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

1) Award Information: Provided as a separate Cover Sheet.

2) Project Summary

NANOOS continues to be engaged, through NOAA funding, in an active, and proactive, 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, 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 – regrettably, reductions in anticipated NANOOS funding have to this point prohibited additional HF sensors.
- **Maintaining and (should additional funds be available) expanding 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 HABs, which are major regional concerns affecting ecosystem and human health, fisheries, and coastal economies – funding limitations have greatly limited our success in this effort.
- **Maintaining and <u>slightly</u> expanding core elements of existing beach and shoreline observing programs in Oregon and Washington.** This will improve 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.** Our intent was to extend operational models from the head of tide of estuaries to the outer edges of the exclusive economic zone (EEZ). This NANOOS vision remains credible but reductions in anticipated funding have substantively reduced our options – details below.
- **Commenced development of state of the art cross-shore profile change models and probabilistic shoreline change models.** Such models will be used by coastal managers to assist with predicting future coastline positions.
- **Bolster ongoing Data Management and Communications (DMAC) activities to support routine operational distribution of data and information.** The NANOOS 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.

The above summation points delineate a specific NANOOS 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, as in our first progress report we divide this document into sections of : a) our efforts in observing systems (further divided because of our unique environment into shelf, estuaries, shorelines, and currents) b) modeling (again divided further into estuaries, shelves and a (now unfunded) integrative synthesis section, which we maintain mention of because of its central importance; c) Data management and Communications (DMAC); and finally, d) Education and Outreach. We list specific accomplishments in bullet form in each of these areas below and follow each section with a tabular representation of progress to this point:

a) Observing System efforts

- **Shelf**

  - The mooring component, headed by Murray Levine, provides daily delivery of meteorological data, currents, and water column temperature, salinity, and dissolved oxygen, and has served as a platform of opportunity, with measurements of bioptical properties and dissolved CO_2 being made under funding from other programs (though not reported in real time). The real-time measurements are being reported both to the web through OSU, NANOOS, (http://agate.coas.oregonstate.edu/data/nh10.html) and to NOAA's NDBC, which also presents the data. In December 2007, a strong storm, which triggered the first ever hurricane warning in the Pacific Northwest from the National Weather Service, damaged this mooring, tearing it loose from the anchor. The team successfully located and recovered the bulk of the mooring after about a week, saving many of the instruments and mooring gear from being lost; nonetheless, the program suffered about $25K in lost or damaged equipment. The mooring was refitted with a somewhat reduced complement of instruments, and redeployed on April 10, 2008. On September 13-14, 2008, the mooring was recovered, and the winter mooring was deployed, with reduced instrumentation to survive the

winter storms. Sensor cross-calibration was performed by lowering all temperature/salinity sensors together on a deep cast.

- **Estuaries (All listed efforts are enabled and/or leverage NANOOS resources)**

  - Alicia Helms and Adam DeMarzo (Oregon Department of State Lands / South Slough National Estuarine Research Reserve) both attended a technical training workshop in Georgetown, SC hosted by the NERRS Centralized Data Management Office. The workshop included sessions on establishment and operation of the Sutron SatLink2 telemetry transmission equipment, and on troubleshooting field operations with the GOES satellite telemetry system.

  - Alicia Helms and Adam DeMarzo (Oregon Department of State Lands / South Slough National Estuarine Research Reserve) also attended a second technical training workshop in Corbin, VA hosted by the NERRS and the NOAA/National Geodetic Survey (NGS). The workshop provided instruction and guidance on techniques to establish vertical control for field measurements of water levels, and to provide numerical links between field monitoring stations and NOAA NWLON tide stations.

  - Staff members from the South Slough NERR worked in the field during June and July with representatives from the NOA NGS to install and conduct GPS surveys for a series of elevation benchmarks located throughout the shoreline of the South Slough estuary. Additional field work is scheduled for June 2009 to tie these land-based elevation benchmarks to the free-standing towers in the estuarine tidal channels that are used as support platforms for the NERR-SWMP/NANOOS anchor stations. When this survey work is completed all water level measurements generated by the NANOOS anchor stations in the South Slough estuary will be referenced to the US standards of Mean Sea Level (MSL) and the North American Vertical Datum (NAVD-88).

  - The South Slough NERR team is responsible for the following stations of the NERR-SWMP/NANOOS network (see http://www.nerrs.noaa.gov/monitoring/water.html and http://cdmo.baruch.sc.edu/QueryPages/Stationmap.cfm? Site_ID=SOS): Oregon Institute of Marine Biology-Boat House; Charleston Pier; valino Island; Wincheseter Arm; Sengstacken Arm. Each of these monitoring stations is equipped with a remotely-operated YSI-6600 multi-parameter datalogger with the array of sensors located 50 cm above the bottom of the estuarine tidal channel. Each of these monitoring stations was in continuous operation throughout the spring and summer with recordings of the following water parameters every 15 minutes: water level, temperature, conductivity, pH, dissolved oxygen, turbidity, fluorescence.

  - A new free-standing welded stainless-steel pipe tower was installed within the Sengstacken Arm of the South Slough estuary to allow for the placement and

operation of the Sutron SatLink2 / GOES telemetry equipment. The historic Sengstacken SWMP/NANOOS station was attached to an old log piling, and the site had become inoperable due to the accumulation of silt and mud.

- In accordance with the NANOOS year 1 budget, the following equipment was purchased to support and upgrade one of the NERR-SWMP/NANOOS anchor stations: two YSI-6600 V2 dataloggers with sensor arrays and underwater field cables; a Sutron SatLink2 /GOES telemetry system, a Dell XFR-D630 fully rugged laptop field computer; two 12VDC AGM batteries, a 20 W solar panel and charge controller; and miscellaneous mounting hardware.

- In Puget Sound, leveraging NANOOS resources, Washington State's Department of Ecology (DoE) maintains three fixed mooring stations which have monitored nearshore, near-bottom water temperature, salinity, and dissolved oxygen since 2006. All three Puget Sound stations are configured for telemetry, and data have been available in real-time on the web: http://www.ccalmr.ogi.edu/nanoos/. The Budd Inlet mooring was removed in September due to staffing shortage (see 4) A.) In August 2008, a second fixed sensor package was added to the Squaxin pier site in South Puget Sound to collect near-surface data (water temperature, salinity, chlorophyll fluorescence and turbidity). Paired with the near-bottom sensor, this mooring will provide information on water column stratification, which is of particular interest to our collaborator Vera Trainer and the Marine Biotoxins Group at NOAA for investigating the development of harmful algal blooms.

- In Willapa Bay, four DoE mooring stations have monitored near-surface water temperature, salinity, and chlorophyll fluorescence since 1997 (cut back to 1 station as of September 2008, see section 4 A.). Ecology completed communication testing in the lab of a system for achieving real-time telemetry at floating moorings in Willapa Bay using Bluetooth wireless devices in sync with CTD instruments and broad spectrum radios. Randy Fabro at UW/Oceanography designed a watertight housing and power source for Bluetooth transmitter. In August 2008 installation of real-time data delivery capability was completed at the Bay Center mooring in Willapa Bay. Unfortunately OHSU stopped receiving the real-time data approximately two weeks after install. We are taking steps to trouble shoot and fix the system which we believe is likely related to antenna issues exacerbated by the difficult weather conditions common in Willapa Bay. Our progress has also been hampered by Stephanie Jaeger (Ecology's mooring coordinator) leaving the agency. See section 4) A.

- *WA State DoE NANOOS-funded expected activity for next 6-month period* – We will continue to maintain the 3 remaining moorings in WA estuaries. We will continue to maintain and service the Manchester and Squaxin Passage sites by working with volunteers from Ecology's Manchester Lab and the Marine Biotoxins Group at NOAA.

- WA DoE is looking into alternative ways to send and receive data from the

Bluetooth unit installed in Willapa Bay. We are investigating moving towards satellite, rather than radio, communications. We have been looking into the possibility of adding GOES telemetry Radio to the SBE-16plus Mooring CTDs. After talking with Design Analysis we have a couple of options. Here are the questions we must address to go down the easiest path.

1) Does the SBE-16plus support NMEA 183 devices?
2) Can SEABIRD use NMEA code to communicate with other probes attached to the CTD or is it limited to navigation devices only? (Using a probe specific command to turn them on, retrieve data and turn them back off.)
3) Will Design Analysis' current SDI-12 translator to NMEA work for communication with the SEABIRD SBE-16 plus CTD?

Option two is a much more difficult path and we need to explore path one before we even consider path two.

- Columbia River Estuary observation network

  - A 3-person field team, based in Astoria and led by Michael Wilkin, provides the primary OHSU contribution to the collection of NANOOS observations. Charles Seaton, a staff based in Portland, conducts monthly quality control of the data. All staff is supported through a combination of the NSF core CMOP grant, NANOOS and regional stakeholders. Data collection is focused on the Columbia River estuary (most stations) and near-plume (two stations)
  - During the reporting period, the field team continued the maintenance of the CORIE/NANOOS network (see http://www.stccmop.org/corie/observation_network).
    1. Stations of the network include: Jetty A, Desdemona Sands, Fort Stevens Wharf, Hammond Basin Tansy Point, Astoria-Meglar Bridge pier 169, City of Astoria waste water outfall, Grays Point, Mott Basin, Cathlamet Bay North Channel, Eliot Point, Woody Island range light, Tenasillahe Island dock, Ocean buoy 'ogi01', Ocean buoy 'ogi02'.
    2. Variables: Most stations measure salinity and temperature at a single level. Selected stations measure water levels (in most cases through pressure sensors). Selected stations measure velocity profiles.
    3. Data management: Data is stored at a CMOP central database in near real-time, graphically displayed on the web in near real-time, and made available monthly via the web after quality control.
    4. Data quality control: Data quality control is conducted monthly (see protocol at http://www.ccalmr.ogi.edu/CORIE/data/publicarch/methods_meanings.html)
    5. Noteworthy: Several of the CORIE stations date back to the mid-late 1990's, offering a unique temporal context for the variability of the Columbia River estuary-plume system (e.g., Fig. 1).

6. Maintenance: The set-up of CORIE/NANOOS stations is being progressively modified, to reduce dependency on diving operations. This has emerged as a priority, as diving operations are limiting in the complex environment of the Columbia River estuary.
7. Usage: Data is used by a range of regional stakeholders, several of which (e,g., NOAA Fisheries Science Center, Corps of Engineers, City of Astoria, Bonneville Power Administration) fund elements of the network. Data is also used to provide skill assessment for the CORIE/SATURN modeling system, and for scientific analyses of Columbia River processes; examples of recent publications using CORIE data are Chawla et al. 2008 and Bruland et al. 2008. Data is being used in conjunction with data assimilation strategies (Frolov et al., in press A) to explore optimal configurations of the network (Frolov et al., in press B)

- During the reporting period, the field team developed and maintained two experimental multi-disciplinary stations of the NSF-supported SATURN network, which data is contributed to NANOOS:
  1. Stations: Pt Adams Packing pier (SATURN-03), Astoria-Meglar Bridge pier 11 (SATURN-01).
  2. SATURN01: Located at Astoria Meglar Bridge pier 11, this station is designed to actively profile the water column with a suite of instruments (currently: CTD, ISUS and FLNTU). The station is still in a period of experimental operation. Variables include: salinity, temperature, fluorescence, turbidity, and nitrate. Anticipated expansions: oxygen, and pCO_2.
  3. SATURN03, located at Pt Adams Packing Pier. This station too has a multi-disciplinary instrumentation package (CTD, ISUS and FLNTU). The covered pier and availability of utility power is allowing us to begin experimenting pumping seawater from a sampling point to instruments on top of the pier. The final design calls for multiple sampling ports, at different depths.

     Though NSF core funding to CMOP, the CMOP team maintains a SWAP2 telemetry network in the Columbia River (with equivalent capabilities maintained in Yaquina Bay by OSU)., This network supports internet availability to UNOLS and other vessels visiting Newport and Astoria, provides telemetry for the fixed stations in the Columbia River and telemetry links for CODAR coastal radar in Newport.

- **Shorelines (all efforts listed are enabled and/or leverage NANOOS sponsorship):**

  - Nearshore bathymetry measurements by Peter Ruggiero's group at OSU (details immediately follow) have been collected along portions of the Rockaway littoral cell and the Columbia River littoral cell in collaboration with the state agencies of Oregon and Washington.

    - In summer 2008, Ruggiero's group at OSU successfully completed the collection of nearshore bathymetry along the Columbia River littoral cell

in close collaboration with the Washington State Department of Ecology and the US Geological Survey. Over 200 individual cross-shore profiles were collected in the cell 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 12 days of field data collection. In all cases these nearshore bathymetry measurements are being combined with topographic measurement collected by Ecology to develop complete maps of the nearshore platform.

- These data have been processed from their raw format into deliverable text files and have passed a rigorous quality assurance process.

- This group, in close collaboration with DOGAMI and Ecology, planned and executed the first nearshore bathymetric data collection within the Rockaway littoral cell in Oregon. Over 70 individual cross-shore beach profiles were collected from the lower intertidal to approximately 20 m of water depth (~1500 m from the shoreline). These data are being combined with topographic data collected synoptically by DOGAMI.

- These data have been processed from their raw format into deliverable text files and have passed a rigorous quality assurance process.

- Continuing this coastal hazard mitigation effort with NANOOS sponsorship, Ruggiero delivered nearshore bathymetry data from the Clatsop Plains in Oregon to researchers at the O.H. Hinsdale Wave Research Laboratory who used the data to aid in developing physical scale models of Seaside, OR for tsunami inundation research.

- This group, with support from NANOOS, continues to develop a 4th generation Coastal Profiling System (CPS), a platform for a physical/biological sampling system for the nearshore ocean. The platform essentially consists of a pair of personal watercrafts (PWCs) outfitted with fixed sampling equipment for high-resolution surveying of sea bottom topography and for physical and ecological sampling in the previously inaccessible surf zone. The Coastal Profiling System is a unique asset that is supporting emerging research into nearshore ocean processes in the PNW.

- Ruggiero presented results from the CRLC time series of nearshore bathymetry at the 2008 AGU Ocean Sciences Meeting in Orlando, FL and at the 85th Meeting of the Coastal Engineering Research Board held in Portland, Oregon.

- The data and information obtained from this monitoring program continues to be a critical component to ongoing work on regional sediment management at the mouth of the Columbia River. Results of the

monitoring program have been presented and discussed at several meetings hosted by the Lower Columbia Solutions Group (LCSG), convened by the Governors of Washington and Oregon, in their ongoing projects, including the Southwest Washington Littoral Drift Restoration (Benson Beach) Project, and the Oregon Nearshore Beneficial Use Project.

- The Washington State Department of Ecology's Coastal Monitoring & Analysis Program (CMAP) continued to maintain a beach and shoreline monitoring effort in the Columbia River littoral cell (CRLC) at a reduced scale during year 1, including support for the Coastal Profiling System through collaboration with Oregon State University. The monitoring program performs beach profile surveys on a quarterly basis and performs beach surface mapping on a biannual basis.

- CMAP collected geospatial data on transects at 46 locations in the CRLC twice during this semiannual period. In addition, a total of thirteen surface maps were collected, which contain an average of 10,000 data points over an alongshore distance of three to four kilometers. These quarterly field campaigns serve to continue ongoing monitoring that is now in its 11th year of operation.

    - These data have been processed from their raw format into deliverable text files and have passed a rigorous quality assurance process, which continues to be refined over time. The text files are organized and cataloged into onsite network drives with accompanying FGDC metadata.

- CMAP continues the effort to recover and examine the geodetic network used to spatially reference our data sets. We visit each monument, complete any required maintenance, photograph the site, and correct and discrepancies with descriptions found in NGS datasheets. Once complete these updates will be submitted to the NGS website as 2008 recovery notes.

- CMAP presented information from the beach and nearshore monitoring program at the 85th Meeting of the Coastal Engineering Research Board held in Portland, Oregon. The monitoring data are showing recent coastal erosion trends that are consistent with long-term trends derived from historical shoreline and bathymetric data. Importantly, the monitoring data are also showing expansion of areas undergoing erosion, which along some shoreline reaches, represent a reversal from historical accretion patterns.

- The data and information obtained from this monitoring program continues to be a critical component to ongoing work on regional sediment management at the mouth of the Columbia River. Results of the monitoring program have been presented and discussed at several meetings hosted by the Lower Columbia Solutions Group (LCSG), convened by the Governors of Washington and Oregon,

in their ongoing projects, including the Southwest Washington Littoral Drift Restoration (Benson Beach) Project, and the Oregon Nearshore Beneficial Use Project. This summer, data from the monitoring program was used to guide the placement of 125,000 cubic yards of dredged material adjacent to the Columbia River North Jetty, in an effort to increase the resiliency of the jetty and reduce the impacts of coastal storms.

- Based on the shoreline change trends extracted from the recent beach monitoring data, CMAP provided technical advice to the Washington State Parks and Recreation Commission to help them decide where beach sand could or should not be taken from along the southwest Washington coast. WA State Parks has been under increasing pressure to allow sand extraction for use by cranberry farmers. CMAP recommended that WA State Parks do not permit beach sand mining where shoreline accretion rates are relatively low or where there is net erosion. CMAP provided WA State Parks with map products showing shoreline change rates based on beach profile data and historical shorelines. Data analysis and interpretation was performed to support specific recommendations on which areas of the coast were most appropriate to permit sand extraction.

- Information from the beach morphology monitoring program were used in review and comment on the draft Ocean Shores Critical Areas Ordinance (CAO), which is a local set of land-use regulations that must consider best available science. CMAP reviewed the erosion/geological hazards portion of the draft Ocean Shores CAO, and provided recommendations in light of beach response to coastal storms – particularly large El Niño events – and the state's Shoreline Master Program guidelines.

- At the request of a reporter at the Chinook Observer newspaper, CMAP provided information on beach profile changes at 3 sites we monitor just north of North Head. At the most southern site, BMAC, approximately 2 miles south of the Seaview access road, the dune has retreated over 7 feet landward since last summer, and probably most of that erosion happened during the early December 07 storm. This information resulted in a feature article on erosion of the Seaview dunes and the ongoing erosion of the southern Long Beach Peninsula. The article also reported on the wasting of sand by the U.S. Army Corps of Engineers and the need to pump dredged material onto Benson Beach. The article prompted a request from the City of Long Beach for more information on erosion rates and locations of survey sites within the city limits.

- CMAP provided information from the beach monitoring program through an interview with a public radio correspondent, in support of a report on the trend of increasing wave height and beach erosion in the Pacific Northwest, and the connection to climate change. This past winter the Washington coast experienced beach lowering of about 1 ft compared to last year on most beaches; substantial dune retreat has also occurred in Westport, Washaway Beach, and Cape Disappointment State Park.

- CMAP provided educational outreach and information on beach erosion to several high school students working on similar class projects. CMAP also gave six lectures on coastal processes and dune ecology to grade school and high school students in Ilwaco and Long Beach.

    - In Oregon, leveraging NANOOS funds, monitoring of the Oregon Beach and Shoreline Mapping Analysis Program (OBSMAP) was successfully undertaken at 119 sites on several occasions between March 31, 2008 and September 30, 2008. The large number of surveys spanning a broader section of the coast than was originally anticipated was made possible by additional funding through the Coastal Management program of the Oregon Department of Land Conservation Development agency. Specifically, beach cross-section surveys were carried out in April 2008 (post-winter survey), June 2008 (spring survey), and in September 2008 (post-summer survey) along the Neskowin and Rockaway littoral cells and along the Clatsop Plains, and in June 2008 (spring survey) along the Newport cell (Yachats to Otter Rock). The beach surveys involved the conventional approach of re-measuring the existing transect sites using RTK-DGPS surveying technology developed for PNW beaches. Results of the profile measurements and contour excursion 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.

- Shoreline variability continued to be measured as part of the OBSMAP beach monitoring effort. The approach used involved periodically 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 shoreline, along each of the littoral cells. Information from this latter effort was initially used as part of a pilot effort to identify potential "hotspots" for erosion along the Rockaway cell in the 2007/08 winter, with the results being provided to the Oregon Parks and Recreation Department to see if this additional effort would be useful. The outcome was that the identified "hotspot" sites were indeed subjected to localized erosion (above normal erosion) and was used by OPRD staff to assist with their permitting process for deciding whether to allow new emergency engineering to occur. To that end, similar maps are being developed for the OBSMAP monitoring sites for the ensuing 2008/09 winter.

- As described above, nearshore bathymetry measurements by Peter Ruggiero's group at OSU have been collected along the length of the Rockaway littoral cell and the Columbia River littoral cell in collaboration with the state agencies of Oregon (DOGAMI) and Washington (WDoE).

- Outreach efforts in the form of public presentations were presented at the Oregon Shores south coast coastal conference (April), Coastal Hazards Working Group meeting (May), and Oregon Planners Conference (September). OBSMAP also provided various information relating to beach monitoring and oceanographic information to the news media concerning marine and beach morphology changes that took place over the 2007/08 winter, including an interview with the Oregon Public Broadcasting service.

OR shoreline management principals participated in a number of DMAC meetings, including assisting the DMAC chair with the development of material that was presented at the NOAA June review.

b) Currents

- The HF surface current mapping program directed by Mike Kosro at Oregon State University (OSU) has been providing near-real-time maps of ocean currents along the Oregon coast to the public via the web (http://bragg.coas.oregonstate.edu, plus links to this page from 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. In December 2007, an unusually severe, hurricane-strength winter storm battered the Oregon coast, leaving communities without phone or power for up to a week and producing widespread damage to structures. The HF equipment suffered storm damage at several locations, due to erosion and to high-winds on antennas. This damage has now been fully repaired, and the system again is operating at full strength. Electronics and/or antenna repairs have been performed at 3 additional sites. During summer 2008, antenna pattern measurements were performed over the ocean at three sites to update calibration of the direction-finding capability of the HFs there. Computers were upgraded at about half the field sites, allowing data acquisition and operating system software to be updated. The web site was transitioned to a new computer architecture (Mac from Sun). An improved hard-drive-based data backup system was put in place. Site diagnostics available to operators have been improved. High-speed data access was installed using a backhaul system between the site in Crescent City, CA and an ISP in Brookings, OR in Oct 2008, and SWOP-radio data systems were installed at Yaquina Head in spring; these latter systems also serve to expand the range of wireless data availability to coastal vessels, including Wecoma. The group participated in a planning workshop for a coordinated national HF system, in August 2008, and in a Data Quality/Data Assurance workshop for west-coast HF providers in September 2008.

Summary: Observing System Milestone Schedule and Evaluation of Progress.

Area	**Sub-element**	**Proposed Effort For Year 1**	**Progress Assessment**
Observations			
	Shelf	- Purchase equipment for coastal buoy at Juan de Fuca eddy for HAB warning focus - Maintain OrCOOS (OR) buoy in Newport line for hypoxia/anoxia alerts	-Partially satisfactory – reduction in level of funding has delayed WA buoy component completion. Potential for Foundation funding could help alleviate this issue. Going into reduced capability winter mode for OR buoy.
	Estuaries	- Maintain Puget Sound, Columbia River, Willapa Bay, Gray's Harbor, and South Slough moorings	- Satisfactory – we have maintained some Puget Sound, Columbia River, Willapa Bay, Gray's Harbor, and South Slough moorings though have been hampered by less than anticipated funding
	Shorelines	- Maintain quarterly profiles at numerous sites - Maintain 3-D mapping at 16 sites - Maintain expanded NANOOS Pilot efforts at 46 sites	Per above text – progress here is satisfactory though restricted funding and winter weather have hampered our efforts.
	Currents	- Maintain OR radar sites ~~and survey/obtain permits for three WA HF sites~~ (strikethrough added for emphasis)	- Funding has only allowed repair and minimum maintenance of OR sites. WA State Radar effort abandoned due to insufficient NOAA funds – effort remains halted for now.

c) Modeling efforts

- Baptista participated in the MAST meeting in Washington DC, making a synthesis presentation of the NANOOS modeling efforts.

- Computer circulation modeling of PNW coastal ocean shelf conditions is being conducted by Alexandre Kurapov's group at OSU, which produces new forecasts each day of ocean conditions, including currents, temperatures and salinities through the water column. Maps of the nowcasts and forecasts are posted daily to the web (http://agate.coas.oregonstate.edu/forecast_index.html) available through the NANOOS website.

- The temperature forecasts from this modeling effort have been tailored into a product designed to assist tuna fishers in locating promising fishing grounds based on temperature. The value of the product was demonstrated recently when a fisher contacted the modeling team to notify them that their model hadn't updated, and that he was waiting for these forecasts before deciding where to fish. http://www.noaanews.noaa.gov/stories2008/20081014_tunamodel.html
    - Two projects under the original proposal package were not scheduled to receive funding during year 1 due to budget reductions. These were the repeat sampling of water column temperature, salinity, currents and dissolved oxygen along the historically well-sampled Newport Hydrographic Line, using autonomous gliders (Kipp Shearman/Jack Barth), and the ports radar system which provides real-time wave information (Mick Haller).

- At the UW, The Stanford SUNTANS model has been implemented for a model domain including Puget Sound, eastern Strait of Juan de Fuca, the San Juan and Gulf Islands waterways and into the Georgia Strait. The model is currently run on a Linux cluster on which up to 96 computational cores are available for our effort. The model is still undergoing tidal calibration, which has turned out to be a considerable challenge due to the need for accurate implementation of tidal boundary conditions along the two open boundaries. This work is heavily leveraged by support from Bonneville Power Administration and, quite possibly in future, U.S. Department of Energy, which is supporting a Mechanical Engineering graduate student working on the model under the supervision of Dr. Kawase and the Mechanical Engineering faculty for studies on tidal power generation.

- Also at the UW, Made changes to the tidal forcing at the boundary in the Puget Sound model running quasi-operationally at the APL UW. This has greatly increased our ability to realistically model the Puget Sound. Our tide output in the model is three times more accurate after this modification.

    - Improved the system that coordinates data injection. We now have fewer data outages. Another aspect of data injection that we have changed in the last six months is we have switched from the older MM5 atmospheric model to the new WRF model as our data source for surface forcing. This

new atmospheric model should help us increase realism by itself being more realistic.

- Developed new means to distribute the model output. This includes maintaining and up grading the existing openDAP server for scientists and researchers and testing new methods to visualize the output for all people interested in the Puget Sound. To this end we have demonstrated the ability to use ubiquitous desktop clients, such as Goggle Earth, to geolocate and display plots of model data. Also, we are actively developing automated visualization packages that will ingest buoy data and create plots that help monitor model performance over long periods.

- Though a combination NSF core funds for CMOP, stakeholder funds, and NANOOS funds, a CMOP team coordinated by Grant Law maintains:

  - Daily 3D circulation forecasts for the following "extended PNW" estuaries: Columbia River, Coos Bay; Fraser River; Grays Harbor; Humboldt Bay; Monterey Bay; Siletz and Depoe Bay; Tillamook, Nahalem and Netarts Bays; Willapa Bay; and Yaquina and Alsea Bays.

  - Multi-year simulation databases for the Columbia River estuary and plume, dating back to January 1 1999.

  - Recent progress includes (same funding sources):
    1. A set of quantitative skill assessment metrics that apply to all Columbia River forecasts and simulation databases (and is extendable to other estuaries)
    2. Substantial improvement in the skill in representing salinity intrusion under all types of flow discharges and tidal coefficients.
    3. Substantial improvement in the skill of temperature simulations in the Columbia River estuary, in response to needs of fisheries science requirement to guide management decisions on hydropower and ecosystem restoration.
    4. A set of model-based environmental sentinels are being developed/used for analysis of impacts of climate and human activities in the Columbia River ecosystem.

- Usage: Forecasts and simulation databases are used by a range of regional stakeholders, several of which (e.g., NOAA Fisheries Science Center, Bonneville Power Administration) fund elements of the modeling system. Models are also used to support scientific research, including near real-time support of scientific cruises (EcoHAB, RISE, CMOP). Three publications currently in review (Burla et al A and B; Zhang et al.) illustrate the applications of the model in support of the larger community.

Area	**Sub-element**	**Y1**	**Y2**
Modeling		**Proposed Effort For Year 1**	**Progress Assessment**
	Oregon/Washington Estuaries	- Integrate and enhance existing forecasting capabilities at OSU, OHSU, & UW	- Progress is satisfactory given level of funding. Progress continues to come by leveraging projects funded by agencies other than NOAA.
	Oregon/Washington Coastal Shelves	- Begin to develop state of the art cross-shore profile change models and probabilistic shoreline change models at OSU	- Progress is satisfactory with caveat noted above.
	Integrative Synthesis Operational Modeling	*- Liaise with stakeholders to verify prioritized operational modeling requirements*	- This effort now unfunded due to Y2 NOAA budget shortfalls – project halted and resources (very minor) for Y1 going to other modeling efforts (this was previously reported to NOAA).

d) **Data Management and Communications**:

Managerial aspects

- NANOOS DMAC will achieve operational status on October 29, 2008.
- Provided a NANOOS DMAC briefing to the Pacific Coast Ocean Observing System (PACOOS) Board of Directors in May 2008. Steve Uczekaj accompanied Jan Newton of NANOOS to the PACOOS Board Meeting in San Diego, CA to provide a briefing on progress of NANOOS' DMAC initiative.
- Participated in NOAA's review of NANOOS progress in June 2008. Representatives of NOAA's IOOS office visited NANOOS to review progress that had been made with grant funds provided. NANOOS' DMAC team participated in the overall review and discussed progress and plans for the architecture. This segment of the overall positive NOAA review of NANOOS was highlighted as particularly impressive.
- Provided NANOOS' support of a NOAA request to have LMI, an independent organization, review the status of NANOOS' DMAC efforts and progress.
- Conducted a Critical Design Review of NANOOS' DMAC architecture and implementation plans to support an October 2008 Initial Operating Capability (IOC).

- Alex Jaramillo joined CMOP in late May 2008, to serve as the primary OHSU representative in the NANOOS DMAC team. Alex replaces Bill Howe in this capacity, the current semester having allowed for an ordered transition of responsibilities. Alex is jointly supported by NANOOS, regional stakeholders, and the core NSF CMOP grant.

DMAC Technical Aspects

Data Discovery and Registration

- Reviewed IOOS DIF xml standard. Current standard covers seven core ocean observation variables. Relies on FGDC and OGC metadata standards.
- Created JAXB binding classes for IOOS DIF XML Schema and distributed to IOOS community.
- Designed and implemented NANOOS data provider xml schema.
- Designed and implemented NANOOS registry Data Base.
- Reviewed OGC catalogue service as a starting point to the Data Provider Registry.
  - OGC XML schemas overly complex for our use.
  - OGC CWS data model is not too complex for NANOOS.
- Implemented Data Discovery and Data Provider web service.
- Hosted web service on NANOOS equipment housed at UW. Web service and registry installed 9/30/08.
- Created a standalone application to register data providers in the NANOOS registry.
  - Guides the user in correctly filling out the needed XML fields.
  - Connects to registry node at UW to register data sources.
  - Available as a Java Web Start program over the web from the NANOOS Registration web site.
- Integrated NANOOS registration and discovery into the NANOOS web portal.

Data Integration Services

Components

- PySOS, a python based implementation of OGC SOS 0.0.3 standard. PySOS works in conjunction with a web server that supports the common gateway interface (CGI) and serves data from a relational database. The PySOS software has been downloaded and installed.
- SOS Browser, flex(R) based graphic client that allows browsing SOS OCG 1.0.0 compliant through a graphic user interface (GUI) has been installed.
- Python client, command line SOS client has been installed
- Core variables, salinity, sea level, seawater temperature, ocean color, currents are functioning.

Activities for the NANOOS DMAC Initial Operating Capability

- Register CMOP SOS and WMS services with the NANOOS DMAC Service Registry
- Update PySOS to OGC SOS 1.0.0 standard
- Finalize new data sources to CMOP SOS (Ocean color)
- Write documentation for the PySOS software
- License and release the PySOS software
- Implement a graphical client for SOS 0.0.3

Progress and Accomplishments

- Deployed an SOS server integrating and providing access to data from 40 platforms across 5 observation networks around the Northwest and millions of observations. These data are made available to National applications that use SOS.
- Recently incorporated new feeds from Washington Department of Ecology and ORCA Meteorological Stations.
- Added ocean color to SOS offerings. The data source is originated by Aqua MODIS, a NASA Earth Sciences satellite mission.
- Supporting and extending PySOS for use by others. Specifically, we now support MySQL as well as PostgreSQL as database backends. We are working with APL-UW to install PySOS there to serve additional data.
- Erected two WMS services: one for CMOP model results and one for Sea Color data using the NOAA Coast Watch site as a data source.
- Advised on the architecture of the NANOOS DMAC system, establishing emphasis on standards such as SOS as an early priority. NANOOS was one of the "early adopters" of SOS, collaborating with the OOSTethys and Oceans Interoperability Experiment (http://www.oostethys.org/ogc-oceans-interoperability-experiment).
- Developed a suite of SOS clients to help with the adoption of SOS, these SOS clients will help the scientific community to get acquaintance with the advantages of using SOS. Currently there are two SOS clients a command line client to plot time series and a graphic client to navigate through SOS offerings.

NANOOS Asset List and Sensor Format

- Developed a comprehensive NANOOS ocean observing asset list that includes university, state and federal assets. Boeing and UW have developed a MySQL database version of the asset list. UW is working towards populating the database, which is currently running on a UW server and developing an interactive asset list map.

NANOOS User Interface Portal

The following Portal Design and Framework actions were completed:

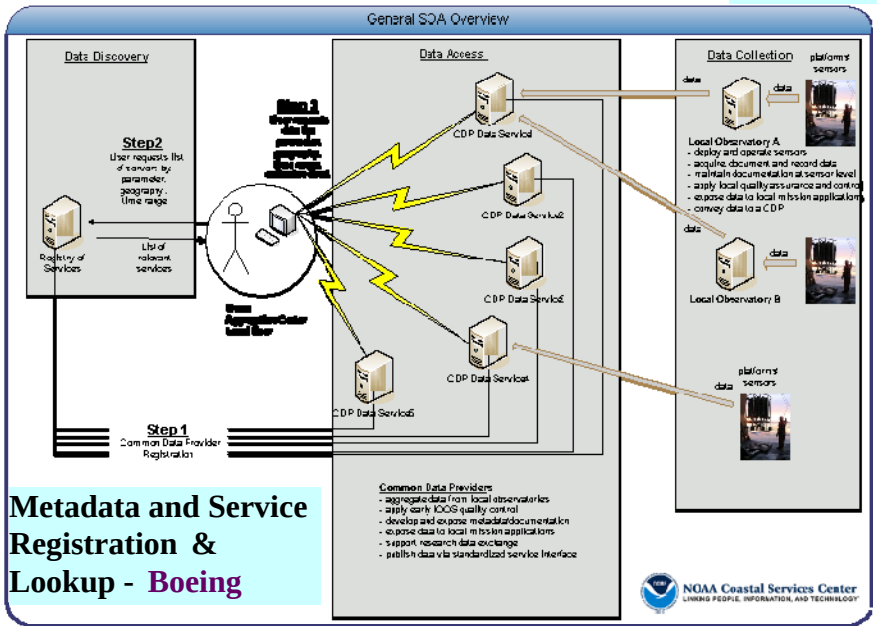
- Developed Portal Content (Data, Overview, Documentation, Education, Internal)
- Developed user tools for Portal (Content Editor, Image Editor)
- Developed an asset list database (working to ensure registry compatibility)
- Incorporated NVS (Pulls data from BIS data stream and displays assets)
- Incorporated a Data Explorer
- Supported various server setup actions (NANOOS, sati, itas)
- Assisted with registration and lookup service

- Participated in and responded to PDR and CDR tasking

Figure 1. NANOOS DMAC Architecture

Asset List & Sensor Formats - OSU

User Interface Portal - UW



Metadata and Service Registration & Lookup - Boeing

Data Integration Framework - DIF

Data Integration Services - OHSU

Area	**Sub-element**	**Y1**	**Y2**
Data Management and Communications		**Proposed Effort For Year 1**	**Progress Assessment**
	Task 1: DMAC Systems Architecture Definition and Development	- The Boeing Company lead with OHSU co-lead develop conceptual systems architecture design in compliance with IOOS standards and protocols	- Satisfactory - as noted above.
	Task 2: DMAC Network Engineering Definition and Development	- OHSU lead with The Boeing Company co-lead develop NANOOS DMAC	- Satisfactory - as noted above.

		network engineering design in compliance with IOOS standards and protocols	
	Task 3: DMAC User-product development	- UW lead with OSU co-lead define NANOOS DMAC/Web interface specifications in compliance with IOOS standards and protocols based on direct liaison with NANOOS stakeholders	- Satisfactory - as noted above.

e) Education and Outreach

- Under the leadership of Amy Sprenger (NANOOS Education and Outreach Specialist) and Mike Kosro (NANOOS Education and Outreach Committee Chair), the NANOOS Education and Outreach Committee has held 3 bi-monthly meetings to discuss NANOOS E&O efforts as well as E&O activities of NANOOS members. Sea Grant, CMOP STC, and COSEE staff are part of this Committee and actively participate.

- Amy Sprenger has participated in the monthly conference calls of the NFRA Education subcommittee.

- The Quinault Indian Nation, a NANOOS member, invited NANOOS to post an exhibit that Amy Sprenger presented at the May 2008 Tribal Habitat Conference in Quinault, WA.

- NANOOS data is featured in data visualization exhibits at Hatfield Marine Science Center in Newport, OR. Largely the Masters project of Sarah Mikulak (OSU) working with Jack Barth and Craig Risien (OSU) as well as Nancee Hunter (Hatfield Director of Education) and Shawn Rowe (Hatfield Science and Education) and , this work was presented at the 2008 Ocean Sciences Meeting in Orlando, FL.

- In June, Amy Sprenger traveled to Charleston/Coos Bay OR to meet with South Slough NERRS and COSEE Pacific Partnership staff. They discussed areas of coordination, synergy, and future directions.

- Amy Sprenger conducted a workshop “Using Ocean Observing Data in the Classroom” at the NAME (NW Aquatic and Marine Educators) conference in July

2008. Amy was elected to the Board of NAME as the Washington State Director.

- Amy Sprenger attended the NMEA (National Marine Educators Association) conference in Savannah GA, July 2008.

- Several NANOOS investigators participated on a cruise in Puget Sound and the Strait of Juan de Fuca held by EPA on the R/V Bold. Following the cruise, an Open House was held on R/V Bold at Pier 66 on the Seattle waterfront on August 19-20. Jan Newton and Amy Sprenger put together a NANOOS exhibit for the event. The ship was open to the public for one day and to dignitaries and other guests on the second day. Attending were EPA Administrator Steven Johnson, EPA Regional Administrator Elin Miller, Congressman Jay Inslee, Nisqually Tribal Chairman Billy Frank Jr., several local and state agency heads and staff, and the media.

- The NANOOS-NERRS Pilot Project on real-time data for shellfish growers continued via the efforts of Cathy Angell (NERRS) working with Jan Newton and Amy Sprenger. NERRS provided funds for updates and revision of the data products available on the web and inclusion of 3 new real-time sites from the Washington State Dept of Ecology.

Area	**Sub-element**	**Y1**	**Y2**
Education and Outreach		**Proposed Effort For Year 1**	**Progress Assessment**
	E&O infrastructure	- Fund the NANOOS Education and Outreach (E&O) Coordinator to work with the E&O SC Chair, the Executive Director, and the web development team	Fully Accomplished Note: per last report, this had a delayed start.
	Ocean Literacy	- Focus on 7 basic principles of ocean literacy - Enhance collaboration with PNW COSEE efforts and NSF-funded CMOP STC ocean education efforts	- Satisfactory. Due to delayed start, per above, delivery of marine education material via the NANOOS web (Ed-Web) will occur in the first quarter of Y2, but has progressed satisfactorily. - NANOOS has accomplished collaboration with COSEE and CMOP STC, via meetings and inclusion to NANOOS E&O

			Committee. Also focused efforts on synergies with ongoing PNW marine education venues including OIP, NAME, and WAML.
	Focus area products	- Begin development of education materials for four NANOOS focus areas of: fisheries, maritime operations, coastal hazards, and ecosystem impacts - Focus on SAFE for fisheries - Focus on BIS for marine operations - Continue joint pilot with NERRS for ecosystem impacts	- Progress is satisfactory as we continue to develop education materials for NANOOS focus areas according to stakeholder prioritization. Ongoing work with SAFE, and the Hatfield Marine Science Center on products for fisheries, maritime operations, and ecosystem impacts as well as on-going support of BIS, and NERRS for other educational products. -
	Training	-Establish a training group to meet with one user focus group per quarter	-Progress on this has been delayed due to difficulty of the implementation and need for much networking. The NANOOS E&O Committee decided to target our first effort on the Columbia River Harbor Pilots. Further progress for this is anticipated in the next quarter.

4) Issues

In addition to the points noted previously, NANOOS notes the following specific issues in relation to available funding:

A. Estuarine observations

Due to a WA-state agency hiring freeze we have been unable to replace WA DoE mooring lead Stephanie Jaeger. As a result of limited staff, we removed the Naselle mooring in Willapa Bay on 9/4/08. We also removed the Budd Inlet mooring on 10/9/08. Although installation of the Bluetooth wireless intermediary system was completed, data was only received by OHSU for two weeks. Servicing of the Bay Center mooring revealed the Bluetooth unit was still receiving power and communicating. So the break in communication is believed to be between the antenna in the field and the receiving antenna back at Naselle. We are looking into alternative ways to send and receive data from the Bluetooth unit. The mooring system and design continues to be considered robust for future applications. We look forward to replacing the mooring lead and redeploying moorings as the budget allows.

B. Beach and shoreline observations

The duration of this campaign and the harsh environment that our equipment must operate continues to take a toll on its reliability and functionality. CMAP's primary equipment includes vehicles and GPS surveying equipment. Both of these have suffered causalities recently. Fortunately, funding from the Washington Department of Ecology and the U.S. Army Corps of Engineers were leveraged to replace the amphibious ATV used to collect surface map data with a new all-terrain utility vehicle. Some of our GPS gear is over 12 years old and the manufacturer no longer offers parts to service this older equipment. In the past we had two GPS receivers used for collecting bathymetry data from two Waverunners operated in tandem. One of these receivers has stopped functioning. Fortunately, the U.S. Geological Survey was able to provide a GPS unit this summer. However, this summer one of CMAP's GPS units was damaged by water due to deterioration of a water-tight seal, and cost to repair this unit is estimated to be $8,000. Given the limited NANOOS budget for this year and next, we are in a process of seeking additional funds from other agencies so that we can repair or replace GPS equipment so that we are able to efficiently perform our surveys as we have over the past 10 years.

As a result of ongoing assessment of coastal processes, the impacts of storm events, and navigational hazards at the mouth of the Columbia River, a need for a nearshore Waverider buoy – significantly inshore of the present NDBC 46029 wave buoy – has been identified. Such a wave gauge would significantly increase the (near real time) observational reliability of wave conditions affecting navigation at the mouth of the Columbia River. Interested parties include the U.S. Coast Guard, Columbia River Bar pilots, Columbia River Crab Fisherman's Association, Columbia River Solutions Group, U.S. Army Corps of Engineers, U.S. Geological Survey, Oregon State University, Washington Department of Ecology, and others. The Columbia River Bar Pilots have been considering deploying a GPS-driven unit that is currently being used in Japan that has potential of providing real-time wave height data on the Bar. However, this technology has not been proven in Pacific Northwest conditions, and may not give reliable measurements of wave height. Discussions to date have been focused on installing a Waverider buoy, similar to installation at the entrance to San Francisco Bay, specifically to increase the accuracy of the Bar Forecasts. At present, interested parties are seeking to combine resources and institutional initiatives to deploy and maintain a waverider buoy through the Coastal Data Information Program, and would be proposed as an ocean observing station under the umbrella of NANOOS.

C. DMAC

- Standards: Current metadata xml standards are complex and hard to comprehend. This makes for a steep learning curve and a high cost of entry. Complexity is also a major obstacle in getting these data standards used. Standards are developed to insure and facilitate interoperability. A complex standard will likely not be used, even if adapted or mandated. This will lead to further balkanization of the data leading to the eventual failure of DMAC.
- SOS standard is not suitable to publish Ocean color core variable, WMS is a better candidate for this variable.

5) Key Personnel Changes
There are none to note.

6) Budget Analysis
All financial reports are up to date. At the end of September 2008 (100% of the Year 1 time allotted), NANOOS had satisfactorily encumbered/obligated Year 1 resources with all necessary subcontracts in force. Given the uncertainty of future Year (i.e., Year 3) resource levels, no prediction (or estimates of total expenditures based on "anticipated" revenues at this point) of future financial obligatory status is provided though no difficulties, other than the impacts on various efforts due to reduced funding mentioned above are expected. Assuming a three year effort, at the end of September 2008 the project was 33% completed with 49% of resources remaining (i.e., Year 2 funding has been received and subcontracts awarded).