



2021 Work Plan Oil Spill Recovery Institute

September 2020

Contents

I. Purpose and organization of this document	2
II. OSRI Strategic Goals and FY21 Work Plan New Projects	2
A. Goal #1 Understand:.....	2
a. Identifying needs associated with food security	3
b. Impacts of oil on Arctic cod	3
c. Funding partnership with the North Pacific Research Board (NPRB)	4
B. Goal #2 Respond:	5
1. Technology research and development	5
a. Collaborate with the Canadian Multi Partner Research Initiative.....	5
b. Herder/burner partnership project.	5
C. Goal #3 Inform:	6
1. Education	6
a. Graduate Research Fellowships	6
b. K-12 Programs:.....	8
2. Outreach	9
a. Workshops and Conferences	9
b. Communication Plan Priority Project	9
D. Other Programs	9
1. Program coordination	9
2. OSRI Science and Technical Committee meetings.....	11
E. Partnerships	11
F. FY21 New Programs Spending Summary	12
III. Prior Years' Encumbered Projects Continuing in FY21	13
A. Goal #1 - Understand.....	13
1. Degradation additive effectiveness	13
B. Goal #2 Respond:	13
C. Goal #3 Inform:	13
1. Graduate Research Fellowships.....	13
2. Communication Planning.....	15

Prince William Sound Oil Spill Recovery Institute 2021 Work Plan

I. Purpose and organization of this document

This document describes the Oil Spill Recovery Institute (OSRI) 2021 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 2021 Work Plan provides descriptions of projects proposed for funding in the 2021 fiscal year beginning October 1, 2020 and a brief description of projects funded in previous years that have funding continuing into fiscal year 2021 (FY21). 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 FY21 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 sub-Arctic marine environments.** Four goals were identified as part of the strategic plan: Understand, Respond, Inform, and Partner (see OSRI Science Plan). The fiscal year 2021 Work Plan has been placed in the context of these four goals.

A. Goal #1 Understand:

Attain an interdisciplinary understanding of Arctic and sub-Arctic 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 \$288K for projects related to Goal #1. OSRI has elected to support a portfolio of initiatives, including:

- (1) Identifying needs associated with food security during an oil spill.
- (2) Arctic cod sensitivity to oil and impacts on growth.
- (3) Partnership with North Pacific Research Board.

a. Identifying needs associated with food security (OSRI cost: \$75K)

Research into food safety should connect the concerns of coastal communities, the needs of the risk assessment modelers, and research capabilities. The current practices used to determine food safety and risk assessment need to be made available in a manner appropriate for coastal communities to understand and the needs of the response community identified. Input from coastal communities should be sought to determine issues of concern related to the impacts of oil spills on food safety and security and to determine what information exists on food consumption patterns. This input should guide further projects on this topic.

As part of this project we seek the development of outreach materials describing food safety procedures during oil spills. Those materials are then to be used to seek input from coastal communities on research priorities associated with food safety during oil spills.

This is envisioned as a single year project with up to \$75K of support provided in FY21.

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 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 is the third year of a three-year research project and OSRI expects to provide \$65K of support in FY21. The project is funded in partnership with NOAA.

c. 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 FY21 for one or more projects relevant to its research plan.

B. Goal #2 Respond:

Enhance oil spill response and mitigation capabilities 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 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 \$200K 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. Collaborate with the Canadian Multi Partner Research Initiative (OSRI cost - \$100K)

The Government of Canada established a Multi Partner Research Initiative (MPRI) to examine non-traditional oil spill response. 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 FY21 is a potential experimental oil release to be conducted in the summer of 2021.

OSRI expects to provide \$100K of support in FY21 to support the MPRI field testing or collaborations with MPRI projects.

b. Herder/burner partnership project. (OSRI cost - \$100K)

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.

A total of \$100K is expected to be available to contribute to the partnership in FY21. This partnership is expected to be completed this year.

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 objectives OSRI proposes spending \$195K 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 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 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 FY21. We anticipate two continuing students and OSRI will release an RFP for the selection of up to one new student. Up to \$30K of support per year will be available to each fellowship. A twenty five percent match by the proposing institution is required.

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.

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

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.

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

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

OSRI will continue to support the Prince William Sound Science Center's Headwaters to Ocean program in order 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 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 FY21. The total cost of this program is between \$130K 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: \$20K)

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 FY21 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 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 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 Scientific and Technical Committee to attend the workshop.

(3) **Workshops of opportunity.** (OSRI cost: \$10K) There are several other workshops and conferences that provide opportunities to highlight areas of interest to OSRI, such as the International Oil Spill Conference and AMOP Technical Symposium. There are also workshops that could provide improved products with a little additional support. OSRI will allocate a total of \$10K to support conferences or workshops that align with the OSRI mission.

b. Communication Plan Priority Project (OSRI cost: \$25K)

In FY20 OSRI contracted with Mindfront to begin the development of a communication plan to help identify ways to better inform various audiences about OSRI's activities. While the planning process is currently underway, we understand there will be projects identified in the planning process that we should address as soon as possible. OSRI will allocate a total of \$25K to support projects identified in the communication plan.

D. Other Programs

1. Program coordination (OSRI cost: \$137K). 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 provide assistance, 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 \$115.2K personnel (8.0 months), \$12.7K travel, \$2.0K contractual, \$12.0K outreach, and \$0.1 K commodities for a total of \$137K.

2. OSRI Science and Technical Committee meetings (OSRI Cost: \$5K).

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. Under 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 into 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. 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. FY21 New Programs Spending Summary

Area	Project	FY21 Work Plan
Understand		
	Food Security	\$75K
	Arctic cod	\$65K
	NPRB Partnership	\$100K
		\$240K
Respond		
	MPRI Collaborations	\$100K
	Herder/Burner JIP	\$100K
		\$200K
Inform		
	Graduate Fellowships	\$90K
	K-12	\$60K
	Workshops	\$20K
	Outreach	\$25K
		\$195K
Other		
	Research Program Manager	\$137K
	STC Travel	\$5K
		\$142K
Subtotal		\$777K
Administration		
	Based on 20% of total expenditure	\$194K
Total		\$971K

III. Prior Years' Encumbered Projects Continuing in FY21

Because OSRI projects are started at the beginning of each quarter, many projects funded in previous years will continue into fiscal year 2021. The purpose of this section is to identify those projects so that the work plan aligns with the FY21 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 FY21 – 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. Degradation additive effectiveness

In FY16 OSRI released a request for proposals to address the effectiveness of degradation agents. Several products have been proposed as additives to spilled oil to speed up the natural degradation of oil by microbes. Few have been tested in conditions expected in the Arctic or sub-Arctic. Some have not been tested by independent parties. We desire to test the efficacy of these agents prior to a spill so we can understand their potential for spill remediation and their potential effects on the environment. There is a need to understand, if the agents are enhancing degradation or dispersing the oil, what the natural response time is to the additive, and what end and intermediate products are produced.

OSRI selected to fund a proposal from Dr. Leigh of the University of Alaska Fairbanks. The work aims to 1) evaluate the effectiveness of Oil Spill Eater II on crude oil and marine diesel degradation and detoxification in Arctic and sub-Arctic seawater, 2) determine its mode(s) of action, 3) compare its efficacy to that of chemical dispersants (Corexit 9500A), and 4) to assess effects on indigenous microbial communities. The proposal outlined a three-year research project to address these objectives.

B. Goal #2 Respond:

C. Goal #3 Inform:

1. Graduate Research Fellowships

Continuing fellowship: Fate and Effects of Petroleum Contamination and Chemical Dispersants in Arctic Marine Environments Gofstein, University of Alaska Fairbanks.

This study examines how Arctic marine ecosystems may be impacted by petroleum contamination by examining the fate of petroleum contaminants and chemical dispersants, their interactions with the environment, and the factors which influence their biodegradation. This project seeks to: 1) assess the influence of the dispersant Corexit 9500 on oil biodegradation processes in Arctic seawater; 2) investigate the fate of Corexit in marine environments; 3) study the effects of chemical dispersants on microbial community structure and function and identify the organisms responsible for degrading each in the Arctic; and 4) to investigate the extent of the role that nutrients play in driving the biodegradation of hydrocarbons, including identifying any nutrients that are possible limiting factors. Incubations of seawater from the Arctic Ocean in the presence of Alaska North Slope crude oil, Corexit 9500, and both together will be performed over a 60-day time course. Degradation of both components will be measured by GC/MS for the crude oil and by LC/MS/MS for the Corexit. Microbial analyses will be performed for each treatment using 16S rRNA sequencing using an Illumina MiSeq. Nutrients (NO_2^- , NO_3^- , NH_4^+ , PO_4^{3-} and SiO_4^{4-}) will be measured flow injection analysis and total iron by atomic absorption spectroscopy. Results from this study will help enable decision makers to make an informed choice of appropriate response strategies in the event of a spill as well as increase our general understanding of petroleum biodegradation in the Arctic marine environment.

Continuing fellowship: Cost-effective monitoring of anthropogenic impacts and environmental change in marine Arctic ecosystems Gonzalez, University of Washington. Detecting and understanding potential biological impacts of oil spills in the Arctic requires characterizing and understanding dynamics of fish and macrozooplankton communities. One efficient approach uses stationary active acoustics to characterize and monitor seasonally ice-covered waters of Arctic marine ecosystems. But to understand the scope of the measurements, the spatial area that is represented by acoustic point source measurements (i.e. representative range) must be quantified to ensure an effective characterization and monitoring of pelagic community dynamics.

This project will characterize spatial and temporal variability in densities and vertical distributions of fish and macrozooplankton, and quantify the representative range of temporally-indexed, acoustic measurements in the Chukchi Sea. Up to 6 years of multifrequency acoustic data from an Acoustic Zooplankton Fish Profiler (AZFP) echosounder that is part of the Chukchi Ecosystem Observatory (CEO) located at Hanna Shoal, will be compared to acoustic data from two mobile surveys: the 2015 Arctic Marine Biodiversity Observing Network (AMBON) cruise, and the 2017 Arctic Shelf Growth, Advection, Respiration and Deposition (ASGARD) cruise. Wavelet analysis will be used to describe scales of spatial and temporal variation of animal vertical distributions and densities. Multiple methods that calculate representative ranges of means and variances will be used and compared to assess the consistency of estimated representative ranges. Results from this work will increase our ability to detect and monitor biological responses to oil spills, help design distributed monitoring networks, and, more generally, monitor environmental change in Arctic ecosystems.

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.

2. Communication Planning

In FY20 OSRI contracted with Mindfront to begin the development of a communication plan. The process includes reviewing 14 components of OSRI's communication approach to identify how to reach target audiences more effectively and how to measure the success of communication efforts.