Progress Report for the Enhancement of the
Northwest Association of Networked Ocean Observing Systems (NANOOS)
Regional Coastal Ocean Observing System (RCOOS)

As one of five IOOS Regional Associations awarded a competitive RCOOS grant in FY 07 (NA07NOS4730203 covering Y1-3 of the NANOOS RCOOS), NANOOS was requested to and submitted a successful proposal for a one-year bridge award (NA10NOS4730018 covering Y4 of the NANOOS RCOOS). This one-year duration was timed to permit NANOOS to compete for the omnibus IOOS RCOOS FFO in FY11. NANOOS requested and was granted a 1 year no-cost extension to our initial Y1-3 award in order to assure continuity in the RCOOS activities while the new Y4 award was being set up. Accordingly, NANOOS presently has two active RCOOS awards in place (both NA07NOS4730203 and NA10NOS4730018). As these RCOOS activities are necessarily blended during this transition phase, similar Progress Reports are submitted for each.

1) Award Information: Provided as a separate Cover Sheet.
Reporting period: 01 Apr 2011 – 30 Sep 2011

2) Project Summary
NANOOS is engaged, through this NOAA funding, in an active process to develop, implement, and integrate various in-water and land-based systems that will constitute a fully robust and user-driven Regional Coastal Ocean Observing System (RCOOS) for the Pacific Northwest (PNW). This includes all necessary sub-systems to provide PNW, west coast, and national stakeholders with the ocean data, tools, and knowledge they need to make responsive and responsible decisions appropriate to their individual and collective societal roles. Our ongoing knowledge of prioritized issues and user needs is gained through proactive NANOOS interactions with a wide range of PNW stakeholders.

To attain the goals of this project, with adjustments for funding realities, we are:

- **Maintaining existing surface current mapping capabilities and evaluating the use of additional HF radar sites in the PNW.** This tool is a fundamental foundation block for building an observing system for the coastal ocean and serves a multitude of disparate users.
- **Maintaining observation capabilities in PNW estuaries.** The NANOOS objective in this arena is a federated real-time observation network across Oregon and Washington estuaries to address PNW societal needs.
- **Strategically maintaining coverage and range of observations in the PNW shelf, in coordination with emerging national programs.** We have targeted the use of fixed (buoys) and mobile (glider) assets to provide advanced information on hypoxia/anoxia and Harmful Algal Blooms (HABs), which are major regional concerns affecting ecosystem and human health, fisheries, and coastal economies.
- **Maintaining core elements of existing beach and shoreline observing programs in Oregon and Washington.** This is improving coastal hazard mitigation by providing better decision support tools for coastal managers, planners, engineers, and coastal hazard mitigation decision makers.

- **Evaluating the creation of a federated system of numerical daily forecasts of PNW ocean circulation.** We are extending utility and availability of operational models from the head of tide of estuaries to the outer edges of the exclusive economic zone (EEZ).
- **Bolstering ongoing Data Management and Communications (DMAC) activities to support routine operational distribution of data and information.** Our DMAC design mandates a collaborative, dynamic distributed system of systems that provides a wide range of products, tools, and services to regional user communities while allowing unfettered access to the IOOS national backbone and national information infrastructure.
- **Building from and strengthening ongoing NANOOS education and outreach efforts.** We are conducting these in coordination with other regional efforts (e.g., NSF-funded STC and COSEE projects), to foster ocean literacy and facilitate use of NANOOS products in the PNW by stakeholders, decision makers, and the general public.

We have delineated a specific NANOOS RCOOS focus on high-priority PNW user-driven applications of: **a) maritime operations; b) ecosystem impacts including hypoxia and harmful algal blooms; c) fisheries; and, d) mitigation of coastal hazards** as these issues represent applications having the greatest impact on PNW citizenry and ecosystems and, we believe, are amenable to being substantively improved with the development of a PNW RCOOS.

3) Progress and Accomplishments

NANOOS reports in this section in the fashion it adopted in the original proposal; specifically, we divide our progress report into the sections of our efforts for: a) observing systems (shelf, estuaries, shorelines, and currents); b) modeling (estuaries and shelves); c) Data management and Communications (DMAC); and, d) Education and Outreach. Administrative efforts orchestrating this RCOOS effort are reported separately in our NANOOS RA progress reports.

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

- Shelf

1. Washington Buoy and Glider observing network operations:

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 new NEMO subsurface mooring (completed in April 2011) and the Seaglider.

The Seaglider was deployed at the beginning of May and the two moorings later in the month. Though the subsurface mooring, which employs a "crawler" (McLane Moored Profiler or MMP), an ADCP and a CTD, was largely a success in that data from the CTD and ADCP were being transmitted in near real-time back to shore via Cha Ba, the mooring was recovered just a day after deployment because data were not being sent from the MMP. Inspection of the mooring wire after recovery indicated that the wire jacket had been damaged during deployment---we believe a consequence of using the ship's capstan and not the standard mooring winch, which was inoperable, for deployment. With the jacket damaged inductive data transfer from the MMP was not possible.

The NEMO subsurface mooring was re-deployed in early August from the R/V Thompson in conjunction with field servicing of Cha Ba. Ship time was generously donated by Dr. Jim Mercer of APL. Although Cha Ba performed well up until about mid-July, power was being

consumed and batteries were being depleted at much faster rates than expected. To attempt to address the power issue, a number of changes were made to Cha Ba during the August field servicing, including changing the entire system from 24 V to 12 V. A small test wind generator was also added to the buoy, though was not connected to the batteries since its survivability was yet to be field tested. All systems on NEMO subsurface operated as planned for about the first week of deployment, then MMP data transfer stopped unexpectedly.

In mid-September it once again became apparent that Cha Ba was consuming power much more rapidly than predicted despite the engineering improvements. Given the limited availability of ship time for the planned fall mooring servicing, uncertainty in the time required to troubleshoot Cha Ba's problems, and the failure of real-time data transfer from the MMP on NEMO subsurface, we decided to recover both moorings and address all engineering issues as well as make upgrades over the winter. We plan to deploy both moorings in early spring. Seaglider 187 was recovered in mid-September with generous assistance from the Olympic Coast National Marine Sanctuary, completing a successful 4-1/2 month deployment.

The number of engineering and logistical issues that arose over the past six months highlight the additional challenges and costs that are almost always associated with implementing relatively complex, novel systems in remote, harsh environments. Without strong leveraging of resources (and generous donation of ship time), the maintenance of the complete system would not be possible given the current funding level.

However, these assets have contributed never before possible data on physical, nutrient, oxygen, chlorophyll and carbonate system variables from the remote WA coast, at the entrance waters to Puget Sound. We look forward to analysis of these data (Ocean Sciences abstract submitted) and dissemination to user groups. NANOOS will be working with POST to understand the glider's acoustic data transceiver data and what has been learned re marine biota.

2. Oregon Glider operations: The Oregon State University (OSU) glider group led by J. Barth and K. Shearman continued deployments of an autonomous underwater glider off Newport, Oregon, using a combination of NANOOS, NSF, and private funding (Moore Foundation). The gliders measure vertical profiles of temperature, salinity, dissolved oxygen, chlorophyll fluorescence, colored dissolved organic matter fluorescence and light backscatter from near the shore in about 20 m of water to out over the continental slope approximately 45 nautical miles offshore. Near real-time, the glider reports position and returns a subset of data to shore every 6 hours. The April to September 2011 glider operations were challenged by the anomalously high amount of freshwater present in the Columbia River plume at the sea surface due to the melting of the twice-average La Nina snow pack. During May and early June, we had to make emergency recoveries of gliders unable to surface through the unusually buoyant surface layer. The NANOOS mooring at NH-10 recorded surface salinities of 20.5 during these episodes. A description of these unusual low-salinity pulses will be presented at the 2011 Eastern Pacific Ocean Conference and the 2012 Ocean Sciences Meeting. In spite of these challenges, we were able to maintain our nearly continuous sampling off Newport, Oregon, from April to September 2011.

Ocean observing off Oregon was featured in a National Geographic TV special "X-Ray Earth" on May 15, 2011. Our Oregon gliders were included in a July 2011 American Society of Mechanical Engineers article "Robots Plumb the Depths" (http://www.asme.org/kb/news---articles/articles/robotics/robots-plumb-the-depths).

During summer 2011, Ms. Kelly Mauser (Colorado State University) joined our glider research team as a Research Experiences for Undergraduates fellow. COAS Graduate Student Chris Ordonez talked about our gliders at the Hatfield Marine Science Center Career Day in October 2011. PIs Barth and Shearman assisted a NOAA PMEL glider team, working as part of Dr. Richard Feely's investigation of carbon dioxide dynamics, in planning glider operations off central Oregon.

3. Oregon Buoy (mooring) operations: Led by M. Levine (OSU), a mooring about 10 miles off Newport, Oregon, in 80 m of water (site NH-10) has been in operation since mid-2006, partially supported by NANOOS. About twice a year the mooring is recovered and a refurbished mooring is deployed. Successful mooring turn-arounds were conducted in April and September 2011. The next turnaround is scheduled for late March 2012.

As most sensors are borrowed from other projects, the number of sensors on a given deployment depends upon availability. The infrastructure is in place to increase the number of real-time sensors should funds become available. Some of the data are transmitted to shore through a cellular phone modem in near-real time and in addition to being available in the NANOOS Visualization System are also displayed by the NOAA National Data Buoy Center as station #46094.

The ocean sensors on the current winter time mooring include: 10 temperature and 4 temperature-conductivity. There is also a meteorological package consisting of sensors measuring: wind velocity, air temperature, atmospheric pressure, and incoming solar radiation.

The mooring field work requires the use of a medium-sized UNOLS vessel or equivalent for a minimum of 1 day, twice per year. Funding for ship time is currently being provided by NSF through the Science and Technology Center for Coastal Margin Observation and Prediction (CMOP).

4. 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). Funding for the operation and maintenance of the glider and SATURN-02 was primarily through the National Science Foundation (OCE 0424602). The CMOP glider operates spring through fall, in collaboration with the Quinault Indian Nation (QIN) Department of Fisheries, typically in a radiator pattern for 1-5 weeks, across the WA shelf from Grays Harbor to Quinault in support of fisheries management (QIN), science, and modeling; of particular interest is the characterization of upwelled water, for detection of hypoxia and biological blooms. The glider has flown 351 days since its first deployment on May 2009. During the reporting period, four missions were flown (April-May; June-July, July-August and September). The first mission had to be aborted, due to glider failure, and the glider needed to be sent back to the manufacturer for repairs. Ensuing missions were successful. A second glider was ordered and expected in early 2012; the new glider will mirror the sensing

capabilities of the existing one, and its primary goal will be to allow a deployment rotation that minimizes data gaps due to repairs of maintenance requirements.

The SATURN-02 buoy is installed in the northern OR shelf, at ~40m depth, within the region of influence of the Columbia River ebb tides. It is deployed year-round, in two settings: extensively equipped from spring to fall; and minimally equipped (single surface CT) in winter. During the reporting period, the spring-to-fall SATURN-02 buoy was deployed in April and recovered in late September, when it was replaced for the winter by the winter buoy. The spring-to-fall buoy was refurbished, extended in sensing capabilities (as described above), and will be deployed in April 2011. Sub-sets of data are reported near real-time every hour (spring-to-fall only) via spread-spectrum radio. Data are collected in support of salmon ocean-survival biological opinions (with NOAA/NWFSC) as well as science and modeling.

The OGI01 buoy, installed in the northern OR shelf, at 100m depth, is typically deployed year-round and has over time been instrumented (physical sensors only) in different configurations to support calibration and validation of circulation models covering the far-field of the Columbia River plume. This year, the buoy was only deployed in September, with the minimalist "winter sensor" configuration (surface CTD).

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**

1. 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 in Puget Sound (Pt Wells), and one in south Puget Sound (Carr Inlet). The North buoy in Admiralty Inlet has been awaiting repair/maintenance and will be serviced as technician time allows. All buoy data are 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.

During the report period we 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). The ORCA team provided field support for trouble-shooting the system and collected water samples to aid system calibration. 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 continued works started over the winter to finish upgrading the power systems on the buoys, including wind generators and new solar charging units that will allow logging of power system status. The upgrade also included new weather stations that measure wind speed and direction ultrasonically, which eliminated moving parts prone to fouling.

In May the sensor package deployed at Carr Inlet got stuck in the mud and the cable parted, leaving the package in the sediment. We collaborated with a local company to recover the sensor package using an ROV equipped with sonar and a video camera to go down and attach a line onto the package cage. The recovery was successful and the sensors appeared to have no damage; full depth profiling was subsequently resumed.

Oxygen concentrations again decreased mid-depth at Hoodport during the month of September, raising the risk of a potential fish kill if southern winds were to blow the surface layer north and cause upwelling of low oxygen water to the surface. We continued to closely monitor the situation into October.

As September ended, we began decreasing sampling frequencies at the moorings, as is typical when solar radiation diminishes in fall and winter. We are hopeful that the wind generators will help maintain battery charge, and frequencies will not need to be decreased as low as has been necessary in the past (often as low as once per day).

Presentations acknowledging NANOOS support:

Newton, J., A. Devol, C. Sabine, R. Feely, S. Alin, D. Fagergren, W. Palsson, and D. Hannafious. Using real-time buoy and citizen monitoring data for measuring hypoxia and ocean acidification to aid decisions on aquaculture, fisheries management, and water quality in Puget Sound, Washington, through NANOOS/IOOS. *Coastal Zone 2011 Meeting*, Chicago, IL, July 17-21, 2011.

Newton, J., S. Alin, R. Feely, C. Sabine, A. Devol, A. Suhrbier, D. Cheney, B. Eudeline, J. Davis, B. Allen, B. Peabody, and C. Krembs. Ocean acidification in Puget Sound: Recent observations on water chemistry and implications for larval oyster success. *Second Annual PNW Climate Science Conference*, Seattle, WA, Sept. 13-14, 2011.

Newton, J., A. Devol, C. Krembs, and K. Stark. Observing Climate Influenced Variation in Puget Sound Marine Waters. *Second Annual PNW Climate Science Conference*, Seattle, WA, Sept. 13-14, 2011.

Newton, J. and J. Apple. The Value of Peer-to-peer Knowledge Transfer for Engaging Pacific Northwest Tribes in STEM Education and Oceanographic Studies. *Oceans '11 MTS/IEEE*, Kona, Hawai‘i, Sept 19-22, 2011.

2. Washington State estuarine monitoring: Coordinated by D. Mora, the WA State Department of Ecology (Ecology) continues to contribute to regional estuarine *in situ* observations by maintaining monthly-calibrated moorings in Willapa Bay and Puget Sound, reviewing data, providing quality control, compiling monthly reports, and reporting on anomalies. This work is funded by WA State, augmented by NANOOS.

Ecology, with the help of collaborative partnerships, operates a network of five mooring stations (seven total sensor packages) in Puget Sound and two moorings in Willapa Bay. Ecology funded the establishment of the mooring stations and NANOOS funding partially supports maintenance. Ecology’s deployment locations are primarily designed to capture inter-basin exchange of temperature, salinity, and oxygen. Moorings maintained during this period were located in Admiralty Reach, Shannon Point, Manchester (two depths), Mukilteo (two depths), Squaxin Passage, and Willapa Bay (two depths). Data are available via the NANOOS Visualization System as well as from Ecology’s web page. Key collaborative partners include Everett Community College, Western Washington University, University of Washington APL, and NOAA.

Our Willapa Bay mid-column sensor package is currently not reporting because of cable damage and an inability to retrieve the instrument during routine servicing. We will recover the instrument and re-deploy using EPA divers in November, 2011. Telemetry broadcasts of real-time data will resume at that time.

Ecology is continuously developing monthly condition reports that include summarized observations from mooring stations. Reports can be downloaded at:
http://www.ecy.wa.gov/programs/eap/mar_wat/moorings.html

The value of our mooring observations can be greatly improved by better understanding how flow around our moorings varies over the tidal cycle. In the past, we have assumed that flow in the vicinity of our moorings was directly related to tidal height measurements with minimum flows around low and high tide and maximum flows during intermediate phases, as inferred from our pressure measurements. We had assumed the source of sampled water was seaward during rising tides and landward during falling tides. To improve our understanding, and to increase the value of mooring observations we conducted numerous current profiling (ADCP) transects across Rich Passage, Squaxin Passage, and Possession Sound during low wind conditions in 2011. Across each transect we continuously measured temperature, salinity, current speed and direction. Based on these transects, we are developing filling curves that relate tidal height to cross-sectional flow around the mooring station. In Squaxin Passage, for example, highest observed water velocities typically occurred shortly after low tide. This asymmetry may be due to the presence of mud flats in the region that concentrate the flow, like a venturi, until the mudflats submerge part way through the tidal cycle.

3. 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 NANOOS, NSF 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). Eleven of those stations measure one of more physical parameters (temperature, salinity and/or water level), while five have an extensive array of biogeochemical sensors. All endurance stations operate year round, as a part of CMOP's SATURN observation network, a member of the NANOOS federation of systems. Data are collected in support of salmon ocean-survival biological opinions (with NOAA/NWFSC, BPA and others) related to hydropower management, estuarine management and restoration projects (with NOAA/NWFSC, LCREP and others), monitoring of impact of channel deepening (with USACE), scientific discovery, and modeling. Data are available as described in item "Northern OR to Central WA shelf", above.

During this reporting period, we continued to improve and maintain the network, with increasing emphasis on the biogeochemical stations, and associated data quality control. We have also prepared to deploy an additional biogeochemical station in Baker Bay, in an attempt to explain the formation of late-summer plankton blooms that appear to be incubated in this saline lateral bay of the estuary. The deployment is scheduled for early in 2012.

4. Oregon South Slough: Participation by the Oregon Department of State Lands (ODSL) in NANOOS activities is led by S. Rumrill (Chief Scientist and Research Program Coordinator for the ODSL), and coordinated by A. Helms (Estuarine Monitoring Coordinator), and A. DeMarzo

(Estuarine Monitoring Assistant) at the South Slough National Estuarine Research Reserve (NERR).

Staff members from the ODSL / South Slough NERR continued ongoing operations for a series of moored observing stations within the South Slough estuary as part of the NERR/SWMP network of NANOOS anchor stations. The monitoring stations, equipped with a YSI-6600 multi-parameter datalogger located 50 cm above the bottom, are located at: 1) Oregon Institute of Marine Biology–Boat House, 2) Charleston Pier, 3) Valino Island, 4) Winchester Arm, and 5) Sengstacken Arm along the estuarine gradient, providing continuous near real-time data from marine (euhaline), marine-dominated (polyhaline), mixing (mesohaline), and riverine (oligohaline) hydrographic regions of the South Slough estuary. A sub-set of the stations are equipped with Sutron SatLink2 data telemetry systems that transmit the digital datastreams via the Geostationary Operational Environmental Satellite (GOES) system.

The NERR-SWMP / NANOOS water monitoring stations in the South Slough estuary were in continuous operation throughout the period of 1 April 2011 to Oct 10, 2011, and the dataloggers were retrieved, downloaded, recalibrated, reprogrammed, and redeployed on a monthly basis during the spring, summer, and fall seasons. Time-series measurements generated by four of the monitoring stations are available in near real-time from several websites including NANOOS, the NOAA / Hydro-Meteorological Automated Data System, and via the NOAA/NERRS data access website operated by the NERRS Centralized Data Management Office.

South Slough staff are working toward purchasing two new YSI 6600 V2-4 dataloggers with the full array of sensors to continue measuring the suite of estuarine water quality parameters. The V2-4 type dataloggers have 4 optical ports, allowing continued measurements of optical turbidity and chlorophyll but with the addition of optical measurements of dissolved oxygen. The YSI 6600 EDS dataloggers use the 6562 rapid pulse probe, which is a membrane-covered polarographic sensor. The YSI 6150 ROX optical dissolved oxygen probe will enhance the datasets of estuarine dissolved oxygen by significantly reducing data loss or suspect data due to field drift, membrane punctures by small invertebrates and fish, and probe fouling. In addition, the maintenance & calibrations of the optical sensor are less complicated.

Staff members from the South Slough NERR continued to interact directly with the commercial oyster growers in Coos Bay over the summer to provide technical assistance with access to water-quality data, including discussing real-time data issues and aiding with navigation and understanding of the NANOOS Data Product (Real-Time Water Quality Data for Shellfish Growers in the Pacific Northwest). In order to help minimize anomalous or erroneous chlorophyll data and improve the datasets, staff worked with Mindfly Web Design to place a data filter on transmitted chlorophyll data that excludes extremely high values or spikes. The time-series measurements of temperature, salinity, DO, pH, and fluorescence are of primary interest to the local oyster shellfish growers because they provide the essential information to characterize estuary water quality conditions for shellfish mariculture and an indicator of the concentration of phytoplankton available in the estuarine water column as food for filter-feeding oysters.

The Centralized Data Management Office released two new tools to contribute to improved data quality assurance, quality control, and data visualization and access. One tool allows for the correction of historical depth/water level data relative to changes in barometric pressure, which has

become increasingly important as staff work toward the vertical control of the water quality stations for tracking and modeling elevation changes in saltmarshes and eelgrass habitats as well as the integration of monitoring infrastructure to a common reference datum. The second tool is a Real-Time Data Application Product that allows quick and easy visualization of near real time raw data, graphic displays of the parameters, and 24-hour dual-parameter charts. The tool allows users to bookmark favorite stations and visit them directly, and the station pages automatically update with new information after each data transmission and can be left open for display purposes.

Additionally, South Slough staff initiated a datalogger deployment comparison study to increase quality assurance/quality control of dissolved oxygen data; the results may prove beneficial to other water quality parameters as well. Results from this study may lead to small changes in equipment deployment methods. At the Valino Island monitoring station, telemetry problems with intermittent transmission of real-time datastreams were resolved and the station is currently transmitting all parameters hourly. The South Slough staff have gained access to algal toxin testing shared-use equipment (Abraxis, Inc), which would allow the opportunity for future expansion of the water quality monitoring to include information on harmful algal blooms if estuarine/marine testing kits and additional supplies are procured. Although results are not real-time, the ELISA (Enzyme Linked Immunosorbent Assay) based tests produce toxin results within several hours.

- **Shorelines**

1. Washington Shorelines:

NANOOS funds contribute to the Washington State Department of Ecology's Coastal Monitoring & Analysis Program (CMAP) led by G. Kaminsky. CMAP continued to maintain a beach and shoreline monitoring effort in the Columbia River littoral cell (CRLC) during this semiannual period between 1 April 2011 to 30 September 2011. The monitoring program performs beach profile surveys on a quarterly basis and performs beach surface mapping on a semiannual basis. CMAP collected geospatial data on transects at 46 locations in the CRLC during Spring (May-June) and Summer (August-September). In addition, 26 beach surface maps, each spanning approximately 4-km alongshore, were collected including 6 at Benson Beach (monthly) in support of a beach nourishment experiment. 119 beach sediment samples were also collected (65 at CRLC profiles, and 54 at Benson Beach).

CMAP also supported data collection using the Coastal Profiling System (i.e., nearshore bathymetry survey platform) in collaboration with Oregon State University (OSU) and the U.S. Geological Survey (USGS) from 17-22 July, 1-4 August, and 15 August. A nearshore bathymetry survey was attempted at Benson Beach in May in collaboration with the USGS, but equipment difficulties limited data collection to only 3 profiles. The nearshore surveys are also supported with topographic beach profiles and alongshore surface mapping to complete nearly seamless mapping from approximately 50 m landward of the dune crest to approximately 12-m water depth. Two nearshore surveys were performed at Benson Beach—one in July and one in August. The high-resolution topographic surveys at Benson Beach collected approximately 43,000 data points over 64 km (62 profile lines), while bathymetric surveys collected approximately 600,000 data points over 88 km of profile lines.

CMAP staff collaborated with the USGS in surveying the beaches and nearshore at the Elwha River delta from 16-17 May and 25-26 August. These were the last two surveys performed in advance of the removal of 2 river dams which began in September. CMAP surveyed approximately 260 cross-shore transects and 6-8 alongshore lines. Data results were presented by USGS collaborators at the Elwha River Science Symposium held from 15-16 September in Port Angeles.

CMAP researched terrestrial laser scanning technology and purchased an Optech ILRIS scanner for high resolution coastal topography surveys. The scanner is capable of 360° static scans and can also be mounted to the R/V George Davidson to perform mobile laser scanning of beaches and bluffs.

After nearly 5 years of outstanding service, Andrew Schwartz departed the CMAP team to begin graduate school at the University of Hawaii in Ocean Resources Engineering. Andrew's position is being refilled in October by Heather Baron, a recent graduate student of Peter Ruggiero at OSU.

Presentations acknowledging NANOOS support:
G. Kaminsky participated in the Coastal Sediments '11 conference in Miami during 2-6 May 2011. He gave a presentation to the Coastal Inlet Modeling short course on Regional Sediment Management at the Mouth of the Columbia River. Approximately 20 scientists and engineers from around the world participated in the short course.

2. 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). Monitoring was undertaken at 119 sites on multiple occasions at a reduced scale during the period between 1 April 2011 and 30 Sep 2011. Beach cross-section surveys were specifically carried out in May 2011 (spring, Neskowin and Alsea littoral cells: 36 sites), and again in August and September (late summer, Rockaway cell, Clatsop Plains, and Neskowin Cells: 46 sites).

The beach surveys involved the conventional approach of re-measuring existing transect sites using RTK-DGPS surveying technology developed for PNW beaches. Results of the profile measurements and contour change plots (time stack plots that show contour changes near the dune toe (e.g. the 6.0 m and 5.0 m contour) and lower down the beach face near the Mean High Water mark (e.g. the 3.0 m contour)) have been disseminated via the OBSMAP website (http://www.oregongeology.org/sub/Nanoos1/index.htm) and linked through the NANOOS website to the new NVS – Beaches and Shorelines portal (http://www.nanoos.org/nvs/nvs.php?section=NVS-Products-Beaches-Mapping) as part of a technology transfer between NANOOS and DOGAMI. These data are accessed by State resource managers (e.g. Oregon State Parks), Geotechnical consultants and the public for assessing coastal change, stability and erosion/flood hazard risk. For example:

- Beach surveys are being used in the community of Neskowin to assess ongoing problems relating to the loss of sand from the beach system and the increased incidence of damage to engineering structures, including overtopping by ocean waves and inundation of backshore properties.

- Beach change data adjacent to the Columbia River south jetty is being used by the USACE to monitor the erosion of the dunes adjacent to the jetty, which exhibits signs that it may breach in the not too distant future.
- Beach surveys are being used in the community of Rockaway to assess ongoing problems relating to the loss of sand from the beach system and the increased incidence of damage to engineering structures, including overtopping by ocean waves and inundation of backshore properties.
- 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.

Shoreline variability continues to be measured and involves re-measuring the Mean High Higher Water (MHHW) contour located at an elevation of ~2.5 m above MLLW, a tidally-based proxy for the position of the 18 shorelines, along each of the littoral cells. These data are being used on an annual basis to assist the Oregon Parks and Recreation Department with identifying potential erosion "hotspot" sites prior to the ensuing winter. Due to various reasons, the summer seasonal monitoring in the Newport littoral cell was delayed and is scheduled to be completed in late October 2011.

Results from analyses of the OBSMAP beach and shoreline data have been integrated into a Geophysical Research Letters paper that explored the US West Coast beach response to the 2009-10 El Niño. The results from the various monitoring efforts demonstrated the strong coupling between coastal change measurements and ocean processes operating in the North Pacific, including increased (decreased) wave energy levels along the California (Oregon and Washington coasts) and anomalous increases in regional sea levels along the entire West Coast due to the El Niño Modoki climate phenomena. In the Pacific Northwest, although wave energy levels were lower, the tracks of the storms forced ocean waves to arrive from an increasingly oblique angle relative to the coast that produced anomalously high shoreline retreat north of jetties, tidal inlets, and rocky headlands (Figure 1) affecting critical infrastructure in several of those areas.

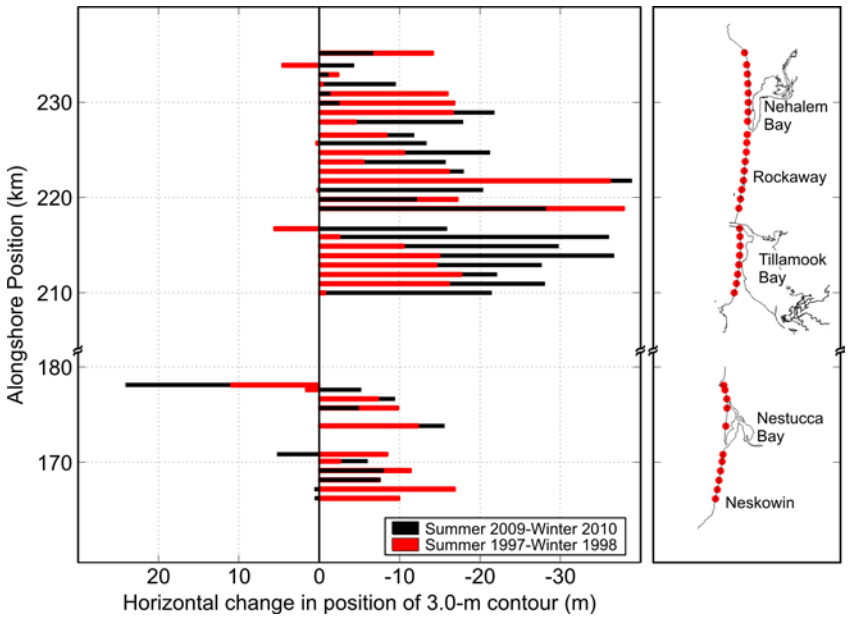

Figure 1. Effects of wave directionality on the Oregon coast in 1997-98 and 2009-10 showing the mean winter shoreline change on the Oregon coast (After Barnard et al., 2011).

Presentations acknowledging NANOOS support:

Barnard, P.L.; Allan, J.C.; Hansen, J.E.; Kaminsky, G.M.; Ruggiero, P., and Doria, A., 2011. The impact of the 2009-10 El Niño Modoki on U.S. West Coast Beaches. *Geophysical Research Letters*, 38.

3. Nearshore Bathymetry: In summer 2011, P. Ruggiero's group at Oregon State University collected nearshore bathymetry data along the four sub-cells of the Columbia River littoral cell (CRLC). Over 200 individual cross-shore profiles were collected during summer 2011 extending from the lower inter-tidal to approximately 12 m of water depth (~2000 m from the shoreline). Approximately 400 kilometers of nearshore mapping took place within 10 days of field data collection. These data have been processed from their raw format into deliverable text files and have passed a rigorous quality assurance process. In all cases these nearshore bathymetry measurements have been combined with topographic measurement collected by NANOOS PI Kaminsky's group at Ecology developing complete maps of the nearshore planform.

In summer 2011, Ruggiero's group collected nearshore bathymetric data within the Rockaway littoral cell in Oregon. Over 70 individual cross-shore beach profiles were processed from the lower intertidal to approximately 25 m of water depth (~1500 m from the shoreline). These data have been combined with topographic data collected synoptically by DOGAMI, and have been processed from their raw format into deliverable text files and have passed a rigorous quality assurance process.

Presentations acknowledging NANOOS support:

Komar, P.D., Allan, J.C., and Ruggiero, P., 2011. Sea level variations along the US Pacific Northwest coast: tectonic and climate controls, *Journal of Coastal Research*, (27) 5, 808-823, DOI:10.2112/JCOASTRES-D-10-00116.1.

Barnard, P., Allan, J., Hansen, J., Kaminsky, G.M., Ruggiero, P., and Doria, A., 2011. The impact of the 2009-10 El Niño on U.S. West Coast beaches. *Geophys. Res. Lett.*, doi:10.1029/2011GL047707.

Hacker, S., Zarnetske, P., Seabloom, E., Ruggiero, P., Mull, J., Gerrity, S., and Jones, C., 2011. Subtle differences in two non-native congeneric beach grasses significantly affect their colonization, spread, and impact, *Oikos,* doi: 10.1111/j.1600-0706.2011.01887.x.

- **Currents**

1. Coastal Currents: Partially supported by NANOOS, the HF surface current mapping program at Oregon State University (PI Mike Kosro, RAs Anne Dorkins and David Langner), has been providing near-real-time maps of ocean surface currents along the Oregon coast as part of NANOOS to the public via the NANOOS web site, as well as downloadable text files containing the data values. These data are also being provided to NOAA/NDBC via the national HFR-net.

During the reporting period, Kosro addressed the National Academy of Sciences Committee on Radio Frequencies on the radio-spectrum needs of HF current mapping (May 16), attended the IOOS HF Technical Steering Committee meeting in Boulder (July 18-20), represented NANOOS at the National Ocean Council listening session on the National Ocean Policy Strategic Action Plans in Portland (July 1) and at the Oregon Coastal & Marine Data Workshop in Salem (June 6). He is serving on the Ph.D. committee of John Osborne at OSU, who is investigating internal tides using ROMS modeling, informed by HF measurements; a journal article from this work is in press at Journal of Physical Oceanography.

Critical to continued HF operation, we have won a competitive OSU equipment grant ($24,000, matched with $6,000 of existing NANOOS funds) to retrofit two of our long-range systems with GPS frequency sharing technology. We anticipate the upgrades being made this winter. In August, we hosted Mike Cook from NPS for training in the use of wholly-redesigned HF processing software system. Also under training, Dorkins and Langner attended the Radiowave Operators Working Group conference at UCSB in very late April. And on Oct 6, we provided a special data collection opportunity with Steve Anderson of Arete Associates, for intercomparison of his airplane-based photo-analysis for current mapping with our HF surface currents.

On Aug 2, Kosro and Craig Risien (DMAC) met with the local US Coast Guard watch at Newport, Oregon, to familiarize them with relevant NANOOS products and to assess their needs and capabilities. We were surprised to find the degree to which perceived national security requirements limited the technology available to them (recent OS upgrade **to** Windows XP). They showed interest in learning more about NANOOS products, which they could access with personal equipment.

On June 13, a police chase jumped the curb and drove into the woods, severing our communications lines to our northernmost site; the situation was repaired within 30 hours. We have been forced by equipment outages to rearrange equipment between sites, to maintain the most continuous coverage possible, while repairs are made at the manufacturer; this has taken considerable field time, equipment repair costs are high, and turn around times can be long. High costs are also expected associated with electrical contractor work at WIN, which is experiencing major problems. Cable leakage has caused down time at WLD, and initial repairs need to be repeated. David repaired a shorted cable at WSH. Many of these problems trace back to need for funds to modernize equipment and infrastructure.

We have retained Jose Montoya at Humboldt State University to act as first contact for problems at the Crescent City, CA site PSG. Operational improvements for bistatic retrievals have been implemented at four sites. A monopole load booster provided by CODAR was tested at YHL for bistatic operations, but produced only marginal improvement in signal-to-noise there.

Publications acknowledging NANOOS support:

Osborne, J.J., A.L. Kurapov, G.D. Egbert and P.M. Kosro, Spatial and temporal variability of the M2 internal tide generation and propagation on the Oregon shelf. (in press) *Journal of Physical Oceanography*, 2011.

2. Port X-band Radar: Led by M. Haller (OSU). During the second quarter of 2011 the wave imaging radar system at the Newport jetties went offline due to a failed hard drive and a failed Koden signal conditioning box. We were also without a field technician during 2nd quarter, as our technician left for another job in February. The good news is that, as of October 1, 2011 our new field tech (Randy Pittman) has started. So far the failed drive has been replaced and operating software reinstalled. We will also use this opportunity to implement the following: 1) NetCDF data storage format, 2) real-time interpolation and mapping via newly installed CUDA card, and 3) Wireshark packet capturing of the radar control sequence. Implementing these three will 1) enable easier data sharing and archiving, 2) enable additional real-time data products, and 3) allow us to eliminate a separate radar control laptop and, hence, make the entire system more robust to power interruptions.

During this time period we also continued our effort with the UHF radar (RiverSonde from CODAR) at the Newport jetties. The system was on-loan from CODAR from Sept. 2010 – March 2011 and collected observations of surface currents through the inlet at high spatial resolution. Much of the data has now been calibrated and our efforts focus on comparing and verifying these data to the in-situ ADCP data collected with Jim Lerczak's group.

Finally, we have also have spun-up a high-resolution, multiply-nested, wave modeling (SWAN) domain for the Newport region in order to model the wave breaking conditions at the mouth of the Yaquina. A long model hindcast encompassing the period when the UHF, marine radar, and in-situ ADCP were deployed simultaneously is being performed. Analysis will focus on the ability of the model to predict wave breaking observed in the marine radar and the influence of the inlet current on the breaking over the bar.

b) <u>Modeling efforts</u>

- **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 horiztonal resolution). Maps of the nowcasts and forecasts are posted daily through the NANOOS Visualization System (NVS). These forecasts are becoming a hot topic of fishermen's blogs (http://www.ifish.net/board/showthread.php?t=369346), indicating that the forecasts are useful. One of the boat charter companies has even made (and posted on their site) a tutorial video of how to use our forecasts via the NVS system (http://amigocharters.com/?page_id=58).

The forecast model, forced with NOAA NAM atmospheric forecasts, uses the climatologic boundary conditions derived by the Navy regional NCOM-CCS model. To improve quality of the forecasts, the system assimilates HF radar surface current observations (provided by our NANOOS partner P. M. Kosro) and hourly GOES SST (from NOAA Coastwatch, D. Foley). In parallel to this case, we have started a second series of runs, in which RADS alongtrack SSH are assimilated, in addition to the surface currents and SST (in collaboration with L. Miller, NOAA STAR). The decision to move the SSH assimilation case will be made soon, after tests of assimilation impacts are completed.

We have established informal collaboration with Dr. Amy MacFadyen (NOAA, the Office of Response and Restoration (ORR) lab, Seattle) who has run preliminary tests of their GNOME oil spill software using our surface velocity forecast fields (Figure 2). Dr. P. Yu, the research associate in charge of the real-time model, has set up the OpenDAP server that will be used to provide fields to ORR in case of emergency.

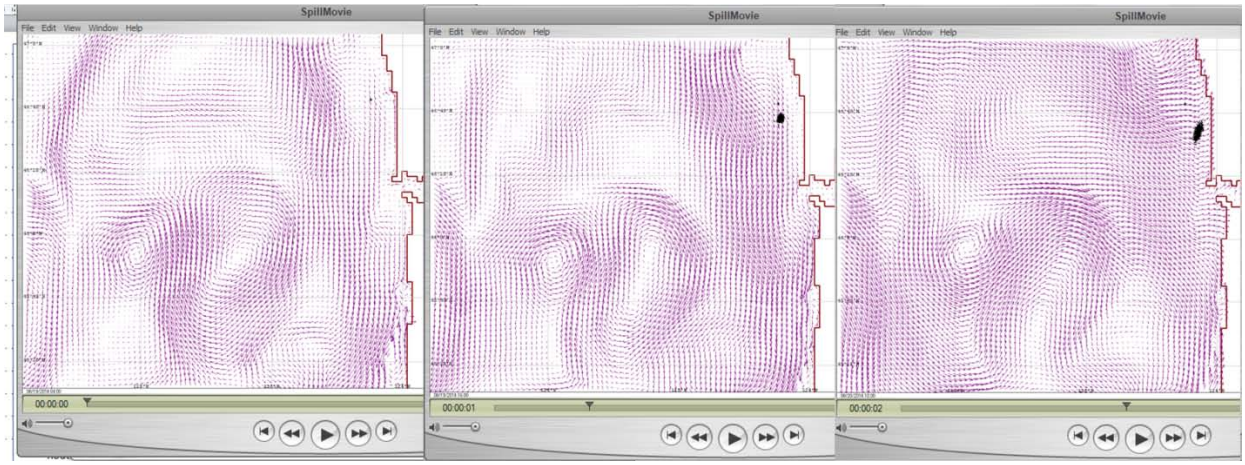

Figure 2. A series of surface velocity snapshots from the real-time coastal ocean forecast system integrated into the GNOME oil spill software (illustration and simulation courtesy of Dr. A. MacFadyen, NOAA-ORR). Black dots show the spreading of the surface contaminant, released at a point near coast north of the Columbia River mouth (left to right: 0, 12, and 30 h since particles are released).

To better understand the impact of different data sources on the coastal ocean prediction, we have run and compared different hindcast cases (the free-run model and cases assimilating SST alone, HF radar currents alone, SST and currents, and SST, currents, and SSH in combination). The effects found are being prepared for publication.

Publications acknowledging NANOOS support:

Kurapov, A. L., D. Foley, P. T. Strub, G. D. Egbert, and J. S. Allen, 2011: Variational assimilation of satellite observations in a coastal ocean model off Oregon, *J. Geophys. Res.*, 116, C05006, doi:10.1029/2010JC006909

Yu, P., A. L. Kurapov, G. D. Egbert, J. S. Allen, P. M. Kosro, 2011: Variational assimilation of HF radar surface currents in a coastal ocean model off Oregon, *Oc. Mod.*, submitted.

Presentations acknowledging NANOOS support:
Assembly of the European Geophysical Union, Vienna, Austria, April 2011.

Gordon Research Conference on Coastal Ocean Modeling, MA, June 2011.
Seminar at the *Satellite Operation Facility*, MeteoFrance, Lannion, France, July 2011.
Seminar at *NOAA STAR*, Aug 2011.
5th Coastal Altimetry Workshop, San Diego, CA, October 2011.
The *PICES meeting* (sponsored by the international North Pacific Marine Science Organization), Khabarovsk, Russia, October 2011.

- **Estuaries**

1. Puget Sound: Overseen by D. Jones, APL-UW has continued to collaborate with Parker MacCready (US School of Oceanography) to develop a ROMS model of the Salish Sea, named MoSSea, that will run in a daily hindcast mode. Included in this effort is the implementation of a shared code management tool called Mercurial (Figure 3). This tool allows our development team to share code revisions and contribute to the process from anywhere in the world.

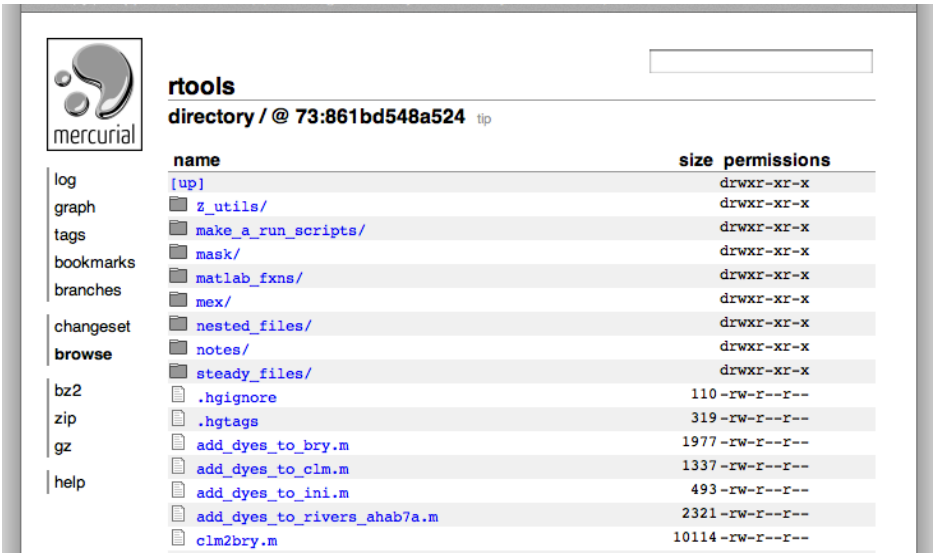

Figure 3. Mercurial tool for developing code with many programmers in multiple geographic regions.

At present, APL-UW is collaborating with oceanographers that are testing the behavior and sensitivity of the model to perturbations in surface forcing, boundary conditions, and extent of the domain. Simultaneously, APL-UW is working on building code that will be used to run the model in a hindcast mode. This code will download and pre-process atmospheric model output, interpolate global and/or regional NCOM ocean model output, calculate tidal forcing, and use USGS and Washington State Department of Ecology river gauge observations to force the surface and boundaries of the MoSSea. APL-UW is also adding support for ROMS model output to NVS as an overlay layer.

APL-UW continues to operate the daily hindcast model named PSPOM. This model has entered its fourth year of continuous service with over 1600 days of model output. This output is shared with an OPeNDAP server written in python, named Pydap, and has been customized by APL-UW to share compressed NetCDF files.

2. Columbia River: With a mix of regional stakeholder funding, NSF funding, and NANOOS funding, CMOP, under the direction of A. Baptista, maintains an extensive modeling system for the river-to-shelf circulation of the Columbia River. Regional stakeholders include the Bonneville Power Administration (BPA), NOAA, U.S. Army Corps of Engineers (USACE), Lower Columbia River Estuary Partnership (LCREP), and Columbia River Inter-Tribal Fish Commission (CRITFC).

The modeling system is integral to the SATURN collaboratory, and is informed by SATURN and other regional observation networks. It is envisioned as a "virtual Columbia River," with an array of products readily available for the use by a broad community of scientists, educators, and managers. Virtual Columbia River products include daily circulation forecasts, decade-long hindcast simulation databases, and scenario simulations (forecasts available through NANOOS NVS).

In 2010 we extended the modeling domain of the Virtual Columbia River upstream of Beaver Army, to include the tidal freshwater in the Columbia River through Bonneville Dam and in Willamette River through Willamette Falls (see October 2009-March 2010 progress report). The changes permit a more effective use of the simulations to support: climate impact studies; salmon and ecosystem restoration projects; flood protection studies; and hydropower and navigation management.

During this reporting period we continued the systematic enhancement of the modeling skill of circulation in the Virtual Columbia River. Activities included: (a) continued optimization of the spatial refinement of the underlying (unstructured) numerical grid; as in the past, particular care was placed in incorporating regions and scales of interest for salmon recovery projects; (b) sensitivity studies to various model parameters, with emphasis on turbulence closure schemes; and (b) characterization of coastal storms.

We have continued applications of the Virtual Columbia River to multiple issues of regional significance, typically in partnership:

(a) Studies associated with the revision of the Columbia River Treaty between the US and Canada; these studies have been conducted in partnership with CRITFC and with funding from NSF.
(b) Studies of the influence of the Columbia River plume on salmon survival; these studies have been conducted in partnership with NOAA and with funding from BPA.
(c) Studies of the variability and contemporary evolution of salmon habitat opportunity in the Columbia River estuary and tidal freshwater; these studies have been conducted in partnership with NOAA and with funding from USACE.
(d) Studies of habitat suitability in the Columbia River estuary and tidal freshwater, funded by LCREP and conducted in collaboration with the Pacific Northwest National Laboratory.
(e) Creation of maps of coastal storm inundation in the Columbia River estuary and Pacific County, funded by FEMA and conducted in collaboration with a consulting company (PBS&J) and DOGAMI

c) Data Management And Communications (DMAC)

1. Managerial: Boeing is lead for managerial duties. S. Uczekaj (Boeing) and E. Mayorga (APL UW) are Co-Chairs of the NANOOS DMAC Committee. Technical implementers include R. Blair (Boeing – Infrastructure and Standards), A. Jaramillo (CMOP OHSU – Data Provider Services [DPS]), E. Mayorga (DPS), C. Risien (OSU – DPS), T. Tanner (APL UW – Portal Services).

Activities for this period included: 1) weekly NANOOS DMAC and User Products Committee (UPC) telecon; 2) annual NANOOS meetings: Tri-Committee (including DMAC), Governing Council, and All-PI's; 3) IOOS Regional DMAC Implementation (RDI) bi-weekly telecon; 4) annual IOOS DMAC meeting (Silver Spring, MD); 5) IOOS SOS Reference Implementation working group bi-weekly telecon; 6) IOOS DMAC Steering Committee monthly telecon; 7) IOOS Non-Federal Asset Inventory tiger team; 8) visit to NANOOS (Seattle) by IOOS DMAC lead, Derrick Snowden; 9) Coastal and Marine Spatial Planning (CMSP) Data Networking workshops in Oregon and Washington; 10) West Coast CMSP Data Network Technical Advisory Committee; 11) Open Geospatial Consortium (OGC) Technical Meeting (Boulder, CO). The NANOOS DMAC and UPC teams continue to work in an effective, integrated fashion towards the prioritization, development and evaluation of data services and user products.

2. Summary of Significant Technical Accomplishments: The NANOOS DMAC architecture continues to mature with significant progress being made to enhance key services. The **NANOOS Visualization System (NVS)** was enhanced with a complete overhaul of the tsunami warning portal (see UPC section for details) to be released in early November together with parallel enhancements to the main NVS application (address navigation, custom user "Places", GIS map layers, etc). NVS continues to add and update regional assets, strengthening its role as a regional data aggregation, discovery and access tool. During this period 24 assets were either added or enhanced, including new high-resolution wave forecasts from OSU made available as overlays and site forecasts. Data from existing NVS providers such as Washington Department of Ecology, Washington King County, and UW were also enhanced. NANOOS DMAC continues to provide and expand data services and products to mobile devices. The NVS smartphone application has now had 3 major releases. The latest release also includes the Plots for Tuna Fishers data product. An additional mobile application for Tsunami Warning is in final testing mode. Significant progress was made in the data services to the NVS data store in support of these mobile platforms. Additional REST based web services were identified for specific data access. JavaScript Object Notation (JSON) data formats were developed to provide efficient data communications between the mobile platforms and backend services.

3. Task 1 Progress: DMAC Systems Architecture Definition and Development: The DMAC Team continued maturing the implementation of IOOS DMAC standards through regular participation in IOOS sponsored working group telecons as well as with software and system enhancements. NANOOS DMAC is an active participant in the newly formed IOOS SOS Reference Implementation working-group. This group was formed in order to investigate the practical aspect of implementing IOOS SOS standard services and to make changes as needed to the IOOS recommended SOS data standards and formats. The output of this working group will be revised standards for data encoding and metadata, preferred SOS reference implementation rec-

ommendation, and guidelines to enable all IOOS regions and stakeholders to deploy conformant SOS services. APL UW has finalized an SOS service connected to the NVS data store to be released in early November. This SOS service, developed from a CMOP OHSU code base, provides access to all in-situ data available from NVS. Challenges uncovered in implementing and deploying this service provided invaluable input to the SOS working group. Support for geospatial data via standard OGC web services was also enhanced through expanded use of the open-source GeoServer software.

4. Task 2 Progress: DMAC Network Engineering Definition and Development: NANOOS DMAC continues to mature data access protocols and services to efficiently transfer data from the NVS data store to mobile applications. This work is key in providing data services to mobile devices such as smart phones that will greatly expand the scope and reach of NANOOS data and data products. NANOOS DMAC is the recognized leader in the mobile area and has provided support and advice to other regional associations to develop a mobile application strategy. Work has started in creating standards for data and metadata encoding and a set of standard services suitable for use in mobile applications.

NVS mobile application was enhanced to add features requested by the user community. These enhancements include favorites, searchable list of assets, user location, and user settable preferences. An overview of these features can be found in Figure 4. The NVS Mobile application has been downloaded more the 2500 times for both the iPhone and Android platforms.

a. b. c. d.

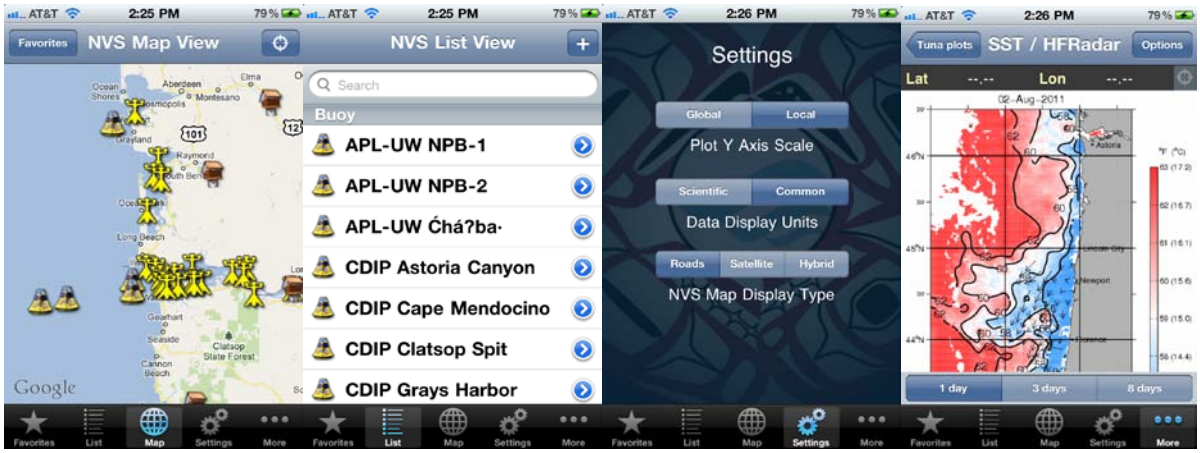

Figure 4. NVS mobile app screen shots: a. New NVS map view. Tabs across bottom provide access to new functionality; b. Searchable list of NVS observing assets; c. User settable option screen; d. Plot for Tuna Fishers access from the "More" tab.

The basic web service architecture for the NVS mobile application was used as the basis of the Tsunami warning mobile application. This mobile application provides users with smartphones access to the latest Tsunami Evacuation zone maps as provided by Oregon and Washington State agencies. The Tsunami warning app is an adjunct to the NANOOS Tsunami Warning Portal using web services to access the same data sources. The APL UW developed a service to provide high-resolution map tiles of the evacuation zones. Both the mobile applications and the tsunami

web portal use this tile service to construct the map overlays. The mobile application has access to the complete NANOOS Tsunami Evacuation data sets using restful web services. By utilizing these services, users have access to the same timely information as available to the web application. Sample screens of the Tsunami Warning app are in Figure 5.

a. b. c.

Figure 5. Tsunami warning mobile app screen shots: a. Cannon Beach, OR, Tsunami Zones; b. Tsunami Warning Bulletin; c. Additional Information Tabs.

Presentations acknowledging NANOOS support:

Martin, D.L., J.C. Allan, J. Newton, D.W. Jones, S. Mikulak, E. Mayorga, T. Tanner, N. Lederer, A. Sprenger, R. Blair and S.A. Uczekaj. Using Web-based and Social Networking Technologies to Disseminate Coastal Hazard Mitigation Information within the Pacific Northwest Component of the Integrated Ocean Observing System (IOOS). *Oceans '11 MTS/IEEE*, Kona, Hawai'i, Sept 19-22, 2011.

Mayorga, E. and T. Tanner. The NANOOS Visualization System (NVS): Data aggregation, management and reuse for a coastal-monitoring user application in the Pacific NW. *CUAHSI Conference on Hydrologic Data and Information Systems*, Logan, Utah, June 22-24 2011.

Mayorga, E. Regional sharing and integration of near-real-time coastal monitoring data in the Pacific NW: NVS, the NANOOS Visualization System (Regional network example, OOS Case Study). *Oregon Coastal & Marine Data Workshop*, Salem, Oregon, June 6-7, 2011.

d) User Products Committee (UPC)

1. 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. 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.

2. Summary of Significant Technical Accomplishments:
A core focus of the NANOOS DMAC-UPC-WEB sub-working group remains the provision of ongoing technical support to the NANOOS Visualization System (NVS). In addition, to this important task, the sub-working group has initiated and completed several important enhancements to the NANOOS web portal and the Oregon Coast Tsunami evacuation portal.

NVS: New assets added to NVS include high resolution nearshore SWAN model forecasts (wave height and peak period) for the entire Oregon and Southwest Washington coasts.

Although no new release to the NVS platform occurred during this period, considerable work has continued to enhance the overall look and efficiency of the NVS portal. This has included efforts directed at developing a synoptic situational awareness overlay that could be integrated into NVS, proving near real-time data from multiple stations (e.g. temperature, pressure, winds, or wave heights). Additional enhancements include further work on the asset database in order to allow for future improvements to the NVS portal, including the synoptic awareness overlay.
Oregon Coast Tsunami Hazards portal: The new Pacific Northwest Tsunami Evacuation Zones portal has been completed and thoroughly vetted by a suite of critical stakeholders. Public release of the new portal is imminent. In addition, NANOOS DMAC and UPC have completed development of a new tsunami evacuation map mobile (iPhone) application that is near final release. The new app integrates the capabilities of smartphone technology providing the user with the ability to locate themselves in a Google map portal enabling the user to determine whether they are in a tsunami evacuation zone or not, integrate near real-time information from the Alaska tsunami warning center (i.e. if a warning is issued and the app is on, the user will be notified (we are also exploring other notification approaches that could be adopted should a phone be turned off)), and the ability to search by geographic location. Development of an android version of the app is now underway.

The NANOOS Data Access Program (N-DAP): Based on Environmental Research Division's Data Access Program (ERDDAP), N-DAP continues to evolve. N-DAP is a data server that aggregates oceanographic, meteorological, and remotely sensed data and model output from diverse sources, offering users the ability to visualize, browse and download available datasets, in many common file formats, via a relatively simple to use user- interface. Development on this new platform continues to proceed slowly, due to the complexity of the system. A variety of model data derived from CMOP, OSU ROMS and HF radar are presently being compiled and added to the N-DAP platform as a test case. Future enhancements remain the development of a NANOOS GUI that will enable easy access to various capabilities offered by ERDDAP.

Website: The NANOOS website continues to undergo various enhancements and modifications. NANOOS President, Martin, and UPC chair, Allan, with input from DMAC (Blair and Mayorga) and Education Outreach (Mikulak) developed a conference proceedings article exploring “Using Web-based and social networking technologies to disseminate coastal hazard mitigation information within the Pacific Northwest component of the Integrated Ocean Observing System (IOOS)”, which was presented at the Oceans'11 conference in Kona, Hawaii. The paper focuses

on the advent of smartphone technology in disseminating critical life-safety information and oceanographic data during times of crisis, using the case-study of the March 11, Tohoku tsunami tragedy in Japan.

Presentations acknowledging NANOOS support:
(Reported in DMAC section above, but appropriate here also:)

Martin, D.L., J.C. Allan, J. Newton, D.W. Jones, S. Mikulak, E. Mayorga, T. Tanner, N. Lederer, A. Sprenger, R. Blair and S.A. Uczekaj. Using Web-based and Social Networking Technologies to Disseminate Coastal Hazard Mitigation Information within the Pacific Northwest Component of the Integrated Ocean Observing System (IOOS). *Oceans '11 MTS/IEEE*, Kona, Hawai'i, Sept 19-22, 2011.

e) <u>Education and Outreach</u>

1. Managerial: The Education and Outreach Committee, chaired by Nancee Hunter (Oregon Sea Grant), was sustained during the reporting period, with membership unchanged since previous reported, except for the addition of a member from the OR Dept. of Land Conservation and Development. NANOOS E&O staff, A. Sprenger and S. Mikulak, continued their participation in IOOS-NFRA E&O monthly calls and in the monthly NANOOS E&O committee conference calls, in collaboration with the E&O Committee Chair. Mikulak is also an active member of the NANOOS User Products Committee (UPC) and participates in weekly DMAC/UPC conference calls, as well as a bi-weekly call with Sprenger and T. Tanner, NANOOS web developer to discuss improvements to the NANOOS portal.

Hunter, Sprenger, Mikulak, and several other members of the E&O committee were in attendance at the annual Tri-committee meeting in Beaverton, OR. Sprenger attended the annual Governing Council meeting in Vancouver, WA, and Mikulak attended the annual NANOOS PI meeting also held in Vancouver, WA. One result from the PI meeting is the creation of a Wiki page by Mikulak as requested by NANOOS PIs to enhance internal communication among themselves.

Education and outreach efforts in the past six months have focused on supporting the continued development of the NANOOS mobile apps (one app for NVS, one app for tsunami evacuation zones) and the redesign of the NANOOS tsunami web portal, continued work to connect with educators in the Pacific Northwest, outreach to users groups, partnering with informal education centers and supporting national IOOS efforts. During this period, Sprenger began maternity leave in August 2011 and we welcome her son Odin.

2. Summary of Education Accomplishments:
By invitation of C. Simoniello, Education Chair of the Gulf Coast Ocean Observing System (GCOOS), Mikulak attended the annual GCOOS education meeting held in New Orleans, LA in June 2011. Mikulak presented her experience with designing exhibits that utilize real-time NANOOS data and provided insight on GCOOS's exhibit design process. The collaboration between the two RAs was very positive for all, and has continued through the monthly IOOS/NFRA E&O calls.

Other NANOOS education activities include events with both informal and formal educators. As part of the exhibit design process for the real-time data exhibit that will be installed at the Port

Townsend Marine Science Center (PTMSC) in Port Townsend, WA, Mikulak attended a docent training at PTMSC in April to demo the exhibit prototype to the staff and volunteers and collect feedback about the exhibit content and design. The results of that are being applied to the exhibit, and future work will include a docent training guide about the content of the exhibit. In July the NW Aquatic and Marine Educators (NAME), a NANOOS member, held its annual conference on the Olympic Peninsula. Sprenger was the conference chair for this 3 day event attended by more than 120 formal and informal educators from Oregon, Washington, British Columbia and Alaska. During the conference Newton gave a keynote address, Mikulak presented on ocean acidification, F. Stahr presented on Seagliders and Sprenger presented on using NVS.

Mikulak and Sprenger along with NANOOS education collaborators attended six events for formal educators during this 6 month time period, reaching over 100 educators. In Oregon Mikulak presented at the Science and Math Investigative Learning Experiences (SMILE) annual High School challenge, where Mikulak featured a lesson plan about ocean observing technology; and the Lincoln County Ocean Literacy Symposium, a day-long professional development symposium for all teachers in Lincoln County, OR, based around ocean literacy. Mikulak presented a tour of NVS, the NANOOS data portal and shared a session with Dr. Tawnya Peterson from CMOP, who presented about CMOP data. Sprenger and Fritz Stahr (Ocean Inquiry Project) partnered with local non-profit organizations to provide Puget Sound area educators in Olympia, Bellingham and Tacoma, day-long on the water professional development experiences demonstrating ocean observing technology, techniques and resources including the NANOOS portal and NVS. Corinne Bassin (APL-UW) presented NVS to community college educators attending the week-long COSEE Pacific Partnership WA Teacher workshop held in Anacortes, WA. Finally, Sprenger and Newton released a contest to teachers to develop lesson plans about NANOOS or NANOOS data: http://nanoos.org/documents/eo/NANOOS_Classroom_Activity_Contest.pdf. Presentations by Sprenger and Mikulak to teachers as regional education conferences are listed below.

3. Summary of Outreach Accomplishments:

Regionally, NANOOS outreach efforts to reach different user groups including fishers, coastal community residents, scientists, the U.S. Coast Guard, and shellfish growers. Major events included: PISCO Pre-season Hypoxia Research Exchange meeting in Corvallis, OR; SEAchange: From Exxon Valdez to Deepwater Horizon in Seattle, WA; National Ocean Council Listening Sessions in Ocean Shores, WA and Portland, OR; and the Pacific Coast Shellfish Growers Association meeting in Salem, OR.

Outreach efforts to the U.S. Coast Guard were initiated by M. Kosro (COAS-OSU), NANOOS PI and E&O committee member, and C. Risien (COAS-OSU), DMAC, UPC, and E&O committee member. They scheduled and attended a meeting with U.S. Coast Guard members at the Newport, OR station in September to introduce NANOOS and demo NVS. They were positively received by the USCG, however strict internet security on the base prevented full access to NVS.

Newton and Mikulak wrote an article for the *West End Natural Resources News*, the newsletter of the North Pacific Coast Marine Resources Committee (NPC MRC) based in Port Angeles, WA (http://wdfw.wa.gov/about/volunteer/mrc/files/july_2011_npc_newsletter.pdf). The NPC MRC is comprised of tribal members, county and city representatives, and citizen volunteers.

The article is about the new NANOOS sensor array, which includes the Cha 'ba buoy, a subsurface mooring, and a Seaglider, that is deployed off of La Push, WA.

Mikulak, along with Newton, continued efforts of communicating with tuna fishers primarily from OR about the NANOOS Forecast Information and Data for Tuna Fishers Product page (http://www.nanoos.org/data/products/tuna_fishers/tuna_fishers.php). Mikulak created an FAQ section based on common questions received from fishers and relayed requests for new functionalities in the plots to the DMAC/UPC teams. During the 2011 tuna fishing season (July-Sept), this product page was the most accessed page on the NANOOS portal with over 19,500 unique pageviews. Also, a fisher independently created a YouTube video about how to use the tuna-oriented SST overlay in NVS: http://amigocharters.com/?page_id=58.

Newton and Mikulak attended a unique event, SEAchange, that brought together researchers, emergency responders, science communicators and journalists, tribal members, seafood-related business owners, and the general public, to start discussions in the local community about the response and impact of the Exxon Valdez and Deepwater Horizon oil spills, as well as potential impacts of oil spills on Puget Sound. The event was hosted by the Dean of the UW College of the Environment and Chair of the UW Department of Communication, with several speakers from NOAA, including representatives from the Office of Response and Restoration, the Emergency Response Division, and the Northwest Fisheries Science Center. Newton presented the benefits of NANOOS and the utility of the NANOOS Visualization System (NVS) as a potential tool for oil-spill response in Puget Sound and Washington's coastal waters.

NANOOS was invited to the 65th Annual Shellfish Conference and Tradeshow in Salem, OR, on Sept 19 – 22, 2011. Mikulak hosted a table and interacted with a variety of growers at this event, many of whom already use NANOOS for water quality conditions.

Mikulak and Sprenger collaborated with Newton and others to create a new NANOOS brochure: http://nanoos.org/documents/legacy/nanoos_brochure.pdf. Other new outreach materials include the Spring 2011 NANOOS Observer (http://nanoos.org/documents/key/NANOOS_Observer_Spring_2011.pdf) and one-page handouts that are tailored for targeted end-user groups and feature specific NANOOS data products relevant to that group.

Nationally, Mikulak and Sprenger have continued work with the IOOS/NFRA E&O group to produce regional one-pagers (http://www.ioos.gov/library/nanoos2011onepager.pdf) and have provided content to populate the new IOOS.gov website. Mikulak continues to provide feedback to the IOOS office to help improve the new website.

Presentations acknowledging NANOOS support:

Newton, J. Keeping Watch Over the Sea (NANOOS). *SEAchange 2011. From Exxon Valdez to Deepwater Horizon: Telling Tales of Environmental Disaster, Justice, and Recovery.* University of Washington, Seattle, WA. April 2, 2011.

Sprenger, A, and Stahr, F. Eyes on Washington Waters, Bringing Ocean Observing Data Into the Classroom. *Washington Watershed Education Teacher Training Program*: Olympia WA, May, 2011; Tacoma WA, June, 2011; Bellingham WA, June 2011.

Newton, J. Keynote Speaker: *Salish Sea Student Science Symposium*; Mountaineers Club, Seattle, WA; June 3, 2011.

Mikulak, S. Ocean Acidification in the Pacific Northwest. *Northwest Aquatic and Marine Educators Association Conference*. Olympic Park Institute, Port Angeles, WA. July 14, 2011.

Stahr, F. Gliders Observing the Coastal Waters of Washington & Oregon, or "Robots Are Our Friends". *Northwest Aquatic and Marine Educators Association Conference*. Olympic Park Institute, Port Angeles, WA. July 14, 2011.

Sprenger, A. Using authentic data to teach science concepts: MBARI's EARTH Program, NEPTUNE CANADA and NANOOS. *Northwest Aquatic and Marine Educators Association Conference*. Olympic Park Institute, Port Angeles, WA. July 16, 2011.

Newton, J. Invited talk about NANOOS: Ocean observing systems: a matter of perspective. *Northwest Aquatic and Marine Educators Association Conference*. Olympic Park Institute, Port Angeles, WA. July 16, 2011.

Newton, J. Observing Puget Sound. *National Environmental Monitoring Conference 2011*, Bellevue, WA, Aug 18, 2011.

Bassin, C. Use of NANOOS/NVS for incorporating real-time data into the classroom. *COSEE Pacific Partnership WA Community College Educator Workshop*. Shannon Point Marine Center, Western Washington University, Anacortes, WA. Aug 23, 2011.

Newton, J. Pacific Northwest ocean acidification observing efforts (from coastal buoys and shellfish farms) and resultant data streams. *World University Network Workshop on Ocean Acidification*, Friday Harbor Laboratories, University of Washington, Friday Harbor, WA, Aug.29, 2011.

Mikulak, S. OLS Tour of the NANOOS Visualization System (NVS). *Lincoln County Ocean Literacy Symposium*. Hatfield Marine Science Center, Newport, OR. Aug 30, 2011.

4) Issues (NONE)

5) Key Personnel Changes (NONE)

6) Budget Analysis

NA07NOS4730203: NANOOS RCOOS Y1-3

This grant/award concluded on 9/30/2011. We have therefore concluded the performance period of the award and have effectively used or committed 100% of the authorized funding (e.g., only $3,082 of $4,500,000 has not used or committed according to our calculations and records at this point). We are actively engaged with our subcontractors in ensuring we have received all final invoices and will report final, complete budget information in the final report due the end of December of this year.

NA10NOS4730018: NANOOS RCOOS Y4

This effort had an initial completion date of 9/30/2011 but we requested and obtained a no-cost extension through 9/30/2012 to ensure prudent expenditure of funds as we were conservative in our expenditure plan to minimize the possibility of needing to cease effort or remove assets from service if federal budget processes were delayed. Accordingly, we have effectively committed or obligated effectively 100% or our authorized funding and are modifying subcontracts and monitoring efforts to ensure necessary NANOOS activities (including subcontractors) and associated burn rates will allow completion of this effort by approximately 6/30/2012.