

## **Sustaining NANOOS, the Pacific Northwest component of the US IOOS**

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## LONG-TERM GOALS

Our goal is to sustain, and, depending on funding, enhance the Northwest Association of Networked Ocean Observing Systems (NANOOS), the Pacific Northwest Regional Coastal Ocean Observing System (RCOOS) that serves regional stakeholders in alignment with the vision of the U.S. Integrated Ocean Observing System (IOOS). NANOOS seeks to maintain the integrated in-water and land-based observing systems, data management and communications, analyses and products, and education and outreach subsystems that it has developed, implemented, and integrated with NOAA IOOS and substantial leveraged funding. NANOOS will remain focused on delivering to diverse stakeholders data-based products and services that are easy to use, to address high-priority issues and aid decision-making. NANOOS will continue its proactive interactions with a wide range of PNW stakeholders, to prioritize and refine our observations, products, and outreach efforts.

## OBJECTIVES

For FY12 (= Y2 of NOPP award = Y6 of NANOOS RCOOS), our specific objectives are to:

- 1) Maintain NANOOS as the PNW IOOS Regional Association. Sustain our proven role for regional coordination, administrative infrastructure, and stakeholder engagement.
- 2) Maintain surface current and wave mapping capability. Maintain existing HF-radar foundational capability, providing a portion of critical national capacity, and continue investment in wave mapping at a critical port.
- 3) Sustain existing buoys and gliders (with reduced glider deployment in WA) in the PNW coastal ocean, in coordination with national programs. Maintain these essential assets providing regional observations, with focus on hypoxia, HABS, ocean acidification, climate change detection and modeling input.
- 4) Maintain observation capabilities in PNW estuaries, in coordination with local and regional programs. Maintain these to aid sustainable resource management, water quality assessment and sub-regional climate change evaluation, with high priority new feeds.
- 5) Maintain core elements of beach and shoreline observing programs. Contribute to hazard mitigation by providing essential observations and decision support tools for coastal managers, planners and engineers, as resources allow.
- 6) Maintain NANOOS' Data Management and Communications (DMAC) system for routine operational distribution of data and information. Sustain, as feasible, the DMAC system NANOOS has built, including the NANOOS Visualization System (NVS), for dynamic and distributed data access and visualization for IOOS.
- 7) Contribute to a community of complementary numerical regional 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 EEZ in both OR and WA.

8) Deliver existing user-defined products and services for PNW stakeholders. Continue to provide to succeed in this vital translation: meaningful and informative data products that will connect with user applications and serve society.

9) Sustain NANOOS education and outreach efforts. Foster ocean literacy and facilitate use of NANOOS products for IOOS objectives, the core task for which the entire NANOOS RCOOS is constructed, via existing approaches for engaging users.

## **APPROACH AND WORK PLAN**

Details of our Approach and Work Plan for the NANOOS Regional Coastal Ocean Observing System (RCOOS) are given in our project proposal and revised work plan and milestones on record at the NOAA IOOS Program Office. Highlights are given here for the five primary functions of NANOOS.

The University of Washington (UW) is the legal fiscal representative for this project. Co-PIs Martin (NANOOS Board Chair, UW) and Newton (NANOOS Executive Director, UW) oversee sustained management, development, and operation of NANOOS in accordance with IOOS principles and according to the objectives of this project. For some of the work, sub-contracts are made to partner PIs at Oregon State University (OSU), Oregon Health and Sciences University (OHSU), The Boeing Company (Boeing), Washington Dept Ecology (Ecology), Oregon Dept of Geology and Minerals Industries (DOGAMI), and the Oregon Dept of State Lands (ODSL).

1) Coordinated Regional Management for the PNW: NANOOS is sustaining our proven capacity for regional coordination, administrative infrastructure, and stakeholder engagement and maintaining our role as the US IOOS Regional Association for the PNW. Management of NANOOS is through our proven 5-y old governance structure, codified by our Memorandum of Agreement (MOA), comprised of: 1) a decision-making Governing Council (GC) of representatives from member (MOA-signatory) institutions; 2) an Executive Committee to serve the GC's needs, composed of elected GC Board members (with sector representation from federal, state and local agencies, tribes, academia, industry, and NGOs) and NANOOS operational committee chairs; 3) a Board Chair and Vice Chair for leadership; 4) an Executive Director for project oversight; and 5) distributed partner PIs who execute the subsystems of the NANOOS RCOOS. Annual GC meetings are used to identify priorities, new members, and deficiencies for the NANOOS enterprise. The ExCom is consulted when decision-making issues arise. NANOOS held Board elections in June 2012.

Martin and Newton assure that NANOOS continues to participate actively with the IOOS National Federation of Regional Associations (NFRA), newly renamed as the IOOS Association, and the US IOOS Program Office, attending NFRA Board and IOOS Regional Coordination meetings. Through their efforts, NANOOS submits required IOOS progress reports, assessments, and performance metrics and will seek certification as a member of US IOOS once certification standards and processes are determined.

2) Observing Subsystem: NANOOS is sustaining observing assets within four observational domains: coastal ocean surface currents/waves, coastal ocean shelf, estuaries, and shorelines according to our RCOOS Conceptual Design. These assets collectively address NANOOS' four priority topical areas and feed data product development for each. NANOOS has emphasized both real-time and time-series observing, the latter critical to our capability to evaluate climate change. These assets are operated by the investigator and institution indicated in parentheses. Funding from this NOPP award covers only a

fraction of operational costs, so all assets are highly leveraged. All assets below currently deliver datastreams into the NANOOS Visualization System (NVS), which is then linked to the US IOOS data system.

Coastal Ocean Surface Currents: Maintain several OR HF radar sites (Kosro, OSU) and one X-band radar site (Haller, OSU).

Coastal Ocean Shelf: Maintain buoys at La Push, WA (Alford, UW), Newport, OR (Levine, OSU) and Columbia R. (Baptista, OHSU). Maintain WA (Alford, UW) and OR (Barth, OSU) glider transects, as possible at current funding level.

Estuaries: Maintain Puget Sound (Devol, UW), Columbia R. (Baptista, OHSU), Willapa (Maloy, Ecology) and South Slough (Rumrill, ODSL) moorings.

Shorelines: Maintain shoreline observations in WA (Kaminsky, Ecology) and OR (Allan, DOGAMI) and deliver these datastreams via the NVS

3) Data Management and Communications (DMAC) subsystem: NANOOS maintains its ongoing DMAC subsystem that is providing IOOS standards-based data products, tools and services to local, regional and national users. We focus on both a robust DMAC Information System (the NANOOS Visualization System or NVS) and an informative Web and User Products capacity. We work closely with other IOOS Regional Associations and the national IOOS Program Office to leverage ongoing work and contribute to the definition and implementation of a consistent set of certification criteria following guidelines set forth in the IOOS DMAC implementation document. NANOOS DMAC is conducted by a highly collaborative industry-university-agency team: Uczekaj (Boeing Research and Technology), Jones/Mayorga (UW), Batista (OHSU), Kosro (OSU), and Allan (DOGAMI).

Our approach for developing DMAC information system capabilities meet overall IOOS goals and objectives and include efforts in: Data Discovery and Regional Coordination; Standards-Based Service-Oriented Architecture; Information System Components; Robust, Mature Infrastructure and Archiving and Certification and Governance. The NANOOS web and products team, in coordination with the NANOOS User Products Committee, DMAC, and Education & Outreach committees, continues to enhance the web interface, user products, and visualization and data discovery tools, as funding permits.

4) Modeling and Analysis Subsystem: With limited funds, NANOOS is focused on use of existing numerical modeling systems in WA and OR, as operated by UW (Jones, MacCready, Banas), OHSU (Baptista), and OSU (Kurapov). Currently, these circulation models cover coastal OR (OSU), Columbia R and other OR estuaries (OHSU) and Puget Sound (UW). These models feed a variety of tools and user products. Our long-range intention is to build on previous investments, both IOOS and non-IOOS, with the goal of integrating the various NANOOS sub-regional modeling efforts into a unified ocean analysis and prediction system that incorporates NOAA/IOOS standards for model validation and data availability. The NANOOS ocean analysis and prediction effort is not be focused on improving the numerical modeling for its own sake, but emphasizes useful, validated products and tools that support a full range of critical decision making and problem solving domains, including crisis response and marine spatial planning.

5) Education and Outreach (E&O) Subsystem: NANOOS E&O efforts are focused on education and user engagement in three main areas: 1. Networking: to increase awareness about NANOOS and

products; 2. Product Development: to engage users in NANOOS ocean observing efforts through NANOOS designed communication tools and products; 3. User Engagement: to support users in accessing and interpreting NANOOS data in a manner appropriate to their needs.

We are building on current accomplishments with a focus on strengthening two-way communication between NANOOS (PIs, committees, and Governing Council) and end-user groups. This is a necessary next step as NANOOS matures in efforts to effectively meet user needs through product development and engagement. A part-time NANOOS E&O staff member is located in both Seattle, WA and Portland, OR, aiding our regional coverage.

Our developed partnerships with key programs in the PNW and nationally – including Oregon Sea Grant, Padilla Bay National Estuarine Research Reserve, COSEE Ocean Learning Communities, COSEE Pacific Partnerships, COSEE Networked Ocean World, the NFRA Education and Outreach Committee, and NANOOS members such as the Northwest Aquatic Marine Educators, Center for Coast Margin Observations and Prediction, and Ocean Inquiry Project – provide learning opportunities surrounding ocean observing data for classrooms and non-classroom audiences. We utilize this partner network to participate in professional development workshops for educators and present and receive feedback on NANOOS educational materials.

## **WORK COMPLETED**

NANOOS has successfully sustained the observations, modeling capacity, data management and delivery system, data products, outreach and education services that the entirety of the NANOOS enterprise has created, as outlined by our workplan above, in this sixth year of operation. NANOOS is meeting all of the project objectives, detailed above, in this on-going effort.

## **RESULTS**

Detailed project results are reported every six months to the US IOOS Program Office and are available at [http://www.nanoos.org/about\\_nanoos/documents.php](http://www.nanoos.org/about_nanoos/documents.php). Only a few highlights are recounted here, focusing specifically on NANOOS data systems and outreach products.

***Data via the NANOOS Visualization System (NVS):*** Enhancements to NVS encompass on-going asset datastream additions and updates, including: new near-real-time in-situ monitoring assets by Taylor Shellfish Farms; UW Friday Harbor Labs, and Whiskey Creek Shellfish Hatchery and an ecosystem database from UW Pelagic Ecosystem Function surveys. The NVS platform will expand in capabilities and scope via a newly NSF-funded collaboration between APL-UW and the NSF Critical Zones Observatories Network's cyberinfrastructure program, focused on national data integration.

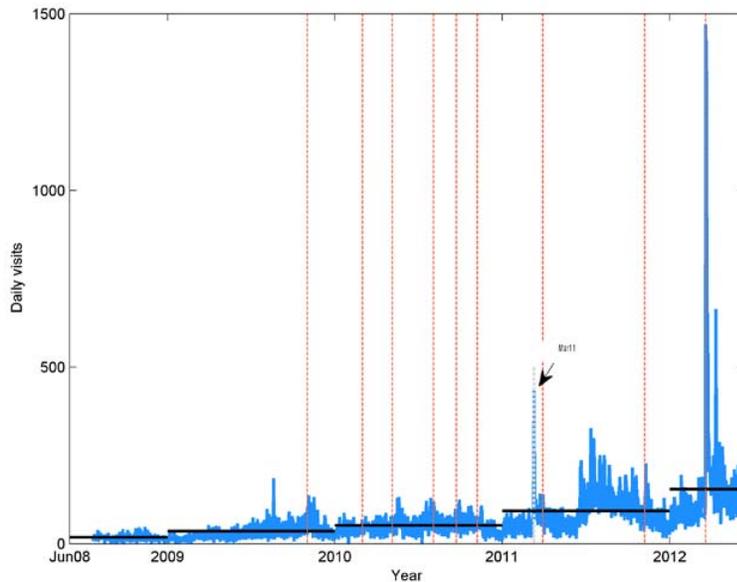
***Biological Data:*** NANOOS is co-leading a new IOOS-supported project addressing animal acoustic tracking data, in collaboration with IOOS and POST (<http://postprogram.org>). NANOOS hosted the project kick-off meeting in March, with local and remote attendance by partners from across the country and Canada; the project is making steady progress.

***West-Coast Coastal and Marine Geospatial Data:*** NANOOS coordinated closely with IOOS Regional Associations SCCOOS and CeNCOOS to co-lead a collaboration with the West Coast Governors' Alliance (WCGA) and its partners that will enhance regional discovery, access, coordination and prioritization of coastal and marine geospatial data. The three Regional Associations presented a

common vision at the West Coast Regional Data Framework workshop in Oakland, CA, and NANOOS actively supported follow-up activities, including coordination of the IT working group.

**Ocean Acidification Data:** NANOOS strongly supported the ongoing NOAA-led Ocean Acidification Data Management project, participating in its Steering Committee, hosting a March workshop in Seattle led by Newton at NOAA’s Ocean Acidification Program Office request, and follow-up data-management discussions. The workshop hosted over 30 federal and academic OA scientists and data managers, and resulted in a “Declaration of Interdependence” now hosted on the NODC website (<http://www.nodc.noaa.gov/oceanacidification/index.html>). NANOOS also supported the west-coast wide asset inventorying activities of the California Current Acidification Network (C-CAN), as well as data dissemination and access needs of the regional shellfish aquaculture industry.

**NANOOS Website:** NANOOS continues to maintain, refine and update content on the web site. Currently, NANOOS provides links to 42 products, of which 21 are custom built to meet the needs of NANOOS stakeholders. Figure 1 provides a time history of web traffic for the complete NANOOS web site. Of significance is the progressive increase in daily visits to NANOOS over time, emphasizing the increasing use and interest in NANOOS related data and products by Pacific Northwest stakeholders. As of June 2012, the NANOOS site experiences on average 154 “visits” per day. Also apparent from the figure are the periodic large hits that occurred on March 11, 2011 (Japan earthquake) and March 2012 (public release of the new NVS Tsunami web application and smart-phone apps), both of which generated significant interest in NANOOS products as stakeholders either sought pertinent life-safety information, or were accessing a new product.



**Figure 1:** Time history of daily web visits to NANOOS. Arrow indicates the Japan earthquake on March 11, 2011.

**NVS Update.** NANOOS launched work on an entirely new graphical user interface (GUI) to NANOOS products. Although not yet released (anticipated late 2012 or early 2013), the new GUI is simpler and should enable easier access to existing NANOOS products. In addition, the new GUI will enable easier integration of future NANOOS web applications, planned for the coming year. Work also commenced on a new Maritime Operation Web Application that will depict information (ocean wave conditions and climate related information) relevant to the maritime industry (e.g., fishermen,

mariners, Coast Guard, etc.). In particular, the web app will include a new situational awareness capability enabling users to visualize parameters from multiple observation platforms without having to click on a particular station.

**Mobile Applications:** NANOOS developed new Pacific Northwest Tsunami Evacuation web-based and mobile applications. The purpose of the revamp was to enhance the older tsunami web portal, bringing it more in line with the NVS platform, enhancing it with new overlay data from Washington State, improving content and capabilities, and providing links to the West Coast Alaska Tsunami Warning Center. The on-line and smart-phone apps were released in March 2012.

## **IMPACT AND APPLICATIONS**

### **National Security**

Improving National and Homeland security is one of the major societal pillars that will benefit from a robust and competent IOOS. Regionally, the developing RCCOS being advanced and managed by NANOOS in the Pacific Northwest continues to have significant potential to provide needed information, tools, knowledge and techniques important in both National Security and/or Homeland Defense to regional military and Homeland Security responders. Indeed, presentations by the Oceanographer/Navigator of the Navy at both the recent MTS/IEEE Oceans12 conference and the recently concluded national IOOS Summit highlight the importance of IOOS to national security stakeholders. NANOOS principals have participated in both classified and unclassified homeland defense and national security discussions that have stressed the importance of the types of information and products NANOOS produces.

### **Economic Development**

NANOOS continues to rely upon direct involvement of private industry to ensure we optimize the economic development potential of our efforts. In this regard, our industry partners make up nearly 25% of the members of the NANOOS Governing Council. Since the spectrum of products and services delivered and/or planned by NANOOS is broad, similarly the areas of possible economic development are wide ranging. Listing a few examples, commercial and recreational fishing, marine transportation, fisheries management, and recreation are areas of economic development that are enhanced by the information provided and knowledge obtained through NANOOS. By directly engaging with our industry partners, NANOOS helps to ensure that the return on investment for the RCCOS is solid and long lasting.

### **Quality of Life**

Pacific Northwest waters have played critical roles in the history, culture and lifestyles of residents, both Native American and later arrivals, for many centuries. Today, increasing urbanization of major estuaries and the Salish Sea place increasingly difficult demands on coastal and estuary ecosystems and, without adequate information to adequately manage these vital resources, the quality of life of residents in our region will be negatively impacted. NANOOS fully participates in developing the data, information, tools, knowledge and techniques needed to be able to make scientifically-sound decisions about regional coastal and estuary ecosystems in the time frame necessary for these decisions to be useful and beneficial.

## **Science Education and Communication**

The long-term maintenance of a regional component of the IOOS such as NANOOS depends on the entrainment of an enlightened and informed constituency among regional marine stakeholders who understand the intrinsic value of healthy marine ecosystems and the importance of adequate information provided by NANOOS to support decision makers involved in managing aspects of estuarine and coastal waters. In this important mission, NANOOS has continued its science education and communication efforts through a variety of efforts to reach and inform a broad regional audience about the scientific challenges and opportunities in coastal and estuary areas.

## **TRANSITIONS**

### **National Security**

In this transition area, NANOOS chose to concentrate on maintaining strong ties with regional military (primarily USN and USACE) operators to ensure they are aware of the data, tools and information provided by NANOOS. This knowledge transfer from NOAA/NANOOS to DoD assets represents a transition of the intellectual, scientific and operational products derived from resources funding this effort to operators invested in regional national security efforts.

### **Economic Development**

The full potential of positive economic developments to which NANOOS will contribute when fully capitalized and enhanced will take some time to realize. Already however we have transitioned a sophisticated numerical modeling suite that incorporates ocean observations into an operationally run product greatly valued by Pacific Northwest tuna fishers. Similarly, NANOOS, with strong regional federal agency support, has led the effort to provide real-time information on ocean acidification (OA) to scientists, the general public, and shellfish growers. In this latter group, a local hatchery manager equated the deployment of an OA sensor on a NANOOS buoy to that of “putting headlights on a car” in terms of the profound importance this now operational sensor and transitioned data stream provides his industry.

### **Quality of Life**

As noted in the impacts section above, regional coastal waters and estuaries are critical to the quality of life in the Pacific Northwest. Recognizing this, NANOOS has transitioned a number of data products to daily operations to both help the regional populace better understand their marine environment and provide information on past, current and future states of our waters and coastal lands impacted by them. These products include a now operational smart-phone “app” that provides readily understood and geo-referenced coastal hazard information to iPhone and Android phone users. Similarly, many other NANOOS efforts, now also transitioned to operations, positively impact peoples’ quality of life by providing near-real time information on a wide variety of ocean parameters.

## **Science Education and Communication**

NANOOS has continued its formal involvement in traditional educational fora (e.g., Washington and Oregon COSEE efforts, partnering with the educational efforts in the NSF-funded Science and Technology Center for Coastal Margin Observation and Prediction, and direct affiliation with major research universities in the Pacific Northwest). These efforts are bolstered in NANOOS by focused and proactive outreach efforts to local/regional aquaria, private ocean science education efforts such as The Ocean Inquiry Project, and training courses/syllabi provided on the NANOOS website for elementary and secondary school use. We have used these various scientific communication and

education venues to inform a broad spectrum of Pacific Northwest residents on a wide range of environmental or coastal issues that include Tsunami evacuation routes, ocean acidification, anoxia and hypoxia issues, and general oceanographic/estuary science to name just a few topics.

## **RELATED PROJECTS**

NANOOS is one of eleven Regional Associations that deliver regional coastal ocean observing data, products, and services for the nation as part of US IOOS (<http://www.ioos.gov/>). NANOOS works with the other Regional Associations, as part of the National Federation of Regional Associations (<http://www.usnra.org/>), newly renamed the IOOS Association. In September 2011, NANOOS joined with its two sister Regional Associations on the contiguous U.S. west coast, Central and Northern California Ocean Observing System (CeNCOOS; <http://www.cencoos.org/>) and Southern California Coastal Ocean Observing System (SCCOOS; <http://www.sccoos.org/>) to sign a Memorandum of Understanding, which is featured on our NANOOS website (<http://www.nanoos.org/>).

To further optimize efficiencies and integration, in October 2012 The West Coast Governors' Alliance on Ocean Health (WCGA) and these three IOOS Regional Associations (NANOOS, CeNCOOS, and SCCOOS) signed a two-year agreement in October of 2012 to advance effective management of coastal and ocean resources for the benefit of current and future generations, with a specific focus on using ocean observing systems to help address harmful algal blooms and ocean acidification as well as advancing surface current mapping and a regional data framework. This MOU and the media release can be found on our NANOOS website (<http://www.nanoos.org/>).

NANOOS is well-networked with other Pacific Northwest observing efforts including the National Science Foundation's Ocean Observing Initiative (OOI) and Center for Coastal Margin Observation and Prediction (CMOP). Two NANOOS buoys (Cha'ba off La Push, WA, and NH-10 off Newport, OR) are part of NOAA's Ocean Acidification Program.

## **OUTREACH MATERIALS**

NANOOS has constructed many outreach materials, including a brochure ([http://www.nanoos.org/documents/legacy/nanoos\\_brochure.pdf](http://www.nanoos.org/documents/legacy/nanoos_brochure.pdf)), newsletters, and other key NANOOS documents ([http://www.nanoos.org/about\\_nanoos/documents.php](http://www.nanoos.org/about_nanoos/documents.php)) including NANOOS summary presentations and a publication list.

The latest NANOOS Observer newsletter includes stories on NANOOS efforts to bring biological data into IOOS, media reaction to the NANOOS Tsunami Evacuation Map apps release, and a recap of the NANOOS Industry Day 2–3 February 2012, sponsored by Microsoft Research at their Campus in Redmond, Washington. The workshop, "Pacific Northwest Waters: Gateway to Our Future" was the 5th Interagency Ocean Observation Committee (IOOC) Industry Workshop, attended by 150 participants. Videos, presentations and the meeting program are available online at: [http://www.nanoos.org/education/events/pnw\\_waters/pnw\\_waters\\_workshop.php](http://www.nanoos.org/education/events/pnw_waters/pnw_waters_workshop.php).