



2012 Work Plan Oil Spill Recovery Institute

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Prince William Sound Oil Spill Recovery Institute

2012 Work Plan

I. Purpose and organization of this document

This document describes the Oil Spill Recovery Institute (OSRI) 2012 Work Plan in the context of the overall Research Plan approved by the OSRI Board in February 2010 for fiscal years 2011 through 2015. The Research Plan should be referenced for detailed descriptions of the OSRI Program, the planning process and supporting documents. The annual reports and previous work plans should be referenced for more information regarding previously funded projects. The 2012 Work Plan provides descriptions of projects proposed for funding in the 2012 fiscal year beginning October 1, 2011 and a brief description of projects funded in previous years that have funding continuing into fiscal year 2012 (FY12). The OSRI Science Plan and previous OSRI Work Plans can be found on the internet at: www.pws-osri.org.

II. OSRI Strategic Goals and FY12 Work Plan New Projects

The Advisory Board of OSRI and the Executive Committee of the Board of Directors for the PWSSC conducted a strategic planning session in 2008. The purpose of the planning session was to evaluate the past, the present, and plan for the future of OSRI. Four goals were identified as part of the strategic plan: Understand, Respond, Inform, and Partner (see OSRI Science Plan). The fiscal year 2012 Work Plan has been placed in the context of these four goals.

A. Goal #1 Understand:

Attain an interdisciplinary understanding of: the fate and effects of spilled oil in Arctic and sub-Arctic marine environments; and the recovery of those environments following a spill.

Real time physical observations of surface and subsurface current direction and magnitude, and biological observations on resources in the path of the spill are absolutely essential to effective and timely oil spill response. Without a reliable forecast of the direction and speed of a spill, and knowledge of the resources likely to be impacted, even the best clean up technologies in the world may be misapplied.

This goal addresses the OSRI mandate to “determine, document, assess, and understand the long-range effects of Arctic or subarctic oil spills”. The objectives listed in the science plan are to:

- Evaluate short and long-term effects.
- Identify chemical, biological, and physical impacts and consequences.

- Emphasize the nearshore region.
- Identify the impacts of oil spill response options.
- Profile potential impacts from oil spills on the economy, life-style and well-being of communities and resource users.

This work plan describes projects totaling \$195K for projects related to Goal #1. OSRI has elected to support a portfolio of initiatives.

- (1) Support for operation of Snotel meteorological stations in partnership with AOOS.
- (2) Research leading to validation of hydrological models.
- (3) Continued partnership with NPRB for biological research.

1. Physical science programs

The OSRI science plan outlines an approach for addressing goal #1. This approach builds upon lessons learned during 2009 Sound Prediction experiment that tested the modeling and observational capabilities of the Prince William Sound Observing System (PWSOS). There are two primary goals of the Prince William Sound Observing System. The first is to combine long-term monitoring with short-term hypothesis-driven process studies to understand mechanisms underlying the regional ecosystem dynamics. Understanding the circulation and the patterns of water exchange will provide a solid scientific foundation for addressing fisheries and ecosystem management needs related to long term oceanic and climatic variability. The second goal is to provide information to the major user groups in PWS including the coastal communities, oil and gas transportation industry (tanker traffic and oil spill response), air taxis, commercial fishermen, recreational and commercial boaters, and Coast Guard search and rescue operations.

Coastal surface circulation is commonly determined by seasonal freshwater input. Our ability to predict freshwater fluxes in PWS is challenging due to: 1) high quantities of rainfall in southern Alaska, 2) few gauged rivers, 3) Amount of freshwater flowing in small creeks, and 4) the contribution of freshwater from glacial melt. Errors in the modeling of freshwater input lead to biases in the modeled salinity that potentially lead to errors in modeled surface currents that are important to oil spill response. The PWSOS includes several SNOTEL meteorological stations that are designed to help improve our understanding of freshwater input. We desire to build off of these stations to build an observation program designed to test the hydrological model.

These programs address the surface circulation portion of the OSRI five-year plan.

a. Meteorology (OSRI cost: \$20K)

Understanding the circulation of Prince William Sound requires accurate measurements of wind fields and precipitation. Snow melt runoff and rainfall leads to a freshwater layer that sets up aspects of the surface circulation. Wind stress then modifies the circulation creating local and seasonal circulation patterns. All of this is on top of the currents caused by the tides. By understanding the basic meteorological conditions including precipitation we hope to improve our ability to model the hydrology of Prince William Sound, improve our understanding of the forcing driving seasonal changes in circulation, and provide oil spill response organizations with necessary data.

Snowpack Telemetry (SNOTEL) meteorological stations set up in partnership with the Natural Resources Conservation Service (NRCS) and the Alaska Ocean Observing System (AOOS), measure precipitation from snow and rain throughout the year and are needed to establish the freshwater budget. Since the summer of 2005, six new SNOTEL stations have been deployed at sea level in PWS, and two stations at alpine elevations. Each station in PWS measures wind speed and direction, air temperature, air pressure, precipitation from rain and snow, and solar radiation. With several years worth of data now available, we are able to begin to more quantitatively test our understanding of freshwater input into PWS.

The SNOTEL stations provide important information about the amount of freshwater stored as snow in the watershed of Prince William Sound, an important driver of summertime circulation in the Sound. Deployment of the SNOTEL Stations was funded by a combination of grants to the Prince William Sound Science Center (PWSSC) from the National Oceanic and Atmospheric Administration (NOAA), Exxon Valdez Oil Spill Trustees Council (EVOS) and AOOS (Congressional earmarks), PWS Regional Citizens' Advisory Council, and OSRI.

The annual operating cost for the weather stations is about \$5,000 per station per year. The operating costs include regular maintenance, calibration of sensors, access to the sites, and telemetry related expenses. The FY12 budget includes \$20K for National Resource Conservation Service maintenance of seven sites. Additional funding from AOOS will be required for telemetry and logistics required in maintaining the sites.

b. Hydrological Model Validation (OSRI cost: \$75K)

A bias in the modeled salinity was observed during the 2009 Sound Predictions exercise. This bias was the underlying cause of the difficulty of hydrological modeling in a region with limited information on freshwater flow and large input of freshwater from precipitation and glacial melt. The existing hydrological model relies on river gauge data from the Copper River, which has a very different watershed than PWS, and modeled precipitation, which has not been validated. In 2009 the meteorological modeling effort funded by OSRI included a precipitation validation component. However, nothing is available for estimating input from glacial melt.

OSRI will seek proposals for a three year project to validate the hydrological model currently being used as input to the oceanographic model developed for Prince William Sound. The modeling effort is currently being led by Dr. Yi Chao at the Jet Propulsion Laboratory. The successful applicant can either work with Dr. Chao or run a stand-alone version of the hydrological model. We expect that the analysis will include a section on how errors in the hydrological modeling may affect the circulation results.

The effort should be designed to identify the influence of rainfall on freshwater input. We recommend a design that aims to validate small portions of the PWS watershed with more clearly defined inputs, such as glaciers free versus glacial dominated. The ability to link freshwater flow to the measured precipitation is desired.

The overall project budget is expected to be \$280K with \$75K in FY12, \$125K in FY13, and \$80K in FY14. This budget profile assumes a larger field component in FY13. We are seeking an additional \$25K, \$50K, and \$50K through the three-year period from the Alaska Ocean Observing System.

2. Biological science programs

The current five-year research plan includes an emphasis on nearshore biology and a desire for working in partnership. To understand the recovery from an oil spill requires a biological research program capable of both helping define baseline conditions and monitor recovery. To achieve the objective laid out in this Science Plan, OSRI expects to fund the following research program.

Funding partnership with the North Pacific Research Board (NPRB) (OSRI cost: \$100K)

The NPRB and OSRI have science plans that encourage research partnerships. Section 4.2.3 of NPRB's science plan directly responds to a strong recommendation of the National Research Council to seek partnerships with other entities to support joint research and funding of projects of mutual interest. Similarly, Section III.A.1 of OSRI's research plan identifies a potential partnership with NPRB to support ecological research projects in Arctic and sub-Arctic climates. NPRB and OSRI have science and implementation plans that provide the foundation for defining research priorities of mutual interest in any given year.

This year OSRI will review proposals from many potential topic areas in the NPRB request for proposals that overlap with its research plan. The OSRI research plan notes that the near shore environment is the most likely area to be impacted by an oil spill, therefore knowledge of the environment and ecology of this zone is of greatest use to OSRI. There is also increasing pressure from shipping and oil development in the Arctic that makes that area of particular interest.

OSRI may contribute up to a total of \$100K for one or more projects relevant to its research plan.

B. Goal #2 Respond:

Enhance the ability of oil spill responders to mitigate impacts of spills in Arctic and sub-Arctic marine environments.

This goal addresses the OSRI mandate to “identify and develop the best available techniques, equipment, and materials for dealing with oil spills in the Arctic and subarctic marine environment”. The objectives listed in the science plan are to:

- Fill knowledge gaps on behavior of spilled oil.
- Fill knowledge gaps on the use and effectiveness of specific mitigation techniques.
- Identify and evaluate new prevention and response technologies.

The components to achieve these objectives are described below.

1. Technology research and development

This work plan describes projects totaling \$150K for projects related to Goal #2, oil spill response, OSRI is looking to fund projects in partnership with other organizations or that complement ongoing research programs.

a. Partnership proposals. (OSRI cost - \$150K)

A number of agencies and organizations as well as industry fund research designed to improve spill response. The missions of the various groups can be diverse, but have overlap with OSRI’s mandate to identify and develop the best available techniques, equipment and materials for dealing with oil spills in the Arctic and sub-Arctic marine environment. Such organizations include, but are not limited to, Bureau of Ocean Energy Management, Regulation and Enforcement (www.boemre.gov), Coastal Response Research Center (www.crrc.unh.edu), Alaska Clean Seas (ACS, www.alaskacleanseas.org), Prince William Sound Regional Citizens Advisory Council (PWSRCAC, www.pwsrcac.org), United State Coast Guard (USCG, <http://www.uscg.mil/hq/cg9/rdc/>), and the oil industry. The oil industry currently has a joint industry program focused (JIP) on biodegradation in the Arctic, and in May 2011 started another JIP focused on several arctic spill response issues including, detection and tracking, improved mechanical recovery, in-situ burning, and fate of dispersed oil.

By pursuing potential partnerships OSRI can leverage its limited funds to engage in larger projects, expanding the total budget for innovation. It should be noted that it is inherently expensive to work in the Arctic and sub-Arctic regions, which increases the cost of proposals. OSRI will look to contribute to a JIP aligned with our research goals. If a partnership in a JIP or elsewhere is unavailable for the OSRI developed research topics

OSRI will develop and release an RFP as the sole funding source. The research topics will be guided by these OSRI science plan response subjects:

- 1) Oil Spill Detection and Tracking
- 2) Spill Response in Ice
- 3) Best Practices

Potential areas of research include, but aren't limited to:

- 1) Demonstration of airborne remote sensing technologies for broken ice conditions.
- 2) Demonstration of Autonomous Underwater Vehicle (AUV) application under ice.
- 3) Development of the Arctic ERMA implementation.
- 4) Testing the stickiness of physically and chemically dispersed oil on arctic organisms.
- 5) Demonstration of unmanned vessels for meteorological measurements.
- 6) Testing new spill recovery equipment in Arctic and sub-Arctic waters.
- 7) Developing best practices and tactic guides for spill response.

A total of \$150K is expected to be available to fund one or more proposals under this topic area.

C. Goal #3 Inform:

Disseminate information and educate the public on the issues of oil spill prevention, response, and impacts.

The objectives of this goal are to:

- Facilitate the exchange of information and ideas through education and outreach.
- Brief the scientific community and oil spill responders on OSRI products.
- Develop and maintain a web page that provides relevant and timely information.
- Provide graduate and undergraduate fellowships and internships.

The approach to reaching these objectives OSRI proposes to spend \$120K to fund a suite of projects related to education and outreach along with supporting workshops and conferences that provide a means to disseminate OSRI research.

1. Education

Development of future researchers, engineers, and others involved in oil spill response requires an education component that exposes students to the issues important to ecology and technology. OSRI has been a strong supporter of education programs

targeting students from kindergarten to graduate school. OSRI intends to continue building upon the existing regional education and outreach programs.

a. Graduate Research Fellowships (OSRI Cost: \$50K)

Support of graduate students provides a means of focusing people at the start of their careers on oil spill related issues. OSRI funds are provided to support graduate projects that will better understand the social and economic effects of oil spills on coastal communities, provide information needed by managers and decision-makers for oil spill response and recovery, improve the technologies available to spill responders, and improve public awareness and understanding of marine and estuarine ecosystems.

Masters students may be supported for two years and doctoral students for up to three years. Applications for extensions beyond that time frame will be considered during the last year of existing funding. Students will be expected to present results to the OSRI Board at some point in their fellowship. Two Graduate Research Fellowship projects will be supported in FY12. We anticipate that will be the continuation of one student from FY11 and advertising one new position in FY12.

Continuing fellowship: Remediation monitoring using microbial DNA profiles Saum, University of California Riverside.

Lingering oil pockets still found in the beaches of the Prince William Sound (PWS) demonstrate that petroleum hydrocarbons can persist and continue to damage ecosystems decades after initial cleanup efforts following a marine oil spill. Currently, the methods of monitoring marine oil bioremediation efficiency are chemical processes that can take over a month to return results and can cost up to \$1,000 per assay if outsourced commercially. The goal of this research project is to develop molecular biology tools to monitor the state of polycyclic aromatic hydrocarbon (PAH) degradation in oil contaminated beach sediments in near real-time by tracking the dominant bacterial species and their associated dioxygenase genes that function for oil degradation. Bacterial populations of PWS beaches will be collected via sediment sampling as well as activated carbon sampling columns. The extracted and purified microbial DNA will be amplified at both the 16S rRNA and dioxygenase gene sequences via polymerase chain reaction (PCR), and analyzed with terminal restriction fragment length polymorphism (TRFLP) through capillary electrophoresis. In order to quantify the 16S rRNA gene sequences, each purified DNA sample will also be analyzed via real-time PCR using primers for bacterial species of interest. The community composition and dioxygenase enzyme patterns will then be used to train a neural net statistical program for pattern recognition of PAH degradation status. Chemical analyses will be conducted via gas chromatography to verify the PAHs present in each sample.

The results of this project will produce a more rapid and inexpensive method of monitoring the rate of marine oil degradation by microbial communities. Potential application of the data generated by this procedure includes evaluation and addition of

the dominant bacterial species' trace nutrient requirements in order to achieve effective biostimulation in the PWS.

b. K-12 School Year Programs: (OSRI Cost: \$45K)

OSRI will continue to support the Prince William Sound Science Center's Discovery Room school year programs in order to introduce younger students to the concepts important to understanding oil spill response and the recovery of the environment. Programs included oceanographic monitoring, environmental education, and an introduction to oceanographic technologies. Beyond classroom delivery OSRI is requesting that a strategy be developed to transfer the classroom activities to other geographic areas, particularly rural communities, and effectively develop partnerships.

This funding is for the second year of a three year project to continue the Discovery Room environmental and technical education at the K-12 level. Funding in FY12 is expected to be \$45K with a three-year total of \$135K.

c. Summer Programs: (OSRI Cost: \$10K)

Summer programs provide an opportunity to expand the geographic extent and age distribution of students reached by the education programs. Camps, weekend education programs, and day activities can be used to work with students of all ages to provide hands-on learning opportunities about marine ecosystems and spill response.

In FY11 OSRI selected a five-year proposal from Prince William Sound Science Center to develop partnerships and activities that can lead to spill related information being included in several different summer programs. This will be the second year of funding for that program with the focus of the work being the development of activities that can be used by multiple organizations. In FY12 OSRI is committing \$10K for the continued work on this subject.

2. Outreach

Outreach to the public, researchers, and spill responders is important in ensuring OSRI's activities provide benefits and are peer-reviewed. Several means have been used to outreach OSRI's activities including sponsoring workshops and conferences, outreach activities of the Research Program Manager, and supporting public outreach through lecture series, radio programs, and development of printed materials. This year the funding for the latter activities has been included in the Research Program Manager's budget.

a. Workshops and Conferences (OSRI cost: \$15K)

These funds are for workshops or special projects at the discretion of the OSRI Advisory Board. Funding is set aside for regularly scheduled conferences where OSRI funded research is presented and for supporting workshops that help OSRI achieve its mission. Workshops being considered for FY12 support include:

(1) **Alaska Marine Science Symposium.** (OSRI cost: \$2K) Each January, researchers from throughout Alaska are invited to participate in a 3-4 day conference. It is an excellent opportunity for presentation of new results and networking. OSRI will contribute \$2K to support this workshop, which will be held in late January in Anchorage.

(2) **Alaska Forum on the Environment.** (OSRI cost: \$5K) OSRI will continue its support of the Alaska Forum on the Environment, which is typically during February in Anchorage. The conference covers many issues relevant to understanding the potential impact of oil spills in Arctic and sub-Arctic marine environments. OSRI will allocate \$5K to the Alaska Forum on the Environment. A limited number of registration waivers will be available for the staff, Board, and STC to attend the workshop.

(3) **Workshops of opportunity.** (OSRI cost: \$8K) It is recognized that many important workshops occur that could provide improved products as outcomes with a little additional support. The support provided here is intended to help cover the cost of running the workshop, the addition of teleconference capabilities, providing a facilitator or report editor, or other needs. OSRI will allocate a total of \$8K to support workshops that align with the OSRI mission.

D. Other Programs

1. Program coordination (OSRI cost: \$135K). The position of OSRI Research Program Manager is a programmatic expense. The total costs include salary, benefits, travel and commodities. The Research Program Managers responsibilities include:

- Preparation of annual work plan in consultation with the Board-appointed Work Plan Committee and in accordance with the Five-Year Science Plan adopted in 2005. Compile information about potential projects, write brief project descriptions and prepare project budget estimates.
- Implement the work plan as approved by the Board. This includes drafting requests for proposals based on the Annual Work plan priorities, and coordinating the peer review process with OSRI's Scientific and Technical Committee and with other organizations OSRI partners with for research projects.
- Coordinate with the Chair of OSRI's Scientific and Technical Committee (STC) to assure regular transfer of information between the OSRI Board and the STC. Also provide assistance, as requested by the STC Chair, in scheduling meetings.
- Meet 2-3 times per month with the OSRI Executive Director (ED) to exchange information concerning program issues and contract awards. Work with the ED to develop a monthly program report for distribution to the OSRI Board.
- Assist the Executive Director to ensure compliance with all policies and procedures of the OSRI Grant Policy Manual.
- Coordinate the processing of contracts for successful proposals. Monitor progress and final report deadlines for these contracts.

- Prepare bi-annual reports on OSRI grant awards and research and education programs for distribution to the OSRI Board.
- Prepare and publish an Annual Report for broad distribution.
- Supervise maintenance of the OSRI website.
- Collaborate with the OSRI Executive Director to develop and maintain cooperative agreements with other organizations for research and education programs, for example with the Exxon Valdez Oil Spill Trustee Council, two Regional Citizens' Advisory Councils, and the Alaska Department of Environmental Conservation, the Alaska Ocean Observing System (AOOS), the North Pacific Research Board, the UNH/NOAA Coastal Response Research Center, US Minerals Management Service, and Norwegian SINTEF's Joint Industry Program.
- Periodically represent OSRI at professional meetings and workshops.
- Maintain files and a library on oil pollution issues
- Provide leadership in planning future research programs and work plans.
- Prepare technical reports on OSRI programs.
- The Research Program Manager oversees many outreach activities as a component of that position. These include presenting at workshops and conferences, maintaining the OSRI website, and publishing the OSRI annual report. Other outreach efforts are aimed to disseminate OSRI efforts through a wide array of media options, such as printed materials, radio broadcasts, and video or computer presentations.

OSRI funding will provide approximately \$112.4K personnel, 7.6K travel, 14.4K contractual, and 0.6K commodities for a total of \$135K.

2. OSRI Science and Technical Committee meetings (OSRI Cost: \$8K).

Funds are set aside to support the functions of the OSRI Science and Technical Committee, and to support Board and STC travel related expenses associated with OSRI partnerships such as the JIP, NPRB, etc.

E. Partnerships

The use of partnerships is a goal outlined in the OSRI strategic plan. While there is not any funding that is dedicated solely to the development or maintenance of partnership programs, there are many existing partnerships and opportunities to develop new partnerships. We continue to partner with the Alaska Ocean Observing System (AOOS) to support an ocean observing system in Prince William Sound and to validate the physical and biological models developed through efforts by OSRI and AOOS. The meteorology and oceanography programs described in the Understand section contribute to this partnership. We worked with AOOS to develop a partnership on the hydrological model validation component as well. In the biological sciences we continue to partner with NPRB.

To achieve our objectives under the Respond goal requires partnerships. We are looking to work with industry sponsored research programs that align with OSRI's science plan. Industry is currently considering the development of six different programs, four of which are closely linked with the goals outlined in the OSRI science plan.

Our Inform goal related projects are also heavily dependent on partnerships, most often developed by the programs we fund. OSRI contributes a portion of the cost of the education programs outlined. These programs gain additional funding from several private, corporate, and grant contributions. The Discovery room is also a collaborative effort with the U.S. Forest Service. OSRI contributes small amounts to the Alaska Marine Science Symposium and the Alaska Forum on the Environment. The workshop of opportunity section is designed to provide an opportunity to develop new partnerships to achieve OSRI's goals.

F. FY12 New Programs Spending Summary

Area	Project	FY12 Work Plan
Understand		
	Meteorological Stations	\$20K
	Hydrological Model Validation	\$75K
	NPRB Partnership	\$100K
		\$190K
Respond		
	Partnership Projects	\$150K
		\$150K
Inform		
	K-12	\$45K
	Summer Programs	\$10K
	Graduate Fellowships	\$50K
	Workshops	\$15K
		\$125K
Other		
	Research Program Manager	\$135K
	STC travel	\$8K
		\$143K
Subtotal		\$608K
Administration		
	Based on 20% of total expenditure	\$152K
Total		\$760K

III. Prior Years' Encumbered Projects Continuing in FY12

Because the OSRI projects are started at the beginning of each quarter many projects funded in 2011 will continue into fiscal year 2012. The purpose of this section is to identify those projects so that the work plan aligns with the FY12 budget sheets. These projects are listed as the Prior Years' Encumbered portion of the budget. If an existing project is to get new funding in FY12 – multi-year grants – the project description will reference the previously provided section. Because the exact amount of funds that are being carried forward will not be known until sometime in October, there are no dollar amounts provided with the individual projects.

A. Goal #1 - Understand

1. Physical science programs

a. Oceanography (*Halverson, PWSSC, Contracted through 12/31/11*)

Water exchange between PWS and the Gulf of Alaska and seasonal variations of hydrographic properties in central PWS

A primary component in improving our understanding of the circulation of Prince William Sound is the collection of oceanographic measurements. These measurements allow direct studies of circulation, the exchange of water between Prince William Sound and the Gulf of Alaska (GOA), and provide validation data for testing circulation models.

The OSRI funded oceanography work is a constituent of the Prince William Sound Observing System (PWSOS). In its current state, the program encompasses three components: 1) Long-term monitoring of the water exchange between the Gulf of Alaska and Prince William Sound, and 2) Monitoring of the seasonal variability of the hydrographic properties and circulation in PWS,

The goal of the water exchange component of the five-year observational oceanography program is to provide an improved description of the flow through the straits connecting PWS with the GOA. This is a necessary step towards a better understanding of the relationship between circulation variability and biological variability in PWS. The current mooring program addresses two limitations of previous mooring programs (lateral variations not accounted for and lack of data in the near surface part of the water column). Knowledge acquired from this five-year program should provide an understanding of measurements made using a single downward-looking ADCP at the NDBC buoys, which is the long-term monitoring planned for the area.

This program is currently in the analysis phase. All equipment was removed from the water in the spring of 2010 to allow the focus to be on analyzing the data collected. The

program worked with Dr. Musgrave to analyze historic Conductivity-Temperature-Depth (CTD) data to provide a report on the climatology of oceanographic conditions in Prince William Sound with a focus on the near surface conditions that drive circulation and decisions on response techniques. The mooring data continues to be processed and analyzed to determine the currents responsible for water exchange in PWS.

2. Biological science programs

a. Larval Trajectory Mapping (*Beegle-Krause, Research 4D; and Xiaochun Wang, UCLA, contracted through 6/30/2012*)

Understanding larval transport and survival is critical to effective fisheries management. Larval transport models aid fisheries, habitat and marine protected area decision makers in understanding how ocean circulation and larval behavior affect survival. This project continues development of a community larval transport model, LarvaMap, and expands the Regional Ocean Modeling System (ROMS) model time-series data for Prince William Sound (PWS) in 2004 and 2009 to a 7-year time series from 2004 to 2010. The LarvaMap / ROMS combination will be used to generate probability maps of settlement for Pacific herring and Dungeness crab.

LarvaMap is a 3D web-based larval fish and invertebrate transport model connected to ROMS circulation fields for the northeast Pacific, with initial and continuing development by the NOAA Alaska Fisheries Science Center (AFSC) funding through NOAA High Performance Computing Center (HPPC). LarvaMap can use any circulation dataset formatted using the network Common Data Format for Climate and Forecast (NetCDF CF) available through a Thematic Realtime Environmental Distributed Data Services (THREDDS) data server (TDS). Both NetCDF and TDS are oceanographic community standards. LarvaMap output can be viewed in combination with field data and circulation model results using HabitatSpace, a 4D data analysis tool previously developed by members of this team for the AFSC.

LarvaMap will be enhanced with user capability to construct egg and larval stage drift and behavior characteristics by leveraging Sarah Hinckley's (NOAA/AFSC) larval behavior model and new research. The Herring and Dungeness crab organisms constructed in this study will be available in LarvaMap's library for direct use or modification.

b. The three amigos- A shoreline biota monitoring program for Prince William Sound (*Harper, Coastal & Ocean Resources Inc., contracted through 6/30/2012*)

This proposal outlines an approach to establish an intertidal biotic monitoring program within the Gulf of Alaska. As a pilot, the program would support broader scale ecological studies by providing detail on seasonal and inter-annual changes to intertidal biota within Prince William Sound. We propose to develop a draft protocol (our interpretation of a the *white paper* component of the RFP) that is based on a tiered imagery collection

program with a few timelapse camera locations (providing daily data), a dozen or so quarterly photo-registered (e.g., Mearns Rock type photos) and a few dozen annual photo-registered locations. The tiered reference locations would be focused on a single habitat type (e.g., protected, rock cliffs or benches) that can be tied directly to the spatial mapping of ShoreZone. The intention of the tiered station network is to capture temporal changes at the frequently monitored sites and to capture the spatial extent of change within the Sound at a more widely distributed network of monitoring sites. A daily time series of imagery at a few sites is likely to provide direct observations of the agents of change such as hard-freezes, ice-scraping events, severe heat events or biological invasions.

Imagery data collected in PWS will be validated by cross-comparison with annual on-the-ground surveys of an intertidal site in Kachemak Bay, Alaska that has been regularly censused since 1999 (Klinger and Fukuyama, submitted). Establishing a site at which daily, quarterly, and annual images are collected *in combination with* annual quadrat sampling will assist in interpretation of the imagery data and improve the power of the analysis.

An image-based monitoring program will allow citizen scientists and community scientists to interact with research scientists throughout the program. Image acquisition can be performed by citizen scientists and by community-based scientists. Image categorization can be performed by community-based scientists using the *three-amigo* protocol. A quarterly program review will be conducted by research scientists to ensure data management and interpretation meet anticipated standards.

The ultimate goals of such a program are: (1) to publish results in a refereed journal to ensure they are to a rigorous scientific standard and can be used as high-quality baseline data; (2) disseminate the protocols for implementation across a broader geographic area; and (3) invest community scientists in performance of long-term monitoring of their local sites.

c. Data rescue: Epibenthic invertebrates from the Beaufort Sea sampled during WEBSEC and OCS cruises in the 1970s (*Bluhm, University of Alaska Fairbanks.*, contracted through 6/30/2012)

This proposal seeks to rescue data on epibenthic invertebrates sampled by trawls and photographs in the Alaskan Beaufort Sea during Western Beaufort Sea Ecological Cruises (WEBSEC) and Outer Continental Shelf (OCS) cruises in the 1970s. The material includes station information, count and weight data, a taxonomic inventory and yet unidentified samples. A major challenge in climate- and human impact-related studies is the lack of historical data against which to assess biological response to changes and stresses in the environment. This is particularly relevant in the Alaskan Arctic with its large changes in the sea ice regime and substantially increased interest in oil and gas exploration in the last decade. Epibenthic fauna includes important prey items for fishes, marine mammals and birds and some epibenthic species may in the future become harvestable in the

Arctic. The historic data in question will form a reference point for the 1970's and can in the future be compared to current surveys in the Beaufort Sea done in 2008 and 2011. The rescue involves 1) transforming tables from reports into digital format, 2) processing unsorted samples, 3) updating the taxonomy to today's standard, 4) making the data available to recognized open access online data bases, and 5) integrating the taxonomic inventory into the Arctic Register of Marine Species. Outreach will include species pages of dominant species in the data and will be posted on the web site of the Arctic Ocean Diversity project from where the content is harvested by the Encyclopedia of Life.

B. Goal #2 Respond:

1. Partnership projects

a. Arctic ERMA (*Murphy, GenWest, Contracted through 12/31/11*)

NOAA has initiated the development of an Arctic ERMA Site. The Environmental Response Management Application (ERMA[®]) is a web-based data management platform integrating real-time (weather, currents, etc.) and static data in an easy-to-use format. ERMA allows environmental responders and decision-makers ready access to response-relevant data for spill drills, planning, response, assessment, and restoration, as well as for other incidents and natural disasters. ERMA is a Web site that incorporates static base layers along with real-time streams of data (e.g., weather, tides, ship tracking data, etc.) into a fast, user-friendly Geographic Information System (GIS) that is accessible to the command post as well as people in the field and other locations. OSRI funding is to be used to help discover and input data into the ERMA system.

b. Oil spill trajectory analysis from the 2009 Prince William Sound field experiment (*Beegle-Krause, Research4D, Contracted through 06/30/12*)

The proposed analysis of the observational data and model predictions from *Sound Predictions* is based on trajectory predictive ability. The intent is to identify areas of higher and lower predictive skill for the field conditions during the experiment, and provide insight and recommendations for future improvements. The proposal fits with OSRI's goal "To identify and develop the best available techniques, equipment and materials for dealing with oil spills in the Arctic and sub-Arctic marine environment" (<http://www.pws---osri.org/>).

The work will examine the effect of observational data assimilation in potential oil spill simulations by comparing observed and simulated drifter trajectories using the General NOAA Operational Modeling Environment (GNOME) model. Observed circulation fields (winds and currents), and two different types of the PWS circulation fields (nowcast and forecast) will be examined in order to isolate the effects of data assimilation without re-running the circulation models. The hindcast fields will have assimilated all available

observations, while the forecast fields will not have the benefit of the observational program. Simulated trajectories will be compared with observed drifter trajectories during *Sound Predictions*, and the other observational data will be used to construct hypothesis for any trajectory differences. If necessary, a diagnostic circulation model will be constructed in GNOME to test these hypotheses.

c. Quantifying the effects of ocean observations and circulation models on oil spill trajectory forecast skill (*McCammon, AOOS, Contracted through 06/30/12*)

Regional coastal ocean observing efforts such as the Alaska Ocean Observing System (AOOS) are part of the national Integrated Ocean Observing System (IOOS). A major goal of IOOS is to provide real-time observational data for assimilation models that can provide comprehensive forecasts of regional atmospheric and oceanic conditions. One major user group of ocean forecasts is the oil spill response community. The Prince William Sound Oil Spill Recovery Institute (OSRI) in Cordova, Alaska along with AOOS supported the Sound Predictions field experiment in 2009. This experiment included measurements of oceanographic conditions, modeling of circulation, and release of several varieties of drifters. The field experiment was designed to evaluate the skill of weather, wave, and ocean circulation models. This proposal will evaluate the utility of ocean observing system measurements and numerical simulation forecasts in improving the performance of models that forecast oil spill trajectories. The primary objective is to quantify the effect of ocean observations and circulation model forecasts on the performance of an oil spill trajectory forecast model in Alaska coastal waters. A secondary objective is to evaluate the ocean circulation model performance in accurately simulating surface water circulation as measured by high-frequency radar and drifting buoys, and the prediction of mixed layer depth. The strategy is to: (1) compare real ocean drifter trajectories to modeled trajectories of simulated oil spills without the benefit of ocean observing system measurements or wind and ocean circulation forecasts; (2) compare real ocean drifter trajectories to modeled trajectories of simulated oil spills with the benefit of ocean observing system measurements or wind and ocean circulation forecasts with and without data assimilation; and (3) quantify the effect of individual ocean observing system measurements and forecasts on oil spill trajectory forecasts. And (4) compare water column variables between measured and model simulated and evaluate forecasts of mixed layer depth. These analyses will test the null hypothesis that the performance of an oil spill response model in predicting drifter buoy positions cannot be improved by measurements or weather, wave, and ocean circulation forecasts from the observing system in Prince William Sound. This project connects to the mission of OSRI by responding to and better understanding the effects of oil spills in sub-Arctic marine environments.

d. Detection and mapping of oil spills under sea ice (DAMOS) (*Wilkinson, Scottish Association for Marine Science; and Sing, Woods Hole Oceanographic Institution Contracted through 06/30/12*)

A practical system for oil spill response in the sea ice environment must be capable of rapidly mapping the extent and quantity of oil over large areas and under a range of ice and weather conditions. To date, no surface-based technique has proven reliable for detection of oil from above. Such methods are slow, labor-intensive and most importantly, impractical to impossible in the dynamic, marginal ice conditions that will often be found in areas where oil exploration and ship traffic are most likely to occur. Airborne systems suffer from the need to effectively see through ice and snow cover for continuous ice. The only feasible means for detection and accurate mapping of oil distribution under sea ice over large areas and all ice conditions is from below.

DAMOS will develop and test a suite of sensors for mounting on an autonomous underwater vehicle (AUV) for detection and mapping of oil under the full range of ice conditions and oil conditions expected to occur. This approach has the advantage of being independent of ice conditions and allows direct measurement of the oil (both under the ice and in the water column), unlike surface based methods. The objectives of DAMOS are:

- 1) Desk study: Theoretically examine and understand the benefits and limitations of sensors capable of detection and mapping of oil under ice for the full range of conditions. This includes hydrocarbons under thin or thick ice with a snow cover, continuous or broken scattered floes, and under calm or highly dynamic conditions.
- 2) Tank experiments: Perform realistic experiments with this sensor suite in an ice tank under a variety of hydrocarbons and sea ice (with snow) conditions
- 3) Analysis: Determine the efficacy and accuracy of each sensor, including possible sensor combinations, for mapping hydrocarbons in varying conditions, and identify the most promising strategies for future development of an expert system that can interpret sensor data in near-realtime and the deployment of an AUV system dedicated to hydrocarbon detection.

The sensor suite will include three existing sensors: 1) a low-light and active camera system for positive visual detection of hydrocarbons under ice, 2) a multibeam sonar for detection and quantification of slick and pooling thickness, and 3) an optical system for detection of fluorescence from oil in and under sea ice. The anticipated final suite on an AUV platform will include an already proven mass spectrometer for detection of hydrocarbons dispersed in the water column.

First, a comprehensive theoretical desk study will evaluate each sensor so that the requirements for each can be refined prior to testing. To evaluate the success and limitations of each sensor, or combination of sensors, realistic and repeatable *in situ* testing will be conducted in an ice tank facility at the US Army Cold Regions Research and Engineering Laboratory. Through tests using varying ice and oil properties, the feasibility and accuracy of the system to detect hydrocarbons located under, or encapsulated within, sea ice will be quantified. A primary focus will be not just on the detection of hydrocarbons, but also a quantitative mapping of its distribution. This analysis will point the way for future development of an expert, multi-sensor system for near-real-time detection of both the extent and volume of hydrocarbons, and for future AUV deployment strategies. Based on these results, the DAMOS group will pursue

further funding for development and testing of a complete AUV system. This approach will not only lead to an effective system for oil spill response, but an instrumented AUV will also be also characterize the three-dimensional environment of the hydrocarbon distribution under the ice with the potential to greatly advance our understanding of the behavior of oil dispersal in the sea ice environment.

C. Goal #3 Inform:

1. Graduate Research Fellowships

- a. Remediation monitoring using microbial DNA profiles;** (*Saum, University of California Riverside*) This project is described under the GRF program above.
- b. Epibenthic communities in the Beaufort Sea;** (*Ravelo, University of Alaska Fairbanks M.S. student Contracted through 6/30/12*)

The purpose of this study is to characterize the epibenthic communities in the central Beaufort Sea (between 147o and 150o west longitude) and compare these communities to the ones found in the adjacent Chukchi Sea. These goals will be accomplish by joining an existing cruise in the summer 2011 that will be conducting epibenthic beam trawls for fishes in the central Beaufort. At this time, very little is known about these soft sediment epibenthic communities of the central Beaufort Sea. Considering the potential oil exploration that this area will be subject to, there are intrinsic needs to increase our knowledge of these communities to be able to monitor the changes caused by anthropogenic activities and better preserve our natural resources. An existing database of epibenthic communities in the Chukchi Sea surveyed in 2009 and 2010 using the same equipment will be used to make comparisons between the two seas. The central Beaufort Sea base-line data collected will include overall species composition and distribution and also abundance, biomass, size and sex structure of targeted species. Multiple questions will be asked with these base-line epibenthic data, including: 1. Are epibenthic communities distributed in patches or are all species evenly distributed throughout the study area? 2. Which species are most important in determining community structure as far as abundance and biomass? 3. What is the current population structure of the most important species as far as size frequency, abundance, biomass, and male to female sex ratio? 4. Does the community vary with any environmental (depth, grain size, temperature, salinity) or fish community parameters? The importance of this project is centered on the need for having a better understanding of the epibenthic community composition and the structuring environmental variables that take place.

- c. Cultural Dimensions of Community Response Preparation and Vulnerability to Future Oil Impacts of the Copper River Region;** (*Springer, University of Alaska Fairbanks Ph. D. student Contracted through 6/30/12*)

The research objectives of this project are to investigate the cultural dimensions of community response preparation and vulnerability to oil impacts of the Copper River region in Prince William Sound. Basic demographic information will be considered but the intention is to focus on cultural connections between individuals and their communities, the knowledge systems people may refer to in the event of a disaster related to oil contamination and the way that information is communicated across community boundaries. Three case studies will be performed: 1) the physical community of Cordova, 2) the occupational community of S01A permit holders, and 3) the institutional community of the Prince William Sound Regional Citizen Advisory Commission.

Research methods for this project are grounded in qualitative social science. They will include: participant observation, focus group interviews, individual interviews, surveys, response mapping and preparation of a final chart to demonstrate knowledge variations within each case-study. Following preliminary fieldwork, a cultural consensus analysis may be applied to one or more of the three cases.

This project responds to the OSRI research focus area 3: Socio-economics. It will be valuable to the efforts of OSRI because it will identify and compare local, industry and institutional knowledge of the Copper River ecosystem, perceived¹ oil-related threats to the ecosystem and current concerns that the groups hold about management plan strategies. Understanding knowledge diversity and varied attitudes towards environmental protection and oil-related problems can contribute to improved response, observation and monitoring activities in the region. This social theme has not been widely cataloged in previous research related to human dimensions of oil-spills.

2. Technology and Scientific Education

a. Oil Spill Response ROV Kit; (*Butters, Prince William Sound Science Center, Contracted to 06/30/12*)

The Prince William Sound Science Center requests \$20,000 from the Prince William Sound Oil Spill Recovery Institute to support a one year, science and technology education project that will develop a transportable student activity kit focused on oil spill science and robotic technology. The **Oil Spill Response ROV Kit** (Remotely Operated Vehicle Kit) will be a teacher and classroom ready “stand alone” education unit containing the materials needed to deliver lessons on marine oil spills and oil spill response technologies.

Using materials contained within the kit, teachers will provide instruction on the potential adverse impacts of oil spills on water, and discuss technological challenges to oil spill clean up. Students will use materials provided in the kit to construct Remote Operated Vehicles designed to clean up simulated oil (popcorn) spilled into a swimming pool, harbor or pond. Students will compete to see what design best recover the spilled popcorn.

The ROV Kit will be available for loan by school teachers, informal and home school programs and Scout/other youth groups. We will actively market the kit through our education contacts statewide and through targeted outreach to include a diverse array of student groups and communities.

Our five-year strategic education plan calls on us to expand the impact of oil spill curricula developed by the PWSSC beyond the Prince William Sound area, making them available to students and educators throughout Alaska. By incorporating the ROV Kit into our long-term education program (and fundraising efforts), we will help expand oil spill education outreach efforts. Integration of the kit into formal classroom, and informal science education programs will continue once the program is established with OSRI funds.

Our education program goal is to provide educational experiences and materials that will prepare future generations of resource managers, educators, researchers, policy makers and community leaders to understand and address issues affecting complex natural systems. We firmly believe that knowledge and skills in the application of technology are necessary for society to adapt and respond to environmental change. The ROV Kit is part of our effort to increase the curiosity and technological literacy of our students.