Semi-Annual Progress Report for Alaska Ocean Observing System (AOOS)
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I. GOALS AND OBJECTIVES: Accomplishments as of August 31, 2007

These accomplishments were achieved by the AOOS project leader, Molly McCammon and the AOOS subcontractors: the Alaska SeaLife Center (ASLC), the University of Alaska Fairbanks (UAF), and Prince William Sound Science Center/Oil Spill Recovery Institute (PWSSC/OSRI). In addition, funds were withheld from the original funding source for NOAA's Pacific Marine Environmental Laboratory (PMEL) to perform some activities in which they had singular expertise.

A. Identify Additional Stakeholders and Stakeholder Benefits; Develop Education and Outreach

Implement Education and Outreach Plan (ASLC)

Extensive stakeholder and user group outreach efforts continue including presentations and participation at state and national symposia. The Senior Outreach Manager gave a presentation, "AOOS: Ocean Literacy at the Dawn of Climate Change," at the National Marine Educators Association in Portland, Maine in July 2007, reaching more than 400 marine educators and agency staff.

The Center for Ocean Science Education Excellence (COSEE) proposal for Alaska, submitted March 1, 2007, was recommended for funding by the National Science Foundation, and initial planning meetings with the co-PIs were held while awaiting the official funding letter due in October. The five-year grant, which will help accomplish many of the AOOS outreach and education goals, will commence in November 2007. The Senior Outreach Manager represented the AOOS Executive Director at the national COSEE COUNCIL meeting of COSEE Directors and principal investigators at the Ira Darling Marine Station in Maine in July.

AOOS staff are participating in the IOOS Education Key Themes and Messages Working Group and NOAA's Alaska Region Communication, Education and Outreach Working Group, (ARCTic). AOOS is also exploring, with the Alaska SeaLife Center/Coastal Learning Centers and the North Pacific Research Board, plans to bring an Ocean-in-the-News Kiosk to Alaska as part of the Smithsonian's Ocean Hall that opens in October 2008, and collaborating with NOAA to bring a "Science on a Sphere" to Alaska, along with development of science modules for spherical display systems and educationally effective environmental data products for public exhibits.

A new AOOS full-size traveling exhibit is in development to replace the tabletop display exhibited at the Alaska Forum for the Environment conference, the Alaska Marine Science Conference and others. AOOS is also involved in planning for the Alaska Marine Science Symposium and Communicating Ocean Science workshop scheduled for January 2008.

The informal AOOS Education and Outreach Advisory Group, used to provide informal advice to AOOS, was expanded to include more representatives of education organizations (schools, research institutes, NGOs, and others). The Alaska SeaLife Center continues to provide support for statewide education and outreach activities for displays, brochures, potential exhibits, and a newsletter that will debut in fall 2007 with the announcement of the pending COSEE Alaska grant and other results from key stakeholder and conceptual development meetings and activities.

B. Expansion of Observing Capacity: AOOS Region 1: Gulf of Alaska

Nitrate Monitoring at the GAK1 Mooring (UAF)

Funds were used to acquire two ISUS nitrate meters that were successfully deployed on the GAK1 mooring in the Gulf of Alaska. This mooring is the termination point for the oceanographic Seward Line that provides data for the longest running oceanographic time series in Alaska waters. After mooring recovery, AOOS receives the data and makes it available via the web. Nitrate is a key nutrient driving production in the surface layer.

GOA ocean observation scientist (ASLC)

A complete draft of the Gulf of Alaska Implementation Plan for that Alaska Ocean Observing System was prepared by Dr. Orson P. Smith. This plan involved specification of approximately 200 new coastal and offshore observing stations and various regular shipboard measurements recommended for observation of change in the Gulf of Alaska (GOA) Large Marine Ecosystem. The GOA LME in this draft plan was divided into 5 regions including the eastern Gulf, the northern Gulf, the western Gulf, Prince William Sound, and Cook Inlet. The northern Gulf was subdivided into eastern and western parts for the sake of logistical considerations, as well as for process modeling.

The implementation plan development included detailed design of combined atmospheric and ocean observing systems intended for deployment at the entrances of Alaska's ports, harbors, and marine terminals. These coastal facilities are typically centrally located in harbor towns and therefore have particular appeal to local mariners, operators of marine facilities, and developers of coastal property, as well as to marine weather forecasters. This conceptual network of coastal stations has come to be known as "Harbornet."

A facility for calibration and testing of ocean sensors and of marine data collection systems was proposed in draft for construction and operation at the Alaska SeaLife Center. The preliminary design involves a stilling well of 48-inch vertical steel pipe fixed to shore by a structural catwalk with power and telemetry from an instrumentation room within the Center. The facility would serve agencies and private enterprise on a reimbursable basis for the substantial instrumentation testing and development needs associated with a large expansion of the ocean observing network in Alaska.

Southeast moorings (PMEL)

After examining the data collected in 2005 in Cross Sound and discussing the results with scientists working in southeast Alaska, a decision was made to deploy two moorings in the region: one in Cross Sound and the second in Chatham Strait. These are the two major entrances and exits to this region of southeast Alaska, which are critical to understanding the inflow and outflow of ocean waters through this series of channels. The PI used the *R/V Media* which regularly conducts research cruises to this region. CTD sections are done in the vicinity of both of these moorings each year by other researchers. The moorings were recovered in March 2007 and provided very good data. The moorings have not been redeployed due to loss of future funding and a decision to analyze existing data first.

Mooring ID	Latitude (°N)	Longitude (°W)	Deployed	Recovered	Water depth (m)
CSP-1A	58° 10’	136° 34.3’	8/28/06	4/22/07	305
CHP-1A	56° 30.1’	134° 23.6’	8/27/06	4/21/07	392

Table 1. Moorings deployed in southeast Alaska from the *R/V Media* and recovered approximately 7 months later on the same vessel. Each mooring is instrumented with an upward looking 75 kHz ADCP and a Seabird Micro-CAT located with 15m of the bottom.

Cook Inlet Nutrients and Chlorophyll (PWSSC/OSRI)
These activities occurred only in year 1 of the grant and not in year 2.

Continued operation of Surface Current Mapper (UAF)
Funds support High Frequency (HF) Radar instrumentation in Prince William Sound (PWS) at Shelter Bay and at Knowles Head to provide real-time surface currents of the PWS central basin. Because of reduced funding for 2007-2008 of this project, the PWS field experiment has been postponed from 2007 to 2009. Both HF radar sites were decommissioned in August 2007 when electronics, batteries, and other equipment were removed. HF radar will be in hiatus until future funding is secured and the field experiment is rescheduled.

Prince William Sound – A Pilot Program for AOOS (PWSSC/OSRI)
The PWS pilot project is progressing as planned under the leadership of PI Dr. Carl Schoch. A budget reduction of about 30% from our year 2 proposal caused many components of the demonstration to be postponed indefinitely. Current activities include:

SNOTEL Gauges for Meteorological and Precipitation Data
Freshwater is a major forcing function of local circulation in PWS. To quantify the volume of fresh water contributed by precipitation, a series of weather stations are being deployed at sea level and near tree line in the PWS watersheds. A new Snotel weather station was deployed on the south side of Valdez Arm at an elevation of about 800 meters. This station is now providing real time data feeds to the AOOS web site. The deployment of the three remaining weather stations at Mt Doran, Naked Island, and Jackpot Cirque is delayed because the U. S. Forest Service is still reviewing the permit applications. The reviews were approved at one time but a turnover of personnel resulted in a reassessment of the review. This is the third year of the permit review process. The USFS has assured us that the permits will be granted by summer 2008. The other seven weather stations are operating very well. The station at the Nuchek spirit camp is scheduled to get a new telemetry system when the camp is upgraded with Starband satellite service.

Central PWS Mooring
The deployment of this mooring is scheduled for the fall of 2007. The mooring hardware has been purchased with AOOS funds, an acoustic release will be borrowed from the University of Alaska Fairbanks, and a CTD will be purchased with funds provided by the Oil Spill Recovery Institute. This mooring will help determine the magnitude and frequency of water renewal in deep basins of PWS. Data will be used to validate and improve circulation forecasts from the ocean circulation models which require information on residence times of water masses.

Real-time telemetry for the Copper River stream gauge

The Copper River stream gauge is functioning very well and a stage/discharge relationship has been established so that river discharges are now being reported. Telemetry equipment funded by AOOS allows for real-time data feeds to the web page at waterdata.usgs.gov/nwis and www.aoos.org. With real-time data telemetry, discharge measurements from the Copper River stream gauge can be assimilated into the ROMS ocean circulation model. An MOU is in place between the PWS Science Center and the U.S. Geological Survey for the long term operation of this gauge.

Thermosalinograph/fluorescence surveys

The *Alena K* has continued the monthly thermosalinograph cruises of PWS throughout the 2007 summer. The instrument package includes a temperature and conductivity (salinity) sensor, a fluorometer for surface chlorophyll measurements, and a transmissometer to quantify turbidity. The University of Alaska in Fairbanks was contracted to develop software that combines these measurement values with a GPS position and record to a computer hard drive. Surface salinity mapping will help quantify fresh water inputs to PWS for assimilation by the ROMS model. Chlorophyll fluorescence also will be measured in PWS to provide a measure of interannual and seasonal variability.

Mooring enhancements to measure biophysical coupling

Key factors in the ecology of PWS are the timing and magnitude of nutrient enhancements and plankton blooms relative to water volume transport and physical properties of flow through the major entrances of PWS. Four CTDs and fluorometers were purchased in the fall of 2005 and deployed at 30 meters depth on four existing oceanographic moorings in Hinchinbrook Entrance and Montague Strait. These data will be processed as part of the on-going mooring program maintained by the Prince William Sound Science Center.

ROMS ocean circulation model

AOOS is augmenting a project initiated by the Prince William Sound Science Center to develop a high resolution ocean circulation model for PWS. This is year 2 of the 3 year project: the model developed at UCLA will be delivered to JPL where the data assimilation module will be integrated.

Nutrient/Phytoplankton/Zooplankton Model (NPZ)

The current fiscal year is the first of two consecutive years for developing an NPZ model for PWS and the adjacent Gulf of Alaska. This NPZ model will be integrated with the ROMS ocean circulation model being developed at UCLA and JPL. In 2007 the PWS Science Center received a grant from AOOS to administer the project and has signed a contract with the University of Maine to develop the model. The model will be an integrated component of the ROMS model being developed at UCLA and JPL and will be capable of data assimilation upon completion in 2009. Efforts are now underway to secure funds to instrument the perimeter of PWS with telemetered fluorometers in anticipation of streaming real-time data for assimilation by the completed model. This will be funded by the biophysical monitoring item in the current fiscal year budget.

C. Expansion of Observing Capacity: AOOS Region 2: Bering Sea and Aleutian Islands

Amukta Pass moorings (PMEL)

Amukta Pass (sill depth ~450m) is a key passage for monitoring volume transport and other fluxes from the

North Pacific into the Bering Sea. Four moorings were deployed in May 2006 in Amukta Pass. Each mooring was instrumented with an upward-looking, bottom-mounted 75 KHz acoustic Doppler current profiler, and a SBE-37 to measure temperature and salinity. These instruments had been modified through the addition of auxiliary battery packs. This should permit the deployment of the moorings for a year, rather than the previous 6-7 months, thus reducing costs of the moorings and helping to resolve the problem of limited ship time. Amukta Pass is approximately18 hours from Dutch Harbor, AK and transiting to the pass twice a year is becoming more difficult with available ship time.

The moorings were recovered by the *Miller Freeman* in late February 2007. All ADCPs functioned for the entire period as did the Micro-CATs. In addition, during deployment and recovery, a series of 5 CTD casts were done across Amukta Pass. All of these data will be available on the PMEL data server and will eventually be on the AOOS website. The important accomplishment of this deployment is that the instruments functioned for 10 months with the new battery packs.

With the recovery of the moorings in February 2007, PMEL has collected over 4 years of data in Amukta Pass. This data is the only measure of transport into the Bering Sea. There are some predictions that with changing weather patterns the total transport into the Bering Sea will decrease, which would impact the heat, salt and nutrient fluxes into the Bering.

All four Amukta moorings were redeployed in February 2007 with recovery planned for March 2008.

Mooring ID	**Latitude (°N)**	**Longitude (°W)**	**Deployed**	**Recovered**	**Water depth (m)**
AMP-1A	52° 26’	171° 27’	5/4/06	2/22/07	411
	52° 26’	171° 27’	2/22/07		
AMP-2A	52° 25’	171° 40’	5/4/06	2/22/07	456
	52° 25’	171° 40’	2/22/07		
AMP-3A	52°24’	171° 55’	5/4/06	2/21/07	308
	52°24’	171° 55’	2/21/07		
AMP-4A	52° 23’	172° 7’	5/4/06	2/21/07	356
	52° 23’	172° 7’	2/21/07		

Table 2. Moorings deployed in Amukta Pass. Each mooring is instrumented with an upward looking 75 kHz ADCP and a Seabird Micro-CAT located within 15m of the bottom. All dates are GMT.

Maintaining and Enhancing Physical and Nitrate Monitoring of Bering Strait (UAF)
These activities were a stopgap measure to ensure an uninterrupted time-series of flow measured through Bering Strait. NOAA and NSF have now partnered to maintain this mooring at least over the next several years. Funds for physical oceanographic moorings for the first year were a one-time support that enabled AOOS to acquire the data as soon as mooring are recovered and the data processed. Funding in year two was for operational costs to place nitrate monitors on the Bering Sea moorings.

D. Expansion of Observing Capacity: AOOS Region 3: The Arctic

Monitoring sea ice edge and motion (UAF)
Real-time information on sea ice motion and the position of the sea ice edge continues to provide data on the extent, velocity and evolution of coastal sea ice. The installation of the radar is complete, and data are being logged and available on the AOOS web site. The ice edge radar provides useful data to coastal residents near Barrow and to researchers at UAF and elsewhere. Preliminary data suggest that the "break out" events that remove ice from the nearshore zone may be related to "flickering" of the radar images in the moments before the event. Data are being colleted to further explore this possibility and understand whether and how it can be used to improve marine safety. These funds were used for hardware upgrades for the sea ice radar and for support of a graduate student.

Measuring sea ice thickness (UAF)
A proposal to NOPP by Johnson (and co-PI Bill Emery), with support from Shell and ConocoPhillips, was submitted in 2006 with AOOS support to purchase a helicopter mount for the airborne sea ice thickness instrument (IcePic) to be flown both offshore and over nearshore areas with landfast ice to provide measurements of thickness that cannot be gained by other means (satellites do poorly when the sensor sees both land and ocean). Despite being well reviewed, the proposal was declined. At present, there is no reliable way to collect thickness data for assimilation into model forecasts of sea ice and for recording climate change. Sea ice thickness continues to be one of the key unmeasured parameters necessary to improve model forecasting.

E. Integrate Data across Components, Regions, Agencies, Funding Sources

Data Management and Communications (DMAC) (UAF)
The DMAC team continues to demonstrate its ability and knowledge in both data management and communications and is well connected with the national effort. Rob Cermak serves on the national DMAC committee and has a key role in writing DMAC planning documents. Significant real-time data is now on line, along with the popular web-cams from a number of statewide locations. DMAC is working directly with stakeholders in PWS, Minerals Management Service, Coast Guard Search and Rescue, and others to update and improve the web pages. AOOS, in collaboration with the North Pacific Research Board, has hired a new data and web manager to help launch the Alaska Marine Information System which will include a project browser and metadata browser. The browser is installed, and we are currently expanding the project database to include ocean observing projects across Alaska. A significant challenge continues to be working with AOOS stakeholders in the three Alaska regions to ensure their information needs are being met. In February 2007 the AOOS sites had more than 2.4 million hits and the maximum hits of 30,000 per hour are overloading our servers. A plan to increase our capacity is limited by the existing funding. To meet national standards, we are developing an internal metadata browser that will search the AOOS data records to automatically update the status of our data holdings. Experience gained through this will apply to the development of the broader metadata browser necessary for allowing stakeholders to search for specific data. New data streams acquired by AOOS should meet IOOS metadata standards, however, at present we have elected to acquire as much data as possible with the hope that future funding will allow a dedicated data handler to work with data providers to help them create metadata.

F. Data and Information Product Development

Data Visualization (UAF)

Data visualization has become a shared task among the full AOOS team. New "custom pages" have been developed for Barrow, Cook Inlet and Prince William Sound. The Barrow page takes advantage of an eighteen month effort with NASA to acquire and display SAR data along the North Slope. The positive response to the Barrow page sets the stage for developing similar pages for Nome and Kaktovik. The Cook Inlet page provides HF radar data in real time, tidal currents, and RAMS meteorological forecasts. We continue to work on the tidal forecast "look and feel" of this page to meet stakeholder needs. Similarly, a Prince William Sound "boaters' page" has been created that integrates tide tables with buoy data and marine forecasts. Key stakeholders in Cordova and Whittier are reviewing these pages to assess how well they meet stakeholder needs.

Satellite Data Products (UAF)

The AOOS satellite technician is funded at 33% time and currently provides geo-referenced MODIS, AVHRR, SAR, and GOES data sets for display of SST, visible imagery, sea ice concentration, sea ice extent, chlorophyll-a, and SAR-derived winds via the AOOS web pages. We are working on producing the monthly means from these data streams (the climatology) to meet stakeholder needs.

Modeling and Analysis Group (MAG) (UAF)

A critical need as forecast models are developed is analysis and validation of the accuracy and performance of a model. The MAG team – in collaboration with the University of Alaska's Arctic Region Supercomputer Center and additional funding from the U.S. Department of Energy – was developed to do this. A biological modeler at the post-doctoral level has been hired to build an NPZ model into ROMS and is currently conducting experiments on fisheries problems in the Bering Sea. Johnson and AOOS member S. Gaffigan have completed an analysis of sea ice models and compared them with observations, published recently in a peer-reviewed publication (see Johnson et. al, 2007, J.Geophys.Res. Res., 112, C04S11). A second article is in preparation. Those data-model results are now on the AOOS web site. Additional comparisons between observations and other models (NCEP, MM5, NOGAPS) are underway as we archive longer time series of observed data. The MAG group is working closely with the DMAC team to ensure that model output is displayed in ways that are useful to various AOOS stakeholder groups. Discussions continue on how the Alaska region will conduct the overall modeling required to meet IOOS needs, but a workshop is necessary to refine these discussions to develop a coherent national modeling program. At present, new hires to the modeling group are not possible without sustained funding.

II. Overall Program Issues and Concerns

The following issues continue to be of concern to the overall development of AOOS:

A. Funding uncertainty

AOOS began operating in the summer of 2005 using a $2 million FY 2005 earmark. That earmark was reduced to $1.7 million in FY 2006. Following a competitive process, AOOS was awarded $750,000 in June 2007. This funding variability and uncertainty continue to make it very difficult to develop and sustain a program, hire and keep qualified personnel, and proceed forward with long-term plans. The reduction in 2007 required AOOS to drop its financial support for the Amukta Pass and Southeast

mooring programs and the Barrow ice radar, reduce staffing for the DMAG group, and significantly pare down the goals for the Prince William Sound pilot project. These are significant losses to the AOOS stakeholders since they are in addition to the loss of the Bering Strait moorings and work in Cook Inlet/Kachemak Bay in 2006. With the recent record minimum Arctic ice in summer 2007, there is a pressing need for improved monitoring and forecasting capability in Alaska – the U.S. Arctic - for marine navigation and safety and to continue to understand climate change.

If the AOOS program is looking at approximately $2 million a year as its base funding for the near future (as opposed to ramping up from a $2 million minimum), the AOOS board likely would re-consider how we approach the issue of expanding observation capacity in the three AOOS regions. The board may consider focusing more of its financial resources on the data and modeling components of AOOS and using those to integrate existing observation efforts and develop stakeholder products, although these would have less utility with fewer observations. In all cases, we will continue our existing efforts to leverage the AOOS data system with other agency programs that might have future funding for observation components.

B. Future of HF Radar

The major issue regarding the use of HF radar as a tool in Alaska's ocean observing program relates to the lack of electricity at remote sites and the need for a robust, cost-effective remote power source. Major funding is required to develop and maintain a team to work on HF radar year round. Apparently this is an issue of concern to other Regional Associations, and thus, might be appropriately addressed at the national level. We are exploring how to tap into existing power infrastructure in Prince William Sound because the HF radar there (as elsewhere) is critical for data assimilation into models.

C. Integration with IPY

The International Polar Year is providing a pulse of activities in Alaska's Arctic and Bering Sea regions, many of which the National Science Foundation is collecting into an umbrella Arctic Observing Network (AON). AOOS will participate with other research entities to assess which of these activities might be sustained over the long-term and incorporated into the overall AOOS program. We are already the archival and display portal for SIZONet, an Arctic program that generates sea ice data sets.

D. Integration with OOI

AOOS is collaborating with NSF's planned Barrow Cabled Observatory (BC), part of its Ocean Observatories Initiative (OOI). There have been no recent activities.

E. DMAC and MAG development without national standards

A key challenge has been to develop the AOOS DMAC and MAG programs without clear national standards. The current DMAC planning documents are fairly generic. These teams are closely tapped into the national DMAC Steering Team. In the absence of clear guidance, AOOS is moving forward on its own by making its own connections with DMAC teams from other regional OOSs. The AOOS DMAC plan was adopted by the AOOS board at its March 20, 2007 board meeting.

Since March 2006, the following issues of concern have been identified and continue to be of concern:

F. Modeling needs

The ocean circulation models being developed for Alaska waters depend on the boundary conditions identified through large-scale North Pacific models. The other Pacific ocean observing systems will rely on these large-scale North Pacific models, as will international efforts such as the Global Ocean Observing System (GOOS). IOOS needs to address the issue of what are national responsibilities for modeling, and what are regional responsibilities.

Alaska's largest challenge is with ecosystem based management and models to support these efforts. There is still significant uncertainty regarding this. A strategy should be developed to build a modeling component that will build on and share expertise at the local level and nationally.

G. Interaction with global efforts

An Arctic GOOS is reportedly under development, as is SAON – a Sustained Arctic Observing Network. Since Alaska is the U.S. Arctic, the question arises regarding the role of AOOS in these efforts. This is still to be defined. PICES, an international scientific organization, also has interest in developing a North Pacific GOOS alliance. How should AOOS play in this arena?

H. Expectation management

Given the uncertainty of future funding, AOOS staff has had a difficult time "selling" the IOOS program, particularly to commercial fishermen and other industry sectors – potentially our largest customers and stakeholders. We need to develop a national strategy for this that can be used at the regional level.

I. Transition from research to operations

We are going to find it challenging in Alaska to transfer many of our observing system components into an operational system. Given our remote coastline, vast distances to ship and human support, and extreme weather conditions, our systems will need substantial time and funding to become truly operational.