribute to the maturation of the IOOS DMAC enterprise, and meet IOOS/DMAC requirements. NANOOS DMAC is managed and operated by a distributed, collaborative team: Tanner (UW), Seaton (CRITFC), Risien (OSU), Allan (DOGAMI). Our strategic DMAC work plan, to be evaluated annually, focuses on sustaining ($3M budget) and expanding ($6M budget) work per our Data Management Plan (Appendix), as well as the user-facing web and products suite, including the integrated and thematically customized NVS framework.

NANOOS and PacIOOS are beginning to share DMAC expertise, exploiting the power of both groups to satisfy the needs of each other. These two RAs evolved differently to meet their users' needs and to adapt to their data streams. A larger percentage of data PacIOOS serves its users is generated by PacIOOS and relies more on models than observations to serve their larger domain. This has led to PacIOOS investing early in ERDDAP. NANOOS has a highly diverse suite of observational data that it serves from a variety of data providers, which led to development of a more specialized NANOOS database to make user product development more efficient and customizable. Both RA DMAC groups see synergies that will fill needs and go beyond the sum of the parts. PacIOOS will share ERDDAP and THREDDS and other standardized data management expertise. NANOOS will continue to serve ocean acidification data collected in the Pacific Islands and beyond into the Global Ocean Acidification Observing Network (GOA-ON) data portal. In addition, NANOOS will share expertise on user product development, specifically for a climatology app. Initially, PacIOOS will work with NANOOS to improve archiving and data serving procedures and NANOOS will work with PacIOOS to optimize a global wave climatology specific to their region.

Objective 7. Maintain, harden, and enhance NANOOS' DMAC system for routine operational distribution of data and information. *NANOOS will sustain and enhance the DMAC system developed over the last decade, including the NANOOS Visualization System (NVS), for dynamic and distributed data access and visualization*. We will sustain and enhance our DMAC information system, and the regional Data Assembly Center (DAC) that supports it, linked to the IOOS Enterprise, in the following areas:

Mature Regional DAC Operations: NANOOS will continue its regular strategic assessment of current and future needs for DAC operations, to sustain, refresh, and enhance a highly available, robust, distributed hardware and software environment; maintain appropriate staffing and team coordination; and maintain up-to-date operations and system documentation to ensure transparent and clear descriptions of DAC architecture. This includes replacing aging infrastructure and transitioning from legacy MATLAB functions to version-controlled Python scripts. During this process, NANOOS will conduct a study of the risks and opportunities associated with moving elements of the NANOOS Cyberinfrastructure to the cloud. This could be running numerical models in the cloud, serving data or model results via the cloud, providing disaster recovery options beyond current protocols for storing important files in different seismic zones (see NANOOS Data Management Plan, Appendix), or moving operational infrastructure (TWR dockservers or HF Radar servers) to the cloud. NANOOS already tracks usage broken down by app for our use; we will make these metrics publicly available. We will expand the use of applications such as Google Analytics, Nagios, Prometheus and Grafana to monitor and publish metrics on system servers, data servers (e.g., THREDDS and ERDDAP), data flows and processing, as well as web services and NVS applications. We will support the ingestion, processing, and data delivery of all NANOOS supported observing assets and the distribution of our numerical model results via THREDDS. We will expand engagement of local, non-NANOOS funded data providers, integrating their data into NVS and ERDDAP, assisting with data management and workflows where possible. DAC capabilities and efficiencies will be strengthened through partnerships with state agencies, municipalities, tribes, and industry. NANOOS will deliver, via ERDDAP,

IOOS Metadata Profile v1.2 compliant data sets from all NANOOS funded observing assets during our current funding cycle. These data sets will include an initial set of Quality Assurance of Real Time Oceanographic Data (QARTOD) test results. Through this data delivery system NANOOS will transmit data to NDBC and the WMO GTS. We propose next to include data from non-NANOOS funded partners and data sets, with required and recommended QARTOD test results. NANOOS DMAC will continue to support the submission of data to the IOOS Glider and HF Radar DACs and will work with PIs on NCEI data archiving, including automated archiving of near-real time data and intermittent archiving of verified data.

NVS Support and Development: The user-friendly NVS data discovery, access, and visualization application framework serves a central and critical role in NANOOS' service to its stakeholders. The NANOOS DAC will maintain NVS support as one of its central roles, 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. DMAC support will cover more complex data types, including profilers, drifters, and gliders, the delivery of data beyond the current 60-day limit and the visualization of QARTOD test results. A Citizen Science data service registration and access service will integrate with NVS to manage public and private sector stakeholders' contributions of their own data sets.

Engagement in National and Cross-regional DMAC Efforts: NANOOS will continue to actively participate in IOOS DMAC community development activities, including QARTOD, vocabulary management and semantic mapping, climatology data development and dissemination, unstructured model grids, and collaborative code development and testing via Github and other channels. NANOOS DMAC will sustain its collaborations with West Coast RA DMAC teams, via the West Coast Ocean Data Portal, IPACOA, and other efforts. We will proactively leverage and interact with marine-DMAC relevant efforts team members are engaged in, particularly the NSF-funded Ocean Observatories Initiative, estuarine and watershed monitoring initiatives, international ocean acidification monitoring activities and Canadian collaborations.

Objective 8. Continue to deliver existing and create innovative and transformative user-defined products and services for PNW stakeholders. *Continue our NVS innovation to succeed in this vital translation: meaningful and informative data products that connect with user applications and serve society* [27, 28]. The NANOOS web and products team (PI Tanner, UW; NANOOS User Products Chair Allan, DOGAMI), will continue to enrich the NANOOS web interface, NVS, user products, and visualization and data discovery tools. Our work plan for this objective, described below, will be re-evaluated and prioritized annually by the Tri-Com based on user feedback, GC and PI input, and outreach results for regional priorities. Feedback will also be derived from enhanced in-page web-tracking capabilities using Google Analytics to better understand the needs of our users and the content they use the most.

Web Site: Web content relevant to stakeholder issues, especially those related to Maritime Operations[29], Ecosystem Assessment[3, 30], Fisheries & Biodiversity[31], Coastal Hazards[28, 32], and Climate, will continue to be evaluated and updated as new information/issues become available. Our flexible framework has proven an effective and cost-efficient approach for making information quickly available, responding to events and stakeholder needs as they appear[28]. Aided by investment in an advanced search and discovery web app we recently developed, users can interactively select assets and variables for data searching and viewing.

NVS Improvements: NANOOS stakeholders have highlighted new capabilities they desire, including access to geospatial information (e.g., bottom habitat, fishery information), model query and animation, and user notification capabilities. With the rapid growth in geospatial data compiled by state and federal agencies founded on proprietary platforms (e.g., Esri ArcGIS) and a corresponding need by stakeholders (e.g., fishers) to access these data, NANOOS is well placed to expand its web-mapping capabilities. We intend to explore new capabilities within NVS needed to integrate a variety of existing geospatial formats (e.g., WMS, WFS) to enable unfettered access to various habitat, fishery, and biodiversity geospatial overlays. Development of this effort will reflect collaboration with state coastal management programs. NANOOS provides existing capabilities to query model data at user-defined locations, yet this capability is

not uniform across the NVS enterprise. We propose to standardize this practice across all model overlays, while exploring new approaches for animating model forecasts. With the growing need for real-time information and conditional thresholds for undertaking critical job-related activities, NANOOS will develop new notification capabilities to be integrated across various platforms. Current investment has enabled this capability to be successfully developed for our TsunamiEvac smartphone app[33], which pushes notifications to the public from the national Tsunami Warning Center. Expansion of this capability into other web apps will allow users (e.g., shellfish growers) to receive notifications when measured values fall outside a specified range, which can be broadcast via email, text, or mobile applications.

Visualization Tools: Our scientific community has long requested improved plotting capabilities to allow comparisons between multiple variables and across multiple assets. To address this, NANOOS proposes to initiate development of multi-variable plotting capability allowing users to evaluate several assets and variables within a single plot. Additional plotting capabilities will be developed to address model data, including plotting depth vs. time, depth vs. value, and a transect plotting tool designed to allow users to interactively query 3D models. The user will be able to draw transects on a map in NVS, with plots from the model output generated. Recognizing many of our assets measure conditions throughout the water column, a unified depth tool will be developed to allow users to evaluate and interact with depth related information. This new capability will be similar to how the NVS timeline currently functions, by providing a consistent manner for viewing and interacting with variables over both depth and time. Once the depth control is functional, we will add new depth layers to appropriate overlays. Finally, to facilitate implementation of our DMAC plan, we will commence development of approaches for visualizing QARTOD results for NVS asset time series. As we move to expand and enhance our ERDDAP data capabilities (Objective 7), we will modify our NVS framework to extend our time series data beyond the current 60 days shown on NVS.

Tailored Product Development: NANOOS annually evaluates priorities at the Tri-Com meeting, based on outreach feedback, regional issues, GC, and PI input. High-priority products are introduced here, though we will regularly adapt this plan. A major focus will be implementation of a fully operational particle tracker for predicting oil spill trajectory and search and rescue based on a prototype tool expected to be completed early in the next funding cycle. As society becomes increasingly reliant on mobile technologies for their information needs, NANOOS is well-placed to commence development of new smartphone applications that can be tailored to specific stakeholder groups. NANOOS will implement significant improvements to its NVS mobile app, specifically, to enhance the user experience when viewing time series data, add new capabilities to visualize model and remotely sensed overlays, while also allowing for user customization to save assets and overlays as favorites. NANOOS continues to receive requests for inclusion of data collected by citizen scientists across the region. We propose to develop a new citizen science web-based application that will allow for assimilation of several new data streams. These include proposed efforts to establish a regional community of high schools and fishers who will build and deploy satellite tracked drifters and to observe near real-time changes in temperature and dissolved oxygen sensors mounted on fishing crab gear and distributed across the shelf, and use of fishing vessels of opportunity to attach sensors to fishing gear in order to profile the water column as the gear is deployed and retrieved.

Pan-Regional Products: The West Coast IOOS RAs (NANOOS, CeNCOOS, and SCCOOS) share the responsibility of providing high-quality data and information to stakeholders within the California Current Large Marine Ecosystem. As such, we have a history of partnering on pan-regional ocean observing and product development in support of regional priorities articulated years ago by the West Coast Governors Alliance on Ocean Health and more recently, the Pacific Coast Collaborative (PCC) and the West Coast Ocean Alliance (WCOA). At the global level, the West Coast RAs have collectively contributed to major initiatives, such as the Global Ocean Observing System (GOOS), Global Ocean Acidification-Observing Network (GOA-ON), OceanObs'19, and the UN Decade of the Oceans. NANOOS plans collaborations with several IOOS RAs and with CIOOS-Pacific (Letter, Appendix) to develop user-products of common interest.

Through informative and user-friendly infographics, and compelling narratives, we will distill complex relationships, trends, and indicators into an interactive digital format and build on pan-regional expertise.

With CeNCOOS, SCCOOS, and AOOS, we will develop a new user-friendly portal, the "Oyster Dashboard," to be customizable by RA and site incorporating data, model output, or content tailored to the area and user group. This builds off a previous proposal with CeNCOOS, with interest from CIOOS-Pacific. The modular design of NVS allows customization by each RA; we will build in new features for ease of use. This continues the interaction we have on OA and shellfish growers via the IPACOA project. We propose to develop a Maritime Operators app on the scale of the Pacific for AOOS, the west coast (NANOOS, CeNCOOS, and SCCOOS), and across to PacIOOS. We receive positive feedback from users on our NANOOS NVS Maritime Ops app and we want to leverage that success to work with the other RAs to assess needs for expansion of scale and new features that satisfy the broader user community they represent. We plan to develop a Climatology app with PacIOOS, who wants an app for model output in particular. Our NANOOS NVS Climatology app currently has this ability and we propose to expand and adapt this for PacIOOS, with some possible Pacific-scale applications.

NANOOS joins SCCOOS and CeNCOOS in proposing to establish a unified West Coast acoustic receiver network allowing pan-regional observations of coastal shark movement to be shared. As budget allows, we anticipate developing a new portal that will allow for assimilation of these data, while recognizing the unique roles of the West Coast RAs. Similarly, our proposal to establish a West Coast Ocean Sound Observation Network will leverage existing and historic passive acoustic monitoring infrastructure and expertise to establish a new partnership for coordinated sound monitoring and standardized sound data product generation to track marine mammals and vessels, as well as geological hazards.

v. Engagement Subsystem:

Objective 9. Sustain, diversify, and strengthen NANOOS engagement. *NANOOS proposes to continue ongoing engagement with diverse stakeholders and the public; to engage more audiences in observations, increasing ocean awareness and literacy; to expand and 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 was constructed. Additionally, we will work with the IOOS Program Office, IOOS Association, and other RAs to increase the diversity of the IOOS workforce pipeline and access to ocean, coastal and Great Lakes data and information by underserved or underrepresented communities.*

NANOOS leverages its history of effective stakeholder engagement gaining user input on NANOOS' vision and products through sustained and meaningful interaction[3, 28]. We propose to build from and strengthen our ongoing Engagement efforts. In coordination with other regional efforts, NANOOS will facilitate informed use of our products with targeted user groups, decision-makers, and the public to foster greater ocean literacy. NANOOS commits to broadening our engagement to diversify our audience and our partners engaged in observing, including the fishing industry, citizen scientists, and students. Our strategic work plan will be to sustain the three efforts below ($3M budget) and further enhance efforts, including addition of a NANOOS Internship ($6M budget). Our work plan will be evaluated annually.

Product Co-Development: The primary mission of the user-driven NANOOS is to provide PNW stakeholders with ocean data, tools, and information they need to make responsive and responsible decisions. To do this, NANOOS identifies and meets user needs for product development (Objective 7) within our priority topical areas through a user engagement lens[3]. For new products, Engagement staff provide a connection between NANOOS DMAC and product development staff and users by engaging them in focus groups, targeted interviews, or surveys. These interactions garner initial input, solicit feedback on products as they are developed, and assess ease-of-use or desired improvements to the final products. This iterative development was used for the NVS Tsunami App[33] and several others[28].

To engage users in accessing and using NANOOS products in a manner appropriate to their needs, we seek out opportunities to reach targeted user groups for whom over time we have developed a user-specific NANOOS apps, including fishers, shellfish growers, boaters, surfers, beach users, maritime operators, climate scientists, coastal managers, and the public seeking forecasts for the coastal sea or to avoid tsunamis. We benefit from years of experience presenting and exhibiting at user group meetings, submitting articles to user group publications (annual recreational fishing regulation publications, industry newsletters, etc.), and providing hands-on trainings. These activities have proven effective for recruiting diverse groups as users of NANOOS products and tools. A metric of success is that NANOOS previously requested most engagement opportunities, but now groups are reaching out to invite us to provide regular NANOOS user product trainings for their communities. Engagement efforts are critical to reach new potential users at a grassroots level and inform about NANOOS and what we can offer. We propose to continue such practice to reach new communities.

NANOOS has valued working with PNW coastal tribes as co-PIs, GC members, and collaborators. For example, the Quinault Indian Nation (QIN) and (former partner) OHSU adapted the Columbia shelf glider for hypoxia assessment, with QIN vessel support. OSU now partners with CRITFC on this glider operation, still in coordination with QIN. The South Slough NERRS maintains a water quality station in partnership with the Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians for informing their shellfish harvest. Our new CRITFC partner is a tribal organization that coordinates resource management policy for the Yakama, Warm Springs, Umatilla, and Nez Perce tribes in the Columbia River basin. We will leverage these relationships to further engage Native American communities. Through the integrative life cycle of salmon, ocean conditions are important to the interests of the tribes throughout the Columbia River basin. The Future of Our Salmon (FOOS) conferences are hosted by 15 US tribes and 17 Canadian First Nations of the Columbia Basin and serve to build consensus across tribes toward a unified vision of salmon restoration in the Columbia River. The 2023 FOOS conference will focus on estuary and ocean influences and provide an opportunity to connect the regional ocean and estuary research community with tribes of the Columbia Basin, through an associated technical workshop supported by NANOOS, if budget allows.

Lastly, coordination is essential to meet NANOOS' mission as a user-driven RA, requiring facilitation of two-way engagement between end-users and NANOOS for product development. We use weekly Tri-Com tag-up calls to bring user feedback to DMAC and User Products staff, working collectively to find solutions to optimize the NANOOS user experience. The Tri-Com evaluates the website and product suite annually.

Diversity, Equity, and Inclusion: While NANOOS partners with traditional groups fostering ocean literacy (WA and OR Sea Grants, South Slough and Padilla Bay NERRS, NW Aquatic & Marine Educators (NAME), Ocean Inquiry Project, Salish Sea Expeditions, Seattle Aquarium, Port Townsend Marine Science Center, NOAA OCNMS and NOAA NWFSC) from whom we enjoy periodic invitations for outreach opportunities, we recognize this is reaching a small and predictable segment of society. NANOOS will 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 new (2020) NANOOS "Enabling Change" working group, made up of NANOOS staff and partners (currently federal, university, and state agency) will move forward with two actions. The first will be to assess NANOOS' ability to partner with existing internship programs (e.g., Dr. Nancy Foster Scholarship Program), who have established connections with underrepresented communities in oceanography, with the goal of hosting a summer intern during years 3-5 of this award (see Milestones Schedule). The second is to engage with the Seattle Technology Access Fund (TAF), OSU's Science and Math Investigative Learning Experiences, Northwest Indian College, and others to facilitate the use of ocean observing data and NANOOS products to support STEM education especially for underserved communities of Black, Indigenous, & People of Color. NANOOS provides a clearinghouse of

applicable learning resources and lesson plans. We will build upon this suite of learning tools, real-time data lesson plans. and other education materials, incorporating curricula developed by other ocean literacy groups in the region (listed above) and input from teachers and STEM program managers.

Education is only one way to reach underserved and underrepresented communities. We also plan to engage a broader spectrum in our active observations. Target groups are citizen scientists on the coast (Marine Reserve project), the fishing industry (Crab pot and Fishing gear projects), and students (Drifter project). We plan to develop a citizen science repository, enabling citizen scientist- and student- collected data to become part of NANOOS' portal. This would include metadata requirements and material explaining the importance of metadata and data standards for ocean monitoring, thus introducing and emphasizing to citizen scientists at all ages and levels how FAIR data practices improve equity in ocean data access.

Communication: Communicating our impact is essential to increase the public's understanding of and support for NANOOS and IOOS and the benefits of an ocean observing system for our region and nation. We will work to keep the NANOOS web portal content fresh and current, maintain up-to-date success stories shared via nanoos.org and IOOS, and employ effective use of social media through Facebook, Twitter and our blog. We will be responsive to regional and local events (e.g., harmful algal blooms, marine heat waves, hypoxia, floods, etc.) by highlighting "from-the-field" stories from NANOOS members and partners to enhance the public's understanding of these events and the relevance of NANOOS efforts to improved monitoring, prediction, and response to these events. We maintain strong connections with regional and national media, including from Canada, to inform wider audiences about ocean conditions. We will support national communication through IOOS Program Office and IOOS Association collaborations.

E. Milestone Schedule

Our NANOOS Milestone Schedule shows how we plan to sustain effort across the five subsystems to meet our nine objectives, providing ocean observations and information to the PNW over the next five years. Specifics detailing our Y1-5 milestones, key products, deliverables, and outcomes are provided in Table 2. Because our goal is to sustain this service, many of the specific milestones span all five years.

F. Project Budget

We submit a five-year, $30M budget designed to sustain and enhance NANOOS, presented below by funding category. We also detail our $30M budget in Table 3 broken out by subsystem elements; these subsystem element costs can then be cross-linked with our NANOOS Effort vs. Application Map (Table 1) and Milestone Schedule (Table 2), which use the same categories. A $15M budget showing NANOOS' prioritized efforts (aka Tier 1) is shown in Table 4. Lastly, the $30M budget broken out by sub-award partners and their tasks is presented in Table 5. Further details are explained in the Budget Narrative, including partner Budget Justifications (all in the Appendix).

	Year 1	Year 2	Year 3	Year 4	Year 5	**Total**
Personnel & Benefits	1,138,837	1,277,401	1,273,218	1,276,010	1,273,109	**6,238,575**
Travel	28,839	46,745	47,285	49,304	49,804	**221,977**
Equipment	227,528	276,975	66,032	236,975	251,269	**1,058,779**
Supplies	61,658	67,625	62,986	88,851	83,517	**364,637**
Services/Contractual	822,062	820,337	821,994	838,279	834,004	**4,136,676**
Indirect Costs	482,599	475,263	472,831	482,927	480,644	**2,394,264**
Subawards	3,156,633	2,959,302	3,179,302	2,951,302	2,951,302	**15,197,841**
NOAA holdback	81,844	76,352	76,352	76,352	76,351	**387,251**
Total	**6,000,000**	**6,000,000**	**6,000,000**	**6,000,000**	**6,000,000**	**30,000,000**

4. APPENDICES

A. List of Abbreviations

AOOS	Alaska Ocean Observing System
ATN	Animal Telemetry Network
AWIPS	Advanced Weather Interactive Processing System
BDC	Berring Data Collective
BIO	Biological Integration and Observation Task Team
CA	California
CeNCOOS	Central and Northern California Ocean Observing System
CIOOS	Canadian Integrated Ocean Observing System
CIS	CRITFC Information System
CMOP	Coastal Margin Observation and Prediction
COMT	Coastal and Ocean Modeling Testbed
CRITFC	Columbia River Inter-tribal Fish Commission
DAC	Data Assembly Center
DMAC	Data Management and Cyberinfrastructure
DOGAMI	Oregon Department of Geology and Mineral Industries
ED	Executive Director
EEZ	Exclusive Economic Zone
EOI	Expression of Interest
EPA	Environmental Protection Agency
ERDDAP	Environmental Research Division's Data Access Program
ExCom	Executive Committee
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FVOP	Fishing Vessels of Opportunity
GOOS	Global Ocean Observing System
GOA-ON	Global Ocean Acidification Observing Network
FHL	Friday Harbor Laboratories
FHLOO	Friday Harbor Laboratories Ocean Observatory
FOOS	Future of Our Salmon
FVOP	Fishing Vessels of Opportunity
GC	Governing Council
GOMLF	Gulf of Maine Lobster Foundation
HABs	Harmful Algal Blooms
HF	High-Frequency Radar
IOOS	US Integrated Ocean Observing System
IPACOA	IOOS Partners Across Coasts for Ocean Acidification
J-SCOPE	JISAO's Seasonal Coastal Ocean Prediction of the Ecosystem
L3S	Level 3 Super-collated
MBARI	Monterey Bay Aquarium Research Institute
MBON	Marine Biodiversity Observation Network
MCR	Mouth of the Columbia River
MEOPAR	Canada's Marine Environment Observation, Prediction, and Response

MLLW	Mean Lower Low Water
MOA	Memorandum of Agreement
NAME	Northwest Aquatic and Marine Educators
NANOOS	Northwest Association of Networked Ocean Observing Systems
NCEI	National Centers for Environmental Information
NDBC	National Data Buoy Center
NERRS	National Estuarine Research Reserve System
NESDIS	NOAA National Environmental Satellite, Data, and Information Service
NGOs	Non-Governmental Organizations
NMFS	NOAA National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPP	National Polar-orbiting Partnership
NPS	National Park Service
NP School	Naval Postgraduate School
NSF	National Science Foundation
NVS	NANOOS Visualization System
NWFSC	NOAA Northwest Fishery Science Center
NWS	National Weather Service (of NOAA)
OA	Ocean Acidification
OAH	Ocean Acidification and Hypoxia
OCNMS	NOAA Olympic Coast National Marine Sanctuary
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ODSL	Oregon Department State Lands
OHSU	Oregon Health & Science University
ONP	Olympic National Park
OOI	Ocean Observing Initiative (of NSF)
OR	Oregon
OSON	Ocean Sound Observation Network
OSU	Oregon State University
PacIOOS	Pacific Islands Ocean Observing System
PCC	Pacific Coast Collaborative
PCSGA	Pacific Coast Shellfish Growers Association
PI	Primary Investigator
PMEL	NOAA Pacific Marine Environmental Laboratory
PNNL	Pacific Northwest National Laboratories
PNW	Pacific Northwest
PWC	Personal Water Craft
QA/QC	Quality Assurance/Quality Control
QARTOD	Quality Assurance of Real-Time Oceanographic Data
QIN	Quinault Indian Nation
RA(s)	Regional Association(s)
RADS	Radar Altimeter Database System
RCOOS	Regional Coastal Ocean Observing System
ROMS	Regional Ocean Modeling System
RTK-DGPS	Real-Time Kinematic Differential Global Positioning System
SCCOOS	Southern California Coastal Ocean Observing System

SCHISM	Semi-implicit Cross-scale Hydroscience Integrated System Model
SST	Sea Surface Temperature
STEM	Science, Technology, Engineering, and Mathematics
TAF	Seattle Technology Access Fund
THREDDS	Thematic Real-time Environmental Distributed Data Services
TLS	Terrestrial Laser Scanning
Tri-Com	NANOOS' Tri-Committee (DMAC, User Products, and Engagement committees)
TWR	Teledyne Webb Research
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UW	University of Washington
UW APL	University of Washington Applied Physics Laboratory
UW Atmos	University of Washington, Department of Atmospheric Sciences
UW Ocean	University of Washington, School of Oceanography
WA	Washington
WCOA	West Coast Ocean Alliance
WCODP	West Coast Ocean Data Portal
WCOFS	West Coast Operational Forecast System
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
WFS	Web Feature Server
WMO GTS	World Meteorological Organization's Global Telecommunication System
WMS	Web Map Server
WOAC	Washington Ocean Acidification Center

B. References

1. Barth, J. A., S. E. Allen, E. P. Dever, R. K. Dewey, W. Evans, R. A. Feely, J. Fisher, J. P. Fram, B. Hales, D. Ianson, J. Jackson, K. Juniper, O. Kawka, D. Kelly, J. M. Klymak, J. Konovsky, P. M. Kosro, A. Kurapov, E. Mayorga, P. McCready, J. Newton, R. I. Perry, C. M. Risien, M. Robert, T. Ross, R. K. Shearman, J. Schumacker, S. Siedlecki, V. L. Trainer, S. Waterman, and C. E. Wingard. 2019. Better regional ocean observing through cross-national cooperation: A case study from the Northeast Pacific. Front. Mar. Sci.6:93. https://doi.org/10.3389/fmars.2019.00093

2. Lindstrom, E., Gunn, J., Fischer, A., McCurdy, A., Glover, L., Alverson, K., et al. 2012. A Framework for Ocean Observing. By the Task Team for an Integrated Framework for Sustained Ocean Observing. Paris: UNESCO. doi: 10.5270/OceanObs09-FOO. http://www.oceanobs09.net/foo/FOO_Report.pdf

3. Iwamoto, M. M., J. Dorton, J. Newton, M. Yerta, J. Gibeaut, T. Shyka, B. Kirkpatrick and R. Currier R. 2019. Meeting Regional, Coastal and Ocean User Needs With Tailored Data Products: A Stakeholder-Driven Process. Front. Mar. Sci. 6:290. doi: 10.3389/fmars.2019.00290 https://www.frontiersin.org/articles/10.3389/fmars.2019.00290/ful

4. Hickey, B., S. Geier, N. Kachel, S. Ramp, P. M. Kosro, and T. Connolly. 2016. Along coast structure and interannual variability of seasonal midshelf water properties and velocity in the Northern California Current System. J. Geophys. Res. Oceans.121(10): 7408–7430. https://doi.org/10.1002/2015JC011424

5. Kosro, P.M., A. Dorkins, and D. Langner. 2012. Mapping the changes in ocean surface currents off the Northwest coast. Sidelights 42(4): 21-23. http://www.mastermariner.org/assets/sidelights_oct2012.pdf

6. Haller, M.C., D.A. Honegger, R. Pittman, A. O'Dea, and A. Simpson. 2019. Real-time marine radar observations of nearshore waves and flow structures from shore-based towers. 2019 IEEE/OES Current, Waves and Turbulence Measurement (CWTM). https://doi.org/10.1109/CWTM43797.2019.8955152

7. Alford, M. H., J. B. Mickett, S. Zhang, P. MacCready, Z. Zhao, and J. Newton. 2012. Internal waves on the Washington continental shelf. Oceanogr. 25(2): 66–79. https://doi.org/10.5670/oceanog.2012.43

8. Newton, J., T. M. Hill, R. A. Feely, J. A. Barth, A. B. Boehm, F. Chan, E. A. Chornesky, A. G. Dickson, B. Hales, G. Hofmann, D. Ianson, T. Klinger, J. Largier, T. T. Pedersen, G. N. Somero, M. Sutula, W. W. Wakefield, G.G. Waldbusser, S. B. Weisberg, and E. A. Whiteman. 2016. Ocean Acidification and Hypoxia Monitoring Network: Tracking the impacts of changing ocean chemistry to inform decisions. California Ocean Science Trust: 7pp. http://westcoastoah.org/wp-content/uploads/2016/02/OAH-Panel-Monitoring-Network-4.1.16-FINAL.pdfP

9. Alin, S. R., R. E. Brainard, N. N. Price, J. A. Newton, A. Cohen, W. T. Peterson, E. H. DeCarlo, E. H. Shadwick, S. Noakes, and N. Bednaršek. 2015. Characterizing the natural system: Toward sustained, integrated coastal ocean acidification observing networks to facilitate resource management and decision support. Oceanogr. 28(2): 92–107. http://dx.doi.org/10.5670/oceanog.2015.34

10. Hickey, B.M, R.M. Kudela, J.D. Nash, K.W. Bruland, W.T. Peterson, P. MacCready, E.J. Lessard, D.A. Jay, N.S. Banas, A.M. Baptista, E.P. Dever, P.M. Kosro, L.K. Kilcher, A.R. Horner-Devine, E.D. Zaron, R.M. McCabe, J.O. Peterson, P.M. Orton, J. Pan, and M.C. Lohan. 2010. River influences on shelf

ecosystems: Introduction and synthesis. J. Geophys. Res. Oceans, 115:C00B17, https://doi.org/10.1029/2009JC005452

11. Burla, M., A. M. Baptista, Y. Zhang, and S. Frolov. 2010. Seasonal and interannual variability of the Columbia River plume: A perspective enabled by multiyear simulation databases. J. Geophys. Res. Oceans 115: C00B16. https://doi.org/10.1029/2008JC004964

12. Harcourt, R., et al. Animal-Borne Telemetry: an integral component of the ocean observing toolkit. 2019. Front. Mar. Sci. https://doi.org/10.3389/fmars.2019.00326

13. Haver, S., Fournet, M.E.H., Dziak, R.P., Gabriele, C., Gedamke, J., Hatch, L.T., Haxel, J., Heppell, S.A., McKenna, M., Mellinger, D.K., Van Parijs, S.M. 2019. Comparing the Underwater Soundscapes of Four U.S. National Parks and Marine Sanctuaries. Front. Mar. Sci. 6, 500, 1-14. https://doi.org/10.3389/fmars.2019.00500

14. Anderson, C.R., E. Berdalet, R.M. Kudela, C.K. Cusack, J. Silke, E. O'Rourke, D. Dugan, M. McCammon, J. Newton, S.K. Moore, K. Paige, S. Ruber, J.R. Morrison, B. Kirkpatrick, K. Hubbard and J. Morell. 2019. Scaling Up from Regional Case Studies to a Global Harmful Algal Bloom Observing System. Front. Mar. Sci. 6:250. doi: 10.3389/fmars.2019.00250 https://www.frontiersin.org/articles/10.3389/fmars.2019.00250/full

15. Chan, F., A. B. Boehm, J. A. Barth, E. A. Chornesky, A. G. Dickson,R. A. Feely, B. Hales, T. M.Hill,G. Hofmann, D. Ianson, T. Klinger, J. Largier, J. Newton, T. F. Pedersen, G. N. Somero, M. Sutula, W. W. Wakefield, G. G. Waldbusser, S. B. Weisberg, and E. A. Whiteman. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major findings, recommendations, and actions. California Ocean Science Trust: 40 pp. http://westcoastoah.org/wp-content/uploads/2016/04/OAH-Panel-Key-Findings-Recommendations-and-Actions-4.4.16-FINAL.pdf

16. Feely R.A., S.R. Alin, J.A. Newton, C.L. Sabine, M. Warner, A. Devol, C. Krembs, and C. Maloy. 2010. The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an urbanized estuary. Estuarine and Coastal Shelf Science 88: 442-449. https://www.sciencedirect.com/science/article/abs/pii/S027277141000185X?via%3Dihub

17. Cai, W-J, Feely, R.A., Testa, J. M., Li, M., Evans, W., Alin, S.R., Xu, Y.-Y., Pelletier, G., Ahmed, A., Greeley, D. J., Newton, J. A., and Bednaršek, N. *in press,* Natural and Anthropogenic Drivers of Acidification in Large Estuaries. Annual Review of Marine Science 2021 13:1 https://doi.org/10.1146/annurev-marine-010419-011004

18. Pool, S., C. Krembs, J. Bos, and B. Sackmann. 2017. Victoria Clipper observations and Noctiluca blooms, p. 27. In S. K. Moore, R. Wold, K. Stark, J. Bos, P. Williams, N. Hamel, C. Krembs, and J. Newton [eds.], Puget Sound marine waters: 2016 overview. NOAA Northwest Fisheries Science Center. https://pspwa.app.box.com/s/hferayhcyzwvcxrao8uohnxjbvjxhpxt/file/253709249820

19. Baptista A.M., C. Seaton, M.P. Wilkin, S. F. Riseman, J.A. Needoba, D. Maier, P.J. Turner, T. Karna, J.E. Lopez, L. Herfort, V.M. Megler, C. McNeil, B.C. Crump, T.D. Peterson, Y. H. Spitz, and H.M. Simon. 2015. Infrastructure for collaborative science and societal applications in the Columbia River estuary. Front. Earth Sci. 9(4):659-682. https://doi.org/10.1007/s11707-015-0540-5

20. Morrice,K., A.M. Baptista, and B. Burke. 2020. Environmental and behavioral controls on juvenile Chinook salmon migration pathways in the Columbia River estuary. Ecological Modeling. https://doi.org/10.1016/j.ecolmodel.2020.109003

21. Raposa, K., K. Wasson, E. Smith, J. Crooks, P. Delgado, S. Fernald, M. Ferner, A. Helms, L. Hice, J. W. Mora, B. Puckett, D. Sanger, S. Shull, L. Spurrier, R. Stevens, and S. Lerberg. 2016. Assessing tidal marsh resilience to sea-level rise at broad geographic scales with multi-metric indices. Biol. Conserv. 204 (Part B):263-275. https://doi.org/10.1016/j.biocon.2016.10.015Ru

22. Baron, H.M., P. Ruggiero, N.J. Wood, E.L. Harris, J. Allan, P.D. Komar, and P. Corcoran. 2014. Incorporating climate change and morphological uncertainty into coastal change hazard assessments. Nat.Hazards 75:2081-2102. https://doi.org/10.1007/s11069-014-1417-8

23. Barnard, P.L., A.D. Short, M.D. Harley, K.D. Splinter, S. Vitousek, I.L. Turner, J. Allan, M. Banno, K.R. Bryan, A. Doria, J.E. Hansen, S. Kato, Y. Kuriyama, E. Randall-Goodwin, P. Ruggiero, I.J. Walker, and D.K Heathfield. 2015. Coastal vulnerability across the Pacific dominated by El Niño/Southern Oscillation. Nat. Geosci. 8: 801-807. https://doi.org/10.1038/ngeo2539B

24. Ruggiero, P., Kaminsky, G.M., Gelfenbaum, G., and Voigt, B. 2005. Seasonal to interannual morphodynamics along a high-energy dissipative littoral cell, Journal of Coastal Research, 21(3), 553-578.

25. Allan, J.C., P. Ruggiero, G. Garcia, F. O'Brien, L. Stimely, and J.T. Roberts. 2015. Coastal Flood Hazard Study, Tillamook County, Oregon. Oregon Department of Geology and Mineral Industries, Special Paper 47: 283 pp. https://www.oregongeology.org/pubs/sp/SP-47.pdf

26. Wilkin J., L. Rosenfeld, A. Allen, R. Baltes, A. M. Baptista, R. He, P. Hogan, A. Kurapov, A. Mehra, J. Quintrell, D. Schwab, R. Signell, and J. Smith. 2017. Advancing coastal ocean modeling, analysis, and prediction for the U.S. Integrated Ocean Observing System. J. Oper. Oceanogr. 10(2): 115-126. https://doi.org/10.1080/1755876X.2017.1322026

27. Risien, C. M., J. C. Allan, R. Blair, A. V Jaramillo, D. Jones, P. M. Kosro, D. Martin, E. Mayorga, J. A. Newton, T. Tanner, and S. A. Uczekaj. 2009. The NANOOS Visualization System: Aggregating, displaying, and serving data. OCEANS 2009 MTS/IEEE BILOXI, Biloxi, MS. http://nanoos.org/documents/key/Oceans09_NVS.pdf

28. Risien, C. M., T. Tanner, E. Mayorga, J. C. Allan, J. A. Newton, M. Kosro, R. Wold, and C. Seaton. 2019. The NANOOS Visualization System (NVS): A decade of development and progress addressing stakeholder needs. OCEANS 2019 MTS/IEEE SEATTLE, Seattle, WA. https://doi.org/10.23919/OCEANS40490.2019.8962588

29. Newton, J., Allan, J., and Tanner, T. 2014. Recent NANOOS contributions to maritime operations and boater traffic, Sidelights, The Council of American Master Mariners, Inc., p. 28-29. http://www.nanoos.org/documents/sidelights/Sidelights_June-Aug2014_NANOOS.pdf

30. Newton, J., D. Martin, E. Mayorga, A. Devol, R. Feely, S. Alin, B. Dewey, B. Eudeline, A. Barton, A. Suhrbier, A. Baptista and J. Needoba. 2012. NANOOS partnerships for assessing ocean acidification in the

Pacific Northwest. Proc. MTS/IEEE Oceans'12,
https://ieeexplore.ieee.org/document/6405086?arnumber=6405086

31. Mayorga, E., T. Tanner, R. Blair, A. V. Jaramillo, N. Lederer, C. M. Risien, and C. Seaton. 2010. The NANOOS Visualization System (NVS): Lessons learned in data aggregation, management, and reuse, for a user application. OCEANS 2010 MTS/IEEE SEATTLE, Seattle, WA.
http://nanoos.org/documents/key/Mayorga-Oceans10-NVSDMAC.pdf

32. Martin, D.L., J.C. Allan, J. Newton, D.W. Jones, S. Mikulak, E. Mayorga, T. Tanner, N. Lederer, A. Sprenger, R. Blair, and S.A. Uczekaj. 2011. Using web-based and social networking technologies to disseminate coastal hazard mitigation information within the Pacific Northwest component of the Integrated Ocean Observing System (IOOS). Proc. MTS/IEEE Oceans'11,
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6107278

33. Allan, J. C. 2020. NANOOS Visualization System Tsunami Evacuation Zones – Ten Years in the Making, TsuInfo Alert, Volume 22, Washington Geological Survey.
https://www.dnr.wa.gov/publications/ger_tsuinfo_2020_v22_no3.pdf?bucobm

C. Figures

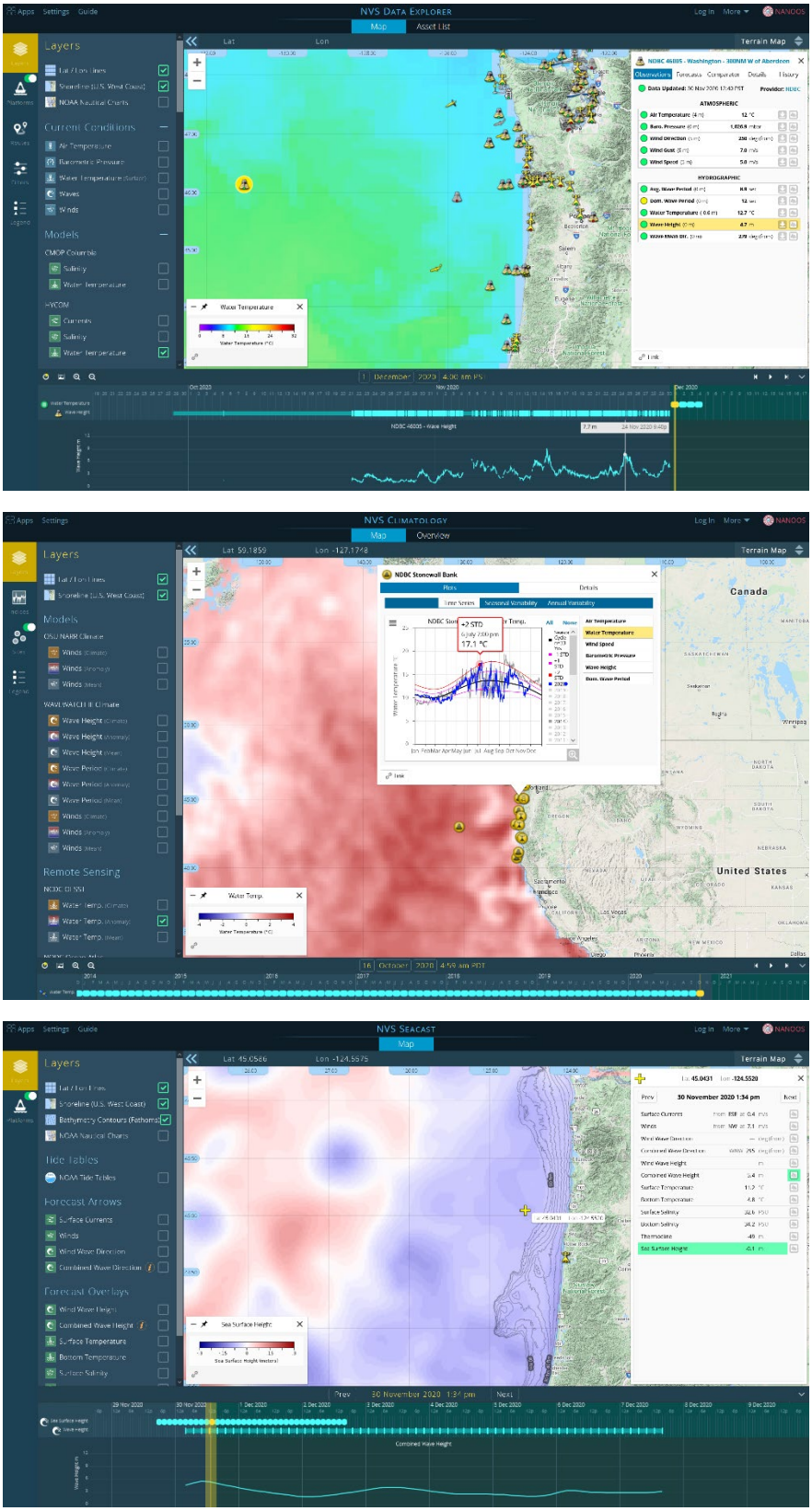


Figure 1: Screenshots of the NANOOS Visualization System (NVS).

The top plot, from the NVS Data Explorer, shows NANOOS assets, highlights a water temperature overlay, and visualizes wave measurements at a buoy. The pop-up shows a variety of real-time values.

The middle plot, from the NVS Climatology app, shows regional water temperature anomaly from remote sensing, plus a time series climatology of water temperature from the Stonewell Bank NDBC buoy.

The bottom plot, from the NVS Seacast app, shows wave conditions (current storm), and pop-up results from a “click anywhere” tool that highlights a variety of observational values where data are available.

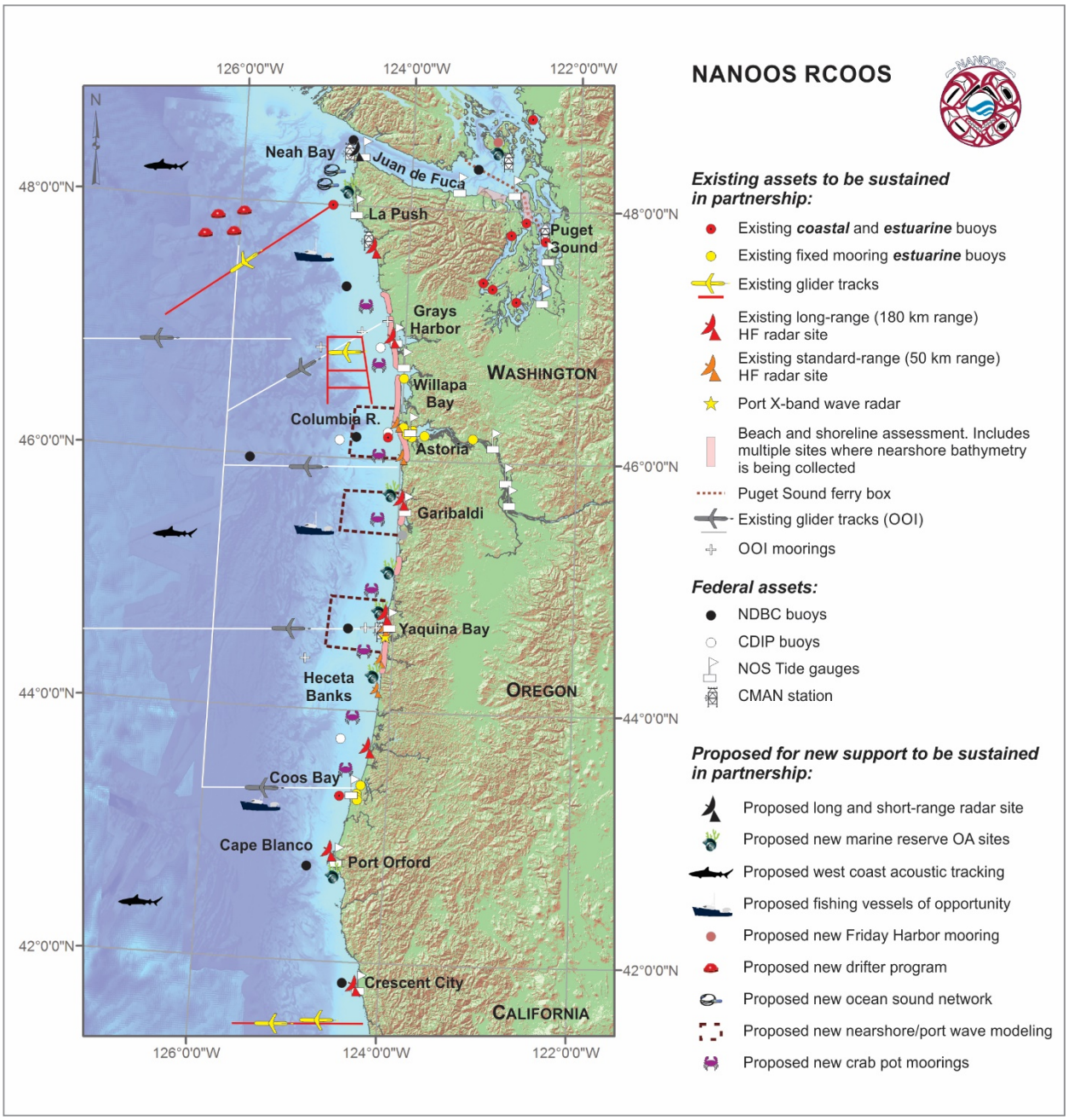


Figure 2: Conceptual design of the NANOOS RCOOS observing subsystem for its implementation years 15-19 (= FY21-25). The original design upon which this current figure is based was conceived by NANOOS stakeholders during numerous NOAA-funded NANOOS workshops during the early 2000s and adopted by the NANOOS Governing Council in 2007. It forms the basis of our Conceptual Design and current operational system. This updated design reflects input from stakeholders, PIs, and users, and is responsive to the EOI process NANOOS used to define its efforts for the next five years. NANOOS and OOI PIs have coordinated a single design that optimizes spatial coverage; we serve OOI data on NVS. The NANOOS RCOOS design's content shown here was approved by the NANOOS Governing Council in August 2020.

D. Tables

Table 1: NANOOS "Effort versus Application" Map for Observing and Modeling. The "Applications" are PNW priorities established by the NANOOS Governing Council over three PNW domains. The "Efforts" represent a mix of sustained (blue) and new (green) investments, with gaps noted.

NANOOS "Effort versus Application" Map for Observing and Modeling

APPLICATIONS: / EFFORTS:	COASTAL OCEAN					ESTUARIES					SHORELINES				
	Mar ops	Ecology	Hazards	Biodivesity	Climate	Mar ops	Ecology	Hazards	Biodivesity	Climate	Mar ops	Ecology	Hazards	Biodivesity	Climate
MULTI VARIATE ASSETS															
WA shelf glider line															
Columbia shelf glider tracks															
CA shelf glider line															
WA shelf buoy															
Columbia shelf buoy															
OR shelf buoy															
WA nearshore OCNMS RT		*no coastal nearshore*													
WA nearshore OAH		*no coastal OAH nearshore*													
PNW nearshore hypoxia		*no coastal nearshore; engage fishing industry*													
OR nearshore OAH		*no coastal OAH nearshore; engage citizens*													
Fishing vessel shelf obs		*expand shelf obs; engage fishing industry*													
Shelf drifters		*expand currents; engage students*													
Puget Sound estuary buoys															
Puget Sound estuary ferrybox															
Columbia estuary buoys															
South Slough estuary moorings															
Central Salish Sea cabled OO						*no central Salish Sea*									
Contaminant obs in Columbia						*no contaminant assessment*									
BIOLOGICAL SAMPLING															
Animal tracking			*no animal obs*												
Passive acoustics			*no animal/sound obs*												
HAB observations	*sustain PNW HABs Bulletin*														
SHORELINES															
Washington shorelines															
Oregon shorelines															
PNW bathymetry															
Add coastal bluffs												*no coastal bluff obs*			
Extend to Puget Sound												*no Puget Sound obs*			
SURFACE CURRENTS															
OR/WA coastlines HF															
NW WA coastlines HF	*final WA HFR*														
Port wave band imaging X-band															
FORECAST MODELS															
PNW circulation forecasts															
Puget Sound circulation forecasts															
Columbia circulation forecasts															
PNW biogeochem forecasts															
Puget Sound biogeochem forecasts															
Columbia estuary habitat forecasts															
Wave forecasts for navigational inlets	*no forecast*		*no forecast*		*no forecast*	*no forecast*		*no forecast*		*no forecast*	*no forecast*		*no forecast*		*no forecast*

KEY:	*Italicized efforts indicate new investment*		
	Currently directly supports	Proposed to directly support	Not applicable
	Currently indirectly supports	Proposed to indirectly support	*no …* Text explains the current gap the proposed activites fill

Table 2: Milestone Schedule for NANOOS Years 15-20 (FY21-26)

Area	Y1	Y2	Y3	Y4	Y5	Outcomes
Observations: - Assess product development needs with observing system design and how observations are providing valuable information to meet user needs via Tri-Com, GC, PI meetings						
Shelf	- Maintain La Push, Newport, and Columbia R. buoys; deliver data via NVS - Maintain WA, OR, and N CA shelf glider transects; deliver data via NVS - Add new observing efforts to fill NANOOS gaps as funding allows (OAH, ATN, acoustics, drifters, & HABs) - Assure all data QA/QC meets Certification standards					NANOOS provides users real-time and time-series data to assess ecosystem impacts (HABs, hypoxia, and ocean acidification); assimilation / verification to models (circulation and ecological forecasting); climate baseline and assessment.
	- Upgrade Columbia / Trinidad glider parts and sensors	- Upgrade aging buoy infrastructure at WA coast	- Purchase glider for central OR operations		- Purchase glider to bring La Push glider operations to year-round coverage - Identify shelf observing gaps of highest priority to region	
Estuaries	- Maintain Puget Sound, Columbia R., and South Slough estuarine moorings; deliver data via NVS - Add new observing efforts to fill NANOOS gaps as funding allows (Central Salish, Contaminants in Columbia R) - Assure all data QA/QC meets Certification standards					
				- Upgrade aging buoy infrastructure in PS	- Identify estuarine observing gaps of highest priority to region	
Shorelines	- Maintain shoreline observations in WA and OR; deliver data via NVS - Add new observing efforts to fill NANOOS gaps as funding allows (bluffs, Puget Sound) - Assure all data QA/QC meets Certification standards					NANOOS provides users data to assess coastal hazards, shoreline stability, tsunami preparedness, climate change effects.
	- Purchase ground-based Lidar system for shoreline observations				- Identify shoreline observing gaps of highest priority to region	
Currents	- Maintain OR Priority HF radar sites to national standards; deliver data via NVS and the National HF Radar system - Maintain X-band radar sites; deliver data via NVS - Assure all data QA/QC meets Certification standards					NANOOS provides users with data to address maritime operations safety, coastal transport, and climate change effects.
	- Purchase final HF for WA coast	- Install WA HF	- Evaluate Strait of Juan de Fuca HFs with CIOOS		- Identify current and wave gaps of highest priority to region	

Area	Y1	Y2	Y3	Y4	Y5	Outcomes
Modeling: - Assess product development needs with modeling capabilities and how forecasts are providing valuable information to meet user needs via Tri-Com, GC, PI meetings						
Circulation and Biogeochemistry for Coastal Ocean and Estuaries; Nearshore Waves	- Maintain models & forecasts at OSU, CRITFC, & UW - Provide model outputs on NVS - Assure model verification/validation					NANOOS model output for web products (Tuna App for ocean fishers, circulation forecasts for tracking HABs; OA forecasts for shellfish growers); provide forecasts in MCR region.
	- Add OR coastal wave forecasting at Col R mouth (MCR)	- Develop data products from MCR model outputs			- Identify modeling gaps of highest priority to region	
DMAC: - Engage with PacIOOS for optimized DMAC sharing respective strengths for data management and products; Assess DMAC user needs via Tri-Com, GC, PI meetings						
Mature Regional DAC Operations	- Sustain, refresh and enhance hardware and software environment, staffing, and operations documentation - 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					NANOOS applications, NANOOS users and IOOS DMAC system are supported by a mature, reliable regional DAC meeting all core IOOS/DMAC Functional Roles, and actively engaged in local to national partnerships.
IOOS/DMAC Functional Roles and NVS Support and Development	- Sustain & enhance existing data streams, IOOS web services, GTS submission - Implement NCEI 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					
	- Harden and refine web service operations, data distribution, core IOOS/DMAC Function Roles					
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 - Pan regional products with sister IOOS RAs - Engage and leverage OOI, international GOA-ON activities, and Canadian collaborations - Engage with other West Coast and Pacific efforts, including WCGA and IPACOA					
Web Site Improvement	- Improve ease of usability - Improve user tracking capabilities					NANOOS users have reliable and informative access to data and data products, with a, user-friendly interface and services they want.
NVS Improvement	- Build WMS/WFS capabilities	- Build across the board capabilities to query model data		Develop and implement notification capability		
Visualization Tool Improvement	- QARTOD visualization tracking	- Transect plots from modeling	- Multivariate plotting	- Glider data/AIS track	- 3-D visualizations	
Tailored Product Development	- Co-design and develop particle tracking (SAR) app - Co-design and develop user customizable smart phone app - Implement push notifications - Co-design and develop citizen science app					

Citizen Science Data Project	- Advisory Group, identify pilot test groups	- Develop "user data input" capability to private access NVS with pilot test groups	- Launch capacity on public access NVS	- Evaluation and alterations	- Completion	Citizen Science Data can be uploaded to NVS, engaging regional groups and the public.
Pan regional products	- Climatology with PacIOOS; Oyster Dashboard with West Coast/Alaska; Maritime Ops with Pacific region; ATN and Sound coast-wide, and others as funding allows and interest drives					Expertise is shared so communities have consistent user products.
Engagement: - Engage more broadly to fulfill our goals for expanded usage and increased diversity of audience; assess user needs and performance via Tri-Com, GC, PI meetings						
Develop products to meet users' needs	- Maintain production of tailored products for specific user needs, engaging users in co-design and co-development - Gain feedback and conduct user assessment after product release. Periodically revisit to assure continued relevancy					More diverse user communities benefit from NANOOS tools and products for everyday decisions; citizens increase their ocean literacy through interactions with NANOOS; NANOOS efforts enable change in terms of diversity of people involved in ocean observing science and ocean information use.
Engage stakeholders to use NANOOS products	- Conduct trainings to broader user groups and evaluate trainings to optimize NANOOS functionality - Evaluate website and product suite annually; interpret evaluation results discussed at weekly Tri-Com tag-up calls					
Diversify NANOOS audience and engagement	- Work with the NANOOS "Enabling Change" workgroup, IOOS Program Office, IOOS Association, and other RAs to increase diversity of the IOOS workforce pipeline and access to NANOOS data and information by underserved or underrepresented communities; pilot an internship program; engage with underserved schools to use ocean observing and NANOOS products to support STEM education, engage with Future of Our Salmon (FOOS) with CRITFC and tribes					
	- STEM pilot with TAF - Design intern program	- STEM expansion - Solicit for interns - Plan FOOS workshop	- Assess STEM - Summer intern - Support FOOS	- STEM expansion - Summer intern	- STEM expansion - Summer intern	
Communicate our impact	- Maintain up-to-date success stories, employing effective use of social media and newsletters - 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 - Support national communication through IOOS Program Office and IOOS Association collaborations					
Administration and Management: - Provide NANOOS with oversight, coordination, and management of the full suite of activities that comprise NANOOS						
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 - 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					NANOOS has a reliable, accountable, interactive, and representative management structure and operating system.
Representation	- 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					
Project oversight	- Conduct annual all-PI meetings and Tri-Committee meetings, providing clear feedback and direction - Share project evaluation at the annual PI meeting					
Coordination	- 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.)					
Accountability	- Submit required IOOS progress reports and respond to other requests - Attain re-certification in 2023 as the Regional Information Coordination Entity of US IOOS for the PNW					

Table 3: Five-year NANOOS budget FY2021-2025. Italics indicate new investments for NANOOS.

NANOOS Element:	Lead Institution	Lead PI(s)	Y15 FY21	Y16 FY22	Y17 FY23	Y18 FY24	Y19 FY25
Observations:							
WA shelf glider line	UW APL	Lee	$ 180,000	$ 180,000	$ 180,000	$ 180,000	$ 400,000
Columbia shelf glider tracks	CRITFC/OSU	Seaton/Barth	$ 280,000	$ 180,000	$ 180,000	$ 180,000	$ 180,000
CA shelf glider line	OSU	Barth	$ 90,000	$ 90,000	$ 310,000	$ 90,000	$ 90,000
WA shelf buoy	UW APL	Curry	$ 186,000	$ 406,000	$ 186,000	$ 186,000	$ 186,000
Columbia shelf and estuary buoys	CRITFC	Seaton	$ 240,511	$ 240,511	$ 240,511	$ 240,511	$ 240,511
OR shelf buoy	OSU	Kosro	$ 222,000	$ 222,000	$ 222,000	$ 222,000	$ 222,000
WA nearshore OCNMS RT	*UW APL*	*Mickett*	$ 62,000	$ 62,000	$ 62,000	$ 62,000	$ 62,000
WA nearshore OAH	*NPS*	*Fradkin*	$ 36,200	$ 36,200	$ 36,200	$ 36,200	$ 36,200
PNW nearshore hypoxia	*OSU*	*Shearman*	$ 115,000	$ 115,000	$ 115,000	$ 115,000	$ 115,000
OR nearshore OAH	*OSU*	*Chan*	$ 64,450	$ 64,450	$ 64,450	$ 64,450	$ 64,450
Fishing vessel shelf obs	*BDC*	*Van Vranken*	$ 52,210	$ 52,210	$ 52,210	$ 52,210	$ 52,210
Shelf drifters	*NOAA*	*Manning*	$ 70,000	$ 67,200	$ 67,200	$ 59,200	$ 59,200
Puget Sound estuary buoys	UW APL	Curry	$ 316,000	$ 316,000	$ 316,000	$ 536,000	$ 316,000
Puget Sound estuary ferrybox	WDOE	Krembs	$ 36,000	$ 36,000	$ 36,000	$ 36,000	$ 36,000
South Slough estuary moorings	OR ODSL	Helms	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000
Central Salish Sea cabled OO	*UW FHL*	*Dethier*	$ 43,293	$ 43,293	$ 43,293	$ 43,293	$ 43,293
Contaminant obs in Columbia	*CRITFC*	Seaton	$ 104,159	$ 104,159	$ 104,159	$ 104,159	$ 104,159
Animal tracking	*OSU*	*Chapple*	$ 76,000	$ 76,000	$ 76,000	$ 76,000	$ 76,000
Passive acoustics	*NOAA*	*Peavey*	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
HAB observations	*UW APL*	Newton/Mickett	$ 359,200	$ 359,200	$ 359,200	$ 359,200	$ 359,200
Washington shorelines	WDOE	Kaminsky	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000
Oregon shorelines *and coastal bluffs*	DOGAMI	Allan	$ 199,932	$ 105,401	$ 105,401	$ 105,401	$ 105,401
PNW bathymetry	OSU	Ruggiero	$ 51,600	$ 51,600	$ 51,600	$ 51,600	$ 51,600
Extend to Puget Sound	*WDOE*	*Kaminsky*	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000
OR/WA coastlines HF	OSU	Kosro	$ 647,000	$ 647,000	$ 647,000	$ 647,000	$ 647,000
NW WA coastlines HF	*UW APL*	Chickadel/Newton	$ 150,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000
Port wave imaging X-band	OSU	Haller	$ 61,200	$ 61,200	$ 61,200	$ 61,200	$ 61,200
			$ 3,974,755	**$ 3,887,424**	**$ 3,887,424**	**$ 3,879,424**	**$ 3,879,424**
Modeling:							
PNW circulation forecasts	OSU	Zaron	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
Columbia circulation forecasts	CRITFC	Seaton	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
PNW circulation and biogeochem forecasts	UW Ocean	MacCready	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
Wave forecasts for navigational inlets	OSU	Ozkan-Haller	$ 143,063	$ 143,063	$ 143,063	$ 143,063	$ 143,063
PNW atmospheric forecasts	UW Atmos	Mass	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000
			$ 605,063	**$ 605,063**	**$ 605,063**	**$ 605,063**	**$ 605,063**
Data Management & Products:							
DMAC UW	UW APL	Tanner	$ 136,500	$ 136,500	$ 136,500	$ 136,500	$ 136,500
DMAC OSU	OSU	Kosro	$ 78,000	$ 78,000	$ 78,000	$ 78,000	$ 78,000
DMAC CRITFC	CRITFC	Seaton	$ 77,656	$ 77,656	$ 77,656	$ 77,656	$ 77,656
Web Devel. & User Products	UW APL	Tanner	$ 327,000	$ 327,000	$ 327,000	$ 327,000	$ 327,000
			$ 619,156	**$ 619,156**	**$ 619,156**	**$ 619,156**	**$ 619,156**
Engagement:							
Engagement & DEI	UW APL	Newton	$ 208,237	$ 208,237	$ 208,237	$ 208,237	$ 208,237
User Products Committee Chair	DOGAMI	Allan	$ 18,000	$ 18,000	$ 18,000	$ 18,000	$ 18,000
Future of Salmon Outreach	CRITFC	Seaton	$ 11,652	$ 11,652	$ 11,652	$ 11,652	$ 11,652
			$ 237,889	**$ 237,889**	**$ 237,889**	**$ 237,889**	**$ 237,889**
Managment:							
NANOOS Management, Contracts, Governance	UW APL	Newton	$ 563,137	$ 650,468	$ 650,468	$ 658,468	$ 658,468
			$ 563,137	**$ 650,468**	**$ 650,468**	**$ 658,468**	**$ 658,468**
			$ 6,000,000	**$ 6,000,000**	**$ 6,000,000**	**$ 6,000,000**	**$ 6,000,000**

Table 4: Five-year NANOOS core budget priority tasks FY2021-2025.

NANOOS Element:	Lead Institution	Lead PI(s)	Y15 FY21	Y16 FY22	Y17 FY23	Y18 FY24	Y19 FY25
Observations:							
WA shelf glider line	UW APL	Lee	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
Columbia shelf glider tracks	CRITFC/OSU	Seaton/Barth	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
CA shelf glider line	OSU	Barth	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000
WA shelf buoy	UW APL	Curry	$ 155,000	$ 155,000	$ 155,000	$ 155,000	$ 155,000
Columbia shelf and estuary buoys	CRITFC	Seaton	$ 200,426	$ 200,426	$ 200,426	$ 200,426	$ 200,426
OR shelf buoy	OSU	Kosro	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000
Puget Sound estuary buoys	UW APL	Curry	$ 180,000	$ 180,000	$ 180,000	$ 180,000	$ 180,000
Puget Sound estuary ferrybox	WDOE	Krembs	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000
South Slough estuary moorings	OR ODSL	Helms	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000
HAB observations	UW APL	Mickett	$ 91,000	$ 91,000	$ 91,000	$ 91,000	$ 91,000
Washington shorelines	WDOE	Kaminsky	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000
Oregon shorelines	DOGAMI	Allan	$ 45,000	$ 45,000	$ 45,000	$ 45,000	$ 45,000
PNW bathymetry	OSU	Ruggiero	$ 43,000	$ 43,000	$ 43,000	$ 43,000	$ 43,000
OR/WA coastlines HF	OSU	Kosro	$ 481,555	$ 481,555	$ 481,555	$ 481,555	$ 481,555
Port wave imaging X-band	OSU	Haller	$ 51,000	$ 51,000	$ 51,000	$ 51,000	$ 51,000
			$ 1,871,981	**$ 1,871,981**	**$ 1,871,981**	**$ 1,871,981**	**$ 1,871,981**
Modeling:							
PNW circulation forecasts	OSU	Zaron	$ 70,000	$ 70,000	$ 70,000	$ 70,000	$ 70,000
Columbia circulation forecasts	CRITFC	Seaton	$ 20,839	$ 20,839	$ 20,839	$ 20,839	$ 20,839
PNW circulation and biogeochem forecasts	UW Ocean	MacCready	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000
PNW atmospheric forecasts	UW Atmos	Mass	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
			$ 140,839	**$ 140,839**	**$ 140,839**	**$ 140,839**	**$ 140,839**
Data Management & Products:							
DMAC UW	UW APL	Tanner	$ 155,000	$ 155,000	$ 155,000	$ 155,000	$ 155,000
DMAC OSU	OSU	Kosro	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000
DMAC CRITFC	CRITFC	Seaton	$ 59,735	$ 59,735	$ 59,735	$ 59,735	$ 59,735
			$ 274,735	**$ 274,735**	**$ 274,735**	**$ 274,735**	**$ 274,735**
Engagement:							
Web Devel. & User Products	UW APL	Tanner	$ 190,000	$ 190,000	$ 190,000	$ 190,000	$ 190,000
Outreach, Engagement & Education	UW APL	Newton	$ 140,000	$ 140,000	$ 140,000	$ 140,000	$ 140,000
User Products Committee Chair	DOGAMI	Allan	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000
			$ 345,000	**$ 345,000**	**$ 345,000**	**$ 345,000**	**$ 345,000**
Managment:							
NANOOS Management, Contracts, Governance	UW APL	Newton	$ 367,445	$ 367,445	$ 367,445	$ 367,445	$ 367,445
			$ 367,445	**$ 367,445**	**$ 367,445**	**$ 367,445**	**$ 367,445**
			$ 3,000,000	**$ 3,000,000**	**$ 3,000,000**	**$ 3,000,000**	**$ 3,000,000**

Table 5: NANOOS Annual and Summary Budgets

NANOOS YR 15-19 PROPOSAL EFFORT DISTRIBUTION BREAKDOWN SUMMARY

YEAR 15

UNIVERSITY OF WASHINGTON - Applied Physics Laboratory:

	APL												UW Other					
Title	Management	DMAC	Products & Web	Engagement & DEI	HABs	WA Shelf Buoy	PS Buoy	La Push Glider	WA HF	HABS ESP	OCNMS RT	**APL UW TOTAL**	Atmos Atm Modl	OCN PS Model	FHLOO	**Other UW TOTAL**	**Combined Yr 15 Grand TOTAL**
Lead	Newton	Tanner	Tanner	Newton	Newton	Curry	Curry	Lee	Chickadel	Mickett	Mickett		Mass	MacCready	Dethier		
Salaries	$ 144,004	$ 53,639	$ 126,279	$ 82,652	$ 98,468	$ 39,067	$ 81,781	$ 42,599		$ 23,138		**$ 691,627**	$ 5,878	$ 63,930	$ 13,611	**$ 83,419**	**$ 775,046**
Benefits	$ 75,746	$ 28,214	$ 66,424	$ 39,632	$ 32,863	$ 20,549	$ 43,017	$ 22,407		$ 12,171		**$ 341,023**	$ 1,781	$ 15,597	$ 5,390	**$ 22,768**	**$ 363,791**
Equipment			$ 10,528	$ -					$ 150,000		$ 62,000	**$ 222,528**		$ 5,000		**$ 5,000**	**$ 227,528**
Travel	$ 3,000	$ 2,989	$ 4,000	$ 2,552	$ 1,858	$ 4,890				$ 6,549		**$ 25,838**		$ 3,001		**$ 3,001**	**$ 28,839**
Sub Awards	$ 3,156,633											**$ 3,156,633**				**$ -**	**$ 3,156,633**
Services	$ 19,000			$ 1,532	$ 41,000	$ 27,094	$ 59,281	$ 46,873		$ 17,621		**$ 212,401**	$ 58		$ 7,940	**$ 7,998**	**$ 220,399**
Supplies	$ 1,500			$ 3,062	$ 743	$ 24,008	$ 12,331			$ 8,394		**$ 50,038**		$ 10,720	$ 900	**$ 11,620**	**$ 61,658**
Student Aid	$ 50,000											**$ 50,000**				**$ -**	**$ 50,000**
Prorated Direct Costs	$ 156,024	$ 29,864	$ 69,240	$ 45,559	$ 9,718	$ 40,694	$ 69,136	$ 39,381		$ 23,891		**$ 483,507**				**$ -**	**$ 483,507**
Total Direct	$ 3,605,907	$ 114,706	$ 276,471	$ 174,989	$ 184,650	$ 156,302	$ 265,546	$ 151,260	$ 150,000	$ 91,764	$ 62,000	**$ 5,233,595**	$ 7,717	$ 98,248	$ 27,841	**$ 133,806**	**$ 5,367,401**
Indirect Costs	$ 113,863	$ 21,794	$ 50,529	$ 33,248	$ 65,350	$ 29,698	$ 50,454	$ 28,740		$ 17,436		**$ 411,112**	$ 4,283	$ 51,752	$ 15,452	**$ 71,487**	**$ 482,599**
Subtotal DC+IDC	$ 3,719,770	$ 136,500	$ 327,000	$ 208,237	$ 250,000	$ 186,000	$ 316,000	$ 180,000	$ 150,000	$ 109,200	$ 62,000	**$ 5,644,707**	$ 12,000	$ 150,000	$ 43,293	$ 205,293	**$ 5,850,000**
NOAA Transfers	$ 68,156											**$ 68,156**				**$ -**	**$ 68,156**
TOTAL (ex HB's)	**$ 3,787,926**	**$ 136,500**	**$ 327,000**	**$ 208,237**	**$ 250,000**	**$ 186,000**	**$ 316,000**	**$ 180,000**	**$ 150,000**	**$ 109,200**	**$ 62,000**	**$ 5,712,863**	**$ 12,000**	**$ 150,000**	**$ 43,293**	**$ 205,293**	**$ 5,918,156**
NOAA Hold Backs	$ 81,844											**$ 81,844**				**$ -**	**$ 81,844**

SUB AWARD - OREGON STATE UNIVESITY:

Title	Nearshore Bathymetry	Port Radar	OSU DMAC	HF Radar	OR Shelf Buoy	TH Shelf Glider	Columbia Glider	OR-WA Model	OA Reserves	Acoustics Network	DO Crab	Inlet Nav	**OSU TOTAL**
Lead	Ruggiero	Haller	Kosro	Kosro	Kosro	Barth	Barth	Zaron	Chan	Chapple	Shearman	Ozkan-Haller	
Salaries	$ 17,720	$ 25,110	$ 27,752	$ 193,449	$ 49,581	$ 15,503	$ 42,141	$ 61,564	$ 19,063		$ 27,767	$ 58,323	**$ 537,973**
Benefits	$ 7,183	$ 12,938	$ 13,043	$ 122,650	$ 28,971	$ 9,497	$ 25,817	$ 28,845	$ 9,391		$ 8,600	$ 25,710	**$ 292,645**
Equipment			$ 5,200	$ 92,200	$ 11,200		$ 100,000				$ 50,000		**$ 258,600**
Travel	$ 4,947	$ 700	$ 4,500	$ 14,000	$ 5,000	$ 1,000	$ 3,500	$ 3,650	$ 2,241		$ 3,000	$ 7,500	**$ 50,038**
Sub Awards													**$ -**
Services			$ 2,000	$ 19,903	$ 41,000	$ 22,606	$ 15,218	$ 2,051	$ 8,500	$ 2,679	$ 375	$ 2,000	**$ 116,332**
Supplies	$ 4,898	$ 2,464	$ 1,728	$ 23,601	$ 17,401	$ 12,000	$ 26,455	$ 4,900	$ 4,206	$ 48,500	$ 4,029	$ 2,806	**$ 152,988**
Student Aid													**$ -**
Total Direct	$ 34,748	$ 41,212	$ 54,223	$ 465,803	$ 153,153	$ 60,606	$ 213,131	$ 101,010	$ 43,401	$ 51,179	$ 93,771	$ 96,339	**$ 1,408,576**
Indirect Cost	$ 16,852	$ 19,988	$ 23,777	$ 181,197	$ 68,847	$ 29,394	$ 54,869	$ 48,990	$ 21,049	$ 24,821	$ 21,229	$ 46,724	**$ 557,737**
TOTAL	**$ 51,600**	**$ 61,200**	**$ 78,000**	**$ 647,000**	**$ 222,000**	**$ 90,000**	**$ 268,000**	**$ 150,000**	**$ 64,450**	**$ 76,000**	**$ 115,000**	**$ 143,063**	**$ 1,966,313**

NOAA Hold Backs - ONMS, NMFS:

	ONMS Ocean Sound	NMFS Ocean Sound	**NOAA Hold Backs TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 25,000	$ 15,000	**$ 40,000**
Benefits	$ 8,500	$ 5,250	**$ 13,750**
Equipment			**$ -**
Travel	$ -	$ -	**$ -**
Sub Awards			**$ -**
Services	$ 22,469		**$ 22,469**
Supplies			**$ -**
Student Aid			**$ -**
Total Direct	$ 55,969	$ 20,250	**$ 76,219**
Indirect Cost	$ 3,000	$ 2,625	**$ 5,625**
TOTAL	**$ 58,969**	**$ 22,875**	**$ 81,844**

SUB AWARDS - Columbia River Inter-Tribal Fish Comm., WA Dept. of Ecology, OR Dept. of Geology & Minerial Industries, OR Dept. of State Lands, Nat'l Parks Svcs, Berring Data Coll., Gulf of Main Lobster Found.:

	CRITFC					DOGAMI	OR ODSL	WDOE		NPS	BDC	GOMLF	
Title	Columbia glider	Obs	Modeling	DMAC	Outreach	OBSMAP & UPC	S. Slough Moorings	Shoreline	PS Ferry	NPS OA	NW FVOP	Student Drifters	**Other Subs TOTAL**
Lead	Seaton	Seaton	Seaton	Seaton	Seaton	Allan	Helms	Kaminsky	Krembs	Fradkin	Van Vranken	Manning	
Salaries	$ 6,761	$ 111,199	$ 74,374	$ 42,675	$ 2,000	$ 41,608	$ 5,775	$ 39,385	$ 15,306	$ 25,785			**$ 364,868**
Benefits	$ 1,606	$ 35,397	$ 26,403	$ 11,643	$ 701	$ 24,829	$ 2,025	$ 17,176	$ 6,273	$ 5,415			**$ 131,468**
Equipment		$ 28,279		$ 1,825		$ 94,531		$ 9,000	$ 2,000	$ 1,500	$ 3,350		**$ 140,485**
Travel	$ 490	$ 1,720	$ 600	$ 720	$ 2,200	$ 8,822		$ 15,817				$ 1,000	**$ 31,369**
Sub Awards						$ 15,000							**$ 15,000**
Services		$ 46,722			$ 3,724		$ 1,338	$ 25,000		$ 1,500	$ 44,460	$ 41,000	**$ 163,744**
Supplies		$ 56,500	$ 13,050	$ 1,096		$ 7,014	$ 40,862	$ 10,124	$ 6,508	$ 2,000	$ 2,000	$ 18,869	**$ 158,023**
Student Aid													**$ -**
Total Direct	$ 8,857	$ 279,817	$ 114,427	$ 57,959	$ 8,625	$ 191,804	$ 50,000	$ 116,502	$ 30,087	$ 36,200	$ 49,810	$ 60,869	**$ 1,004,957**
Indirect Cost	$ 3,143	$ 64,853	$ 35,573	$ 19,697	$ 3,027	$ 26,128		$ 15,498	$ 5,913		$ 2,400	$ 9,131	**$ 185,363**
TOTAL	**$ 12,000**	**$ 344,670**	**$ 150,000**	**$ 77,656**	**$ 11,652**	**$ 217,932**	**$ 50,000**	**$ 132,000**	**$ 36,000**	**$ 36,200**	**$ 52,210**	**$ 70,000**	**$ 1,190,320**

NOAA Transfers via SCCOOS & CeNCOOS:

	SIO	NP School	
	Ocean Sound (via SCCOOS)	Ocean Sound (via CeNCOOS)	**NOAA Transfers TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 9,120	$ 13,114	**$ 22,234**
Benefits	$ 4,163	$ 6,460	**$ 10,623**
Equipment			**$ -**
Travel	$ 3,874		**$ 3,874**
Sub Awards			**$ -**
Services	$ 3,122		**$ 3,122**
Supplies	$ 16,119	$ -	**$ 16,119**
Student Aid			**$ -**
Total Direct	$ 36,398	$ 19,574	**$ 55,972**
Indirect Cost	$ 6,552	$ 5,632	**$ 12,184**
TOTAL	**$ 42,950**	**$ 25,206**	**$ 68,156**

NANOOS YR 15-19 PROPOSAL EFFORT DISTRIBUTION BREAKDOWN SUMMARY

YEAR 16

UNIVERSITY OF WASHINGTON - Applied Physics Laboratory:

	APL											UW Other					
Title	Management	DMAC	Products & Web	Engagement & DEI	HABs	WA Shelf Buoy	PS Buoy	La Push Glider	WA HF	HABS ESP	OCNMS RT	**APL UW Total**	Atmos Atm Modl	OCN PS Model	FHLOO	**Other UW TOTAL**	**Combined Yr 16 Grand TOTAL**
Lead	Newton	Tanner	Tanner	Newton	Newton	Curry	Curry	Lee	Chickadel	Mickett	Mickett		Mass	MacCready	Dethier		
Salaries	$ 213,563	$ 53,586	$ 126,400	$ 80,134	$ 98,468	$ 40,183	$ 80,373	$ 43,560	$ 15,457	$ 22,443	$ 3,410	**$ 777,577**	$ 5,878	$ 66,487	$ 13,883	**$ 86,248**	**$ 863,825**
Benefits	$ 112,334	$ 28,187	$ 66,487	$ 42,150	$ 32,863	$ 21,136	$ 42,276	$ 22,913	$ 8,130	$ 11,806	$ 1,794	**$ 390,076**	$ 1,781	$ 16,221	$ 5,498	**$ 23,500**	**$ 413,576**
Equipment			$ 10,233			$ 214,476					$ 52,266	**$ 276,975**				**$ -**	**$ 276,975**
Travel	$ 18,247	$ 3,069	$ 4,000	$ 2,552	$ 1,858	$ 5,089			$ 1,275	$ 6,809	$ 846	**$ 43,745**		$ 3,000		**$ 3,000**	**$ 46,745**
Sub Awards	$ 2,959,302											**$ 2,959,302**				**$ -**	**$ 2,959,302**
Services	$ 19,606			$ 1,532	$ 41,000	$ 27,907	$ 61,061	$ 45,406		$ 18,169		**$ 214,681**	$ 58	$ 3,000	$ 7,940	**$ 10,998**	**$ 225,679**
Supplies	$ 9,471			$ 3,062	$ 743	$ 24,728	$ 12,700			$ 8,646		**$ 59,350**		$ 7,755	$ 520	**$ 8,275**	**$ 67,625**
Student Aid	$ 50,000											**$ 50,000**				**$ -**	**$ 50,000**
Prorated Direct Costs	$ 131,374	$ 29,864	$ 69,304	$ 45,559	$ 9,718	$ 41,902	$ 69,136	$ 39,381	$ 8,751	$ 23,891	$ 2,130	**$ 471,010**				**$ -**	**$ 471,010**
Total Direct	$ 3,513,897	$ 114,706	$ 276,424	$ 174,989	$ 184,650	$ 375,421	$ 265,546	$ 151,260	$ 33,613	$ 91,764	$ 60,446	**$ 5,242,716**	$ 7,717	$ 96,463	$ 27,841	**$ 132,021**	**$ 5,374,737**
Indirect Costs	$ 95,873	$ 21,794	$ 50,576	$ 33,248	$ 65,350	$ 30,579	$ 50,454	$ 28,740	$ 6,387	$ 17,436	$ 1,554	**$ 401,991**	$ 4,283	$ 53,537	$ 15,452	**$ 73,272**	**$ 475,263**
Subtotal DC+IDC	$ 3,609,770	$ 136,500	$ 327,000	$ 208,237	$ 250,000	$ 406,000	$ 316,000	$ 180,000	$ 40,000	$ 109,200	$ 62,000	**$ 5,644,707**	$ 12,000	$ 150,000	$ 43,293	$ 205,293	**$ 5,850,000**
NOAA Transfers	$ 73,648											**$ 73,648**				**$ -**	**$ 73,648**
TOTAL (ex HB's)	**$ 3,683,418**	**$ 136,500**	**$ 327,000**	**$ 208,237**	**$ 250,000**	**$ 406,000**	**$ 316,000**	**$ 180,000**	**$ 40,000**	**$ 109,200**	**$ 62,000**	**$ 5,718,355**	**$ 12,000**	**$ 150,000**	**$ 43,293**	**$ 205,293**	**$ 5,923,648**
NOAA Hold Backs	$ 76,352											**$ 76,352**				**$ -**	**$ 76,352**

SUB AWARD - OREGON STATE UNIVESITY:

Title	Nearshore Bathymetry	Port Radar	OSU DMAC	HF Radar	OR Shelf Buoy	TH Shelf Glider	Columbia Glider	OR-WA Model	OA Reserves	Acoustics Network	DO Crab	Inlet Nav	**OSU TOTAL**
Lead	Ruggiero	Haller	Kosro	Kosro	Kosro	Barth	Barth	Zaron	Chan	Chapple	Shearman	Ozkan-Haller	
Salaries	$ 18,175	$ 25,130	$ 29,299	$ 189,206	$ 48,534	$ 16,022	$ 43,914	$ 63,940	$ 19,635		$ 43,712	$ 58,005	**$ 555,572**
Benefits	$ 7,497	$ 13,209	$ 14,064	$ 122,596	$ 28,960	$ 9,978	$ 26,387	$ 26,440	$ 9,870		$ 12,009	$ 26,007	**$ 297,017**
Equipment				$ 87,000	$ 25,000								**$ 112,000**
Travel	$ 5,099	$ 600	$ 4,500	$ 14,000	$ 5,000	$ 1,020	$ 5,600	$ 4,650	$ 2,241		$ 3,000	$ 7,500	**$ 53,210**
Sub Awards													**$ -**
Services			$ 2,000	$ 25,302	$ 41,000	$ 23,000	$ 14,825	$ 3,071	$ 7,100	$ 2,679	$ 375	$ 2,000	**$ 121,352**
Supplies	$ 3,977	$ 2,273	$ 2,663	$ 26,001	$ 9,166	$ 10,586	$ 22,405	$ 2,909	$ 4,555	$ 48,500	$ 7,250	$ 2,827	**$ 143,112**
Student Aid											$ 16,476		**$ 16,476**
Total Direct	$ 34,748	$ 41,212	$ 52,526	$ 464,105	$ 157,660	$ 60,606	$ 113,131	$ 101,010	$ 43,401	$ 51,179	$ 82,822	$ 96,339	**$ 1,298,739**
Indirect Cost	$ 16,852	$ 19,988	$ 25,474	$ 182,895	$ 64,340	$ 29,394	$ 54,869	$ 48,990	$ 21,049	$ 24,821	$ 32,178	$ 46,724	**$ 567,574**
TOTAL	**$ 51,600**	**$ 61,200**	**$ 78,000**	**$ 647,000**	**$ 222,000**	**$ 90,000**	**$ 168,000**	**$ 150,000**	**$ 64,450**	**$ 76,000**	**$ 115,000**	**$ 143,063**	**$ 1,866,313**

NOAA Hold Backs - ONMS, NMFS:

	ONMS Ocean Sound	NMFS Ocean Sound	**NOAA Hold Backs TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 20,000	$ 15,000	**$ 35,000**
Benefits	$ 6,800	$ 5,250	**$ 12,050**
Equipment			**$ -**
Travel	$ 2,249	$ 2,000	**$ 4,249**
Sub Awards			**$ -**
Services	$ 20,028		**$ 20,028**
Supplies			**$ -**
Student Aid			**$ -**
Total Direct	$ 49,077	$ 22,250	**$ 71,327**
Indirect Cost	$ 2,400	$ 2,625	**$ 5,025**
TOTAL	**$ 51,477**	**$ 24,875**	**$ 76,352**

SUB AWARDS - Columbia River Inter-Tribal Fish Comm., WA Dept. of Ecology, OR Dept. of Geology & Minerial Industries, OR Dept. of State Lands, Nat'l Parks Svcs, Berring Data Coll., Gulf of Main Lobster Found.:

	CRITFC					DOGAMI	OR ODSL	WA Eco		NPS	BDC	GOMLF	
Title	Columbia glider	Obs	Modeling	DMAC	Outreach	OBSMAP & UPC	S. Slough Moorings	Shoreline	PS Ferry	NPS OA	NW FVOP	Student Drifters	**Other Subs TOTAL**
Lead	Seaton	Seaton	Seaton	Seaton	Seaton	Allan	Helms	Kaminsky	Krembs	Fradkin	Van Vranken	Manning	
Salaries	$ 6,761	$ 111,199	$ 74,374	$ 42,675	$ 2,000	$ 41,608	$ 5,900	$ 39,385	$ 15,306	$ 25,785			**$ 364,993**
Benefits	$ 1,606	$ 35,397	$ 26,403	$ 11,643	$ 702	$ 24,829	$ 2,065	$ 17,176	$ 6,273	$ 5,415			**$ 131,509**
Equipment		$ 28,279		$ 1,825				$ 9,000	$ 2,000	$ 1,500	$ 4,000		**$ 46,604**
Travel	$ 490	$ 1,720	$ 600	$ 720	$ 2,200	$ 8,822		$ 15,817				$ 1,200	**$ 31,569**
Sub Awards						$ 15,000							**$ 15,000**
Services		$ 46,722			$ 3,723		$ 1,338	$ 25,000		$ 1,500	$ 40,810	$ 38,000	**$ 157,093**
Supplies		$ 56,500	$ 13,050	$ 1,096		$ 7,014	$ 40,697	$ 10,124	$ 6,508	$ 2,000	$ 4,200	$ 19,234	**$ 160,423**
Student Aid													**$ -**
Total Direct	$ 8,857	$ 279,817	$ 114,427	$ 57,959	$ 8,625	$ 97,273	$ 50,000	$ 116,502	$ 30,087	$ 36,200	$ 49,010	$ 58,434	**$ 907,191**
Indirect Cost	$ 3,143	$ 64,853	$ 35,573	$ 19,697	$ 3,027	$ 26,128		$ 15,498	$ 5,913		$ 3,200	$ 8,766	**$ 185,798**
TOTAL	**$ 12,000**	**$ 344,670**	**$ 150,000**	**$ 77,656**	**$ 11,652**	**$ 123,401**	**$ 50,000**	**$ 132,000**	**$ 36,000**	**$ 36,200**	**$ 52,210**	**$ 67,200**	**$ 1,092,989**

NOAA Transfers via SCCOOS & CeNCOOS:

	SIO	NP School	
	Ocean Sound (via SCCOOS)	Ocean Sound (via CeNCOOS)	**NOAA Transfers TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 9,828	$ 13,114	**$ 22,942**
Benefits	$ 4,415	$ 6,460	**$ 10,875**
Equipment			**$ -**
Travel	$ 4,024		**$ 4,024**
Sub Awards			**$ -**
Services	$ 3,333		**$ 3,333**
Supplies	$ 14,798	$ 5,492	**$ 20,290**
Student Aid			**$ -**
Total Direct	$ 36,398	$ 25,066	**$ 61,464**
Indirect Cost	$ 6,552	$ 5,632	**$ 12,184**
TOTAL	**$ 42,950**	**$ 30,698**	**$ 73,648**

NANOOS YR 15-19 PROPOSAL EFFORT DISTRIBUTION BREAKDOWN SUMMARY

YEAR 17

UNIVERSITY OF WASHINGTON - Applied Physics Laboratory:

	APL											UW Other					
Title	Management	DMAC	Products & Web	Engagement & DEI	HABs	WA Shelf Buoy	PS Buoy	La Push Glider	WA HF	HABS ESP	OCNMS RT	**APL UW Total**	Atmos Atm Modl	OCN PS Model	FHLOO	**Other UW TOTAL**	**Combined Yr 17 Grand TOTAL**
Lead	Newton	Tanner	Tanner	Newton	Newton	Curry	Curry	Lee	Chickadel	Mickett	Mickett		Mass	MacCready	Dethier		
Salaries	$ 213,563	$ 53,566	$ 126,505	$ 80,134	$ 98,468	$ 36,766	$ 78,924	$ 43,751	$ 15,457	$ 21,734	$ 3,546	**$ 772,414**	$ 5,878	$ 69,147	$ 14,162	**$ 89,187**	**$ 861,601**
Benefits	$ 112,334	$ 28,175	$ 66,542	$ 42,150	$ 32,863	$ 19,339	$ 41,514	$ 23,013	$ 8,130	$ 11,433	$ 1,865	**$ 387,358**	$ 1,781	$ 16,870	$ 5,608	**$ 24,259**	**$ 411,617**
Equipment			$ 9,975								$ 51,057	**$ 61,032**		$ 5,000		**$ 5,000**	**$ 66,032**
Travel	$ 18,247	$ 3,101	$ 4,000	$ 2,552	$ 1,858	$ 5,290			$ 1,275	$ 7,082	$ 880	**$ 44,285**		$ 3,000		**$ 3,000**	**$ 47,285**
Sub Awards	$ 3,179,302											**$ 3,179,302**				**$ -**	**$ 3,179,302**
Services	$ 19,606			$ 1,532	$ 41,000	$ 28,744	$ 62,890	$ 45,115		$ 18,714		**$ 217,601**	$ 58	$ 3,000	$ 7,564	**$ 10,622**	**$ 228,223**
Supplies	$ 9,471			$ 3,062	$ 743	$ 25,469	$ 13,082			$ 8,910	$ 511	**$ 61,248**		$ 1,231	$ 507	**$ 1,738**	**$ 62,986**
Student Aid	$ 50,000											**$ 50,000**				**$ -**	**$ 50,000**
Prorated Direct Costs	$ 131,374	$ 29,864	$ 69,361	$ 45,559	$ 9,718	$ 40,694	$ 69,136	$ 39,381	$ 8,751	$ 23,891	$ 2,394	**$ 470,123**				**$ -**	**$ 470,123**
Total Direct	$ 3,733,897	$ 114,706	$ 276,383	$ 174,989	$ 184,650	$ 156,302	$ 265,546	$ 151,260	$ 33,613	$ 91,764	$ 60,253	**$ 5,243,363**	$ 7,717	$ 98,248	$ 27,841	**$ 133,806**	**$ 5,377,169**
Indirect Costs	$ 95,873	$ 21,794	$ 50,617	$ 33,248	$ 65,350	$ 29,698	$ 50,454	$ 28,740	$ 6,387	$ 17,436	$ 1,747	**$ 401,344**	$ 4,283	$ 51,752	$ 15,452	**$ 71,487**	**$ 472,831**
Subtotal DC+IDC	$ 3,829,770	$ 136,500	$ 327,000	$ 208,237	$ 250,000	$ 186,000	$ 316,000	$ 180,000	$ 40,000	$ 109,200	$ 62,000	**$ 5,644,707**	$ 12,000	$ 150,000	$ 43,293	$ 205,293	**$ 5,850,000**
NOAA Transfers	$ 73,648											**$ 73,648**				**$ -**	**$ 73,648**
TOTAL (ex HB's)	**$ 3,903,418**	**$ 136,500**	**$ 327,000**	**$ 208,237**	**$ 250,000**	**$ 186,000**	**$ 316,000**	**$ 180,000**	**$ 40,000**	**$ 109,200**	**$ 62,000**	**$ 5,718,355**	**$ 12,000**	**$ 150,000**	**$ 43,293**	**$ 205,293**	**$ 5,923,648**
NOAA Hold Backs	$ 76,352											**$ 76,352**				**$ -**	**$ 76,352**

SUB AWARD - OREGON STATE UNIVESITY:

Title	Nearshore Bathymetry	Port Radar	OSU DMAC	HF Radar	OR Shelf Buoy	TH Shelf Glider	Columbia Glider	OR-WA Model	OA Reserves	Acoustics Network	DO Crab	Inlet Nav	**OSU TOTAL**
Lead	Ruggiero	Haller	Kosro	Kosro	Kosro	Barth	Barth	Zaron	Chan	Chapple	Shearman	Ozkan-Haller	
Salaries	$ 18,644	$ 25,129	$ 27,234	$ 194,884	$ 52,570	$ 15,884	$ 45,209	$ 65,859	$ 20,223		$ 45,022	$ 57,567	**$ 568,225**
Benefits	$ 7,823	$ 13,467	$ 13,345	$ 128,222	$ 31,777	$ 11,116	$ 27,549	$ 27,892	$ 10,368		$ 12,994	$ 26,126	**$ 310,679**
Equipment			$ 5,200	$ 92,200	$ 6,000	$ 220,000							**$ 323,400**
Travel	$ 5,256	$ 600	$ 4,500	$ 11,500	$ 5,000	$ 1,100	$ 3,644	$ 2,450	$ 2,241		$ 3,000	$ 7,500	**$ 46,791**
Sub Awards													**$ -**
Services			$ 2,000	$ 19,238	$ 41,000	$ 13,000	$ 13,825	$ 3,072	$ 6,700	$ 2,679	$ 375	$ 3,146	**$ 105,035**
Supplies	$ 3,025	$ 2,016	$ 1,944	$ 19,759	$ 15,108	$ 19,506	$ 22,904	$ 1,738	$ 3,869	$ 48,500	$ 4,450	$ 2,000	**$ 144,819**
Student Aid											$ 17,226		**$ 17,226**
Total Direct	$ 34,748	$ 41,212	$ 54,223	$ 465,803	$ 151,455	$ 280,606	$ 113,131	$ 101,011	$ 43,401	$ 51,179	$ 83,067	$ 96,339	**$ 1,516,175**
Indirect Cost	$ 16,852	$ 19,988	$ 23,777	$ 181,197	$ 70,545	$ 29,394	$ 54,869	$ 48,989	$ 21,049	$ 24,821	$ 31,933	$ 46,724	**$ 570,138**
TOTAL	**$ 51,600**	**$ 61,200**	**$ 78,000**	**$ 647,000**	**$ 222,000**	**$ 310,000**	**$ 168,000**	**$ 150,000**	**$ 64,450**	**$ 76,000**	**$ 115,000**	**$ 143,063**	**$ 2,086,313**

NOAA Hold Backs - ONMS, NMFS:

	ONMS Ocean Sound	NMFS Ocean Sound	**NOAA Hold Backs TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 20,000	$ 15,000	**$ 35,000**
Benefits	$ 6,800	$ 5,250	**$ 12,050**
Equipment			**$ -**
Travel	$ 3,249	$ -	**$ 3,249**
Sub Awards			**$ -**
Services	$ 21,028		**$ 21,028**
Supplies			**$ -**
Student Aid			**$ -**
Total Direct	$ 51,077	$ 20,250	**$ 71,327**
Indirect Cost	$ 2,400	$ 2,625	**$ 5,025**
TOTAL	**$ 53,477**	**$ 22,875**	**$ 76,352**

SUB AWARDS - Columbia River Inter-Tribal Fish Comm., WA Dept. of Ecology, OR Dept. of Geology & Minerial Industries, OR Dept. of State Lands, Nat'l Parks Svcs, Berring Data Coll., Gulf of Main Lobster Found.:

	CRITFC					DOGAMI	OR ODSL	WA Eco		NPS	BDC	GOMLF	
Title	Columbia glider	Obs	Modeling	DMAC	Outreach	OBSMAP & UPC	S. Slough Moorings	Shoreline	PS Ferry	NPS OA	NW FVOP	Student Drifters	**Other Subs TOTAL**
Lead	Seaton	Seaton	Seaton	Seaton	Seaton	Allan	Helms	Kaminsky	Krembs	Fradkin	Van Vranken	Manning	
Salaries	$ 6,761	$ 111,199	$ 74,374	$ 42,675	$ 2,000	$ 41,608	$ 6,175	$ 39,385	$ 15,306	$ 25,785			**$ 365,268**
Benefits	$ 1,606	$ 35,397	$ 26,403	$ 11,643	$ 702	$ 24,829	$ 2,165	$ 17,176	$ 6,273	$ 5,415			**$ 131,609**
Equipment		$ 28,279		$ 1,825				$ 9,000	$ 2,000	$ 1,500	$ 4,000		**$ 46,604**
Travel	$ 490	$ 1,720	$ 599	$ 720	$ 2,200	$ 8,822		$ 15,817				$ 1,200	**$ 31,568**
Sub Awards						$ 15,000							**$ 15,000**
Services		$ 46,722			$ 3,723		$ 1,338	$ 25,000		$ 1,500	$ 40,810	$ 39,000	**$ 158,093**
Supplies		$ 56,500	$ 13,051	$ 1,096		$ 7,014	$ 40,322	$ 10,124	$ 6,508	$ 2,000	$ 4,200	$ 18,234	**$ 159,049**
Student Aid													**$ -**
Total Direct	$ 8,857	$ 279,817	$ 114,427	$ 57,959	$ 8,625	$ 97,273	$ 50,000	$ 116,502	$ 30,087	$ 36,200	$ 49,010	$ 58,434	**$ 907,191**
Indirect Cost	$ 3,143	$ 64,853	$ 35,573	$ 19,697	$ 3,027	$ 26,128		$ 15,498	$ 5,913		$ 3,200	$ 8,766	**$ 185,798**
TOTAL	**$ 12,000**	**$ 344,670**	**$ 150,000**	**$ 77,656**	**$ 11,652**	**$ 123,401**	**$ 50,000**	**$ 132,000**	**$ 36,000**	**$ 36,200**	**$ 52,210**	**$ 67,200**	**$ 1,092,989**

NOAA Transfers via SCCOOS & CeNCOOS:

	SIO	NP School	
	Ocean Sound (via SCCOOS)	Ocean Sound (via CeNCOOS)	**NOAA Transfers TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 9,974	$ 13,114	**$ 23,088**
Benefits	$ 4,481	$ 6,460	**$ 10,941**
Equipment			**$ -**
Travel	$ 4,182		**$ 4,182**
Sub Awards			**$ -**
Services	$ 3,380		**$ 3,380**
Supplies	$ 14,381	$ 5,492	**$ 19,873**
Student Aid			**$ -**
Total Direct	$ 36,398	$ 25,066	**$ 61,464**
Indirect Cost	$ 6,552	$ 5,632	**$ 12,184**
TOTAL	**$ 42,950**	**$ 30,698**	**$ 73,648**

NANOOS YR 15-19 PROPOSAL EFFORT DISTRIBUTION BREAKDOWN SUMMARY

YEAR 18

UNIVERSITY OF WASHINGTON - Applied Physics Laboratory:

	APL											UW Other					
Title	Management	DMAC	Products & Web	Engagement & DEI	HABs	WA Shelf Buoy	PS Buoy	La Push Glider	WA HF	HABS ESP	OCNMS RT	**APL UW Total**	Atmos Atm Modl	OCN PS Model	FHLOO	**Other UW TOTAL**	**Combined Yr 18 Grand TOTAL**
Lead	Newton	Tanner	Tanner	Newton	Newton	Curry	Curry	Lee	Chickadel	Mickett	Mickett		Mass	MacCready	Dethier		
Salaries	$ 213,563	$ 53,582	$ 126,464	$ 80,134	$ 98,468	$ 35,562	$ 79,326	$ 43,885	$ 15,457	$ 21,008	$ 4,280	**$ 771,729**	$ 5,878	$ 71,913	$ 14,446	**$ 92,237**	**$ 863,966**
Benefits	$ 112,334	$ 28,184	$ 66,521	$ 42,150	$ 32,863	$ 18,706	$ 41,725	$ 23,084	$ 8,130	$ 11,050	$ 2,251	**$ 386,998**	$ 1,781	$ 17,544	$ 5,721	**$ 25,046**	**$ 412,044**
Equipment			$ 10,075				$ 195,410				$ 31,490	**$ 236,975**				**$ -**	**$ 236,975**
Travel	$ 20,307	$ 3,076	$ 4,000	$ 2,552	$ 1,858	$ 5,501			$ 1,275	$ 7,366	$ 369	**$ 46,304**		$ 3,000		**$ 3,000**	**$ 49,304**
Sub Awards	$ 2,951,302											**$ 2,951,302**				**$ -**	**$ 2,951,302**
Services	$ 21,371			$ 1,532	$ 41,000	$ 29,606	$ 64,776	$ 44,910		$ 19,275	$ 527	**$ 222,997**	$ 58	$ 3,000	$ 7,064	**$ 10,122**	**$ 233,119**
Supplies	$ 10,619			$ 3,062	$ 743	$ 26,233	$ 25,867			$ 9,174	$ 11,537	**$ 87,235**		$ 1,006	$ 610	**$ 1,616**	**$ 88,851**
Student Aid	$ 50,000											**$ 50,000**				**$ -**	**$ 50,000**
Prorated Direct Costs	$ 133,124	$ 29,864	$ 69,339	$ 45,559	$ 9,718	$ 40,694	$ 74,516	$ 39,381	$ 8,751	$ 23,891	$ 6,675	**$ 481,512**				**$ -**	**$ 481,512**
Total Direct	$ 3,512,620	$ 114,706	$ 276,399	$ 174,989	$ 184,650	$ 156,302	$ 481,620	$ 151,260	$ 33,613	$ 91,764	$ 57,129	**$ 5,235,052**	$ 7,717	$ 96,463	$ 27,841	**$ 132,021**	**$ 5,367,073**
Indirect Costs	$ 97,150	$ 21,794	$ 50,601	$ 33,248	$ 65,350	$ 29,698	$ 54,380	$ 28,740	$ 6,387	$ 17,436	$ 4,871	**$ 409,655**	$ 4,283	$ 53,537	$ 15,452	**$ 73,272**	**$ 482,927**
Subtotal DC+IDC	$ 3,609,770	$ 136,500	$ 327,000	$ 208,237	$ 250,000	$ 186,000	$ 536,000	$ 180,000	$ 40,000	$ 109,200	$ 62,000	**$ 5,644,707**	$ 12,000	$ 150,000	$ 43,293	$ 205,293	**$ 5,850,000**
NOAA Transfers	$ 73,648											**$ 73,648**				**$ -**	**$ 73,648**
TOTAL (ex HB's)	**$ 3,683,418**	**$ 136,500**	**$ 327,000**	**$ 208,237**	**$ 250,000**	**$ 186,000**	**$ 536,000**	**$ 180,000**	**$ 40,000**	**$ 109,200**	**$ 62,000**	**$ 5,718,355**	**$ 12,000**	**$ 150,000**	**$ 43,293**	**$ 205,293**	**$ 5,923,648**
NOAA Hold Backs	$ 76,352											**$ 76,352**				**$ -**	**$ 76,352**

SUB AWARD - OREGON STATE UNIVESITY:

Title	Nearshore Bathymetry	Port Radar	OSU DMAC	HF Radar	OR Shelf Buoy	TH Shelf Glider	Columbia Glider	OR-WA Model	OA Reserves	Acoustics Network	DO Crab	Inlet Nav	**OSU TOTAL**
Lead	Ruggiero	Haller	Kosro	Kosro	Kosro	Barth	Barth	Zaron	Chan	Chapple	Shearman	Ozkan-Haller	
Salaries	$ 19,127	$ 25,105	$ 28,809	$ 200,729	$ 50,342	$ 16,353	$ 46,543	$ 67,834	$ 20,830		$ 46,366	$ 57,320	**$ 579,358**
Benefits	$ 8,162	$ 13,715	$ 14,405	$ 134,077	$ 31,029	$ 11,647	$ 28,797	$ 29,070	$ 10,887		$ 13,754	$ 26,178	**$ 321,721**
Equipment				$ 65,000	$ 6,000								**$ 71,000**
Travel	$ 5,418	$ 300	$ 4,500	$ 11,500	$ 5,000	$ 1,200	$ 5,672	$ 450	$ 2,241		$ 3,000	$ 7,500	**$ 46,781**
Sub Awards													**$ -**
Services			$ 2,000	$ 23,482	$ 43,500	$ 13,000	$ 13,825	$ 3,072	$ 5,806	$ 2,679	$ 375	$ 2,000	**$ 109,739**
Supplies	$ 2,041	$ 2,092	$ 2,812	$ 22,132	$ 15,584	$ 18,406	$ 18,294	$ 585	$ 3,637	$ 48,500	$ 1,817	$ 3,341	**$ 139,241**
Student Aid											$ 18,012		**$ 18,012**
Total Direct	$ 34,748	$ 41,212	$ 52,526	$ 456,920	$ 151,455	$ 60,606	$ 113,131	$ 101,011	$ 43,401	$ 51,179	$ 83,324	$ 96,339	**$ 1,285,852**
Indirect Cost	$ 16,852	$ 19,988	$ 25,474	$ 190,080	$ 70,545	$ 29,394	$ 54,869	$ 48,989	$ 21,049	$ 24,821	$ 31,676	$ 46,724	**$ 580,461**
TOTAL	**$ 51,600**	**$ 61,200**	**$ 78,000**	**$ 647,000**	**$ 222,000**	**$ 90,000**	**$ 168,000**	**$ 150,000**	**$ 64,450**	**$ 76,000**	**$ 115,000**	**$ 143,063**	**$ 1,866,313**

NOAA Hold Backs - ONMS, NMFS:

	ONMS Ocean Sound	NMFS Ocean Sound	**NOAA Hold Backs TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 20,000	$ 15,000	**$ 35,000**
Benefits	$ 6,800	$ 5,250	**$ 12,050**
Equipment			**$ -**
Travel	$ 2,250	$ 2,000	**$ 4,250**
Sub Awards			**$ -**
Services	$ 20,027		**$ 20,027**
Supplies			**$ -**
Student Aid			**$ -**
Total Direct	$ 49,077	$ 22,250	**$ 71,327**
Indirect Cost	$ 2,400	$ 2,625	**$ 5,025**
TOTAL	**$ 51,477**	**$ 24,875**	**$ 76,352**

SUB AWARDS - Columbia River Inter-Tribal Fish Comm., WA Dept. of Ecology, OR Dept. of Geology & Minerial Industries, OR Dept. of State Lands, Nat'l Parks Svcs, Berring Data Coll., Gulf of Main Lobster Found.:

	CRITFC					DOGAMI	OR ODSL	WA Eco		NPS	BDC	GOMLF	
Title	Columbia glider	Obs	Modeling	DMAC	Outreach	OBSMAP & UPC	S. Slough Moorings	Shoreline	PS Ferry	NPS OA	NW FVOP	Student Drifters	**Other Subs TOTAL**
Lead	Seaton	Seaton	Seaton	Seaton	Seaton	Allan	Helms	Kaminsky	Krembs	Fradkin	Van Vranken	Manning	
Salaries	$ 6,761	$ 111,199	$ 74,374	$ 42,675	$ 2,000	$ 41,608	$ 6,475	$ 39,385	$ 15,306	$ 25,785			**$ 365,568**
Benefits	$ 1,606	$ 35,397	$ 26,403	$ 11,643	$ 702	$ 24,829	$ 2,270	$ 17,176	$ 6,273	$ 5,415			**$ 131,714**
Equipment		$ 28,279		$ 1,825				$ 9,000	$ 2,000	$ 1,500	$ 4,000		**$ 46,604**
Travel	$ 490	$ 1,720	$ 600	$ 720	$ 2,200	$ 8,822		$ 15,817				$ 1,200	**$ 31,569**
Sub Awards						$ 15,000							**$ 15,000**
Services		$ 46,722			$ 3,723		$ 1,338	$ 25,000		$ 1,500	$ 40,810	$ 31,000	**$ 150,093**
Supplies		$ 56,500	$ 13,050	$ 1,096		$ 7,014	$ 39,917	$ 10,124	$ 6,508	$ 2,000	$ 4,200	$ 19,277	**$ 159,686**
Student Aid													**$ -**
Total Direct	$ 8,857	$ 279,817	$ 114,427	$ 57,959	$ 8,625	$ 97,273	$ 50,000	$ 116,502	$ 30,087	$ 36,200	$ 49,010	$ 51,477	**$ 900,234**
Indirect Cost	$ 3,143	$ 64,853	$ 35,573	$ 19,697	$ 3,027	$ 26,128		$ 15,498	$ 5,913		$ 3,200	$ 7,723	**$ 184,755**
TOTAL	**$ 12,000**	**$ 344,670**	**$ 150,000**	**$ 77,656**	**$ 11,652**	**$ 123,401**	**$ 50,000**	**$ 132,000**	**$ 36,000**	**$ 36,200**	**$ 52,210**	**$ 59,200**	**$ 1,084,989**

NOAA Transfers via SCCOOS & CeNCOOS:

	SIO	NP School	
	Ocean Sound (via SCCOOS)	Ocean Sound (via CeNCOOS)	**NOAA Transfers TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 10,427	$ 13,114	**$ 23,541**
Benefits	$ 4,684	$ 6,460	**$ 11,144**
Equipment			**$ -**
Travel	$ 4,342		**$ 4,342**
Sub Awards			**$ -**
Services	$ 3,524		**$ 3,524**
Supplies	$ 13,421	$ 5,492	**$ 18,913**
Student Aid			**$ -**
Total Direct	$ 36,398	$ 25,066	**$ 61,464**
Indirect Cost	$ 6,552	$ 5,632	**$ 12,184**
TOTAL	**$ 42,950**	**$ 30,698**	**$ 73,648**

NANOOS YR 15-19 PROPOSAL EFFORT DISTRIBUTION BREAKDOWN SUMMARY

YEAR 19

UNIVERSITY OF WASHINGTON - Applied Physics Laboratory:

	APL											UW Other					
Title	Management	DMAC	Products & Web	Engagement & DEI	HABs	WA Shelf Buoy	PS Buoy	La Push Glider	WA HF	HABS ESP	OCNMS RT	**APL UW Total**	Atmos Atm Modl	OCN PS Model	FHLOO	**Other UW TOTAL**	**Combined Yr 19 Grand TOTAL**
Lead	Newton	Tanner	Tanner	Newton	Newton	Curry	Curry	Lee	Chickadel	Mickett	Mickett		Mass	MacCready	Dethier		
Salaries	$ 213,563	$ 53,601	$ 126,577	$ 80,134	$ 98,468	$ 34,318	$ 75,893	$ 44,804	$ 15,457	$ 20,256	$ 4,149	**$ 767,220**	$ 5,878	$ 74,789	$ 14,734	**$ 95,401**	**$ 862,621**
Benefits	$ 112,334	$ 28,194	$ 66,580	$ 42,150	$ 32,863	$ 18,051	$ 39,920	$ 23,567	$ 8,130	$ 10,655	$ 2,182	**$ 384,626**	$ 1,781	$ 18,246	$ 5,835	**$ 25,862**	**$ 410,488**
Equipment			$ 9,798					$ 220,000			$ 21,471	**$ 251,269**					**$ 251,269**
Travel	$ 20,307	$ 3,047	$ 4,000	$ 2,552	$ 1,858	$ 5,723			$ 1,275	$ 7,659	$ 383	**$ 46,804**		$ 3,000		**$ 3,000**	**$ 49,804**
Sub Awards	$ 2,951,302											**$ 2,951,302**					**$ 2,951,302**
Services	$ 21,371			$ 1,532	$ 41,000	$ 30,495	$ 66,720	$ 43,508		$ 19,854	$ 543	**$ 225,023**	$ 58		$ 6,890	**$ 6,948**	**$ 231,971**
Supplies	$ 10,619			$ 3,062	$ 743	$ 27,022	$ 13,877			$ 9,449	$ 17,934	**$ 82,706**		$ 428	$ 383	**$ 811**	**$ 83,517**
Student Aid	$ 50,000											**$ 50,000**					**$ 50,000**
Prorated Direct Costs	$ 133,124	$ 29,864	$ 69,399	$ 45,559	$ 9,718	$ 40,694	$ 69,136	$ 39,381	$ 8,751	$ 23,891	$ 8,867	**$ 478,384**					**$ 478,384**
Total Direct	$ 3,512,620	$ 114,706	$ 276,354	$ 174,989	$ 184,650	$ 156,303	$ 265,546	$ 371,260	$ 33,613	$ 91,764	$ 55,529	**$ 5,237,334**	$ 7,717	$ 96,463	$ 27,842	**$ 132,022**	**$ 5,369,356**
Indirect Costs	$ 97,150	$ 21,794	$ 50,646	$ 33,248	$ 65,350	$ 29,697	$ 50,454	$ 28,740	$ 6,387	$ 17,436	$ 6,471	**$ 407,373**	$ 4,283	$ 53,537	$ 15,451	**$ 73,271**	**$ 480,644**
Subtotal DC+IDC	$ 3,609,770	$ 136,500	$ 327,000	$ 208,237	$ 250,000	$ 186,000	$ 316,000	$ 400,000	$ 40,000	$ 109,200	$ 62,000	**$ 5,644,707**	$ 12,000	$ 150,000	$ 43,293	$ 205,293	**$ 5,850,000**
NOAA Transfers	$ 73,649											**$ 73,649**				**$ -**	**$ 73,649**
TOTAL (ex HB's)	**$ 3,683,419**	**$ 136,500**	**$ 327,000**	**$ 208,237**	**$ 250,000**	**$ 186,000**	**$ 316,000**	**$ 400,000**	**$ 40,000**	**$ 109,200**	**$ 62,000**	**$ 5,718,356**	**$ 12,000**	**$ 150,000**	**$ 43,293**	**$ 205,293**	**$ 5,923,649**
NOAA Hold Backs	$ 76,351											**$ 76,351**				**$ -**	**$ 76,351**

SUB AWARD - OREGON STATE UNIVESITY:

Title	Nearshore Bathymetry	Port Radar	OSU DMAC	HF Radar	OR Shelf Buoy	TH Shelf Glider	Columbia Glider	OR-WA Model	OA Reserves	Acoustics Network	DO Crab	Inlet Nav	**OSU TOTAL**
Lead	Ruggiero	Haller	Kosro	Kosro	Kosro	Barth	Barth	Zaron	Chan	Chapple	Shearman	Ozkan-Haller	
Salaries	$ 19,623	$ 25,057	$ 28,892	$ 202,621	$ 51,837	$ 16,836	$ 49,918	$ 67,609	$ 21,455		$ 44,094	$ 56,871	**$ 584,813**
Benefits	$ 8,514	$ 13,949	$ 14,735	$ 137,771	$ 32,474	$ 12,164	$ 28,130	$ 29,578	$ 11,428		$ 16,046	$ 26,332	**$ 331,121**
Equipment				$ 65,000	$ 6,000								**$ 71,000**
Travel	$ 5,584	$ 600	$ 4,500	$ 11,500	$ 5,000	$ 1,300	$ 3,704	$ 450	$ 2,241		$ 3,000	$ 7,500	**$ 45,379**
Sub Awards													
Services			$ 2,000	$ 18,033	$ 41,000	$ 13,500	$ 13,325	$ 3,072	$ 4,689	$ 2,679	$ 375	$ 2,000	**$ 100,673**
Supplies	$ 1,027	$ 1,606	$ 2,398	$ 21,995	$ 15,143	$ 16,806	$ 18,054	$ 302	$ 3,588	$ 48,500	$ 1,243	$ 3,636	**$ 134,298**
Student Aid											$ 18,834		**$ 18,834**
Total Direct	$ 34,748	$ 41,212	$ 52,525	$ 456,920	$ 151,454	$ 60,606	$ 113,131	$ 101,011	$ 43,401	$ 51,179	$ 83,592	$ 96,339	**$ 1,286,118**
Indirect Cost	$ 16,852	$ 19,988	$ 25,475	$ 190,080	$ 70,546	$ 29,394	$ 54,869	$ 48,989	$ 21,049	$ 24,821	$ 31,408	$ 46,724	**$ 580,195**
TOTAL	**$ 51,600**	**$ 61,200**	**$ 78,000**	**$ 647,000**	**$ 222,000**	**$ 90,000**	**$ 168,000**	**$ 150,000**	**$ 64,450**	**$ 76,000**	**$ 115,000**	**$ 143,063**	**$ 1,866,313**

NOAA Hold Backs - ONMS, NMFS:

	ONMS Ocean Sound	NMFS Ocean Sound	**NOAA Hold Backs TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 20,000	$ 15,000	**$ 35,000**
Benefits	$ 6,800	$ 5,250	**$ 12,050**
Equipment			**$ -**
Travel	$ 3,250	$ -	**$ 3,250**
Sub Awards			**$ -**
Services	$ 21,026		**$ 21,026**
Supplies			**$ -**
Student Aid			**$ -**
Total Direct	$ 51,076	$ 20,250	**$ 71,326**
Indirect Cost	$ 2,400	$ 2,625	**$ 5,025**
TOTAL	**$ 53,476**	**$ 22,875**	**$ 76,351**

SUB AWARDS - Columbia River Inter-Tribal Fish Comm., WA Dept. of Ecology, OR Dept. of Geology & Minerial Industries, OR Dept. of State Lands, Nat'l Parks Svcs, Berring Data Coll., Gulf of Main Lobster Found.:

	CRITFC					DOGAMI	OR ODSL	WA Eco		NPS	BDC	GOMLF	
Title	Columbia glider	Obs	Modeling	DMAC	Outreach	OBSMAP & UPC	S. Slough Moorings	Shoreline	PS Ferry	NPS OA	NW FVOP	Student Drifters	**Other Subs TOTAL**
Lead	Seaton	Seaton	Seaton	Seaton	Seaton	Allan	Helms	Kaminsky	Krembs	Fradkin	Van Vranken	Manning	
Salaries	$ 6,761	$ 111,199	$ 74,374	$ 42,675	$ 2,000	$ 41,608	$ 6,825	$ 39,385	$ 15,306	$ 25,785			**$ 365,918**
Benefits	$ 1,606	$ 35,397	$ 26,403	$ 11,643	$ 702	$ 24,829	$ 2,400	$ 17,176	$ 6,273	$ 5,415			**$ 131,844**
Equipment		$ 28,279		$ 1,825				$ 9,000	$ 2,000	$ 1,500	$ 4,000		**$ 46,604**
Travel	$ 490	$ 1,720	$ 600	$ 720	$ 2,200	$ 8,822		$ 15,817				$ 1,200	**$ 31,569**
Sub Awards						$ 15,000							**$ 15,000**
Services		$ 46,722			$ 3,723		$ 1,338	$ 25,000		$ 1,500	$ 40,810	$ 31,000	**$ 150,093**
Supplies		$ 56,500	$ 13,050	$ 1,096		$ 7,014	$ 39,437	$ 10,124	$ 6,508	$ 2,000	$ 4,200	$ 19,277	**$ 159,206**
Student Aid													**$ -**
Total Direct	$ 8,857	$ 279,817	$ 114,427	$ 57,959	$ 8,625	$ 97,273	$ 50,000	$ 116,502	$ 30,087	$ 36,200	$ 49,010	$ 51,477	**$ 900,234**
Indirect Cost	$ 3,143	$ 64,853	$ 35,573	$ 19,697	$ 3,027	$ 26,128		$ 15,498	$ 5,913		$ 3,200	$ 7,723	**$ 184,755**
TOTAL	**$ 12,000**	**$ 344,670**	**$ 150,000**	**$ 77,656**	**$ 11,652**	**$ 123,401**	**$ 50,000**	**$ 132,000**	**$ 36,000**	**$ 36,200**	**$ 52,210**	**$ 59,200**	**$ 1,084,989**

NOAA Transfers via SCCOOS & CeNCOOS:

	SIO	NP School	
	Ocean Sound (via SCCOOS)	Ocean Sound (via CeNCOOS)	**NOAA Transfers TOTAL**
	Peavy-Reeves	Peavy-Reeves	
Salaries	$ 11,150	$ 13,115	**$ 24,265**
Benefits	$ 4,778	$ 6,460	**$ 11,238**
Equipment			**$ -**
Travel	$ 4,512		**$ 4,512**
Sub Awards			**$ -**
Services	$ 3,704		**$ 3,704**
Supplies	$ 12,254	$ 5,492	**$ 17,746**
Student Aid			**$ -**
Total Direct	$ 36,398	$ 25,067	**$ 61,465**
Indirect Cost	$ 6,552	$ 5,632	**$ 12,184**
TOTAL	**$ 42,950**	**$ 30,699**	**$ 73,649**

NANOOS YR 15-19 PROPOSAL EFFORT DISTRIBUTION BREAKDOWN SUMMARY

ALL YEARS

UNIVERSITY OF WASHINGTON - Applied Physics Laboratory:

	APL											UW Other					
Title	Management	DMAC	Products & Web	Engagement & DEI	HABs	WA Shelf Buoy	PS Buoy	La Push Glider	WA HF	HABS ESP	OCNMS RT	**APL UW Total**	Atmos Atm Modl	OCN PS Model	FHLOO	**Other UW TOTAL**	**Combined 15-19 Grand TOTAL**
Lead	Newton	Tanner	Tanner	Newton	Newton	Curry	Curry	Lee	Chickadel	Mickett	Mickett		Mass	MacCready	Deithier		
Salaries	$ 998,256	$ 267,974	$ 632,225	$ 403,188	$ 492,340	$ 185,896	$ 396,297	$ 218,599	$ 61,828	$ 108,579	$ 15,385	**$ 3,780,567**	$ 29,390	$ 346,266	$ 70,836	**$ 446,492**	**$ 4,227,059**
Benefits	$ 525,082	$ 140,954	$ 332,554	$ 208,232	$ 164,315	$ 97,781	$ 208,452	$ 114,984	$ 32,520	$ 57,115	$ 8,092	**$ 1,890,081**	$ 8,905	$ 84,478	$ 28,052	**$ 121,435**	**$ 2,011,516**
Equipment	$ -	$ -	$ 50,609	$ -	$ -	$ 214,476	$ 195,410	$ 220,000	$ 150,000	$ -	$ 218,284	**$ 1,048,779**	$ -	$ 10,000	$ -	**$ 10,000**	**$ 1,058,779**
Travel	$ 80,108	$ 15,282	$ 20,000	$ 12,760	$ 9,290	$ 26,493	$ -	$ -	$ 5,100	$ 35,465	$ 2,478	**$ 206,976**	$ -	$ 15,001	$ -	**$ 15,001**	**$ 221,977**
Sub Awards	$ 15,197,841	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 15,197,841**	$ -	$ -	$ -	**$ -**	**$ 15,197,841**
Services	$ 100,954	$ -	$ -	$ 7,660	$ 205,000	$ 143,846	$ 314,728	$ 225,812	$ -	$ 93,633	$ 1,070	**$ 1,092,703**	$ 290	$ 9,000	$ 37,398	**$ 46,688**	**$ 1,139,391**
Supplies	$ 41,680	$ -	$ -	$ 15,310	$ 3,715	$ 127,460	$ 77,857	$ -	$ -	$ 44,573	$ 29,982	**$ 340,577**	$ -	$ 21,140	$ 2,920	**$ 24,060**	**$ 364,637**
Student Aid	$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 250,000**	$ -	$ -	$ -	**$ -**	**$ 250,000**
Prorated Direct Costs	$ 685,020	$ 149,320	$ 346,643	$ 227,795	$ 48,590	$ 204,678	$ 351,060	$ 196,905	$ 35,004	$ 119,455	$ 20,066	**$ 2,384,536**	$ -	$ -	$ -	**$ -**	**$ 2,384,536**
Total Direct	$ 2,681,100	$ 573,530	$ 1,382,031	$ 874,945	$ 923,250	$ 1,000,630	$ 1,543,804	$ 976,300	$ 284,452	$ 458,820	$ 295,357	**$ 26,192,060**	$ 38,585	$ 485,885	$ 139,206	**$ 663,676**	**$ 26,855,736**
Indirect Costs	$ 499,909	$ 108,970	$ 252,969	$ 166,240	$ 326,750	$ 149,370	$ 256,196	$ 143,700	$ 25,548	$ 87,180	$ 14,643	**$ 2,031,475**	$ 21,415	$ 264,115	$ 77,259	**$ 362,789**	**$ 2,394,264**
Subtotal DC+IDC	$ 3,181,009	$ 682,500	$ 1,635,000	$ 1,041,185	$ 1,250,000	$ 1,150,000	$ 1,800,000	$ 1,120,000	$ 310,000	$ 546,000	$ 310,000	**$ 28,223,535**	$ 60,000	$ 750,000	$ 216,465	$ 1,026,465	**$ 29,250,000**
NOAA Transfers	$ 362,749											**$ 362,749**				**$ -**	**$ 362,749**
TOTAL (ex HB's)	**$ 3,543,758**	**$ 682,500**	**$ 1,635,000**	**$ 1,041,185**	**$ 1,250,000**	**$ 1,150,000**	**$ 1,800,000**	**$ 1,120,000**	**$ 310,000**	**$ 546,000**	**$ 310,000**	**$ 28,586,284**	**$ 60,000**	**$ 750,000**	**$ 216,465**	**$ 1,026,465**	**$ 29,612,749**
NOAA Hold Backs	$ 387,251											**$ 387,251**				**$ -**	**$ 387,251**

SUB AWARD - OREGON STATE UNIVESITY:

Title	Nearshore Bathymetry	Port Radar	OSU DMAC	HF Radar	OR Shelf Buoy	TH Shelf Glider	WA Shelf Glider	OR-WA Model	OA Reserves	Acoustics Network	DO Crab	Inlet Nav	**OSU TOTAL**
Lead	Ruggiero	Haller	Kosro	Kosro	Kosro	Barth	Barth	Zaron	Chan	Chapple	Shearman	Ozkan-Haller	
Salaries	$ 93,289	$ 125,531	$ 141,986	$ 980,889	$ 252,864	$ 80,598	$ 227,725	$ 326,806	$ 101,206		$ 206,961	$ 288,086	**$ 2,825,941**
Benefits	$ 39,179	$ 67,278	$ 69,592	$ 645,316	$ 153,211	$ 54,402	$ 136,680	$ 141,825	$ 51,944		$ 63,403	$ 130,353	**$ 1,553,183**
Equipment			$ 10,400	$ 401,400	$ 54,200	$ 220,000	$ 100,000				$ 50,000		**$ 836,000**
Travel	$ 26,304	$ 2,800	$ 22,500	$ 62,500	$ 25,000	$ 5,620	$ 22,120	$ 11,650	$ 11,205		$ 15,000	$ 37,500	**$ 242,199**
Sub Awards													**$ -**
Services			$ 10,000	$ 105,958	$ 207,500	$ 85,106	$ 71,018	$ 14,338	$ 32,795	$ 13,395	$ 1,875	$ 11,146	**$ 553,131**
Supplies	$ 14,968	$ 10,451	$ 11,545	$ 113,488	$ 72,402	$ 77,304	$ 108,112	$ 10,434	$ 19,855	$ 242,500	$ 18,789	$ 14,610	**$ 714,458**
Student Aid											$ 70,548		**$ 70,548**
Total Direct	$ 173,740	$ 206,060	$ 266,023	$ 2,309,551	$ 765,177	$ 523,030	$ 665,655	$ 505,053	$ 217,005	$ 255,895	$ 426,576	$ 481,695	**$ 6,795,460**
Indirect Cost	$ 84,260	$ 99,940	$ 123,977	$ 925,449	$ 344,823	$ 146,970	$ 274,345	$ 244,947	$ 105,245	$ 124,105	$ 148,424	$ 233,620	**$ 2,856,105**
TOTAL	**$ 258,000**	**$ 306,000**	**$ 390,000**	**$ 3,235,000**	**$ 1,110,000**	**$ 670,000**	**$ 940,000**	**$ 750,000**	**$ 322,250**	**$ 380,000**	**$ 575,000**	**$ 715,315**	**$ 9,651,565**

NOAA Hold Backs - ONMS, NMFS:

ONMS Ocean Sound	NMFS Ocean Sound	**NOAA Hold Backs TOTAL**
Peavy-Reeves	Peavy-Reeves	
$ 105,000	$ 75,000	**$ 180,000**
$ 35,700	$ 26,250	**$ 61,950**
$ -	$ -	**$ -**
$ 10,998	$ 4,000	**$ 14,998**
$ -	$ -	**$ -**
$ 104,578	$ -	**$ 104,578**
$ -	$ -	**$ -**
$ -	$ -	**$ -**
$ 256,276	$ 105,250	**$ 361,526**
$ 12,600	$ 13,125	**$ 25,725**
$ 268,876	**$ 118,375**	**$ 387,251**

SUB AWARDS - Columbia River Inter-Tribal Fish Comm., WA Dept. of Ecology, OR Dept. of Geology & Minerial Industries, OR Dept. of State Lands, Nat'l Parks Svcs, Berring Data Coll., Gulf of Main Lobster Found.:

	CRITFC					DOGAMI	OR ODSL	WA Eco		NPS	BDC	GOMLF	
Title	Columbia glider	Obs	Modeling	DMAC	Outreach	OBSMAP & UPC	S. Slough Moorings	Shoreline	PS Ferry	NPS OA	NW FVOP	Student Drifters	**Other Subs TOTAL**
Lead	Seaton	Seaton	Seaton	Seaton	Seaton	Allan	Helms	Kaminsky	Krembs	Fradkin	Van Vranken	Manning	
Salaries	$ 33,805	$ 555,995	$ 371,870	$ 213,375	$ 10,000	$ 208,040	$ 31,150	$ 196,925	$ 76,530	$ 128,925		$ -	**$ 2,122,684**
Benefits	$ 8,030	$ 176,985	$ 132,015	$ 58,215	$ 3,509	$ 124,145	$ 10,925	$ 85,880	$ 31,365	$ 27,075		$ -	**$ 799,965**
Equipment	$ 1,825	$ 122,810		$ 9,125		$ 94,531		$ 45,000	$ 10,000	$ 7,500	$ 19,350	$ -	**$ 326,901**
Travel	$ 2,450	$ 8,600	$ 2,999	$ 3,600	$ 11,000	$ 44,110		$ 79,085				$ 5,800	**$ 192,729**
Sub Awards						$ 75,000						$ -	**$ 75,000**
Services		$ 233,610			$ 18,616		$ 6,690	$ 125,000		$ 7,500	$ 207,700	$ 180,000	**$ 901,281**
Supplies		$ 282,500	$ 65,251	$ 5,480		$ 35,070	$ 201,235	$ 50,620	$ 32,540	$ 10,000	$ 18,800	$ 94,891	**$ 877,436**
Student Aid												$ -	
Total Direct	$ 46,110	$ 1,380,500	$ 572,135	$ 289,795	$ 43,125	$ 580,896	$ 250,000	$ 582,510	$ 150,435	$ 181,000	$ 245,850	$ 280,691	**$ 5,295,996**
Indirect Cost	$ 15,715	$ 324,265	$ 177,865	$ 98,485	$ 15,135	$ 130,640		$ 77,490	$ 29,565		$ 15,200	$ 42,109	**$ 1,000,280**
TOTAL	**$ 60,000**	**$ 1,723,350**	**$ 750,000**	**$ 388,280**	**$ 58,260**	**$ 711,536**	**$ 250,000**	**$ 660,000**	**$ 180,000**	**$ 181,000**	**$ 261,050**	**$ 322,800**	**$ 6,296,276**

NOAA Transfers via SCCOOS & CeNCOOS:

SIO	NP School	
Ocean Sound (via SCCOOS)	Ocean Sound (via CeNCOOS)	**NOAA Transfers TOTAL**
Peavy-Reeves	Peavy-Reeves	
$ 50,499	$ 65,571	**$ 116,070**
$ 22,521	$ 32,300	**$ 54,821**
$ -	$ -	**$ -**
$ 20,934	$ -	**$ 20,934**
$ -	$ -	**$ -**
$ 17,063	$ -	**$ 17,063**
$ 70,973	$ 21,968	**$ 92,941**
$ -	$ -	**$ -**
$ 181,990	$ 119,839	**$ 301,829**
$ 32,760	$ 28,160	**$ 60,920**
$ 214,750	**$ 147,999**	**$ 362,749**

E. Letters of Support

1. Quinault Indian Nation
2. Canadian IOOS-Pacific
3. Columbia River Bar Pilots
4. Emergency Volunteer Corps of Nehalem Bay
5. Pacific Coast Shellfish Growers Association
6. NOAA Pacific Marine Environmental Lab
7. Oregon Coastal Management Program
8. West Coast Ocean Data Portal
9. Olympic Coast National Marine Sanctuary
10. National Marine Sanctuary Foundation
11. California Current Integrated Ecosystem Assessment Team

Quinault Indian Nation

PO Box 189 * Taholah, WA 98587

Dr. Jan Newton
Executive Director, NANOOS
Applied Physics Laboratory
University of Washington
1013 N.E. 40th Street
Seattle, WA 98105-6698

December 2, 2020

RE: Northwest Association of Networked Ocean Observing Systems (NANOOS).

The Quinault Indian Nation is pleased to support the ongoing efforts of NANOOS and is hopeful for this organization's continued funding and enhancement. Quinault has benefitted from a successful and fruitful 16-year relationship with NANOOS since we joined as an original member. Benefits includes collaboration with the Columbia River Intertribal Fish Commission and Oregon State University deploying a glider in our treaty ocean area for seasonal hypoxia and other data, real-time sea and weather information from the NANOOS Visualization System (NVS), and Live Ocean forecasts for our coast. Of continuing importance to Quinault is the NANOOS focus on Harmful Algal Bloom (HAB) monitoring and warning that we hope this 5-year effort will continue to sustain and improve.

The coastal tribes of Washington State are shellfish harvesters and at the mercy of changing winds that transport HABs from incubation sites offshore. Harvesters seldom get warning before HABs are already on the shores where tribal HAB samplers detect them and managers can take action to restrict harvest of shellfish should toxins be present. Having a NANOOS automated HAB sampler with toxin assay capability, offshore between our harvest beaches and HAB generation sites gives tribes forewarning they need to adjust sampling protocols and better protect the health of coastal residents, tribal and non-tribal.

The information and products that we continue to access from NANOOS assists in our management practices and helps to assure safe harvest of Quinault treaty resources.

Sincerely,

Joe Schumacker, Marine Resources Scientist
Quinault Indian Nation, Department of Fisheries

Hakai
Science on the Coastal Margin

December 1, 2020

To whom it may concern:

I am writing as Chair of the Regional Oversight Committee of the Canadian Integrated Ocean Observing System (CIOOS) – Pacific Regional Association, and as CEO of the Hakai Institute, in support of the Northwest Association of Networked Ocean Observing Systems (NANOOS) Proposal for "Implementation and Development of the Northwest Association of Networked Ocean Observing Systems Observing System," submitted under NOAA Funding Opportunity FY 2021 Implementation of the U.S. Integrated Ocean Observing System (IOOS®.)

The Canadian Integrated Ocean Observing System (CIOOS) is an open-access national system that brings together the various elements of ocean observation in Canada. It facilitates access to existing resources, new information, and technology and makes data discoverable. Three Regional Associations work closely with local oceanographic communities and organizations to meet the end-user needs.

The CIOOS Pacific Regional Association will collaborate with NANOOS in the coming five years on observing activities that will mutually benefit the two Regional Associations, especially in the areas of ocean acidification and harmful algal blooms. One project we look forward to is developing a shared "Oyster Dashboard" for displaying OA parameters, working collectively with Canada's Hakai Institute and other IOOS RAs. Additionally, we want to scope HF current needs in the Strait of Juan de Fuca and where opportunities lie for joint collaboration.

As we are both North American west coast regional associations of our respective countries' integrated ocean observing systems, we have much in common. We will look for other projects of mutual interest, in particular building on the climatology for the west coast undertaken by the three west coast Regional Associations (NANOOS, CeNCOOS, and SCCOOS).

We look forward to establishing more formal ties with NANOOS in the coming years.

Sincerely,

Eric Peterson,
President, Hakai Institute
Chair, CIOOS Regional Oversight Committee

THE COLUMBIA RIVER BAR PILOTS

Providing Safe Passage Since 1846

28 November 2020

Dear NANOOS:

I offer strong support for the continuation of NANOOS at a high level, as you propose in your 5-y "Sustaining NANOOS, the Northwest Association of Networked Observing Systems" proposal application to NOAA.

NANOOS has been a valued partner and regional coordinating body, providing unique and effective data for mariners. Ships crossing the Columbia River Bar face one of the most dangerous harbor entrances in the world. The Columbia River Bar Pilots rely on weather forecasts, real time buoy data along with wave and current models when determining safe times for ships to cross the bar. NANOOS provides an excellent location for us to see and compare all the available data sources.

Further, NANOOS has proven itself as a critical link between NOAA management and PNW stakeholders. Most recently, while the NDBC buoy 46089 was being decommissioned. I appreciated working with NANOOS, to codify the requirements for coastal ocean data from the Columbia Bar Pilots and from others. I believe that getting the extent and type of data usage known to the highest levels of NOAA NOS and NWS was a large factor in their decision to preserve this buoy critical to our safe operations.

I am pleased to let you know that NANOOS is making a very real difference to the safety and efficiency of maritime operations in the Columbia River area of the PNW. I wish you success.

Best Regards

Captain Daniel Jordan

100 16TH STREET, ASTORIA, OREGON 97103
OFFICE 503-325-2643 • DISPATCH 503-325-2641 • EMAIL: ACCOUNTING@COLUMBIARIVERBARPILOTS.COM
WWW.COLUMBIARIVERBARPILOTS.COM

EMERGENCY VOLUNTEER CORPS of NEHALEM BAY
P.O.BOX 598, Manzanita, Oregon 97130 • EVCNB.ORG

November 27, 2020

Dr. Jan A Newton
NANOOS Director

RE: DOGAMI's 5-year NANOOS proposal to NOAA IOOS

Dear Dr. Newton,

I am President of a not-for-profit focused on helping our community to better understand how to be prepared. Our organization serves several rural communities on the northern coast of Oregon, with the obvious risk of an earthquake and potential tsunami. We were established in 2008, after hurricane force winds isolated our region for over a week with no help from the "outside" world. We have aging demographics and learned very quickly that the only way to survive was to work together, prepared together and understand that only we could save ourselves.

DOGAMI'S Dr. Jonathan Allan has been instrumental in the development of education materials, community trainings and outreach. He has helped us understand the effects of Climate Change and coastal erosion on our community. He brings factual data and guides, utilizing your excellent resources, allowing us to better understand how to organize and prepare.

NANOOS is a critical part of that educational outreach. NANOOS has been an important partner particularly in our tsunami-educational outreach work. We have utilized your tsunami web application and of course the smartphone application.

I could not more strong support the continuation of your partnership with Dr. Allan and DOGAMI, without the tools and their support we would never have been able to develop are outreach and obtain such universal support from our community.

I sincerely and wholehearted appreciate you amazing, creative and helpful tools.

With warmest regards,

Linda Kozlowski, President
Emergency Volunteer Corps of Nehalem Bay

December 1, 2020

Dr. Jan Newton, Ph.D.
Applied Physics Laboratory
University of Washington 1013
NE 40th St
Seattle WA 98105-6698

Dear Dr. Newton,

I write to you, on behalf of the members of the Pacific Coast Shellfish Growers Association (PCSGA), with enthusiastic support of your five-year proposal for continuation of NANOOS. The PCSGA was founded in 1930 and represents approximately 100 private and tribal farms, providing over 3,000 jobs in Alaska, California, Hawaii, Washington, and Oregon. PCSGA's members are diverse in both farm size and location where oysters, clams, mussels, and geoduck are grown for both domestic and export markets at a value of nearly $300 million.

The work of NANOOS contributes significantly to the Pacific Northwest's shellfish industry which in turn supports coastal economies dependent on the industry for jobs. Shellfish have been an essential part of coastal communities for over a century. During this time, farming techniques have evolved in response to environmental conditions, permitting requirements, and market demands. This current generation of shellfish farmer is reliant upon data and services from NANOOS. Checking the NANOOS app or website before seeding a beach or filling a setting tank has become standard practice.

Sustained funding for NANOOS is crucial to the maintenance of the program's ocean observing network and to the continuity of the important data products and services that these observations enable. PCSGA and individual shellfish companies enjoy our partnerships with NANOOS which provided much needed monitoring of ocean acidification all along the Pacific Coast. Specifically, we very much appreciate NANOOS's collaboration with local, state and federal agencies as well as with researchers around the globe which have resulted in access to vital, resources. Most recently, through NANOOS' leadership, growers have been introduced to LiveOcean which offers growers access to 3-day forecasts of not only currents, tides, temperature, and salinity but also critical information regarding harmful algal blooms. NANOOS ability to know and more importantly develop tools that growers don't yet know they need is remarkable and very much worthy of continued funding.

Please keep up the good work! It makes a big difference to the shellfish community! We wish you luck in securing funding for this on-going effort so valuable to our members. Please keep me posted on your progress and be sure to let me know how I may assist you further.

Respectfully,

Margaret A. Pilaro

120 State Ave. NE, #142 • Olympia, WA 98501 • phone: 360-754-2744 • fax: 360-754-2743

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OAR Laboratories

Pacific Marine Environmental Laboratory
NOAA Building Number 3
7600 Sand Point Way NE
Seattle, WA 98115

November 24, 2020 R/PMEL

To Whom It May Concern:

As the laboratory leading NOAA's West Coast ocean acidification monitoring program, I am writing to express our strong support for the proposal of Dr. Jan Newton and colleagues entitled Sustaining NANOOS, the Pacific Northwest component of the US JOOS. NOAA has been mandated by Congress to lead the nation's ocean acidification monitoring and research effort. NOAA's ocean acidification monitoring network in Pacific Northwest coastal waters, detailed in the NOAA Ocean and Great Lakes Acidification Research Plan, has been designed to capitalize on existing NANOOS assets, which provide essential platforms as well as extremely valuable ancillary sensors that facilitate and complement NOAA's ocean acidification observations, respectively. Without NANOOS assets, our ability to effectively monitor the development and effects of ocean acidification in Pacific Northwest coastal waters would be significantly curtailed.

The Pacific Northwest is a sentinel region for ocean acidification nationwide, because waters upwelled along our coastline are naturally CO_2-rich, such that the addition of anthropogenic CO_2 can render them corrosive to marine organisms sooner than in other regions. We have been extensively collaborating with NANOOS on both infrastructure development and deployment, and outreach and educational efforts over the last several years. We envision that together these components of NANOOS will provide a test bed for the development of an ocean acidification early warning system that would benefit the shellfish industry and other stakeholders in the Pacific Northwest. Thus, we cannot overstate the importance of maintaining NANOOS's infrastructural, data management, and outreach assets for the successful development of NOAA's West Coast and national ocean acidification monitoring networks and information products.

Sincerely,

Richard A. Feely

Richard A. Feely, Senior Fellow
Pacific Marine Environmental Laboratory

Oregon
Kate Brown, Governor

Department of Land Conservation and Development
Oregon Coastal Management Program
635 Capitol Street NE, Suite 150
Salem, Oregon 97301-2540
Phone: 503-373-0050
Fax: 503-378-6033
www.oregon.gov/LCD

November 30, 2020

Jan A Newton, Ph.D.
Principal Senior Oceanographer, NANOOS Director,
Applied Physics Laboratory Affiliate Professor,
Schools of Oceanography & Marine and Environmental Affairs
Washington Ocean Acidification Center Co-Director
University of Washington Seattle, WA

Dear Jan Newton,

On behalf of Oregon's Coastal Management Program (OCMP), I am writing to support DOGAMI's five-year proposal to the Northwest Association of Networked Ocean Observing System for the Oregon Beach Shoreline Mapping and Analysis Program. The proposed effort will help to continue to inform our understanding of the Oregon coast and inform land use planning and coastal management actions at the state and local level.

The state of Oregon requires communities within the coastal zone to regulate development in compliance with FEMA's National Flood Insurance Program and the statewide planning goals, which include specific requirements for areas subject to natural hazards and coastal resources such as beaches and dunes. The beach and shoreline monitoring data supported by NANOOS has been instrumental in helping to support those requirements, such as completing new FEMA regulatory maps, updating the science for foredune management planning purposes, developing coastal hazard zone maps to guide development, and monitoring dynamic revetments used for mitigating the effects of coastal erosion. OCMP would like to support the continuation of this monitoring work by DOGAMI and partners in order to continue to utilize this vital information for coastal planning and management. In addition, we greatly support expanding coastal observational capacity through a pilot bluff monitoring program on the central Oregon coast with a ground based lidar system. Our agency has need to further understand bluff change along the Oregon coast in order to support enhanced land use regulations and account for the impacts of a changing climate.

We look forward to supporting this program if it is funded and using the meaningful data that it produces.

Sincerely,

Patty Snow, Coastal Program Manager
Oregon Coastal Management Program
Department of Land Conservation and Development

December 3, 2020

Dr. Jan Newton
Executive Director
NANOOS
1013 N.E. 40th Street
Seattle, WA 98105-6698

Dear Dr. Newton,

On behalf of The West Coast Ocean Data Portal, we enthusiastically endorse the valuable data and services provided by the Northwest Association of Networked Ocean Observing Systems (NANOOS), and their proposed 5-year budget. NANOOS provides a valuable and essential service in bringing real-time and historic oceanographic data to a broad suite of stakeholders for emergency response, decision-making, and planning.

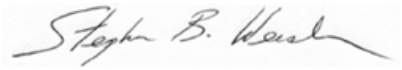
The West Coast Ocean Data Portal (WCODP) seeks to increase access to and discovery of critical ocean and coastal data for resource managers and policymakers on the West Coast. The ocean observing information provided by NANOOS are important resources for us to highlight in our data catalog, so that our users (namely the state, tribal and federal agencies represented in the West Coast Ocean Alliance, or WCOA) can access the most up-to-date data and models to inform their decision-making at local and regional levels. The WCODP and WCOA both feel that comprehensive ocean data is extremely important in meeting the needs of this management community. The marine economy contributes over 150,000 jobs and $15 billion to Oregon and Washington's GDPs (OceanReports 2020), and the data provided by NANOOS helps decision-makers understand how to make tradeoffs between important ocean uses, and provide context to those decisions. Additionally, as the WCODP works on several upcoming data-derived products, the expertise of those at NANOOS has been invaluable, and we expect to continue this working relationship and utilize data from the observing systems they support and maintain well into the future.

As a science-based decision support program, NANOOS collaborates with local, state and federal agencies, tribes, resource managers, industry, policy makers, educators, scientists and the general public to provide data, models and products that advance our understanding of the current and future state of our coastal and global ocean. NANOOS focuses on high-priority regional requirements to provide the information necessary to address marine operations, coastal hazards, climate variability and change, and ecosystems, fisheries, and water quality.

Sustained funding for NANOOS is crucial to the maintenance of the Northwest's ocean observing network and to continue the delivery of important data products and services that these observing systems enable. Please feel free to contact us if you have any questions.

Sincerely,

Andy Lanier
Co-Chair, West Coast Ocean Data Portal



Stephen B. Weisberg, Ph.D.
Co-Chair, West Coast Ocean Data Portal

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

Olympic Coast National Marine Sanctuary
115 E. Railroad Ave , Suite 301
Port Angeles, Washington 98362

October 28, 2020

Dr. Jan Newton, Executive Director
Northwest Association of Networked Ocean Observing Systems
University of Washington, Applied Physics Laboratory
Seattle, WA 98105-6698

Dear Jan,

As Superintendent of Olympic Coast National Marine Sanctuary (OCNMS), I enthusiastically endorse the valuable data and services provided by the Nortwest Association of Networked Ocean Observing Systems (NANOOS), many of which greatly enhance our understanding of ocean ecosystem dynamics influencing conditions within OCNMS. Thank you for your continued dedication to serving the community of resource managers and users in our region so effectively and collaboratively.

I am also writing to encourage your earnest consideration of two projects proposed under the recent call for expressions of interest in the new 5-year NANOOS cooperative agreement: support for development of an ocean sound observing network at Olympic Coast, and transformation of OCNMS oceanographic mooring program by adding capacity for near real-time data delivery. Both of these projects represent critical enhancements to existing research programs and initiatives at OCNMS and align with the sanctuary's priorities for the future, while also complementing the core capabilities of NANOOS and its collaborators. It is difficult to prioritize between the two projects because both are highly compelling and relevant to our work on specific science themes while also contributing valuable information that may be used in developing sanctuary condition reports and informing climate assessment and management planning processes.

Dr. Mickett's proposal to transform OCNMS' ability to deliver mooring data would be a literal game-changer for the sanctuary and the user community that tracks and utilizes the information, including ocean forecast modelers (e.g., LiveOcean, J-SCOPE), natural resource departments of Washington's four Coastal Treaty Tribes, State of Washington agencies, and the public. It is a step that could not be taken without additional expertise from NANOOS partners, nor should it be developed outside the NANOOS umbrella, given our shared missions and close existing partnership.

At the same time, the ocean sound observation network proposal represents the aspirations of OCNMS as well of other sites within the broader Office of National Marine Sanctuaries, since it would further efforts to engage NANOOS, along with CenCOOS, and SCCOOS, in a west-coast wide network for integration of ocean sound monitoring within the context of IOOS nodes and allied efforts such as the Marine Biodiversity Observing Network. At OCNMS, this would involve integration of sound monitoring assets deployed by partners from Scripps Institute of Oceanography, the Naval Postgraduate School, and NOAA Pacific Marine Environmental Laboratory, all of whom have considerable expertise in this field. Further, this project would leverage ONMS assets, such as research vessels and staff from across the program toward shared goals, particularly towards greater incorporation of sound as an Essential Ocean Variable and the development of outreach products to accompany robust, standardized sound metrics that can inform future ecosystem assessments.

In closing, I'd like to reiterate my strong support for both projects which will help to advance both OCNMS and West Coast Regional priorities around ocean monitoring. Please contact me at 360-460-2822 if you need any additional information on our engagement and support.

Sincerely,

Carol Bernthal, Superintendent
Olympic Coast National Marine Sanctuary

National
Marine Sanctuary
Foundation

301.608.3040 | 8601 Georgia Avenue, Suite 510, Silver Spring, MD 20910

November 30, 2020

Dr. Anderson and Dr. Ruhl
The California Ocean Observing Systems
Southern California Coastal Ocean Observing System
Central and Northern California Ocean Observing System

Dr. Newton
Northwest Association of Networked Ocean Observing Systems

Dear Dr. Anderson, Dr. Ruhl, and Dr. Newton:

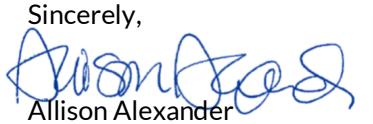
On behalf of the National Marine Sanctuary Foundation, I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS), the Central and Northern California Ocean Observing System (CeNCOOS), and the Northwest Association of Networked Ocean Observing Systems (NANOOS), located at the Scripps Institution of Oceanography, University of California San Diego (UCSD), the Monterey Bay Aquarium Research Institute (MBARI), and the University of Washington, respectively. I'm writing today to further support these IOOS Regional Associations in their proposals to include an Ocean Sound Observation Network in their next five years of funded activity.

The National Marine Sanctuary Foundation is the national non-profit partner to the National Marine Sanctuary System, and supports research and related activities in sanctuaries. Efforts to monitor underwater soundscapes in sanctuaries are already connected to the Foundation in several ways, including through funding from a cooperative agreement between NOAA and the Foundation that supports the West Coast Soundscapes Coordinator staff position (as of November 2020), and in other areas. The West Coast Soundscapes Coordinator is supported through funding awarded through a cooperative agreement with NOAA/NOS/Office of National Marine Sanctuaries (NA17NOS4290190 and NA19NOS4290190A). The Foundation also holds an MOA with NOAA/NOS/ONMS (MOA-2019-075) that states that the two organizations will work collaboratively to "[a]dvance conservation of national marine sanctuaries including through the support and development of scientific research, data collection and monitoring, and use of innovative technologies."

As a science-based decision support program, the west coast Ocean Observing Systems (NANOOS, CeNCOOS, and SCCOOS) collaborate with local, state and federal agencies, tribes, resource managers, industry, policy makers, educators, scientists and the general public to provide data, models and products that advance our understanding of the current and future state of our coastal and global ocean. These IOOS regional associations focus on high-priority regional requirements to provide the information necessary to address marine operations, coastal hazards, climate variability and change, and ecosystems, fisheries, and water quality. I believe that the inclusion of underwater sound within these regional information systems will advance the interests of many stakeholders, including the Foundation.

Sustained funding for SCCOOS, CeNCOOS, and NANOOS is crucial to the maintenance of the state's ocean observing network and to continue the delivery of important data products and services that these observing systems enable. Please feel free to contact me if you have any questions at allison@marinesanctuary.org.

Sincerely,



Allison Alexander
Vice President

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Fisheries Science Center
2725 Montlake Boulevard East
SEATTLE, WASHINGTON 98112-2097
F/NWC1

November 13, 2020

Dr. Clarissa Anderson and Dr. Henry Ruhl
The California Ocean Observing Systems
Southern California Coastal Ocean Observing System
Central and Northern California Ocean Observing System

Dr. Jan Newton
Northwest Association of Networked Ocean Observing Systems

Dear Drs. Anderson, Ruhl and Newton:

On behalf of the NOAA Fisheries Northwest Fisheries Science Center and the NOAA California Current Integrated Ecosystem Assessment (CCIEA) team, I enthusiastically endorse the valuable data and services provided by the Southern California Coastal Ocean Observing System (SCCOOS), the Central and Northern California Ocean Observing System (CeNCOOS), and the Northwest Association of Networked Ocean Observing Systems (NANOOS), located at the Scripps Institution of Oceanography, University of California San Diego (UCSD), the Monterey Bay Aquarium Research Institute (MBARI), and the University of Washington, respectively.

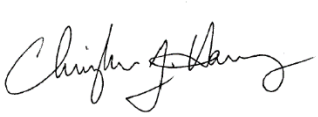
The NOAA CCIEA team is a cooperative team of scientists and policy makers representing the Northwest and Southwest Fisheries Science Centers, the NOAA Fisheries West Coast Regional Office, and many academic and NGO partners. The CCIEA team strives to provide science in support of ecosystem-based management of fisheries, protected species, and other valuable resources and ecosystem services along the U.S. West Coast. We rely heavily upon primary data collection platforms such as those in IOOS to provide monitoring data and expert understanding, in order for us to generate products such as ecosystem status reports, risk assessments, and management strategy evaluations. Among our strongest partners are the Pacific Fishery Management Council; the five National Marine Sanctuaries located along the West Coast; state fisheries management agencies; and the NOAA Fisheries Office of Protected Resources. We also are working on an emerging partnership with the West Coast Ocean Alliance, particularly around areas of non-fisheries activities such as offshore renewable energy development.

Information collected by NANOOS, CeNCOOS and SCCOOS is ideal for the work we do, and is already being incorporated into our efforts, including annual ecosystem status reporting to the Pacific Fishery Management Council and supporting National Marine Sanctuaries with their place-based condition reports. Additional information of the sort proposed by the West Coast IOOS RAs would add considerable value to monitoring and ecosystem status and risk assessment: for example, expanded information on anthropogenic sound profiles at the scale of Sanctuaries would

enhance their ability to assess conditions within their waters for species such as marine mammals, and may also support CCIEA scientists' assessments of risk for marine mammals that are also being affected by other stressors such as coastal habitat quality change and variability in forage. Further, developing good baselines of sound levels and variability is imperative to assessing changes and impacts that may be brought about by offshore renewable energy projects, deep sea mining, and other potential ocean uses that may affect fishery species and protected species.

Sustained funding for SCCOOS, CeNCOOS, and NANOOS is crucial to the maintenance of the ocean observing network and to continue the delivery of important data products and services that these observing systems enable. Continuity of data streams, data processing and delivery, and monitoring focused on emerging priorities are only becoming more essential as other monitoring efforts are curtailed due to funding and logistical constraints. The CCIEA and our many partners thus strongly endorse support and funding of West Coast IOOS projects. Please feel free to contact me if you have any questions.

Sincerely,



Dr. Chris Harvey
Research Fishery Biologist
Co-lead, California Current Integrated Ecosystem Assessment team

F. NANOOS Partner Information

Collaborator	City, State	Congressional District	Performance Location
University of Washington (UW)	Seattle, WA	WA-007	Seattle; Puget Sound, Salish Sea, La Push, WA shelf, San Juan Is.
Oregon State University (OSU)	Corvalis, OR	OR-004	Corvallis and Newport; OR shorelines & shelf; Trinidad Head, CA
Columbia River Inter-tribal Fish Commission (CRITFC)	Portland, OR Astoria, OR	OR-003 OR-001	Astoria and Portland; Columbia River estuary and shelf waters off WA and OR; OR estuaries
Washington State Department of Ecology (WDOE)	Olympia, WA	WA-010	Olympia, WA, waters between Seattle, WA, and Victoria, BC, and WA shorelines
Oregon Department of Geology and Mineral Industries (DOGAMI)	Portland, OR	OR-003	Portland, OR, Oregon shorelines
Oregon Department of State Lands	Salem, OR Coos Bay, OR	OR-005 OR-004	South Slough and Coos Bay estuaries, OR
Olympic National Park	Port Angeles, WA	WA-006	Olympic Coast and San Juan Island, WA
Berring Data Collection	Remote office	Distributed	Coastal ocean waters off WA and OR
Gulf of Maine Lobster Foundation	Remote office	Distributed	Coastal ocean waters off WA and OR
Ocean Sound Observation Network	Remote offices	Distributed	Coastal ocean off Olympic Peninsula, WA

G. Budget Narrative

Our Budget Narrative is laid out by the Subsystems listed in the NOFO (Governance and Management, Observing, DMAC, Modeling and Analysis, and Engagement) in order to relate budget to the work efforts described in our Project Narrative. We also describe the budget according to cost category (salary/benefits, travel, equipment, etc.) in our Budget Justification in Appendix H.

The NANOOS 5-y budget is shown in Table 3 for the full $30M budget and our priorities for the $15M budget are shown in Table 4. Both tables are laid out to match our Effort versus Application matrix (Table 2), for ease of reference to show how NANOOS Observing and Modeling Subsystem efforts serve PNW priority user applications. Our Governance & Management, DMAC & Products, and Engagement Subsystems support all these efforts and enable production of data, data products, and information to serve the users' applications in Table 2 and described in our Work Plan.

Below we show our budget broken out by sub-systems, showing a balanced effort, with the majority allocation toward observing efforts and relatively equitable amounts to the other sub-systems. Under a $3M budget scenario, the Observing Subsystem would be considerably less.

NANOOS Subsystems	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Governance & Management	563,137	650,468	650,468	658,468	658,468	**3,181,009**
Observing	3,974,755	3,887,424	3,887,424	3,879,424	3,879,424	**19,508,451**
Data Management & Products	619,156	619,156	619,156	619,156	619,156	**3,095,780**
Modeling & Analysis	605,063	605,063	605,063	605,063	605,063	**3,025,315**
Engagement & DEI	237,889	237,889	237,889	237,889	237,889	**1,189,445**
Total	**6,000,000**	**6,000,000**	**6,000,000**	**6,000,000**	**6,000,000**	**30,000,000**

Annual detailed budgets showing all efforts and partners are presented in Table 5. We include an overall SF424A and one for each sub-awardee. The University of Washington is the fiscal agent of NANOOS. To execute this work, NANOOS will engage with the partners shown in Table 3. We provide detailed statements of work, budgets, and budget justifications for UW activities, followed by similar packages for each of our collaborators, including their institutional letter of commitment.

Pending the award amount with respect to our prioritized work plan, which will be established annually through the de-scope process, NANOOS will establish a subaward to each institution and submit new information, updated to funding allocation, as part of our annual descope package. (Note: if funded, the Ocean Sound project (Peavey-Reeves, PI) would be funded through transfer of funds by NOAA IOOS to CeNCOOS (to the Naval Postgraduate School) and to SCCOOS (to Scripps Institution of Oceanography), bypassing UW. In the table on p 20 of the Project Description, these funds were included in Services/Contractual). We highlight here the main details and justification from the budget information submitted to NANOOS.

Benefits on all salaries are charged at the PI's institutional rates; indirect costs are also per legal institutional rates and base is according to their practices. UW, the lead fiscal agent for NANOOS has an indirect rate of 19%. For subcontracts, indirect is charged on the first $25,000 of the first year only.

Governance and Management Subsystem: Budget is requested each year to support NANOOS governance and management capacities for the NANOOS RA, assuring regional and national coordination, and its RCOOS subsystems. Salaries are for PIs Executive Director Newton (UW) and NANOOS Program Manager Rome (UW) to oversee and direct all elements of the NANOOS RA and RCOOS and for management and representation of the NANOOS Board. Travel is for regional and national coordination meetings and for workshops/conferences associated with NANOOS, IOOS Association, and IOOS. Permission for international travel is requested. If given permission by the IOOS Program Office via Grants Online, NANOOS may choose to re-budget domestic travel to foreign travel, if necessary, to represent IOOS or NANOOS outside the U.S., following all Fly USA requirements. Service costs are for IOOS Association dues ($15k/y) and for regional workshops (rental, permissive travel, meals).

Observing Subsystem: Funds are for personnel/benefits (lead PIs and technicians), supplies, contractual costs, and travel that are required to maintain and harden existing assets: NANOOS HF and port Radars, coastal buoys and gliders, and estuarine and shoreline observations with strategic new investments on nearshore and biological observations. NANOOS covers observing efforts in the coastal ocean, estuaries, and shorelines of WA and OR. To conduct these efforts, salaries are for observing asset PIs: Mickett, Lee, Curry, Chickadel (UW); Barth, Kosro, Haller, Shearman, Chan, Chapple (OSU); Seaton (CRITFC); Kaminsky, Krembs (WDOE); Allan (DOGAMI); Helms (ODSL); and their field technicians to provide operations and maintenance (O&M) for various observing assets (buoys, gliders, moorings, HF and

X-band radars, shoreline surveying equipment). Other project PIs not requesting salary for themselves include technician salary or sampling costs (Fradkin (NPS), Van Vranken (BDC), Manning (to GOMLF), Dethier, (UW), Peavey-Reeves (to SCCOOS and CeNCOOS partners). Deployment costs, as well as operations and maintenance, are accounted for in the budgets outlined in Tables 3-5 and can be broken out upon request. Equipment is primarily for sensors or new assets; all items above $5,000 are detailed below. Equipment is requested for one HF radar to extend coverage along WA, two gliders (WA and OR) for year-round operations, buoy replacement and enhancement equipment, and new shoreline monitoring equipment. Travel is for local trips associated with observing asset O&M. Services are typically for fabrication, repair, calibrations, or sample analysis. Supplies are primarily for repair /replacement parts (e.g., cables, motors) and consumables (e.g., batteries, chemicals).

Modeling and Analysis Subsystem: NANOOS supports forecast models for the WA-OR coast, the Salish Sea, and the Columbia River estuary/plume and proposes a wave forecast model for that port. Salaries are for lead modeling PIs: MacCready (UW); Seaton (CRITFC); Zaron and Ozkan-Haller (OSU); and their technicians to run forecast models for NANOOS to aid our users decision-making needs. PI Mass (UW) provides atmospheric forecast input to the modelers. Equipment funds are requested for computing and disk storage servers to increase processing capacity. Travel is for IOOS Modeling coordination and regional meetings. Supplies are needed to maintain numerical models. Services are for related items, e.g., cloud data storage.

DMAC Subsystem: NANOOS will sustain its robust and renown DMAC system, including NVS, user specific data products and our web portal. *DMAC operations:* Salaries are for lead DMAC PIs: Tanner (UW); Risien (OSU); Seaton (CRITFC) and their technicians. Equipment is for expanding capacity or replacing servers (database and disk storage servers) to harden the system and expand it for the growing user base; all items above $5,000 are detailed below. Travel is for IOOS DMAC coordination and regional meetings. Supplies are to maintain DMAC capabilities. Services are for related items, e.g., registration fees. *Web and Products development:* Salaries are for lead PIs: Tanner (UW); Allan (DOGAMI) and their technicians to maintain and create innovative NANOOS data products for diverse PNW users including development of a web application for submission of Citizen Science observations. Equipment is requested for web, database, and disk storage servers. Travel is for federal and regional coordination. Supplies are to maintain and expand the NANOOS website, plus increase the functionality of the NVS web application.

Engagement Subsystem: NANOOS values inclusivity and prioritizes connections with diverse stakeholders and educators to fulfill our stated mission. Salaries are for PI Newton and NANOOS Carini and Wold, UW) to oversee and conduct NANOOS user engagement, DEI, and STEM activities in the PNW. Additionally, PI Seaton (CRITFC) will engage tribal users in marine observing through the Future of Salmon conference. Travel is for IOOS-wide Engagement coordination and for regional outreach and meetings. Supplies are for outreach materials. Services are for training and workshop costs, including permissive travel and meals.

As shown in Table 5, NANOOS follows a distributed partnership, with UW as its fiscal agent and several distributed partners who conduct various subsystem elements to provide a cohesive and relevant regional coastal ocean observing system. Institutional responsibilities are: UW for management, coastal ocean and estuarine observing, model forecasts, DMAC support, and engagement leadership; OSU for management, coastal ocean and nearshore observing, DMAC leadership, and model forecasts; CRITFC for coastal ocean and estuarine observing, regional DMAC support, model forecasts, and tribal engagement; WDOE for estuarine and shoreline observing; DOGAMI for shoreline observing and user product development leadership; OR Dept. State Lands for estuarine observing; NPS for nearshore observing; BDC, GOMLF, and NOAA partners for leadership on west coast network developments for fishing vessel, drifter, and ocean sound observations, respectively.

Equipment for purchase by UW and its subcontractors is listed in the accompanying table showing

task, year, amount, and justification. As detailed in each institution's SOW and budget information, rental of the requested equipment is either not available or not cost-effective for sustained operations. Equipment purchased will be owned by UW or its subcontractors but will be used exclusively for NANOOS as funding is sustained. The cost of the equipment listed in the budget is based on quotes from the manufacturer or distributor. Quotes are available upon request.

EQUIPMENT (≥$5,000) TO BE PURCHASED BY UNIVERSITY OF WASHINGTON:

Task	Yr	Equipment	Amt ea.	Justification
WA HFR	1	High Frequency Radar	$150,000	Final WA HFR to fill coastal gap
WA Shelf Buoy	2	McClane profiler	$145,152	Replace aging original unit
WA Shelf Buoy	2	Mooring sensors	$52,350	Replace older sensors: SBE44, SBE WQM, SBE37IMP-ODO, SeaFET
WA Shelf Buoy	2	Acoustic release	$16,974	Replace buoy release to avoid failure
Puget Sound Buoys	4	Mooring sensors	$77,232	Replace older sensors: SBE37IMP-ODO, SeaFET, SBE43, SBE19plus, ECO Dual Channel
Puget Sound Buoys	4	Buoy parts	$118,178	Swappable winch, controller, and ballast ring for continuous service
OCNMS RT Buoys	All	Buoy parts	$218,284 (total)	Purchase and fabricate RT buoys for OCNMS
Products and Web	All	Servers	$50,609 (total)	Harden NANOOS DMAC, products, and web
PS Model (LiveOcean)	1,3	Laptops	$5,000	Computing power for LiveOcean model
La Push Glider	5	Seaglider	$220,000	Purchase to allow year-round observations

EQUIPMENT (≥$5,000) TO BE PURCHASED BY SUBCONTRACTORS:

Task	Yr	Equipment	Amt ea.	Justification
OR Shorelines	1	Riegl RTC360 TLS system	$94,531	New ground-based terrestrial laser scanning technology
CA and Columbia Gliders	1	Sensors and sub-assemblies	$100,000	Refurbish and replace aging equipment
PNW Nearshore Hypoxia	1	Crab pot DO strings	$10,000	Purchase five (5) assemblies for nearshore observations
OR Shelf Buoy	2	Teledyne ADCP	$25,000	Replace aging equipment
CA and Columbia Gliders	3	Glider	$220,000	Recapitalization allowing uninterrupted service
OR HFR	1,2,3	HF antennae	$22,000	Replace aging equipment
OR HFR	1,3	Computers	$5,200	Replace aging equipment
OSU DMAC	1,3	Computers	$5,2000	Replace aging equipment
OR Shelf Buoy	1,3, 4,5	Mooring sensors	$6,000	Replace older/lost sensors: SBE 37 CTD
WA Shorelines	All	Surveying gear	$9,000	Replace aging equipment
Columbia Shelf and Estuary Obs	All	Sensors and mooring gear	$28,279	Replace aging equipment, install new contaminant sensors
OR HFR	All	HF electronics	$65,000	Replace aging equipment

Lease-versus-buy analysis: Lease of the equipment listed above is either not available or not cost-effective for sustained operations. Analysis of lease vs. purchase options for common oceanographic equipment such as current point-measurers or current-profilers, CTDs, wave-tide gauges, sonars, and water quality sensors (temperature, salinity, oxygen, chlorophyll, turbidity, optics) shows leasing rates are generally set to repay instrument purchase costs in 250 to 500 days. Because instruments purchased here will be used in a sustained observing program, beginning with the five-year program funded under this grant, and with the anticipation of future participation, the purchase option is the more cost effective for all of these applications.