OIL SPILL RECOVERY INSTITUTE
CORDOVA, ALASKA

2022 Work Plan
Oil Spill Recovery Institute

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Contents

Prince William Sound Oil Spill Recovery Institute
2022 Work Plan

I. Purpose and organization of this document

This document describes the Oil Spill Recovery Institute (OSRI) 2022 Work Plan in the context of the overall Research Plan for fiscal years 2021 through 2025. The Research Plan should be referenced for detailed descriptions of the OSRI Program, the planning process, and supporting documents. Annual reports and previous work plans should be referenced for more information regarding previously funded projects. The 2022 Work Plan provides descriptions of projects proposed for funding in the 2022 fiscal year beginning October 1, 2021, and a brief description of projects funded in previous years that have funding continuing into fiscal year 2022 (FY22). 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 FY22 Work Plan New Projects

The Advisory Board of OSRI and the Executive Committee of the Board of Directors for the Prince William Sound Science Center (PWSSC) conducted a strategic planning session in 2019. The purpose of the planning session was to evaluate the past, the present, and plan for the future of OSRI. During that planning session, the mission of OSRI was identified to be: **Support research, education, and demonstration projects that improve understanding and response to oil spills in the Arctic and Subarctic marine environments**. Four goals were identified as part of the strategic plan: Understand, Respond, Inform, and Partner (see OSRI Science Plan). The fiscal year 2022 Work Plan has been placed in the context of these four goals.

A. Goal #1 Understand:

Attain an interdisciplinary understanding of Arctic and Subarctic marine environments as it pertains to: baseline conditions; the source, transport, fate, and effects of spilled oil; damage assessment; and the recovery of those environments following a spill.

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
- Identify baseline conditions including the natural variability and their drivers
- Evaluate impacts from oil spills on the economy, food security, subsistence activities, lifestyle and well-being of people, and the resiliency of communities
- Identify and improve new methods for assessing transport, fate, and effects

This work plan describes projects totaling $165K for projects related to Goal #1. OSRI has elected to support a portfolio of initiatives, including:

(1) Oil spill trajectory modeling.

(2) Arctic cod sensitivity to oil and impacts on growth.

a. Cook Inlet Oil Spill Trajectory (OSRI cost: $100K)

NOAA recently developed a new operational model for Cook Inlet that is expected to be used to provide the underlying currents of an oil spill trajectory model. Several steps would improve the reliability and confidence in the model results. The model should be validated, and a water trajectory tool added to allow visualization of trajectories. Validation could involve running a hindcast with the model to allow for a comparison to the Regional Ocean Model that is currently available for Cook Inlet, comparison to historic oceanographic measurements to ensure currents and water properties are accurate, and the collection of additional oceanographic measurements to fill gaps in the existing data. The coupling of a water trajectory tool will provide better visualization of the current structure for planning purposes.

Potential partners on this project include Cook Inlet Regional Citizens' Advisory Council, NOAA, AOOS, and BOEM. The project would have to be built with the partners to completely fund the project. This is envisioned as a three-year project with up to $100K of support provided each year.

b. Impacts of oil on Arctic cod (OSRI cost: $65K)

In the last 15 years, oil spill research at NOAA has focused on three major spill events: the 1989 Exxon Valdez spill in Prince William Sound, Alaska, the 2007 Cosco Busan spill in San Francisco Bay, and the 2010 Deepwater Horizon spill in the Gulf of Mexico. However, three key lessons were learned from these major events: 1) scientific response requires a multidisciplinary effort, 2) reactionary science can delay management response, and 3) species from different ecosystems respond very differently. Here we propose to examine the effects of an oil spill in the Alaskan Arctic by way of potential impacts on a keystone species, Arctic cod (*Boreogadus saida*) under current and future climate scenarios. Results from a 2017 pilot study indicated that Arctic cod are extremely sensitive to very low dose oil exposure, much more than other marine gadids from the Atlantic. In addition, juveniles that were exposed to oil as embryos grew significantly slower than control fish under identical environmental conditions. These findings elevated concerns of the potential impact of oil on Arctic cod while raising a series of new questions as to how oil impacts survival and growth potential and what the minimum effective exposure concentrations are for this species. Moreover, with predicted elevations in Arctic sea surface temperatures, there is a need for determining how oil toxicity will be influenced by combined temperature stress in

Arctic cod. This project will proactively capitalize on a new oil exposure laboratory for Arctic cod to directly address these questions and mechanistically understand both the immediate and latent effects (> 6 months post-exposure) of low dose embryonic exposure to oil.

This project was delayed due to COVID. This is the third year of a three-year research project and OSRI expects to provide $65K of support in FY22. The project is funded in partnership with NOAA.

B. Goal #2 Respond:

Enhance oil spill response and mitigation capabilities in the Arctic and Subarctic 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 Research Plan are to:

- Identify, develop, and/or evaluate prevention, assessment, and response tactics and technologies
- Identify the impacts of oil spill response options on the environment and human health

Projects to achieve these objectives are described below.

1. Technology research and development

This work plan describes projects totaling $240K 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 projects (OSRI cost - $100K)

There are several potential partnership projects that OSRI should consider supporting. Potential partners include the Canadian Multi Partner Research Initiative (MPRI), Emergency Prevention Preparedness and Response (EPPR), and the U.S. Coast Guard Research and Development Center, and others.

The MPRI is supporting a wide variety of projects of interest to OSRI. The purpose of the MPRI is to identify knowledge gaps and research priorities, improve our understanding of how oil spills behave in water and their impacts on fish and other aquatic organisms, develop new technologies and protocols to select the best methodologies for oil spill clean-up, and support science-based decisions that will aim to minimize the environmental impacts of oil spills and enhance habitat recovery. Of particular interest in FY22 is a potential experimental oil release to be conducted in the summer of 2022.

EPPR has projects on the toxicity of low-sulfur fuel oils and a desire to develop a project that would lead to a portal that provides the ongoing and completed research associated with oil spills in the Arctic. The U.S. Coast Guard has been working with the Environmental Protection Agency on mapping and modeling smoke plumes from in-situ burns. The Bureau of Safety and Environmental Enforcement also has several projects that are relevant to OSRI.

OSRI should consider partnering with these agencies by providing supplemental funding to the projects to enhance the final products. The Canadian field trials will be the top priority for funding, but we acknowledge that they may not occur and will continue to seek other partnership opportunities. OSRI expects to provide $100K of support in FY22 to support the MPRI field testing or other partnership activities.

b. Environmental Sensitivity Index mapping project (OSRI cost - $140K)

Environmental Sensitivity Index maps (ESI) are a fundamental tool used during planning, exercises, and spill response. The maps contain a wide array of information including the shoreline sensitivity, biological resources at risk, and human uses of the region. The maps have been very expensive to generate, and this has led to updates being infrequent. While it is expensive to fully update the data and corresponding maps, there is an interest in discovering new approaches that can lead to partial updates that would require less funding or can benefit from related activities, such as ShoreZone mapping.

Potential projects include ones designed to compare shoreline classifications and/or provide an analysis for how to convert other shoreline mapping schemes (such as NOAA's Coastal and Marine Ecological Classification Standard) into the shoreline classification used in the ESI maps. Another need is to provide the temporal and spatial mapping of biological resources at risk. We expect that the use of small sources of funding will allow for partial updates to the full resources. We need to demonstrate that these partial updates can become the building blocks for an update to the ESI maps. Our area of emphasis for this work is Cook Inlet and Shelikof Strait where the existing ESI data is limited or dated.

A total of $140K is expected to be available to contribute to projects in FY22.

C. Goal #3 Inform:

Share information and educate about the issues of oil spill prevention, response, and impacts.

The objectives of this goal are to:

- Publish scientific and technical results in open literature
- Brief the response, assessment, and restoration communities on OSRI efforts
- Facilitate the exchange of information and ideas through workshops and other forums

- Educate future researchers and responders through K-12 programs, undergraduate internships, and graduate fellowships
- Convey information to the general public through various media
- Serve as a source of expertise

The approach to reach these proposed objectives from OSRI, is spending $215K 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. We expect to continue to implement recommendations for activities associated with the Communication Strategy that was developed in 2021.

1. Education

The 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 existing regional education and outreach programs.

a. Graduate Research Fellowships (OSRI Cost: $90K for up to three students)
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 the 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 four 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. Up to three Graduate Research Fellowship projects will be supported in FY22. We anticipate one continuing student and OSRI will release an RFP for the selection of up to two new students. Up to $30K of support per year will be available to each fellowship. A twenty-five percent match by the proposing institution is required.

Oil spills beneath Arctic sea ice: A stochastic sea ice subsurface model to predict under ice oil slick spreading. Frazier, University of Alaska Fairbanks.
Retreating sea ice is expanding the economic development opportunities in the Arctic. As this development occurs, the Arctic is increasingly susceptible to an unintentional oil spill. Whether from a leaking vessel or a subsea pipeline, spilled oil is dangerous to both the environment and the inhabitants that call the Arctic home. One of the confounding factors in an Arctic oil spill, though, is the presence of sea ice. Oil can become trapped

beneath the ice, where an oil slick can move along the subsurface hidden from observation. To address this potential challenge to oil spill clean-up, and to better allocate clean-up resources, new research into the complex sea ice subsurface is proposed.

This project aims to produce new knowledge about Arctic sea ice subsurface characteristics. These profile characteristics are used to improve oil fate and transport models, directly affecting first responders' abilities to respond to an oil spill, determine the overall impact of a spill under ice, and develop the response tactics necessary to mitigate environmental damage from either a sub-surface spill or a spill that migrates beneath the ice. Better sea ice models, including the subsurface profiles, will enable future researchers to identify the physical impacts of oil trapped at the ice-water boundary, evaluate the short and long-term effects of oil trapped in these profiles, and improve future response and remediation technologies. Lastly, the knowledge developed in this project will enable the expansion of capabilities in Arctic-capable oil spill models, such as the ongoing efforts by the NOAA Office of Response and Restoration to integrate such offerings into their General NOAA Operational Modeling Environment (GNOME).

This research proposal will use in-situ sea ice draft measurements to create stochastic surface profiles of different types of sea ice, offer guidelines for predicting the occurrence of those profiles based on observed surface conditions, and develop a Lagrangian particle model, simulating gravity-driven oil flow along the sub-surface of the different sea ice profiles. A range of oil sequestration volumes will be determined to help oil spill modelers produce operational, Arctic-capable oil spill models.

OSRI will provide $30K of support for this Ph.D. project. This is the second year of a two-year proposal.

b. Internship (OSRI Cost: $15K)

OSRI strives to build a diversified future workforce and would like to support an intern working on a project associated with its mission and goals. We desire a proposal that outlines how the proposed internship project is related to OSRI's goals and how applications from candidates from a community underrepresented in the existing oil spill-related workforce will be recruited. The internship may be tied to an existing OSRI project or other projects related to OSRI's goals.

OSRI will provide up to $15K of support to host an intern for at least six weeks at an organization.

c. K-12 Programs (OSRI Cost: $60K)

OSRI will continue to support the Prince William Sound Science Center's Headwaters to Ocean program to introduce younger students to the concepts important to

understanding oil spill response and the recovery of the environment. Programs include components such as oceanographic monitoring, environmental education, and an introduction to oceanographic technologies. Beyond classroom delivery in PWS, OSRI is requesting that portions of the Discovery Room program be delivered to at least two geographic areas outside of Southcentral, or at a gathering that brings together people from those areas. OSRI desires a proposal that continues to support the existing education efforts and includes travel for the delivery of materials to other communities.

This funding is for a single year to continue the Headwaters to Ocean environmental and technical education at the K-12 level. OSRI will provide $60K in FY22. The total cost of this program is between $120K and $150K and is supported by a wide array of other funding sources including grants and contributions.

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 publicize 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.

a. Workshops and Conferences (OSRI cost: $25K)

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. OSRI anticipates potentially having booths at some workshops to further promote the OSRI's projects. Workshops being considered for FY22 support include:

(1) **Alaska Marine Science Symposium**. (OSRI cost: $5K) Each January, researchers from throughout Alaska are invited to participate in a 4-day conference. It is an excellent opportunity for the presentation of new results and networking. OSRI will contribute $5K 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 Subarctic 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 Scientific and Technical Committee to attend the workshop.

(3) **Workshops of opportunity.** (OSRI cost: $15K) Several other workshops and conferences that provide opportunities to highlight areas of interest to OSRI, such as the Alaska Oil Spill Technology Symposium, the AMOP Technical Symposium, and Pacific Clean Seas. The funding may support other workshops to provide improved products. Additionally, these funds may be used to support OSRI having a booth at a conference

to outreach OSRI activities. OSRI will allocate a total of $15K to support conferences or workshops that align with the OSRI mission.

b. Remote Learning (OSRI cost: $25K)

In FY19 OSRI contracted to develop a communication plan to help identify ways to better inform various audiences about OSRI's activities. Remote learning tools were identified as an approach that may address many of OSRI's Inform goal objectives. Development of a Science of Oil Spills (SOS) course has been identified as an approach that can be used to develop materials that can be incorporated by other organizations, such as Prince William Sound College's HAZWOPER course, or in NOAA's SOS course. The materials also provide fundamental information on oil spills and oil spill response to the general public. This project would involve the development of materials necessary to support an SOS course. OSRI will allocate a total of $25K to support the development of the materials needed for a remote learning course.

D. Other Programs:

1. Program coordination (OSRI cost: $140K). The position of OSRI Research Program Manager is a programmatic expense. The total costs include salary, benefits, travel, and commodities. The Research Program Manager's responsibilities include:

- Preparation of the annual work plan in consultation with the Board-appointed Work Plan Committee and in accordance with the Five-Year Research Plan. Compiling information about potential projects, writing brief project descriptions, and preparing project budget estimates.
- Implementing 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.
- Coordinating 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 assist, as requested by the STC Chair, in scheduling meetings.
- Meeting 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.
- Assisting the Executive Director to ensure compliance with all policies and procedures of the OSRI Grant Policy Manual.
- Coordinating the processing of contracts for successful proposals. Monitor progress and final report deadlines for these contracts.
- Preparing bi-annual reports on OSRI grant awards and research and education programs for distribution to the OSRI Board.
- Preparing and publishing an annual report for broad distribution.
- Supervising maintenance of the OSRI website.

- Overseeing many outreach activities including 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.
- Periodically representing OSRI at professional meetings and workshops.
- Preparing technical reports on OSRI programs.
- Maintaining files and a library on oil pollution issues.
- Providing leadership in planning future research programs and work plans.
- Collaborating 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, the Alaska Department of Environmental Conservation, the Alaska Ocean Observing System (AOOS), the North Pacific Research Board, the UNH/NOAA Coastal Response Research Center, Bureau of Safety and Environmental Enforcement, Bureau of Ocean and Energy Management, and Joint Industry Programs.

OSRI funding will provide approximately $117.6K personnel (8.0 months), $12.7K travel (includes $5K for STC member travel), $5.0K outreach, $3.5K other contractual, and $1.2K commodities for a total of $140K.

2. OSRI Science and Technical Committee meetings Funds are set aside within the Research Program Manager budget 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. In the Understand goal, we look to continue our partnership with the Alaska Ocean Observing System (AOOS) as they transition into their next five-year research plan. We work with the North Pacific Research Board to support understanding of the ecology of regions that may experience an oil spill. And we look for other opportunities to partner in the future.

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. We are working with ExxonMobil, Shell, and others to develop new technology for the use of herders and ignition systems. EPPR, BOEM, BSEE, and USCG also have important programs to follow. We seek to support their research programs by providing expertise

or funding as appropriate. The Canadian Multi-Partner Research Initiative is a large oil spill research program with many opportunities for collaboration.

OSRI contributes a portion of the cost of the education programs supported by our Inform goal. These programs gain additional funding from several private, corporate, and grant contributions. The Headwaters 2 Ocean program is a collaborative effort with the U.S. Forest Service and the Copper River Watershed Project. 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. FY22 New Programs Spending Summary

Area	Project	FY22 Work Plan
Understand		
	Cook Inlet oil spill trajectory	$100K
	Arctic cod	$65K
		$165K
Respond		
	Partnership projects	$100K
	ESI mapping	$140K
		$240K
Inform		
	Graduate Fellowships	$90K
	Internship	$15K
	K-12	$60K
	Workshops	$25K
	Remote Learning	$25K
		$215K
Other		
	Research Program Manager/STC Travel	$140K
		$140K
Subtotal		**$760K**
Administration		
	Based on 20% of total expenditure	**$190K**
Total		**$950K**

III. Prior Years' Encumbered Projects Continuing in FY22

Because OSRI projects are started at the beginning of each quarter, many projects funded in previous years will continue into fiscal year 2022. The purpose of this section is to identify those projects so that the work plan aligns with the FY22 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 FY22 – multi-year grants – the project description exists in 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. Identifying needs associated with food security

Nuka Research and Planning Group, LLC (Nuka Research), with support from the Alaska Conservation Foundation's (ACF) Aleutian Bering Sea Initiative (ABSI), was funded to conduct the project *Research Priorities for Food Safety and Security Following an Oil Spill.* The goal of this project is to develop a report on oil spill-related food safety and security concerns of communities and the needs of human health risk assessment modelers to guide future research efforts. Project objectives to achieve this goal include:

• Develop outreach materials appropriate for coastal communities that describe current food safety practices during oil spills
• Use outreach materials to engage with coastal communities through a series of focus groups to seek their input on food safety and security following and oil spill, and apply their concerns to identify research priorities to enhance food safety and security.
• Engage with human health risk modelers and subject matter experts to identify the data and research needs to support human health risk modeling for food safety following an oil spill.
• Synthesize the information gathered from coastal communities and human health risk modelers into a final report that recommends research priorities to advance the state of knowledge and practice to ensure food safety and security following an oil spill.

2. Herder Toxicity

Project was supplemented in 2021 to allow development of manuscripts describing results of the project.

B. Goal #2 Respond:

1. Herder/Burner Joint Industry project

Recent advances in chemical herders that can be used to thicken slicks to provide a more efficient burn have shown a need to advance the systems used to deploy herders and apply an ignition source. OSRI is partnering with ExxonMobil and the Bureau of Safety and Environmental Enforcement to develop new tools that combine the application of herders with an ignitor system, and to develop tools appropriate for use with unmanned aircraft. Combining the herder dispensing and ignition tools will allow a helicopter to make a single trip instead of one to apply the herder and a second to apply an ignitor. The use of unmanned aircraft for the same purpose is desirable to further reduce the risk to personnel and to be able to apply herders and ignition when helicopters are not available. Testing associated with this project has been delayed due to COVID.

2. Oil thickness experiment support

20-10-08 support and 21-10-07 support

C. Goal #3 Inform:

1. Graduate Research Fellowships

Continuing fellowship: Direct visualization of crude oil droplet colonization by oil-degrading bacteria Hickl, University of Illinois and Urbana-Champaign
Traditional biodegradation studies employ the bulk sampling of liters of seawater at discrete time intervals from marine locations or laboratory batch reactors. While these macroscale approaches are important for assessing the biogeochemical state of the environment, they are not designed to elucidate underlying physicochemical mechanisms that fundamentally control transport and biodegradation in marine waters. The microscale approach used in this project addresses this shortcoming by systematically controlling the microenvironment with microfluidic devices while closely observing bacteria dynamics via microscopy. Insights regarding micro-scale processes of how bacteria physically attach to and colonize individual oil droplets are crucial towards (i) understanding the fate and transport of hydrocarbon pollutants in the ocean, and (ii) establishing a quantitative mechanistic framework that will improve environmental-scale contingency planning. Proposed experiments build upon preliminary results from the Juarez lab at Illinois that analyze the physical attachment of bacteria to stationary oil droplets through direct visualization using optical microscopy with novel microfluidic devices. By integrating direct observations in microfluidic devices with mechanistic models, this flexible toolset facilitates analysis of an array of environmentally relevant parameters such as droplet size distribution, crude oil composition, oil-degrading

bacteria concentration, biofilm growth, and community composition. By doing so, this research over the next four years will:

- Provide the first direct visual description of microbial attachment and growth rates on the surface of oil droplets of varying sizes at unprecedented temporal resolution.
- Bridge lab results and field measurements by establishing a direct link between physical processes at the microscale and the oil transport observed in situ following oil spill events.

Continuing fellowship: Investigating microbial biodegradation of crude oil in Arctic marine sediments via shotgun metagenomics and compound specific hydrocarbon analyses. Walker, University of Alaska Fairbanks.

As rapid change is occurring in the Arctic marine environment due to climbing atmospheric temperatures, current models predict nearly ice-free Arctic summers by 2030. Previously ice-covered waters are becoming more accessible to human activities, increasing the likelihood of anthropogenic disturbance and contaminant exposure through oil and gas development, increased commercial shipping, and other activities. Microbial biodegradation is the primary means of petroleum removal from the marine environment following a spill, and oil biodegradation potential should thus be quantified for each ecosystem compartment (i.e. shoreline, sea ice, sea surface, water column, and benthos) to support accurate prediction of the fate and effects of oil contamination and development of effective cleanup strategies. The benthos has received relatively little attention with respect to oil biodegradation studies even though conservative estimates suggest roughly 20-30% of oil from a spill remains in the benthos. The proposed work expands on current research quantifying degradation rates of Alaska North Slope (ANS) crude oil in Chukchi Sea surface sediments, and characterizing associated microbial communities. The work proposed here would further advance our knowledge of the following with respect to Arctic marine sediments: 1) the oil degradation genes and pathways involved in the biodegradation of fresh and weathered ANS crude oil, 2) species-level identification of benthic oil-degrading microbes, 3) the rate and extent of degradation of individual petroleum hydrocarbons, and 4) relative rates of oil degradation in seawater vs. surface sediments.

Continuing fellowship: Subtidal habitat mapping in the Cook Inlet lease area for current and predictive sea otter associations with habitat. Hasan, University of Alaska Fairbanks.

Sea otters, a keystone and Federally Protected Species, were drastically affected by the 1989 *Exxon Valdez* Oil Spill and commercial harvest. Sea otters are now recovering and expanding into areas where they were previously absent. Some of these areas coincide with oil and gas lease sale areas. As the sea otter population in Cook Inlet is expanding, it is necessary to gain a better understanding of critical habitat for these keystone predators to assist management agencies in decision making centered around oil and gas exploration and leasing activities. In addition, current and predictive models of sea

otter habitat associations will aid in response efforts in the event of an oil spill by identifying the most important locations for response efforts.

The objectives of this study are to: 1) develop benthic habitat maps in areas of sea otter use and areas currently lacking sea otters, 2) quantify biological and physical habitat attributes across a gradient of sea otter density to understand the correlation of sea otter density to benthic habitat, and 3) develop predictive maps for areas within study sites of likely sea otter utilization due to expansion within the Cook Inlet lease sale area.

Data collection will utilize Remotely Operated Vehicle (ROV) surveys. Surveys will be conducted in Lake Clark National Park and Preserve, Katmai National Park and Preserve, Kamishak Bay, Kenai Fjords National Park, and Kachemak Bay. ROV imagery/video will be visually processed for substrate, vegetative cover, and invertebrate composition. Single beam sonar will be processed to produce bathymetric structural complexity models. Spatial statistics will be run on overlaid maps of sea otter locations and habitat components to correlate sea otter habitat with subtidal habitat type. The resulting correlations will be applied to ROV-mapped habitats in Cook Inlet that are not currently occupied by sea otters to predict potential locations of sea otter expansion.

2. Remote learning enhancement