Sustaining NANOOS, the Pacific Northwest component of the U.S. IOOS®:
NOAA Award: NA11NOS0120036 Reporting period: 12/01/2011 to 05/31/2012

1) Project Summary

Our overall project goal is to sustain the Northwest Association of Networked Ocean Observing Systems, NANOOS, as the Regional Coastal Ocean Observing System for the U.S. Pacific Northwest that serves regional stakeholders in alignment with the vision of U.S. Integrated Ocean Observing System (IOOS®). NANOOS, with its essential subcomponents (integrated in-water and land-based Observing Systems, Data Management and Communications, Modeling and Analysis, and Education and Outreach) that are closely integrated within the national IOOS® system, provides significant societal benefits across a wide spectrum of users including federal, tribal, state and local governments, marine industries, scientific researchers, Non-Governmental Organizations (NGOs), educators and the general public.
For FY11 (= Y1 of this award; Y5 of the continuing NANOOS RCOOS) period, 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 newer WA transects) 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, incorporating high priority new feeds as funds permit
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 reliable operational distribution of data and information.** Sustain, as feasible, the DMAC system NANOOS has developed, 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, appropriate to a modeling domain extending from the head of tide of estuaries to the outer edges of the EEZ in OR and WA.
8. **Deliver existing user-defined products and services for PNW stakeholders.** Continue to provide useful products and services which succeed in the vital translation of providing meaningful and informative data products that connect directly 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.

2) Progress and Accomplishments

NANOOS milestones for this award are provided in Table 1. We report here progress for following: a) observing systems (shelf, estuaries, shorelines, and currents); b) modeling (estuaries and shelves); c) Data management and Communications (DMAC); d) User Products; e) Education and Outreach; and, f) Administrative. Our assessment is that NANOOS has met these milestones for the reporting period.

Table 1. NANOOS Milestones for FY 11:

Area	**Y1 Award = Y5 NANOOS**
Observations	
Shelf:	Maintain La Push, Newport, and Columbia R. buoys and deliver NRT datastreams via the NANOOS Visualization System (NVS) Maintain WA and OR glider transects (except funds are insufficient for maintaining La Push, WA glider) and deliver these datastreams via the NVS
Estuaries:	Maintain Puget Sound, Columbia R., Willapa and South Slough moorings and deliver these datastreams via the NVS
Shorelines:	Maintain shoreline observations in WA and OR and deliver these datastreams via the NVS
Currents:	Maintain OR HF radar sites and X-band radar site and deliver these datastreams via the NVS
Modeling	
OR/WA estuaries and outer coast models	Maintain modeling & forecasting capabilities at OSU, OHSU, & UW at reduced level and make model output available via the NANOOS web
DMAC	
Web Site Improvement	Enhance NANOOS help section
Tailored Product Development	Focus on Ecosystems and Climate change (OA), as resources permit, to produce a new product for posting on a NANOOS web "theme page".
Education and Outreach	
Networking	Maintain existing and build new relationships with NANOOS priority area users and the education community
Product Development	Work with DMAC, User Products Committee on Tailored Product Development, as per above schedule, and in Tri-Committee meetings
User Engagement	Conduct trainings to select user groups as resources permit
Administration	
Meetings	Represent NANOOS at all NOAA IOOS, NFRA, and national meetings of significance (e.g., Oceans 2011)
Project oversight	Conduct regular PI meetings, annual Tri-Committee meeting, and assist with evaluations, as scheduled
Coordination	Conduct annual GC meeting Conduct sub-regional, and user-group specific workshops (e.g., for CMSP; ocean acidification, etc) as resources allow Coordinate with West Coast RAs and other RAs to optimize and leverage capabilities and assure consistencies, but with no travel and at reduced level
Accountability	Submit required IOOS progress reports, assessments, and performance metrics and seek certification as a member of US IOOS once certification standards and processes are determined

a) Observing System: NB: Data from all assets reported here are served via NANOOS NVS.

- ***Shelf***

Washington Shelf Buoy and Glider:

Led by M. Alford, Applied Physics Laboratory, University of Washington (APL-UW), over this period NANOOS funding was used primarily for field operations and maintenance costs for Cha'Ba, the NEMO subsurface mooring and the Seaglider. In addition to system maintenance, during this period a number of upgrades were made to Cha'Ba to resolve communications and power shortfalls, which included installing a photovoltaic charging system and integrating a cellular modem. Other improvements/ enhancements made during this period include fabrication of a new instrument cage for the deep Wetlabs Water Quality Meter and the addition of an independent satellite tracker. Both moorings were successfully deployed on May 25th from the R/V THOMPSON, with time remaining on the cruise for a short acoustic survey of non-linear internal waves and a number of CTD casts and bottle samples on the shelf and within the Strait of Juan de Fuca. During this period the first scientific paper from these data was published. Additionally, several presentations were given at the Ocean Sciences Conf. in Salt Lake City in February on both the engineering accomplishments and scientific findings to date.

Oregon Shelf Glider: The Oregon State University (OSU) glider group led by J. Barth and K. Shearman continued deployments of autonomous underwater gliders off Newport, Oregon, using a combination of NANOOS, NSF, and private funding (Moore Foundation). The Newport Hydrographic Line was sampled from about the 20-m isobaths out to 300 km offshore using a combination of a Slocum 200-m glider on the inshore part of the line and a 1000-m Seaglider on the offshore part. During Dec 2011 through May 2012, we collected a total of 244 glider-days of measurements along 5247 km of track. This included 14432 vertical profiles and 45 cross-margin vertical sections.

Oregon Shelf Mooring: Led by M. Levine (OSU), a mooring about 10 miles off Newport, Oregon, in 80 m of water (site NH-10) has been maintained since mid-2006, primarily through support by NANOOS. About every six months the mooring is recovered and a refurbished mooring is deployed. Unfortunately the mooring broke free from its anchor in January 2012 during the wintertime deployment. After a few days the buoy drifted onshore and landed safely on a sandy beach in an Oregon state park. Fortunately the buoy was retrieved along with all the instruments with minimal damage.

A refurbished summertime version of the mooring was deployed at the end of March 2012 from the RV Oceanus on a cruise supported by the NSF Science & Technology Center CMOP (Coastal Margin Observation & Prediction). The mooring is currently measuring a combination of atmospheric and ocean parameters. Ocean sensors measure temperature, salinity and water velocity at a number of depths. A few sensors measuring CO2, dissolved oxygen, turbidity and chlorophyll fluorescence are also attached. A meteorological package is measuring wind velocity, air temperature, atmospheric pressure, and incoming solar radiation. Some of the data are being transmitted in near real time by cell phone. Preparation for the next deployment in October 2012 is underway.

Northern Oregon to Central Washington shelf: Led by A. Baptista (OHSU), the Center for Coastal Margin Observation & Prediction (CMOP) continued to maintain a glider and two offshore buoys (SATURN-02 and OGI-01). The operation and maintenance of the glider and SATURN-02 is partially funded through the National Science Foundation.

Glider operations are seasonal (April-September), and are driven in part by collaboration with the Quinault Indian Nation, focused on characterizing shelf hypoxia for fisheries management. Since May 2009, we had 351 days of glider operations (of which 90 days in 2011). During the reporting period, only

one glider deployment was planned. That deployment was conducted in late April 2012, but was unsuccessful, resulting in the loss of the platform. The process of replacing that glider is in progress. A second glider in planned for deployment in July.
SATURN-02 is also a seasonal station, and during most of the reporting period was deployed in its winter configurations (surface CT only, no telemetry). SATURN-02 was deployed in its full interdisciplinary configuration on April 24, recovered on June 12 to repair a faulty bottom DO sensor, and re-deployed on June 27; the station will be returned to its winter configuration in October.

OGI-01 is deployed year-round in "winter configuration" (surface CT, no telemetry), as the deployment of an interdisciplinary suite of sensors–although highly desirable for modeling support–remains unfunded. Deployment of the buoy in minimal configuration is necessary to satisfy USCG regulations.

Archival data from all the above platforms, and those from the Columbia River estuary, below, are publicly available. NANOOS NVS functions as the PNW-integration portal, displaying real-time data and allowing downloads of recent data; it also contains links to the CMOP SATURN website, which offers access to both the near real-time data and since-inception archival data, besides allowing interactive analysis of data within and across stations through the SATURN Data Explorer (http://www.stccmop.org/datamart/observation_network/dataexplorer).

- **Estuaries**

Puget Sound, ORCA Buoy program: Led by A. Devol and J. Newton (UW), during this report period the ORCA (Oceanic Remote Chemical Analyzer) group had three buoys in operation in Hood Canal (Twanoh, Hoodsport, Dabob Bay), one near Admiralty Inlet (Hansville), one in Puget Sound (Pt Wells), and one in south Puget Sound (Carr Inlet). The Hoodsport mooring experienced some downtime in the spring due to a flooded solar panel in December 2011; profiling was restored in April, 2012.

We continued to make all buoy data available in real-time on the NANOOS website. These buoys were built with and maintenance is partially leveraged with the Hood Canal Dissolved Oxygen Program, Ecology, Navy, and NSF funding. The Dabob Bay work was leveraged by a grant from the State of Washington to monitor surface water acidity and water column conditions as they might relate to shellfish hatchery failure. We also continued to provide support and power to the pCO_2 system operated at Dabob Bay and Twanoh in collaboration with NOAA PMEL (C. Sabine, R. Feely) by supplying power to the system and collecting water samples to aid system calibration.

In comparison with past years, spring 2012 was moderate in terms of bottom water dissolved oxygen concentrations in southern Hood Canal. Oxygen concentrations observed in the bottom water at Twanoh were higher than those observed in the previous 7 years, though values were close to those observed in spring 2009. Bottom water temperature was also similar to spring 2009, where both years trended significantly below average. However, this similarity was not observed in all water properties, as bottom water salinity in spring 2012 was average, whereas bottom water salinity in 2009 was solidly above average. These observations are important for State efforts to assess water quality and habitat.

Washington State estuarine monitoring: Led by C. Krembs, the WA State Department of Ecology (Ecology), with the help of collaborative partnerships, operates a network of four (previously five) mooring stations (six total sensor packages) in Puget Sound and one mooring in Willapa Bay. We contribute to regional estuarine *in situ* observations by maintaining our monthly-calibrated moorings, providing quality controlled data, compiling monthly reports, and reporting on anomalies. In addition to annual manufacturer calibrations, we conduct sensor performance assessments in a controlled

environment (bath) before and after each deployment. This work is funded by WA State, augmented by NANOOS. Our mooring program is highlighted on our new website: http://www.ecy.wa.gov/programs/eap/mar_wat/tidaleffects.html .

The deployment locations in Puget Sound are primarily designed to capture inter-basin exchange of temperature, salinity, and oxygen. This is critical for understanding the human influence on the processes driving hypoxia and eutrophication.

1. Admiralty Reach (60 meters): Deployed in November 2011 by UW-APL. Successfully recorded data from November 2011 thru February 2012. Redeployed in May 2012.
2. Shannon Point (8 meters): Deployed by Shannon Point Marine Center divers. Successfully recorded data December 2011-May 2012.
3. Manchester Near-Surface (4 meters): Successfully recorded data throughout.
   Manchester Near-Bottom (11 meters): Successfully recorded data March-May 2012.
   Connection failures led to loss of some data.
4. Mukilteo Near-Surface (4 meters): Successfully recorded data April-May 2012. Power supply issues led to loss of some data.
   Mukilteo Near-Bottom (14 meters): Successfully recorded data throughout.
5. Squaxin Passage (0.5 meters): Successfully recorded data through February 22, 2012. Station decommissioned on that day due to limited funds and reprioritizing of other stations.

Willapa Bay: With the help of EPA divers we recovered the mid-column (4-7 meters) CTD in January. It had continued logging through November 2011.
Our near-surface sensor package successfully recorded samples throughout.

Columbia River estuarine monitoring: CMOP continues to maintain 14 endurance stations in the Columbia River estuary (under the direction of A. Baptista, with a mix of NSF, NANOOS, and regional-stakeholder funding), and two in the tidal freshwater (under the direction of J. Needoba, with a mix of NSF and regional-stakeholder funding). These stations anchor CMOP's *SATURN observation network (*http://www.stccmop.org/datamart/observation_network).

Of particular note during the reporting period, we made several enhancements aimed in part at better characterizing ocean-induced estuarine hypoxia and acidification, and to begin understanding the role of local production in mitigating these deleterious ocean effects. Specifically:

- We maintained and enhanced our network of sensors of dissolved oxygen (and ancillary variables), and implemented QA/QC strategies for those sensors. We now observed DO from river to plume, and have characterized multiple severe events of estuarine hypoxia, some of which partially mitigated by local production.
- We are adding a network of pH and pCO_2 sensors at three stations along the navigation channel of the estuary. These sensors will allow characterizing estuarine hypoxia and acidification as two coupled process, both driven by coastal upwelling of degraded ocean waters.
- We are adding multiple PAR sensors and one ACS sensor, to begin characterizing local solar radiation and light attenuation, to provide context for observations of productivity in the lower estuary.
- We added bottom nodes at two stations (with a third planned for July) with Acoustic Doppler profilers and CT, to better characterize (a) the propagation of acidic/hypoxic ocean waters into the lower estuary, and (b) mechanisms of enhanced estuarine retention that might play a role in mitigating hypoxia/acidification through local production.
- We are progressing towards the adaptive sampling of microbial communities that might play a role in the biogeochemistry of the estuary; specifically, an Environmental Sampling Processor planned for pilot deployment this summer.

SATURN observations are used extensively in support (directly or via data-informed modeling) of regional management and decision making associated with ESA biological opinions, salmon restoration, navigation improvements and hydropower operations.

Oregon South Slough: Participation by the Oregon Department of State Lands (ODSL) in NANOOS activities is led by A. Helms (Acting Research Coordinator) and A. DeMarzo (Estuarine Monitoring Assistant) at the South Slough National Estuarine Research Reserve (NERR).

South Slough NERR continued operating a network of moored observing stations and a real-time weather station as part of the NERRS System-Wide Monitoring Program and NANOOS. The five water quality monitoring stations located along the estuarine salinity gradient provided continuous data over the period Dec 2011- May 2012. Four of the water stations and the weather station are now equipped with telemetry systems, and the Elliot Creek water quality station began transmitting data 5/31/12; this station involved a relocation from the historical site to accommodate telemetry. We began site reconnaissance for a fifth station, working with the Coast Guard and Port of Coos Bay to determine suitable existing range markers/pilings. Equipment upgrades included two new dataloggers, conversion of an older instrument, and new weather sensors to replace aging equipment.

The water quality stations provide real-time data access for shellfish growers (North Bend and Coos Bay Oyster Cos., and Qualman Oyster Farms) to monitor environmental conditions, and water quality data trends for eelgrass, fecal coliform monitoring and native oyster restoration projects. The new station Elliot Creek serves as a riverine reference site, located in a semi-pristine area of the Senstacken Arm surrounded by upland forest and undisturbed marshes with no development. In addition, it is nearest the oyster beds run by Qualman. The weather station provides real-time data to assess the short-term effects of local weather on water quality within the estuary.

- **Shorelines**

Washington Shorelines: NANOOS funds contribute to the Washington State Department of Ecology's Coastal Monitoring & Analysis Program (CMAP) led by G. Kaminsky. CMAP completed Fall 2011 surveys in December with North Beach and Grayland Plains, collecting 23 transects and completing the total of 46 transects of our quarterly beach monitoring program. Winter 2012 surveys were performed in March and April, including 46 profiles, 13 sediments samples, 5 surface maps—after significant repairs to the survey vehicle used to collect beach surface maps. CMAP also performed 23 long occupations (ranging from approximately 2-6 hours) of the benchmarks in our original geodetic control network and logged the GPS observables during these occupations to submit to OPUS and receive updated precise 3-D positions for the benchmarks. These OPUS solutions are meant to be used as checks to verify that the monuments have not moved significantly; however, difficulty in converting between Geoid models has put this on hold. In late March, CMAP performed a beach survey at Cama Beach on Camano Island to document a recent landslide that will provide a substantial supply of sediment to the adjacent beaches and nearshore. As time permits, we intend to return to the area to perform another survey and perform change analysis to monitor sediment transport along this beach. CMAP completed an extensive evaluation of two laser scanner systems that we will primarily use for mapping 3-D topography of Puget Sound bluffs and other coastal monitoring applications. In April the seasonal beach profile and contour plots for the entire CRLC were successfully served up to the NANOOS NVS website. In mid-May CMAP conducted a spring survey at the mouth of the Elwha River in partnership with the USGS and OSU. The survey involved nearshore bathymetry using singlebeam echosounders on jet skis as well as topographic surveys of the beach. The team collected 133 profiles and walked all the topographic features on the beach to generate a 3-D surface map extending a few kilometers east and west of the river mouth.

Oregon Shorelines: Leveraging NANOOS, the Oregon Beach and Shoreline mapping Analysis Program (OBSMAP) efforts are led by J. Allan and V. McConnell of the Oregon Department of Geology and Mineral Industries (DOGAMI). As part of DOGAMI's commitment to NANOOS, the OBSMAP network continues to be sustained, with surveys of the beaches having occurred in February, March, and April 2012. Leveraging other funds, the OBSMAP network was expanded over the same period to include 111 new sites in Tillamook County, bringing the total number of monitoring sites in this county to 175 stations; future monitoring of these latter stations will be dependent on funding. Data for the OBSMAP monitoring sites are available through the NANOOS Visualization System, NVS (http://www.nanoos.org/nvs/nvs.php?section=NVS-Products-Beaches-Mapping).

During this period, problems with aging infrastructure arose. For example, a motherboard on our Trimble RTK-DGPS instrument failed, while a protective roll cage on our ARGO ATV (now 8 years old) broke due to significant rust. Similarly, significant rust on the ATV's wheels necessitated their complete replacement (total cost ~$4000). Data from the OBSMAP beach monitoring is being used by agencies such as the Oregon Parks and Recreation Department to help guide permitting for engineering structures. In addition, OBSMAP data is being used by the community of Neskowin and Rockaway to help guide their understanding of changes taking place along their beach; since 1997, the Neskowin community lost ~30 m of dune, such that wave runup today regularly overtops the riprap structures, damaging property). OBSMAP data is also being used by a coastal engineering firm to help determine suitable short to long-term solutions to the erosion problem in Neskowin. Finally, the combined beach observation dataset now available for Tillamook and Clatsop Counties are being used to assess 1% (100-year) coastal flood and erosion risk along the shorelines of both counties for the purposes of developing updated FEMA flood insurance rate maps.

Nearshore Bathymetry: P. Ruggiero's group at Oregon State University is responsible for collecting nearshore bathymetry data along the four sub-cells of the Columbia River littoral cell (CRLC) and relevant cells within northwest Oregon. This data collection is coordinated with the Washington State Department of Ecology (PI Kaminsky's group) and the Oregon Department of Geology and Mineral Industries (PI Allan's group). Well over 200 individual cross-shore profiles are typically collected in the summer extending from the lower inter-tidal to approximately 12 m of water depth (~2000 m from the shoreline). With partial support from NANOOS, Ruggiero's group has hired a full time field technician, Jeffrey Wood, to assist with data processing, archiving, and field equipment maintenance. Jeff came on board in January of 2012 after working for Ruggiero's group as a student worker for over 1.5 years. Ruggiero's Graduate Research Assistant, Diana Di Leonardo, is using nearshore bathymetry data collected as part of this project for her Master's thesis work. In December, 2011, Diana presented her initial findings at the Fall AGU meeting.

- **Currents**

Coastal Currents: The HF surface current mapping program at Oregon State University (PI Mike Kosro, RAs Anne Dorkins and David Langner), with NANOOS support, has been providing near-real-time maps of ocean surface currents along the Oregon coast, as well as downloadable text files containing the data values, to the public via the NANOOS Visualization System (NVS), These data are also being provided to NOAA/NDBC via the national HFR-net. They also are assimilated in regional ocean circulation model forecasts being done by Alexander Kurapov's group, which in turn are made public via NANOOS.

During this reporting period, the system has been troubled by issues of aging hardware and infrastructure, with three of the eleven systems requiring factory repair during the reporting period. On the positive site, two other instruments received upgrades to allow operation on shared frequencies

(with 80% of the $30K upgrade funds leveraged with a grant from OSU). Communications upgrades have been installed at one site, and we are exploring fixes for unreliable power at another. HF measurements were essential to, and Kosro was a co-author on, five talks presented at Ocean Sciences and Oceans 2012 during the reporting period.

Port X-band Radar: Led by M. Haller (OSU), the wave imaging marine radar station at Newport jetties was non-functional during this period due to a failure in the underground electrical cable to the facility. Efforts are presently ongoing to raise the funds necessary for repair ($55,000 is the estimate), we are optimistic that we will be successful by the end of the summer (2012). During this period data analysis and data product development continued using previously collected data.

b) Modeling efforts

- **Shelf:** Computer circulation modeling of PNW coastal ocean shelf conditions has been conducted by A. Kurapov's group at OSU, which produces daily updates of 3-day forecasts of ocean conditions, including currents, temperatures and salinities through the water column (at 3-km horizontal resolution). The system has assimilated along-track altimetry from Jason-1, Jason-2, and (until April 2008) EnviSat, hourly GOES SST, and surface currents from land-based high-frequency (HF) radars. Results have been provided to fishermen and general public via the NANOOS Visualization System. Via the OpenDAP server, the forecast currents are also provided to the NOAA Office of Response and Restoration (ORR) Lab in Seattle, where they can be used with the tools for oil spill mitigation. Currently, the forecast model is extended to 40.5-47N in the alongshore direction and is focused on the Oregon coast. We have also developed and tested (without assimilation) a 2-km resolution model in the extended domain (40.5-50N), which includes both the WA and OR coasts. Forcing of this model includes tides and the Columbia River fresh water discharge. In preparation to assimilation, we are studying the influence of the river plume on SST and other variables that can be assimilated.

- **Estuaries**

Puget Sound: Overseen by D. Jones, APL-UW has continued to collaborate with Parker MacCready (UW School of Oceanography) and Neil Banas (UW Joint Institute for the Study of the Atmosphere and Ocean) to develop a ROMS model of the Salish Sea, named MoSSea, that will run in a daily hindcast mode. New visualization products for MoSSea were also conceived and developed. In addition to the MoSSea efforts, the APL-UW modeling team was focused on acquiring forecast data from multiple operational models (atmospheric and oceanic) and providing them to NANOOS customers. This requires significant effort to maintain the data flow and availability via the NANOOS Visualization System (NVS). As new observing systems come on line, the modeling team subset model data appropriate for the observing platform. The blending of model data with observations via the easy to use NVS interface has been well received by NANOOS customers.

Columbia River: With a mix of NSF funding, regional stakeholder funding, and modest NANOOS funding, CMOP maintains an extensive modeling system for the Columbia River coastal margin, denoted *Virtual Columbia River* (VCR). The VCR is operated under the direction of A. Baptista, but it is a multi-institutional collaboration involving modelers and non-modelers, in academia and across regional, federal and tribal agencies. On-going during the reporting period:

a) We are improving the skill of the anchoring circulation simulations. Specifically:
   - We have substantially improved the representation of water levels upstream of the confluence of the Willamette River, driven in part by the requirements of studies supporting the Columbia River Treaty Review; needs of regional salmon studies; and operational requirements for navigation. We have also begun to address specific operational requirements for river flood protection.

- We have improved the representation of the stratification in the lower estuary, driven in part by the recognition that stratification thresholds of ecological significance are dam operations.

b) We are expanding the disciplinary scope of the VCR, to be able to address emerging ecological concerns in the estuary. Progress was, in particular, made in developing models to capture estuarine hypoxia, and to describe the sediment dynamics of ecological hotspots in the estuary (lateral bays and estuarine turbidity maxima) whose filtering capacity is susceptible to change by increasing estuarine acidification. Both the dissolved oxygen and sediment transport models are in calibration/validation stages.

c) Data Management And Communications (DMAC) Committee

Co-chaired by E. Mayorga (APL-UW) and S. Uczekaj (Boeing), this committee is composed of members from Boeing, CMOP-OHSU, DOGAMI, OSU and UW. The DMAC and User Products teams work in an integrated fashion towards the prioritization, development and evaluation of data services and user products. NANOOS is an active collaborator in national IOOS DMAC efforts, including the IOOS SOS Reference Implementation (RI) efforts (E. Mayorga) and the IOOS DMAC Steering Committee (S. Uczekaj). NANOOS also supported CeNCOOS by serving on the external review panel for its DMAC program in May.

NANOOS Visualization System (NVS) enhancements encompass continuous asset additions and updates, including: new near-real-time in-situ monitoring assets (Taylor Shellfish; UW Friday Harbor Labs.), new inventory-mode assets (Whiskey Creek Shellfish Hatchery; UW Pelagic Ecosystem Function surveys), and many redeployments and enhancements. The adaptation to NVS in-situ data (via NVS data services) of the existing "CMOP Data Explorer" online tool for sophisticated data exploration is nearly finalized and will be released in July. Finally, 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.

NANOOS and IOOS DMAC system implementation. Enhanced asset-health monitoring capability was deployed in March. NANOOS has been a leading participant in the IOOS SOS RI working-group, including the SOS RI workshop in February that resulted in substantial advances to data services and metadata conventions. E. Mayorga received IOOS funding in May to help document and coordinate the completion of the first SOS RI project Milestone by September.

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 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 RA's presented a common vision at the WC Regional Data Framework workshop in Oakland, CA (Mayorga et al. 2011), and NANOOS actively supported follow-up activities, including coordination of the IT working group.

Ocean Acidification Data. NANOOS DMAC strongly supported the ongoing, NOAA-led Ocean Acidification Data Management project, participating in its Steering Committee, a March workshop in Seattle (Mayorga 2012a), and follow-up data-management discussions. NANOOS also supported the

asset inventorying activities of the California Current Acidification Network, as well as data dissemination and access needs of the regional shellfish aquaculture industry.

d) User Products Committee (UPC)

Managerial: Chaired by J. Allan (Oregon Department of Geology and Mineral Industries) this committee is composed of members from Boeing, OHSU, UW, OSU, NANOOS E&O, OR Sea Grant, and NOAA. The core focus of the NANOOS UPC is to guide the conceptual development of the data/analysis products (i.e. observations, time series, models, applications, etc.) identified by NANOOS stakeholders, and develop the appropriate graphical formats and lines of communications for product dissemination. NANOOS UPC chair Allan participates in weekly "tag-up" calls with a smaller sub-group comprised of members from DMAC, UPC, E&O, and Web development in order to facilitate consistent work efforts and improvements to product development and enhancements. In addition, Allan and others met in June 2012 as part of the NANOOS annual Tri-committee meeting (UPC/DMAC/E&O) in order to review past activities and develop plans and approaches for the coming year.

Achievements:

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 smartphone apps), both of which generated significant interest in NANOOS products as stakeholders either sought pertinent life-safety information, or were accessing a new product.

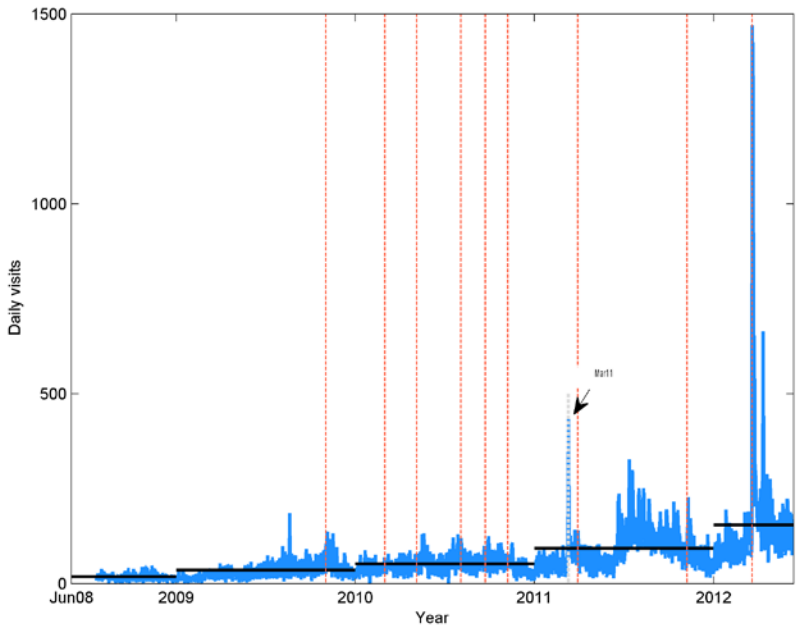

Figure 1: Time history of daily web visits to NANOOS. Arrow indicates the Japan earthquake on March 11, 2011.

NVS: During this period, updates to the NVS beaches and shorelines web application were implemented. This involved the incorporation of coastal change monitoring data collected by the Washington Department of Ecology, and their dissemination as change plots through NVS (http://www.nanoos.org/nvs/nvs.php?section=NVS-Products-Beaches-Mapping). Future efforts will result in the incorporation of bathymetry data that is being collected along discrete sections of the PNW coast. Work was also initiated during this period on an entirely new graphical user interface (GUI) to NANOOS products. Although not yet released, 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. For example, work commenced on a new Maritime Operation Web Application , which will depict information (ocean wave conditions and climate related information) relevant to the maritime industry (e.g. fisherman, 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.

Figure 2: The new NVS web application GUI under development

Mobile Applications: In Y4, work commenced on the development of an entirely new Pacific Northwest Tsunami Evacuation web-based and mobile application[1]. The purpose of this effort was to enhance the older tsunami web portal bringing it more in line with the NVS platform, enhancing it with overlay data from Washington State, improved content and capabilities, and providing links to the West Coast Alaska Tsunami Warning Center. An update to this smartphone app was released in March 2012, which corrected a number of minor bugs.

Presentations and Publications acknowledging NANOOS support: UPC chair Allan, presented at the Pacific Northwest Waters: Gateway to Our Future industry day meeting held a Microsoft Research in Redmond Washington, on February 2-3, 2012.
UPC Chair Allan, NANOOS President Martin, and Executive Director Newton co-wrote an article for the magazine, Sea Technology, titled “Using Social Networking, Mobile Apps to Distribute Tsunami Hazard Information.”

[1] http://www.nanoos.org/nvs/nvs.php?section=NVS-Products-Tsunamis-Evacuation

e) Education and Outreach

Managerial: The Education and Outreach Committee, chaired by N. Hunter (Oregon Sea Grant), was sustained during the reporting period. The NANOOS E&O committee continued monthly conference calls through 2011, but in 2012 changed the frequency to every other month.

NANOOS E&O staff A. Sprenger and S. Mikulak continued to work on NANOOS E&O efforts. Mikulak is an active member of the NANOOS User Products Committee (UPC) and, along with Sprenger and Newton, participates in weekly DMAC/UPC conference calls. A. Sprenger and S. Mikulak continued their participation in IOOS-NFRA E&O monthly calls. Mikulak is a member of the sub-committee for the IOOS video project and has been providing input and guidance in the development process.

Summary of Education Accomplishments: NANOOS education efforts have focused on continued work to connect with educators in the Pacific Northwest and partnering with local and regional efforts.

- NANOOS has a booth at the WA Science Teachers Association/regional National Science Teachers Association (NSTA) conference held in Seattle in December, 2011. The conference was attended by over 500 educators, with over 150 educators visiting our booth.
- The NANOOS funded Hatfield Marine Science Center (HMSC) exhibit was included in an Ocean Gazing podcast supplemental DVD produced for educators in January, 2012 (http://coseenow.net/podcast/2012/04/free-ocean-gazing-dvd/).
- In March, 2012, Sprenger gave a presentation about NANOOS at the Puget Sound Education Summit, a one-day professional development workshop for formal K12 educators organized by the Puget Sound Partnership. The session was attended by 30 educators.
- Newton and Sprenger were invited to discuss NANOOS during the March 2012 monthly conference call of the Ocean Awareness and Literacy Action Coordination Team for the West Coast Governors Alliance on Ocean Health.

Summary of Outreach Accomplishments: NANOOS outreach efforts have been focused on engaging with target user groups, including fishers, coastal community residents, scientists, and shellfish growers, and supported the continued development of the NANOOS Visualization System, NANOOS mobile apps and the redesign of the NANOOS tsunami web portal.

- Newton was appointed to the Olympic Coast National Marine Sanctuary Advisory Council in the Research Chair in January 2012, and to the Washington Governor's Blue Ribbon Panel on Ocean Acidification in February, 2012.
- J. Barth (OSU NANOOS PI) briefed Oregon Senator Wyden about the Japanese Tsunami Marine Debris (JTMD) issue for Oregon waters on 8 Jan 2012. This was followed up with a series of teleconferences and meetings to set up an Oregon plan, in coordination with similar efforts in Washington, for dealing with JTMD.
- NANOOS held a major workshop "Pacific Northwest Waters: Gateway to our Future" hosted at Microsoft Research on 2-3 February 2012. This workshop was part of a national series conducted regionally through assistance of the IOOC (Interagency Ocean Observation Committee), established by Congress in 2009 as part of the Integrated Coastal Ocean Observing Act. This workshop was a huge success, with an attendance of ~150 on day 1 and ~45 on day 2 and a high degree of participant interaction. Its success was hailed on the IOOS website (http://www.ioos.gov/ioos_in_action/stories/industry_workshop_feb2012.html) which includes more details, video links to major presentations, and the workshop agenda and materials. Sprenger tabled for the workshop, supplying NANOOS MOAs, brochures, and newsletters. The first day highlighted user needs and NANOOS services for a variety of sectors. The second day focused on follow-up action items for strengthening NANOOS.

- In March 2012, NANOOS issued a joint press release with the Oregon Department of Geology and Mineral Industries and the Washington Department of Natural Resources (http://nanoos.org/documents/key/nanoos_tsunami_press_release_final_20_mar.pdf) announcing the release of the NANOOS Tsunami Evacuation Zone Portal web and mobile apps. The coverage in local and regional media was great and included several radio interviews with Newton and Allan. Web traffic to the web portal jumped from an average of 39 unique page views per day to 1,352 the first day of media coverage, and 890 the second day. Mobile app downloads also increased the days following the release. A few weeks after, a magnitude 5.9 earthquake occurred off the Oregon coast and the web traffic to the portal increased to 400 pageviews.
- NANOOS had a booth at the annual Saltwater Sportsmen's Show held in Salem, OR, on March 2012, to showcase tuna fisher specific data products, visualizations and mobile apps. There were 600 people in attendance, and Mikulak interacted with over 250 attendees.
- NANOOS partnered with AOOS, CeNCOOS, and SCCOOS to host a booth at the National Shellfish Association Conference held in Seattle, WA, March 2012. Each RA contributed outreach materials and informational sheets tailored to shellfish growers and resource managers in their respective regions. Newton and Sprenger staffed the table, fielded inquiries, and demonstrated RA websites. They held longer conversations with over 25 attendees and identified their respective IOOS RA.
- NANOOS showcased hands-on activities at a "Paws on Science" weekend, focused on research efforts at the University of Washington, hosted at the Pacific Science Center. Sprenger, Newton, D. Hannafious, and C. Bassin with the help of Alison Fundis and Liza Ray from UW's OOI program staffed the booth on "Ocean observing in the Pacific Northwest" during the three-day event. Over 400 people visited the Pacific Science Center each day, and it seemed most visited our booth as it was very busy the entire time. Participants measured and graphed water properties and built buoys.
- On Earth Day, 22 April 2012, Newton participated in a press event sponsored by Senator Maria Cantwell (D-WA) to announce her efforts on continued funding for IOOS and ocean acidification observing efforts in Washington, because these translate into jobs. This event included Taylor Shellfish and the Pacific Coast Shellfish Growers Association, NANOOS' newest member. For more information, see http://www.apl.washington.edu/project/project.php?id=ocean_acidification.
- New NANOOS outreach materials created this reporting session include the Winter 2012 NANOOS Observer (http://nanoos.org/documents/key/NANOOS_Observer_Winter_2012.pdf) and one-page handouts that are tailored for targeted end-user groups.
- To aid ease of user interface, NANOOS released four Tsunami Evacuation Zone Portal Tour videos in March 2012 developed by Mikulak (http://www.youtube.com/playlist?list=PL324845DBA5FBBFC8). These videos provide a quick orientation to the features and functions of the portal, as well as how to interpret the map and data.
- Newton was invited to a Japan Tsunami Marine Debris workshop 25 April 2012 at Ocean Shores, WA; she discussed how NANOOS could contribute to a response plan, both for modeling and outreach.
- During April 2012, J Barth, OSU NANOOS PI, gave glider demonstrations at Cheldelin Middle School, Corvallis, Oregon, and at the Marine Science Day at the Hatfield Marine Science Center, Newport, Oregon.
- CMOP-NANOOS observations support the following Ecological watches:
    - Oxygen watch: http://www.stccmop.org/datamart/observation_network/hypoxia
    - Estuarine turbidity maxima: http://www.stccmop.org/datamart/observation_network/etm
- NANOOS Partner South Slough NERRS staff contributed to: Partnership for Coastal Watersheds meetings, Jan., April, and June 2012, (C. Cornu); South Coast Lamprey Summit, SSNERR Research & Monitoring Overview, May 2012 (J. Bragg); Oregon Coast Education Program Water quality webinar, March 2012, (A. Helms); NERRS Science Collaborative Olympia Oyster Recovery meeting, Feb. 2012, (S. Rumrill); NERR Technician Training Workshop, Detection of pH shifts, Feb. 2012, (A. Helms).

f) Administrative

D. Martin and J. Newton continue to provide leadership to NANOOS operations. They and M. Kosro participate in regular IOOS and NFRA calls. Newton is on and participates in the NFRA Executive Committee teleconferences. Throughout the reporting period, Martin and Newton remained deeply involved with a complimentary research ocean observing effort in the Pacific Northwest, the NSF-funded Science and Technology Center (STC) for Coastal Margin Observation and Prediction, which NANOOS leverages heavily in the areas of DMAC and Education and Outreach. Martin serves as Co-Director for the Center and Newton directs the UW Education efforts for this multi-institution project.

Newton and Martin represented NANOOS at the NOAA IOOS and NFRA meetings 28 February-1 March 2012, giving the annual review update for NANOOS. During the reporting period they represented NANOOS at national meetings of significance, such as the Ocean Sciences session on build-out plans that IOOS co-sponsored in Salt Lake City, the National Water Quality Monitoring Network Panel in Portland Oregon, and other meetings noted in the references section, below. They made plans for the annual Tri-Committee meeting to be held in June 2012 and upcoming annual GC meeting and PI meeting to be held in July 2012. They coordinated with West Coast RAs, following the intent of our mutual MOU, and other RAs to optimize and leverage capabilities and assure consistencies.

Newton hosted a national meeting for Ocean Acidification data management at UW in mid March, as described in the DMAC section above at the request of the NOAA OA Program office, coordinated through our NANOOS grant and is working on the International OA Network meeting scheduled for late June 2012.

3) Scope of Work

There are no current or anticipated changes in scope of work. NANOOS is succeeding in meeting our milestones and deliverables.

4) Personnel and Organizational Structure

There are no changes in key scientific or management personnel for this period.

6) Budget Analysis

At the end of this reporting period, the project period for the NANOOS RCOOS Yr1 award was 100% complete and we have encumbered or spent 88% of the funds provided (~$1.98M). In this context, “encumbered” refers to funds that are dedicated to specific planned expenditures in the UW Financial Systems where they are treated as funds already spent though they are not invoiced until actually spent. For example, all of the subawards are encumbered and thus not available to be spent for any other purpose. Indirect costs are also encumbered. However, encumbered amounts are NOT listed as actual expenditures until subawardee invoices are actually paid and indirect costs are actually charged.

The actual invoiced expenditures at the end of this reporting period are $851,966, or 38%. This difference (88% vs. 38%) reflects the delayed arrival of Year 1 funds to the University and subsequent delays mentioned in our previous Progress Report in establishing subcontracts and thus invoicing by our subcontractors (Year 1 funds were available to UW in August 2011). Given these delays plus inherent lags in the posting of expenditures in our institutional budget tracking systems, we assess that the spend rate is solid and suitable for maintaining robust execution of NANOOS plans to meet our objectives.

Presentations and Publications acknowledging NANOOS support: underline indicate NANOOS PI

Adams, K. A. and J. Barth, 2012: High- to low-frequency variability of moored temperature, currents and dissolved oxygen across central Oregon's coastal ocean. Ocean Sciences Meeting, February 2012.

Alford, M. H., J. Mickett, S. Zhang, P. MacCready, Z. Zhao, and J. Newton, 2012, ``Internal Waves on the Washington Continental Shelf,'' *Oceanography,* 25, 32--46.

Allan, J. Communication through the NANOOS Visualization System. Pacific Northwest Waters: Gateway to our Future Workshop, Redmond, WA, February 2-3, 2012.

Baptista, A. M. (2012) The SATURN collaboratory for the Columbia River coastal margin: capabilities and applications. Columbia River Estuary Conference, May 17, 2012. Astoria, OR

Baptista, A. M., Simon, H., Smit, M., Herfort, L., Seaton, C., Li, B., Peterson, T. D., Needoba, J. A., Crump, B. C., Zuber, P. (2012) Adaptive sampling strategies to characterize microbial communities in a dynamic estuary. Ocean Sciences Meeting, February 2012. Salt Lake City, UT

Barth, J. A., 2012: New eyes on our changing ocean. ICES/PICES Early Career Scientist Conference "Oceans of Change," Mallorca, Spain, April 2012.

Barth, J. A., May, 2012: Hypoxia over the continental shelf in the Northeast Pacific Ocean. Effects of Climate Change on the World's Oceans, Yeosu, South Korea, May 17, 2012.

Barth, J. A., S. D. Pierce and F. Chan, 2012: Hypoxia over the continental shelf in the Northeast Pacific Ocean. Ocean Sciences Meeting, February 2012.

Di Leonardo, D. and Ruggiero, P., 2011. Applying a long-term data set to understand large scale coastal behavior, AGU Fall meeting, San Francisco, CA.

Einolf, A.E., J.A. Lerczak, and M. Haller, Tidally-dependent stratification, shear and secondary currents in Yaquina Bay estuary, Oregon, *AGU Ocean Sciences Meeting*, Salt Lake City, 2012.

Erofeev, A., J. A. Barth, R. K. Shearman, Z. Kurokawa, K. Adams, C. Ordonez, P. Mazzini and T. P. Welch, 2012: Sampling the dynamics Oregon coastal ocean with underwater gliders. Ocean Sciences Meeting, February 2012.

Hickey, B.M., S.L. Geier, N.B. Kachel, S.R. Ramp, P.M. Kosro, "Alongcoast structure of seasonal water properties and velocity on the northen California Current shelf". Ocean Sciences Meeting, Salt Lake City, Feb 23, 2012.

Holman, R.A. and M.C. Haller, Nearshore remote sensing, *Annual Review of Marine Science*, accepted April 2012, to appear in Volume 5, January 2013.

Honegger, D.A., M.C. Haller, J.A. Lerczak, C. Teague, and H. Aguilar, Remote observations of surface current structure at an engineered tidal inlet mouth, *AGU Ocean Sciences Meeting*, Salt Lake City, 2012.

Kim, Sung Yong, E. Terrill, B. Cornuelle, B. Jones, L. Washburn, M. Moline, J. Paduan, N. Garfield, J. Largier, G. Crawford, P.M. Kosro, "Sustained observations of mesoscale and submesoscale surface circulation off the U. S. west coast". Oceans 2012, Yeosu, Republic of Korea, May 24, 2012.

Krembs, C. Eyes Over Puget Sound (May 2012): http://www.ecy.wa.gov/programs/eap/mar_wat/surface.html

Kurapov poster at NOAA Science Week, Kansas City, MO, May 2012

Kurapov talk at the GODAE-OceanView workshop of the Coastal Ocean and Shelf Seas Task Team (COSS-TT), Miami, FL, Jan 2012 (INVITED)

Kurapov, A.L., P. Yu, S. Erofeeva, P.M. Kosro, "Effects of Assimilating GOES SST, alongtrack altimetry, and high-frequency radar surface currents on the coastal ocean surface topography", Ocean Sciences Meeting, Salt Lake City, Feb 20, 2012.

Lopez, J., Baptista, A. M., Spitz, Y. (2012) Enhancing modeling skill of the vertical structure and trapping ability of density gradients in the Lower Columbia River estuary. Ocean Sciences Meeting, February 2012. Salt Lake City, UT.

Lopez, J., Baptista, A.M., Spitz Y. (2012) Modeling sediment dynamics in the Columbia River estuary. Columbia River Estuary Conference, May 17, 2012. Astoria, OR

Martin, D. Why We Are Here. Pacific Northwest Waters: Gateway to our Future Workshop, Redmond, WA, February 2-3, 2012.

Mayorga, E. 2012a. IOOS National and Regional Components and Ocean Acidification Data. *Ocean Acidification Data Management Workshop, Seattle, WA, Mar. 13-15*

Mayorga, E. 2012b. The role of CUAHSI in the NANOOS Visualization System (NVS): A user-friendly, regional application for environmental data aggregation and dissemination. *CUAHSI eNews Brief 6(4, April)*, http://cuahsi.org/enews/enews-201204.html

Mayorga, E., H. Kerkering and C. Cohen. 2011. IOOS West Coast Regional Experience and Capabilities. *West Coast Regional Data Framework Workshop, Oakland, CA, Dec. 13-14*

Mickett, J. B., M. Alford, J. Newton and A. Devol. The NANOOS Northwest Enhanced Moored Observatory—A Novel Three-tiered Approach to Observations on the Washington Coast. , presentation at Ocean Sciences Conf., Salt Lake City, Feb. 2012

Newton, J. 2011. News from the U.S. Integrated Ocean Observing System (U.S. IOOS®) and Northwest Association of Networked Ocean Observing Systems (NANOOS). Sidelights, The Council of American Master Mariners, Inc., December, 2011.

Newton, J. Delivering Observations in the Northwest Region. Pacific Northwest Waters: Gateway to our Future Workshop, Redmond, WA, February 2-3, 2012.

Newton, J. The Northwest Association of Networked Ocean Observing Systems (NANOOS): Exploring contributions to Public Health. Chesapeake Bay and Puget Sound Health Workshop, March 21-22, 2012.

Newton, J. A. and D.L. Martin. NANOOS: Serving the Pacific Northwest. Ocean Sciences Meeting, Salt Lake City, UT, February 21, 2012.

Newton, J. Advancing the implementation of a National Water Quality Monitoring Network (The Network) for U.S. Coastal Waters and their Tributaries Panel. National Water Quality Monitoring Conference, April 30-May 4, 2012.

Newton, J. and D. Martin. 2011. Tsunami Hazard Information through the Integrated Ocean Observing System (IOOS): How NANOOS is employing web-based, social networking and mobile application technologies in the Pacific Northwest. Sidelights, The Council of American Master Mariners, Inc., February, 2011.

Newton, J. and E. Mayorga. The Northwest Association of Networked Ocean Observing Systems (NANOOS): Exploring contributions to weather services. Pacific Northwest Weather Workshop 2012, March 2-3, 2012.

Newton, J. NANOOS: Partnerships and contributions to understanding ocean acidification. National Shellfisheries Association 26-29 March, 2012, Seattle, WA

Newton, J. West coast ocean acidification information and data needs and an inventory of observing assets. California Current Acidification Network Workshop, Palo Alto, CA, December 13-14, 2012.

Osborne J. J., A. L. Kurapov, G. D. Egbert, and P. M. Kosro, 2012: Energetic diurnal tides along the Oregon coast, JPO, submitted

Osborne, J. J., Kurapov, A. L., Egbert, G. D., & Kosro, P. M. (2011). Spatial and temporal variability of the M2 internal tide generation and propagation on the Oregon shelf. Journal Of Physical Oceanography, 41(11), 2037–2062. doi:10.1175/JPO-D-11-02.1

Osborne, J., A.L. Kurapov, G.D. Egbert, P.M. Kosro, "Modeling slope-shelf interactions in the coastal ocean", Ocean Sciences Meeting, Salt Lake City, Feb 21, 2012.

Pierce, S. D., J. A. Barth, R. K. Shearman and A. Y. Erofeev, 2012: Declining oxygen in the Northeast Pacific. J. Phys. Oceanogr., 42, 495-501.

Rostaminia, M. and Baptista, A. M. (2012) Impact of sea level rise on habitat opportunity of Columbia River juvenile Chinook salmon. Columbia River Estuary Conference, May-2012, Astoria, OR

Rostaminia, M., Baptista, A. M., Spitz, Y. (2012) Impact of changes in climate and hydropower operations on habitat opportunity and survival of Columbia River juvenile Chinook salmon. Ocean Sciences Meeting, February 2012. Salt Lake City, UT

Seaton, C., Baptista, A. M., Jarmillo, A. (2012) SATURN Data Explorer: a powerful and expandable tool for exploration of Columbia River data. Columbia River Estuary Conference, May 17, 2012. Astoria, OR

Seaton, C., Baptista, A. M., Lopez, J. E., Riseman, S. ., Wilkin, M. (2012) Development Of An Estuarine Turbidity Maximum Watch: From Process Understanding To Operational Implementation. Ocean Sciences Meeting, February 2012. Salt Lake City, UT.

Sprenger, A. Ocean observing data and resources for Puget Sound educators. Puget Sound Education Summit, March 15, 2012 Coupeville, WA.

Terrill, E., et al. Kosro, "Role of a Networked Ocean in Assessing Large Marine Ecosystems – Monitoring Ocean Currents at a Cascade of Scales with HF radar", Ocean Sciences Meeting, Salt Lake City, Feb 20, 2012.

Welle, P., Baptista, A. M., Spitz, Y., Lopez, J. E., Needoba, J. A., Peterson, T. D., Seaton, C. (2012) Understanding Oxygen Variability In Relation To Biological Processes In The Columbia River Estuary Through A Biophysical Model . Ocean Sciences Meeting, February 2012. Salt Lake City, UT

Welle, P., Baptista, A. M., Spitz, Y., Lopez, J. E., Needoba, J. A., Peterson, T. D., Seaton, C. (2012) Understanding Oxygen Depletion in the Columbia River Estuary through Data- Supported Numerical Modeling. Columbia River Estuary Conference, May 17, 2012. Astoria, OR

Yu, P., Kurapov, A. L., Egbert, G. D., Allen, J. S., & Kosro, P. M. (2012). Variational assimilation of HF radar surface currents in a coastal ocean model off Oregon. Ocean Modelling, 49-50(C), 86–104. doi:10.1016/j.ocemod.2012.03.001.

Zhang, S., M. Alford, J. Newton, "Internal Waves off the Washington Coast", presentation at Ocean Sciences Conf., Salt Lake City, Feb. 2012

Sustaining NANOOS, the Pacific Northwest component of the U.S. IOOS®:
NOAA Award: NA11NOS0120036

June 2012 Progress Report Annual Supplemental

The reporting period for this supplemental is not for an entire year since our Y1 funds were received in October 2012. Therefore, the reporting period is actually 10/1/2011-5/31/2012.

- **Training and Education Activities**

Per IOOS Supplemental Report request, we confirm that the NANOOS training and education activity information in the IOOS Education, Outreach and Training web tool is current and up-to-date.

During this period, NANOOS' education efforts have focused on continued work to connect with educators in the Pacific Northwest and partnering with local and regional educational efforts. NANOOS seeks to see where we may partner and provide new capacity, as opposed to re-inventing wheels or competing. We highlight some examples of partnering and collaborations to further ocean literacy.

In December 2011, NANOOS partnered with Washington Sea Grant, Northwest Aquatic and Marine Educators, and COSEE Ocean Learning Communities to exhibit "Marine Education Opportunities in the Pacific Northwest" at the joint WA Science Teachers Association/regional National Science Teachers Association (NSTA) conference held in Seattle. The conference was attended by over 500 educators, with over 150 educators visiting our exhibit. Expansion of use of real-time data and other learning activities was our goal.

Sometimes NANOOS products gain an even wider application and delivery than anticipated by our initial investment. Prior to this period, Sarah Mikulak, NANOOS Education and Outreach Specialist, had produced an exhibit at the Hatfield Marine Science Center (HMSC) that was partially funded by NANOOS. During this reporting period, this exhibit is now included in a supplemental DVD for Ocean Gazing podcasts. The podcast producer, Ari Daniel Shapiro, had previously created a podcast about WET Labs, Inc., a NANOOS member organization, and was creating a DVD of supplemental information for educators to use in their classrooms. Since the HMSC exhibit showcases data collected using WET Labs equipment, it is included in the DVD to supplement the podcast about WET Labs (http://coseenow.net/podcast/2012/04/free-ocean-gazing-dvd/).

As a result of our efforts over the years NANOOS' visibility has gained in the region such that NANOOS is typically invited to regional events involving marine educators. In March 2012, NANOOS Education and Outreach Coordinator, Amy Sprenger was invited to present on NANOOS, focusing on observing and data streams in the Puget Sound area, at the Puget Sound Education Summit, a one-day professional development workshop for formal K12 educators organized by the Puget Sound Partnership. The Puget Sound Partnership is a state agency aimed at protection and restoration of Puget Sound. Sprenger's session was attended by 30 educators. The intimacy and regional specificity of the interaction takes staff time, but has resulted in building productive relationships with educators and increased the use of NANOOS products in their work.

A final example of NANOOS' stature in the region is that Newton and Sprenger were invited to discuss NANOOS during the March 2012 monthly conference call of the "Ocean Awareness and Literacy Action Coordination Team" for the "West Coast Governors Alliance on Ocean Health." The chair of the Action Coordination Team is recommending that the IOOS Regional Associations have a seat on this team. This is another example of NANOOS making solid progress to increase involvement with the West Coast Governors Alliance.

- **Marketing, Outreach, and Engagement Activities**

Per IOOS Supplemental Report request, we confirm that the NANOOS outreach and engagement activity information in the IOOS Education, Outreach and Training web tool is current and up-to-date.

The major marketing and engagement activity for this period was the large stakeholder workshop, "Pacific Northwest Waters: Gateway to our Future", held Feb 2-3, 2012. Hosted at Microsoft Research, this workshop was part of a national series conducted regionally through assistance of the IOOC (Interagency Ocean Observation Committee), established by Congress in 2009 as part of the Integrated Coastal Ocean Observing Act.

The workshop featured keynote speaker Laura K. Furgione, Deputy Assistant Administrator of the National Weather Service, who delivered the strong message that a climate-ready nation needs an IOOS. Also scheduled to keynote was WA State Senator Kevin Ranker of the 40th Legislative District, who had to cancel due to legislative demands, but who sent a strong message of support. Next was an overview of IOOS & NANOOS, its regional footprint and capabilities, and some of its major tools (e.g., the NANOOS Visualization System), by David Martin, NANOOS Board Chair, Jan Newton, NANOOS Executive Director, and Jonathan Allan, NANOOS User Products Committee Chair. This was followed by a panel of speakers who presented the application of observation data in making policy and community resilience decisions in the Pacific Northwest. The bulk of the day presented six panels of speakers who represented major industries, including tribal fisheries, shellfish aquaculture, marine energy, coastal engineering, and maritime operations, and presented case-studies showcasing the observation data they depend on. Each of these included much time for audience discussion and questions. Some of the user groups were new to NANOOS, and highlighted their needs; others were NANOOS veterans who highlighted how NANOOS data are making a difference to their operations.

The workshop was a major success, with an attendance of ~150 on day 1 and ~45 on day 2 and a high degree of participant interaction. Its success was hailed on the IOOS website (http://www.ioos.gov/ioos_in_action/stories/industry_workshop_feb2012.html) which includes more details, video links to major presentations, and the workshop agenda and materials. The second day brought together those interested in specific facets of the NANOOS enterprise. After a presentation by Microsoft Research, the group focused on recommendations for follow-up action items for strengthening NANOOS. These will be used to guide NANOOS efforts, though most of the ideas would require additional funding to implement. The workshop resulted in new NANOOS members and others who expressed interest in being NANOOS members or in partnering. All in all, this workshop increased NANOOS visibility in the region and was useful for engaging new and existing users. Fostering increased partnering with federal agencies is presenting to be the most difficult factor to follow up on.

NANOOS' on-going outreach and engagement activities are focused on three major user groups that we have been actively targeting, based on stakeholder input and suitability of our products to their needs. These are: 1. tuna fishers, 2. shellfish growers, and 3. coastal residents about tsunami hazards.

1. Outreach efforts with recreational tuna fishers continued for the third year in a row at the annual Saltwater Sportsmen's Show Mar 31-Apr 1, 2012. There were 600 people in attendance, and Mikulak interacted with over 250 attendees. The additions to the tailored product page from last year, including a point-and-click function to get lat/long coordinates on the data plots and an FAQ list, were well received and many fishers who used our page during the last fishing season indicated the value of the product we provide. Fishers were also excited about using the NVS mobile app on their iPhones to access the data and forecast plots we provide on the web.

2. Previous outreach and collaboration with shellfish growers were enhanced during this reporting period as NANOOS data manager and DMAC Co-chair Emilio Mayorga worked with four different shellfisheries, Pacific Shellfish Institute (PSI) (out of Olympia, WA with installations in Willapa Bay, WA), Whiskey Creek Hatchery (Netarts Bay near Garibaldi, OR), Lummi Shellfish Hatchery (Lummi Bay near Bellingham, WA), and Taylor Shellfish Hatchery (Dabob Bay near Quilcene, WA), to stream their data on

the NANOOS Visualization System. PSI is actively monitoring three sites in Willapa Bay. The three hatcheries are collecting data of their intake water. All of this activity is in coordination with the Pacific Coast Shellfish Growers Association, and the facilitation of some of the monitoring instruments was through federal funding secured by US Senator Maria Cantwell. The partnership with the shellfish growers has been extremely successful, and the hatchery managers have expressed that we have helped them with their jobs since they can access their data either online or via a smartphone app.

Another notable outreach activity with shellfish growers was in partnership with AOOS, CeNCOOS, and SCCOOS by hosting a table at the National Shellfish Association Conference held in Seattle, WA, March 24-28, 2012. Each RA contributed outreach materials and informational sheets tailored to shellfish growers and resource managers in their respective regions. Newton and Sprenger staffed the table and fielded inquiries, and demonstrated various RA websites, including to conference goers from the east and gulf coasts. They held longer conversations with over 25 attendees. Also at this conference, Newton was invited to give a presentation on NANOOS activity to support observation of ocean acidification conditions.

The strong partnering with the Pacific Coast Shellfish Growers' Association gained NANOOS federal attention, not only to NANOOS but IOOS. On Earth Day, 22 April 2012, Newton was invited to participate in a press event sponsored by Senator Maria Cantwell (D-WA) to announce her efforts on continued funding for IOOS and ocean acidification observing efforts in Washington, because these translate into jobs. This event included Taylor Shellfish and the Pacific Coast Shellfish Growers Association, NANOOS' newest member. For more information, see http://www.apl.washington.edu/project/project.php?id=ocean_acidification. This invitation was evidence of the PCSGA's appreciation of the NANOOS tools and the IOOS concept that is serving their industry. Senator Cantwell underscored the efficient use of resources used to bring real-time data on ocean acidification state to the hands of shellfish hatchery managers, the pay-off in local jobs, and the benefit to the economy as well as human health from protecting the region's shellfish resources.

3. NANOOS also has focused on coastal residents as regards tsunami hazards. NANOOS released its updated Tsunami Evacuation Zone Portal (http://nanoos.org/nvs/nvs.php?section=NVS-Products-Tsunamis-Evacuation) web app and newly created Apple and Android smartphone apps in November of 2011. The release of these web and mobile apps were widely announced to the public through a joint press release with the Oregon Department of Geology and Mineral Industries and the Washington Department of Natural Resources (http://nanoos.org/documents/key/nanoos_tsunami_press_release_final_20_mar.pdf).

The coverage in local and regional media was significant and included several radio interviews with Newton and Allan. Web traffic to the web portal jumped from an average of 39 unique page views per day to 1,352 the first day of media coverage, and 890 the second day. Mobile app downloads also increased the days following the release. A few weeks after, a magnitude 5.9 earthquake occurred off the Oregon coast and the web traffic to the portal increased to 400 pageviews.

To assist with understanding how to use the web app, Mikulak created a 4-part video tutorial. Available through YouTube, (http://www.youtube.com/playlist?list=PL324845DBA5FBBFC8) the NANOOS Tsunami Evacuation Zone Portal Tour videos provide a quick orientation to the features and functions of the portal, as well as how to interpret the map and data. These videos are also available through the IOOS Education/Training web page: http://www.ioos.gov/training/welcome.html.

- **Regional Ocean Governance Organization activities**

In September of 2011, NANOOS, CeNCOOS, and SCCOOS co-signed a "Memorandum of Understanding (MOU) for Integrated Coastal and Ocean Observing in the California Current Large Marine Ecosystem (CCLME). The purpose of the agreement is to further the mission of the U.S. IOOS by expanding and strengthening West Coast regional ocean observing collaboration to improve linkages

between the three West Coast RICEs to serve the needs for ocean observation, data, and information at the scale of the CCLME.

The three West Coast RICEs share responsibility for observing the CCLME. The MOU affirms the Parties' commitment to jointly plan CCLME observations and share information that will mutually benefit each sub-region and the larger CCLME. In addition, important issues in regional ocean governance, management, science, and marine operations span the West Coast and CCLME, including, but not limited to, the West Coast Governors' Agreement on Ocean Health (WCGA), the Pacific Coast Collaborative (PCC), the Ocean Observatories Initiative (OOI), and the designation of the West Coast as a single regional planning area for Coastal and Marine Spatial Planning (CMSP) in the National Ocean Policy (NOP). Through this MOU the Parties have committed to work together at the CCLME scale, and to work cooperatively with governmental and nongovernmental entities to identify and provide information products for multiple users within the region that inform scientific, economic and management activities in areas including: fisheries and water quality; climate variability and change; coastal hazards; marine commerce and safety; and priorities identified by the NOP, WCGA, PCC and other region-wide marine and ocean groups. The Parties recognize that collaborating and leveraging human and financial resources will benefit planning and decision making at both sub-regional and CCLME levels.

Following this, with assistance from our NOAA Regional Team Lead Timi Vann, the three RAs drafted an MOU for signature with the West Coast Governors' Alliance (WCGA). This document is circulating through the three states for signature. This will codify a strong partnership and the role the IOOS RAs can play. Partnering is already happening, as evidenced by NANOOS involvement in Data Management, Education and Outreach, and other WCGA Action Coordination Teams (ACTs). The NANOOS Executive Director and data team lead are part of the newly created Regional Data Framework ACT. The NANOOS data team lead is also the coordinator of the IT working group, while SCCOOS staff have been engaged in outreach and general coordination efforts.

In addition, NANOOS has been party to proposal submissions in partnership with the WCGA. In 2011, the WCGA received $250,000 from NOPP which is being used largely to prioritize data and data product needs for the region. The RAs participated in a December 2011 WCGA workshop to refine their goals. Recently it was agreed to allocate most or nearly all the funding to a contractor who will carry out the work specified in a recently developed Work Plan. The work plan includes a strong emphasis on data catalogs, data products and building relationships.

The WCGA effort addresses the data needs of a wide range of partners, but with initial prioritization based on needs already highlighted in WCGA ACT reports, where state agencies have played a prominent role. One of the main challenges is to connect the various CMSP data efforts occurring on the west coast. Due to their large number of partners and their expertise in data coordination and interoperability, the RAs are playing a key role in this effort.

- **Efforts to leverage IOOS funding**

NANOOS is substantially leveraged in every aspect of its effort. None of NANOOS' assets or teams are supported by 100% IOOS funds. Maintaining the sources of the current leverage, in times of budget cuts and shrinking funding levels affecting all sectors of NANOOS, represents a major commitment of time. NANOOS leadership, Newton and Martin, as well as all of its PIs, actively engage to leverage and build capacity for our existing systems. Recent proposals include to NOAA MERHAB, NSF STC, WA National Estuary Program, Puget Sound Institute, WA Dept of Health, as just a few examples.

A major success was that during year 2 of this current award, the NOAA Ocean Acidification Program will be sending their funds through NANOOS to partially support a buoy off La Push that is now part of NOAA's National OA Program. This success is witness to substantial conversations and collaborations involving NANOOS, IOOS, and within sectors of NOAA to coordinate this activity, starting

at the Seattle IOOS workshop in August 2009 where Newton invited Richard Feely and Chris Sabine to discuss their work and their observing needs.

Newton's participation on the "Advancing the implementation of a National Water Quality Monitoring Network (The Network) for U.S. Coastal Waters and their Tributaries Panel" at the National Water Quality Monitoring Conference, Portland, OR, April 30-May 4, 2012, was another important connection to lay the groundwork for increased integration of "The Network" with IOOS. While that was the concept at the start, many of the implementers of The Network were not aware of the maturity IOOS and its Regional Associations. This talk was very well received and hopefully can start future leveraging of and support for the IOOS RAs as principal components of The Network. EPA had invited IOOS Program Director Zdenka Willis, who requested Newton to go and represent both National and Regional aspects of IOOS.

- **Update to RA membership, Board of Directors, committee members**

NANOOS gained the following four new members: Intellicheck Mobilisa, a local technology industry and buoy provider in Puget Sound; NortekUSA, a oceanographic technology industry, manufacturing current meters and other sensors; Grays Harbor Historical Seaport Authority, a non-profit organization out of Grays Harbor, WA, championing preservation and enjoyment of life at sea; and the Pacific Coast Shellfish Growers Association, the premier organization representing shellfish growers and their concerns along the Pacific Coast.

Our Board and committee members have not changed, and have stayed strongly connected.