OIL SPILL RECOVERY INSTITUTE
CORDOVA, ALASKA

2023 Work Plan
Oil Spill Recovery Institute

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Contents

Prince William Sound Oil Spill Recovery Institute
2023 Work Plan

I. Purpose and organization of this document

This document describes the Oil Spill Recovery Institute (OSRI) 2023 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 2023 Work Plan provides descriptions of projects proposed for funding in the 2023 fiscal year beginning October 1, 2022, and a brief description of projects funded in previous years that have funding continuing into fiscal year 2023 (FY23). 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 FY23 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 2023 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 $200K for projects related to Goal #1. OSRI has elected to support a portfolio of initiatives, including:

(1) Oil spill trajectory modeling.

(2) Partnership with the North Pacific Research Board.

a. Cook Inlet Circulation (OSRI cost: $100K)
OSRI is currently supporting the development of a hindcast using the NOAA operational forecast model for Cook Inlet. This work includes comparing the results to existing data and results from a previous modeling effort. In collecting the existing data it became clear that there were significant gaps in the data available. Very little data is available north of Anchor Point and very little information is available on the oceanography of the tide rips. The tide rips are convergence zones that would collect spilled oil. They also have significant vertical movement of water that may downwell the oil and transport it away from the rip where it can resurface making it difficult to know where to send response equipment. The rips may also be places where marine birds, mammals, and fish congregate to take advantage of the convergence zones.

OSRI desires to support the collection of oceanographic and biological observations of rips in the central portion of Cook Inlet. We desire information on the hydrography and currents associated with the rips. We also would like to know the role of rips in concentrating wildlife. Preferably, projects should show how the characteristics of the rips may change through a tide cycle and through a spring-neap cycle. All data collected by this project would need to be made available, with appropriate embargo period, through the Alaska Ocean Observing System's data portal.

Potential partners for this project include Cook Inlet Regional Citizens' Advisory Council, NOAA, AOOS, and BOEM. This is envisioned as a single-year project with up to $100K of support provided.

b. Funding partnership with the North Pacific Research Board (NPRB) (OSRI cost: $100K)
The NPRB and OSRI have science plans that encourage research partnerships and the two organizations have been partnering to fund research of joint interest since 2006. 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. In 2018 OSRI and NPRB signed a new agreement that has OSRI committing to providing up to $100K in funding for three years between 2018 and 2023.

This year OSRI will work with NPRB staff to identify proposals from any topic areas in the NPRB request for proposals that overlap with OSRI's research plan for review by OSRI. Studies that examine baseline conditions or monitor variability in the surface waters and nearshore regions that are most likely to be impacted by an oil spill will be sought out. We will also look at proposals that address food safety and security issues that can be incorporated into understanding impacts of an oil spill.

The OSRI research plan notes that the surface waters and the nearshore environment are the most likely areas to be impacted by an oil spill, therefore knowledge of the environment and ecology of these zones is of greatest importance to OSRI. There is also increasing pressure from shipping and oil development in the Arctic and Aleutians that makes these geographic regions of particular interest.

OSRI may contribute up to a total of $100K in FY23 for one or more projects relevant to its research plan.

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 $180K 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 FY23 is a potential experimental oil release to be conducted in the summer of 2023.

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, and in developing a portal containing information on oil spill research 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 FY23 to support the MPRI field testing or other partnership activities.

b. Potential Ports of Refuge (OSRI cost - $80K)

Potential Ports of Refuge (PPOR) are areas identified as spots where a stricken vessel may be taken to so that repairs can be made. Sometimes the PPOR are established anchorages but often these are areas that committees have selected as places they expect a ship to be able to be taken to. These selections are made without fully knowing if the location selected is appropriate. A recent project examining PPOR in Prince William Sound found that several of the locations selected in that area were not appropriate for the tankers that the PPOR were selected for. Using expert knowledge and vessel operations simulations it was possible to identify which PPOR locations were appropriate for tankers in Prince William Sound. OSRI is interested in continuing that effort with a focus on western and northern Alaska PPOR. We expect that analysis of PPOR will be based on vessel types operating in the Bering, Chukchi, and Beaufort seas, and along the Aleutian Islands.

This is expected to be a multi-year effort with $80K expected to be available to contribute to projects in FY23. The total project cost is anticipated to be close to $250K.

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 FY23. 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.

Detection and toxicity of hydrocarbon oxidation products formed through the photodegradation of spilled oil in Cook Inlet. Harsha, University of New Orleans. The goal of this project is to study the formation and toxicity of the petroleum-derived dissolved compounds, known as hydrocarbon oxidation products, that are formed through the photodegradation of spilled crude oil, marine diesel, and heating oil in Cook Inlet. This research is crucial due to the relevance and risks associated with the oil and gas industry in Alaska. Specifically, Cook Inlet is of particular interest due to its diverse ecosystem, populous areas, commercial fishing, tourism and new lease sales for petroleum production. A potential oil spill event in Cook Inlet could have devasting effects. In order to study the effects of an oil spill, it is essential to understand the contaminate in question: oil. The chemical composition of oil is incredibly diverse and complex, containing tens-hundreds of thousands of organic compounds, making the detection and effects of an oil spill extremely challenging. Spilled oil in aquatic environments can undergo and oxidative photodegradation from solar radiation, forming hydrocarbon oxidation products (HOPs). HOPs are ubiquitous in aquatic environments due their increased solubility in water that allow them to diffuse vastly and greatly. Detection of HOPs is extremely difficult with conventional analytical techniques such as gas chromatography and liquid chromatography due to HOPs residing in an unresolved complex mixture. Ultrahigh-resolution mass spectrometry and fluorescence excitation-emission matrix spectroscopy can be used in tandem to characterize HOPs through molecular-level composition and optical properties. Studying the effects of HOPs is crucial due to the possibility of photo-enhanced toxicity of oil. The toxicity of HOPs can be studied with exposure studies to early life stage Pacific herring (*Clupea pallasii*) embryos. Pacific herring are a species of interest in Cook Inlet due to their ability to be commercially fished. Further understanding of toxicity can be understood by using a biochemical assay measure 7-ethoxy-resorufin-*O*-deethylase activity.

The formation of HOPs in Cook Inlet through the photodegradation of spilled oil can be studied through laboratory simulations of spilled oil with Cook Inlet environmental conditions. Ultrahigh-resolution mass spectrometry and fluoresce excitation-emission matrix spectroscopy can be employed to characterize the HOPs formed in the laboratory simulations. Finally, the HOPs formed in laboratory simulations can be

used to expose Pacific herring embryos and analyzed by 7-ethoxy-resorufin-*O*-deethylase activity assay. The toxicity tests can uncover important toxicological endpoints of HOPs.

OSRI will provide $30K of support for this Ph.D. project. This is the second year of a three-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 FY23. 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 FY23 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: $150K). 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 $128.5K personnel (8.5 months), $13.2K travel (includes $5K for STC member travel), $5.0K outreach, $2.7K other contractual, and $0.6K commodities for a total of $150K.

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. FY23 New Programs Spending Summary

Area	Project	FY23 Work Plan
Understand		
	Cook Inlet circulation	$100K
	NPRB	$100K
		$200K
Respond		
	Partnership projects	$100K
	PPOR	$80
		$180K
Inform		
	Graduate Fellowships	$90K
	Internship	$15K
	K-12	$60K
	Workshops	$25K
	Remote Learning	$25K
		$215K
Other		
	Research Program Manager/STC Travel	$150K
		$150K
Subtotal		**$745K**
Administration		
	Based on 20% of total expenditure	**$186.3K**
Total		**$931.3K**

III. Prior Years' Encumbered Projects Continuing in FY23

Because OSRI projects are started at the beginning of each quarter, many projects funded in previous years will continue into fiscal year 2023. The purpose of this section is to identify those projects so that the work plan aligns with the FY23 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 FY23 – 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. Impact of anthropogenic climate and oil stressors on the survival potential of Arctic cod during the 1st year of life

Dr. Kristiansen with the Farallon Institute was funded in FY22 to complete analysis of data on Arctic cod that had been exposed to oil. This project replaced an experiment on Arctic cod that was unable to continue because of lab closures associated with COVID-19.

This study will spatially model the winter survival potential of juvenile Arctic cod following scenarios of embryonic exposure to oil in the spring e.g., oil spill on spawning grounds. Models will integrate the latest growth/lipid impact results from oil exposure 1 (OSRI-funded exposure, Incardona et al. in prep) with experimentally determined temperature-dependent over-winter lipid loss rates for age-0 Arctic cod (Copeman et al. in review), and downscaled CMIP6 high-resolution temperature models of the Alaskan Arctic region. Models will be constructed using three scenarios Societal Socioeconomic Pathway (SSP) 1-2.6, SSP2-4.5, and SSP5-8.5 for surface and bottom depths for the period 1993-2010.

2. Cook Inlet circulation modeling

Axiom Data Science was funded in 2022 to begin work on creating a hindcast using the NOAA Cook Inlet Operational Forecast model. The hindcast is to be compared to existing field data and output from different circulation model that was run for BOEM.

The goal of the Cook Inlet Circulation Modeling project is to develop the resources and tools needed to calculate oil spill trajectories by creating a minimum of a 10-year hindcast model using the NOAA Cook Inlet Operational Forecast System (CIOFS) model and comparing the results with other model and field data. CIOFS runs on NOAA's high performance computing systems in standard modeling frameworks

developed by the National Ocean Service Center for Operational Oceanographic Products and Services. The operational system generates nowcasts and 48-hour forecasts 4 times per day and generally captures the highly-variable bathymetry and tides of Cook Inlet making it potentially well-suited for coastal planning and resource management applications. However, the model currently uses limited freshwater forcing and its accuracy is unclear for subtidal currents, temperature, and salinity patterns, all of which are important for ecological applications and oil spill response.

To address these gaps, the Cook Inlet Circulation Model project will: i) generate and make available a 10-year, 3-dimensional oceanographic hindcast product for the period of 1999-2008 using the CIOFS model and make it publicly-available through the Alaska Ocean Observing System (AOOS) data system, ii) assess CIOFS skill by comparing it to the Northwest Gulf of Alaska Three-Dimensional Ocean Circulation Numerical Model (Danielson et al., 2016), and iii) validate the CIOFS hindcasts using physical measurements to assess the accuracy of model results.

3. HF-radar data recovery

The University of Alaska Fairbanks was funded to process existing HF radar data that had been collected in Cook Inlet and provide it and metadata to OSRI for use by the Cook Inlet Circulation Modeling project. The work includes cleaning up and processing using up-to-date standards of data collected by UAF since the year 2000.

4. Food safety and security concerns

Nuka Research was contracted with in FY21 to collect and organize community input on the perceived research needs for food safety and security during an oil spill. This project is expected to help guide future research on food safety.

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. ESI shoreline classification

Research Planning Inc. was funded in FY22 to test the ability to make incremental updates to the ESI electronic maps by determining if more recent mapping efforts, like ShoreZone, can be used to update the shoreline layer used. The objectives of this project are to: 1) evaluate the ShoreZone (SZ) databases for the State of Alaska to determine the suitability of using SZ data to update the ESI vector shoreline layer and shoreline classification in accordance with the National Oceanic and Atmospheric Administration (NOAA) ESI Guidelines; and 2) based on the suitability assessment, provide an estimate of the effort required to update the Cook Inlet Subarea. Research Planning, Inc. (RPI) will work closely with personnel from OSRI, NOAA, and ShoreZone to achieve these objectives.

3. Update of bird habitat layer

Research Planning Inc. was funded in FY22 to test the ability to make incremental updates to the ESI electronic maps by updating the marine bird layer for Cook Inlet. The objectives for the update of bird habitat ESI classification for the Cook Inlet and Kenai Peninsula, Alaska include developing high-quality, current data on sensitive resources for both oil spill planning and response and implementing strategies to facilitate incremental updates. Research Planning, Inc. (RPI) will work closely with OSRI to achieve these objectives.

4. Fluorsensor development

Michigan Technical University was selected in FY22 to develop a fluorsensor capable of being flown by a drone. The concept is to allow mapping of oil at night using a drone. The fluorosensor use a ultraviolet light source and a camera with filters designed to receive the fluorescence from oil.

5. UAS regulations during spill response

The University of Alaska Fairbanks was contracted in FY20 to develop a report on regulations associated with the use of UAS during a spill response. The report is to encompass local, state, and federal regulations by various agencies.

C. Goal #3 Inform:

1. Graduate Research Fellowships

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.

Continuing fellowship: 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.

Continuing fellowship: Influence of an environmental cascade on high-latitude intertidal communities. McArthur, University of Alaska Fairbanks.
Climate change-induced warming in high-latitude coastal environments is driving shifts in environmental conditions that will likely have significant, community-wide impacts. Ecological communities, including those found in the intertidal, are adapted to and structured by both stable static and fluctuating dynamic environmental variables. However, as glacial cover in these systems recedes due to melting, the resulting increase in sediment-laden freshwater from glaciers, to rivers, to estuaries, will alter a wide array of dynamic variables, including water temperature, salinity, dissolved oxygen, turbidity, photosynthetically active radiation (PAR), and carbonate chemistry. The objective of this project is to understand how high-latitude intertidal community variability and resilience may be shaped by the response of a major ecosystem engineer, the Pacific blue mussel *Mytilus trossulus*, to the effects of these changing environmental conditions. Mussels create important habitat for other organisms through the interstitial spaces of their byssal threads and dense shell aggregations. They are also prey for many top predators, including sea stars, sea otters, and humans. If conditions become less favorable for mussels, their ability to maintain strong byssal threads that keep them attached to the substrate and also their shell strength may decline, possibly making them and their associated community more susceptible to disturbances. This project is closely aligned with OSRI's mission, as it seeks to improve our understanding of how climate change-related dynamic environmental variables may decrease the ability of Subarctic mussels, and intertidal communities overall, to recover from disturbances to the environment, such as oil spills. This project will specifically identify baseline conditions including the natural variability and environmental drivers of a foundation species (blue mussels).

To investigate the impacts of both static and glacially-influenced dynamic environmental variables on mussel byssal thread attachment and shell strength, and on intertidal community variability, this study will take place at multiple intertidal sites located within a series of watersheds receiving varying amounts of fresh water and glacial discharge (i.e., a "glacial gradient"). This gradient should drive differences in water temperature, salinity, dissolved oxygen, turbidity, PAR, and carbonate chemistry. Environmental sensor data, mussel byssal thread and shell strength data, intertidal community data (percent cover and biomass), and a variety of statistical analyses will be used to achieve three main objectives, which are to 1) identify if there are trends in dynamic environmental variables along the glacial gradient, 2) determine if weaker byssal threads and shells are associated with sites experiencing more glacial influence, and 3) determine the influence of glacially-influenced dynamic environmental variables, static environmental variables, and mussel byssal thread and shell strength

on the seasonal and interannual variation in intertidal community structure. Overall, this project will determine if receding glaciers can drive a cascading impact on high-latitude intertidal communities, where changing environmental conditions decrease mussel attachment and shell strength to an extent that the entire intertidal community's stability and resilience to disturbance is impacted as well.

2. Internship

In FY22 Nuka Research was funded to support an internship. The internship will provide an Alaska student the opportunity to support an international effort to monitor coastal biodiversity in the Arctic. Under contract to the U.S. Fish and Wildlife Service, Nuka Research coordinates the Coastal Expert Monitoring Group of the Circumpolar Biodiversity Monitoring Program, or CBMP. (That program is the cornerstone program of the Arctic Council's Conservation of Arctic Flora and Fauna Working Group.) A U.S. Coastal Expert Network is now being formed and requires Intern support to advance development of a coastal biodiversity knowledge map bringing together sources from scientific monitoring, Indigenous knowledge, and local knowledge.