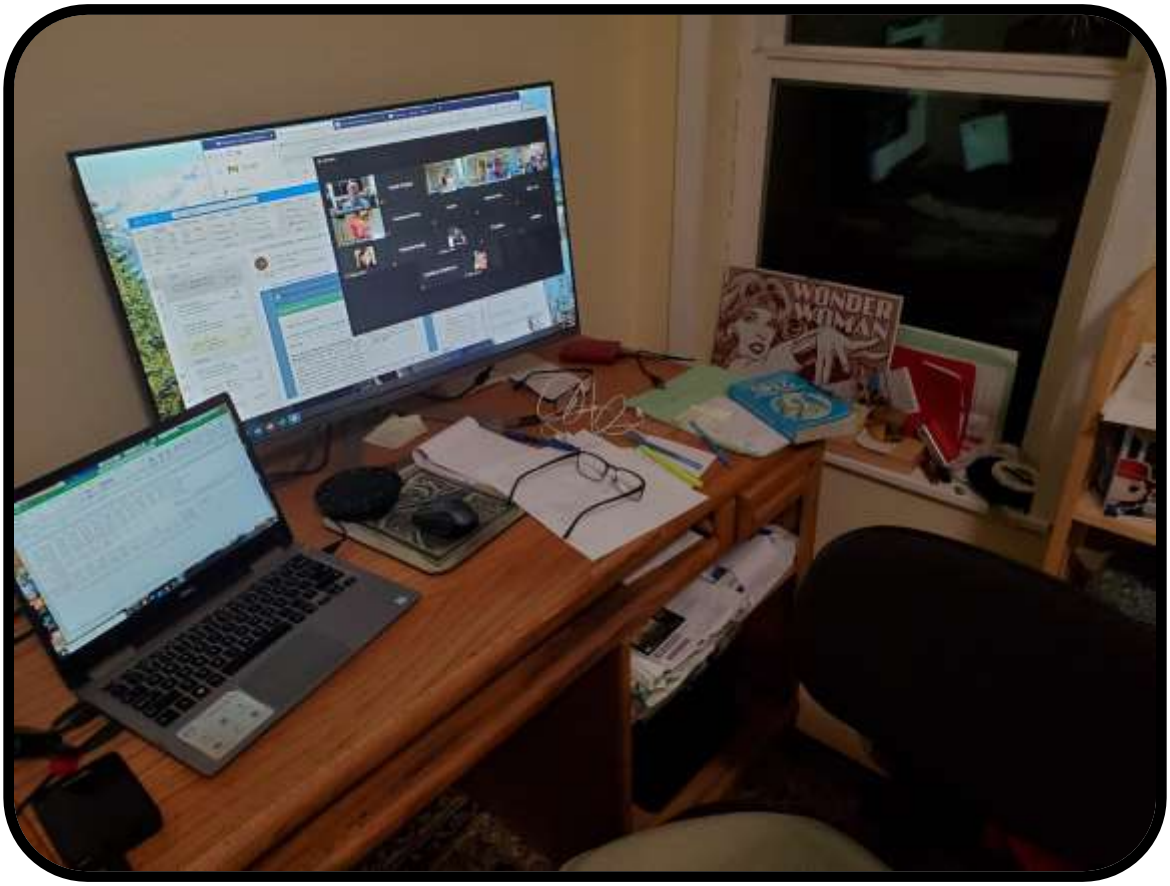
OSRI

Annual Report FY 2020



2020 has been the year of working from home and attending zoom meetings.

Oil Spill Recovery Institute
Cordova, Alaska

Contents

Message from the Executive Director

OSRI's mission to support research, education, and demonstration projects that improve understanding and response to oil spills in Arctic and sub-Arctic marine environments remained dynamic despite the changes a global pandemic wrought upon FY20. Understandably, some projects had to be temporarily delayed due to safety protocols that limited personnel access to laboratories, offices, and fieldwork. However, the work carries on—as will the necessary adaptations.

The use of uncrewed aerial systems (UAS) has grown, yet no entity has detailed the myriad ways such systems are being used in Arctic oil spill response, nor compiled the state, federal, Tribal, and municipal policies that define how UASes may be used in oil spill response in the U.S. Arctic. To help clarify these issues, OSRI funded the University of Alaska Fairbanks to characterize the currently available aircraft that can be used to support all phases of an Arctic or sub-Arctic oil spill response or exercise, and the requirements to safely and legally fly them in advance of, or as part of, a response. Associated data collection activities and how UAS teams can be integrated into incident command will be addressed through this work, as well.

We were also pleased to partner with the Canadian Multi-Partner Research Initiative to support research testing existing technologies capable of measuring oil thickness.

OSRI supports the advancement of oil spill-focused experts by supporting graduate students pursing studies in relevant fields. In FY20, we were pleased to support a new project by PhD candidate Vincent Hickl at the University of Illinois at Urbana-Champaign. Hickl is investigating how oil-degrading bacteria colonize crude oil droplets. We are also pleased to support master's degree candidate Liza Hassan at the University of Alaska Fairbanks as she works to map subtidal habitat and generate predictive sea otter association data in the Cook Inlet lease area.

It is thanks to our many advisors who have deep and rich knowledge of the state of oil spill response, ecotoxicology, ecosystem function, and technology development and deployment that OSRI advances the cutting edge of research to improve our nation's ability to respond to oil spills. To that end, we are extremely grateful for the service provided by the volunteers on OSRI's Scientific and Technical Committee and the members of the OSRI Advisory Board.

In service to our mission,

Executive Director
Oil Spill Recovery Institute

Advisory Board members

Programs of the Oil Spill Recovery Institute (OSRI) are determined by a 16-member Advisory Board composed of: (1) three Federal representatives from the Departments of Commerce, Interior and Transportation appointed by the Secretaries of the respective departments; (2) three State of Alaska representatives from the Departments of Environmental Conservation, Fish and Game, and Natural Resources appointed by the Commissioners of the respective departments; (3) two representatives each from the fishing industry, Alaska Native community (one of whom is a resident of Prince William Sound), oil and gas industry, all of whom are appointed by the Governor of Alaska; (4) two at-large representatives from communities impacted by the Exxon Valdez oil spill and who are appointed by the remaining Advisory Board members; and (5) one non-voting representative from the Institute of Marine Science at the University of Alaska Fairbanks and one non-voting representative from the Prince William Sound Science Center (PWSSC). The OSRI Advisory Board meets twice each year to set policies, adopt annual work plans and review the implementation of OSRI programs. The Board's structure includes four committees - Executive, Scientific and Technical, Financial and Work Plan - each of which meet as needed throughout the year. Annual work plans are adopted by the Advisory Board in the early fall and determine continuing projects and new project solicitations to be issued in the coming year.

Federal Representatives

Doug Helton, Chair
Operations Coordinator
Office of Response and Restoration - National Oceanic & Atmospheric Administration
Seattle, Washington
Years of Service: 2012 - present

Phillip Johnson
Department of Interior
Anchorage, Alaska
Years of Service: 2013 - present

Captain Kevin Riddle
Captain, U.S. Coast Guard, 17th District
Juneau, Alaska
Years of Service: 2019 - present

State Representatives

Gabriel Wolken
Geologist
Alaska Dept. of Natural Resources
Fairbanks, Alaska
Years of Service: 2017 - 2020

Jeanette Alas
Habitat Biologist
Alaska Dept. of Fish & Game
Anchorage, Alaska
Years of Service: 2013 - present

Rick Bernhardt
Prevention & Emergency Response Program
Alaska Dept. of Environmental Conservation
Anchorage, Alaska
Years of Service: 2013 – 2020

Graham Wood
Prevention & Emergency Response Program
Alaska Dept. of Environmental Conservation
Anchorage, Alaska
Years of Service: 2020 - present

Fishing Industry Representative

William Lindow
Cordova, Alaska
Years of Service: 2006 - present

Andrew Craig
Cordova, Alaska
Years of Service: 2013 – present

Alaska Native Representatives

Angela Totemoff
Eagle River, Alaska
Years of Service: 2011 - present

Glenn Ujioka
Cordova, Alaska
Years of Service: 1997-2013, 2016 - present

Oil & Gas Industry Representatives

Andres Morales
Operations Director –SERVS
Alyeska Pipeline Service Company
Valdez, AK
Years of Service: 2011 - present

Bark Lloyd
General Manager
Alaska Clean Seas
Anchorage, AK
Years of Service: 2016 - present

At-Large Representatives

David Totemoff
Tatitlek, Alaska
Years of Service: 2020 - present

Susan Saupe
Homer, Alaska
Years of Service: 2003 - present

Non-Voting Representatives

Charles P. Meacham
Deputy Commissioner Alaska Dept. of Fish and Game, retired
Prince William Sound Science Center Board of Directors,
Gig Harbor, Washington
Years of Service: 2006 - present

Brenda Konar
Director of the Institute of Marine Science
University of Alaska Fairbanks
Years of Service: 2017-present

Scientific and Technical Committee

This committee provides advice to the OSRI Advisory Board, OSRI Research Program Manager and OSRI Director on the conduct and support of research, projects, and studies related to Arctic and sub-Arctic oil spills and their effects. It includes specialists in matters relating to oil spill containment and cleanup technology, Arctic and sub-Arctic marine environment, and the living resources and socioeconomics of Prince William Sound and its adjacent waters.

Sarah Allan, Ph.D. National Atmospheric & Oceanic Administration
Gina Coelho, Ph.D. Bureau of Safety and Environmental Enforcement
Charles Greer, Ph.D. National Research Council Canada
Chris Hall Alaska Clean Seas
Brenda Konar, Ph.D. University of Alaska Fairbanks
Lee Majors Retired
Gary Shigenaka, National Atmospheric & Oceanic Administration
Laura Conner, Ph.D. University of Alaska Fairbanks
Patrick Tomco, Ph.D. University of Alaska Anchorage

Testing of oil in ice recovery tactics in Cook Inlet.

Mission and Goals

The mission of the Oil Spill Recovery Institute (OSRI) is to support research, education, and demonstration projects that improve understanding and response to oil spills in the Arctic and Subarctic marine environments.

In September 2019 the OSRI Board adopted the following goals to guide OSRI work into the future:

UNDERSTAND
Attain an interdisciplinary understanding of Arctic and Subarctic marine environments as it pertains to: the baseline; the source, fate, and effects of spilled oil; and the recovery of those environments following a spill.
• 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, life-style and well-being of people and the resiliency of communities
• Identify and improve new methods for assessing transport, fate, and effects.

RESPOND
Enhance the ability of oil spill response and mitigation capabilities in Arctic and Subarctic marine environments.
• Identify, develop, and/or evaluate prevention, assessment, and response technologies and tactics
• Identify the impacts of oil spill response options on the environment and human health

INFORM
Share information and educate about the issues of oil spill prevention, response, and impacts.
• Publish scientific and technical results in the 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

PARTNER
Partner with other organizations to take advantage of shared funding, facilities, knowledge, and experience.
• Coordinate with other efforts related to OSRI's mission
• Expand OSRI's involvement in Arctic research through partnership opportunities

Background

The Oil Spill Recovery Institute (OSRI) was authorized in 1990 by the United States Congress to "*identify and develop the best available techniques, equipment, and materials for dealing with oil spills in the Arctic and sub-Arctic marine environments*"; and, also to "*determine, document, assess and understand the long range effects of the EXXON VALDEZ oil spill on the natural resources of Prince William Sound. . . and the environment, the economy and the lifestyle and wellbeing of the people who are dependent on them* (Title V, Section 5001, Oil Pollution Act of 1990, OPA90)." In 1996, the act was amended to expand the area of emphasis from the Exxon Valdez oil spill region to the Arctic and sub-Arctic marine environments. A 2005 amendment extends OSRI programs to continue until one year after the completion of oil exploration and development efforts in Alaska.

OPA90 identifies the Prince William Sound Science and Technology Institute (known as the Prince William Sound Science Center, or PWSSC) in Cordova, Alaska, as administrator and home for OSRI. Between 1992 and 1995, Congress appropriated $500,000 for OSRI. Since 1996, when amendments instituted a funding mechanism for OSRI, the program has received annual interest earnings from a $22.5 million portion of the National Oil Spill Liability Trust Fund. In 2013, that principal was adjusted to $35.3 million.

OPA90 also set up an Advisory Board to determine policies of and programs supported by OSRI. This includes oversight of the development of strategic plans, research plans, and annual work plans. The Advisory Board includes three federal, three state, two oil and gas industry, two fishing industry, two native community, and two at-large representatives. Additionally, there are non-voting members from the Institute of Marine Science/University of Alaska Fairbanks, and the Prince William Sound Science Center. The Board's structure includes four committees - Executive, Scientific and Technical, Financial, and Work Plan - each of which meet as needed throughout the year. Annual work plans are adopted by the Advisory Board in the early fall and determine continuing projects and new project solicitations to be issued in the coming year.

OSRI's first strategic plan for oil pollution research and development (1995) focused on the risks and costs of oil spills. OSRI adopted an objective to improve predictive capabilities. This also addressed the assessment of costs, a key element in identifying the best oil spill prevention and response technologies. The mission and goal statements of the strategic plan were reviewed and modified in 2002, 2008, and 2015. Each review led to the development of a five-year Science Plan.

OSRI solicited its first proposals for grant projects in late 1997. Since 1998, OSRI has awarded approximately nine hundred thousand dollars a year to support a wide range of projects. The projects awarded funds in any given year are outlined in the annual work plan, which is based on the five-year Science Plan. The Science Plan is organized around four strategic goals: Understand, Respond, Inform, and Partner. The types of projects OSRI funds to fulfill each strategic goal are described in the annual report.

Practicing deflection boom tactics in Prince William Sound.

Programs

STRATEGIC GOAL: UNDERSTAND

These projects are designed to help attain an interdisciplinary understanding of Arctic and sub-Arctic marine environments as it pertains to: the source, fate, and effects of spilled oil; and the recovery of those environments following a spill. In the past, much of the work was focused on modeling and observations in Prince William Sound in partnership with the Alaska Ocean Observing System. In recent years more of the effort has been focused on understanding response option impacts to recovery. To achieve this objective, we need to collect observations of the physical and biological environments and integrate them with biological and physical models.

MAINTENANCE OF SNOTEL METEOROLOGICAL STATIONS

Snowpack Telemetry (SNOTEL) stations, set up in partnership with the Natural Resources Conservation Service (NRCS), measure wind speed and direction, air temperature, air pressure, and precipitation from snow and rain throughout the year (https://www.wcc.nrcs.usda.gov/snow/). They are fully-automated, land-based stations that are set up in remote locations. Eight stations are operated in Prince William Sound in collaboration with the Alaska Ocean Observing System (AOOS). Data from these stations are expected to improve the hydrological model needed to understand ocean circulation and to verify meteorological models run for Prince William Sound.

Beginning in FY13 OSRI reduced its contribution to the array as it transitioned from a research and development project to an operational system. AOOS now provides most of the operational costs with some OSRI support for system upgrades.

This is a continuing program with to $4,035 spent to purchase a wave measuring buoy in 2020. No funds were required for the SNOTEL stations.

EVALUATING THE EFFECTS OF OIL SPILL EATER II ON OIL SPILL DEGRADATION IN ALASKAN MARINE ENVIRONMENTS

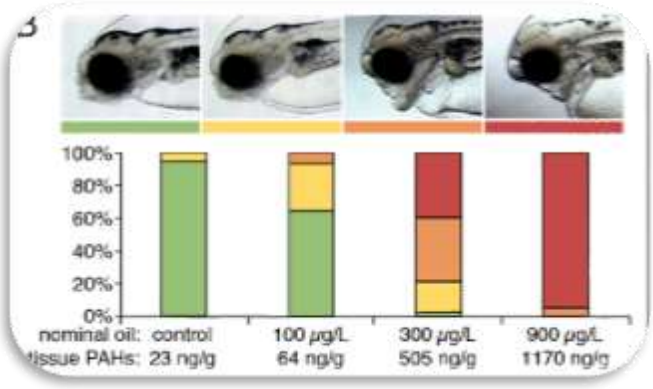
The Alaskan Arctic and sub-Arctic marine environments are subject to growing risks of crude oil and marine fuel spills due to increased ship traffic and the potential for offshore oil and gas development. It is important for oil spill preparedness planning to be based upon a sound scientific understanding of the efficacy of spill response products and their potential environmental impacts to marine ecology. Yet, the fate and effects of several products on the Environmental Protection Agency's National Contingency Plan (NCP) product schedule have not been evaluated thoroughly for Alaskan waters. Chemical dispersants are receiving increased research attention, but there has not yet been a thorough scientific evaluation of the heavily marketed bioremediation product, Oil Spill Eater II (OSEII) in any marine environment, including in Alaska. OSEII's formulation is not publicly known, but it reportedly contains mineral nutrients, amylase and protease enzymes, molasses as a carbon source, and an oleophilic surfactant. Although OSEII is listed on the NCP Schedule as an enzymatic additive, the enzymes it reportedly contains (protease and amylase) are not capable of directly catalyzing petroleum biodegradation. OSEII's diverse ingredients suggest multiple other possible modes of action, such as chemical

dispersion, biostimulation through nutrient addition and/or through additions of labile carbon sources. Rigorous scientific examination of the effectiveness and mode(s) of action of OSEII for biodegrading and detoxifying oil, as well as its impacts on microbial ecology of marine ecosystems, is warranted in order to ensure that this product is effective, properly classified on the NCP Schedule, and that its potential effects are understood prior to field application.

The aims of this proposed project are to 1) evaluate the effectiveness of OSEII 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 effects of OSEII on crude oil and diesel biodegradation and detoxification will be determined using laboratory incubation studies with freshly collected seawater containing indigenous microorganisms from the Arctic (open water and under-ice) and sub-Arctic (open water) marine environments in Alaska. The potential for OSEII to act as a dispersant will also be investigated using EPA dispersant effectiveness test methods. Additional treatments will isolate and examine the roles of nutrients, molasses, and enzyme additives in petroleum degradation. The effects of OSEII on indigenous microbial communities, including oil-degraders and degradation genes, will be examined using advanced molecular methods (16S rRNA sequencing, metatranscriptomics, qPCR). This team has experience investigating oil biodegradation in Arctic waters, assessing the fate and effects of oil spill response chemicals (e.g., Corexit 9500A), and in applying advanced molecular microbiological tools to these questions. The proposed work aligns with OSRI's mission to support scientific evaluations of the potential effectiveness and impacts of oil spill response methods, including additives on the U.S. EPA NCP Schedule. Results will be communicated through conference presentations, peer-reviewed scientific publications, and through direct communications with OSRI, the Alaska Department of Environmental Conservation, and other agencies and stakeholders.

This is a continuing project led by Dr. Mary Beth Leigh of the University of Alaska Fairbanks with no new funding provided in FY20.

ACCUTE AND LATENT MULTI-STRESSOR IMPACTS OF OIL EXPOSURE AND TEMPERATURE REGIME ON ARCTIC COD EMBRYOS, LARVAE AND JUVENILES



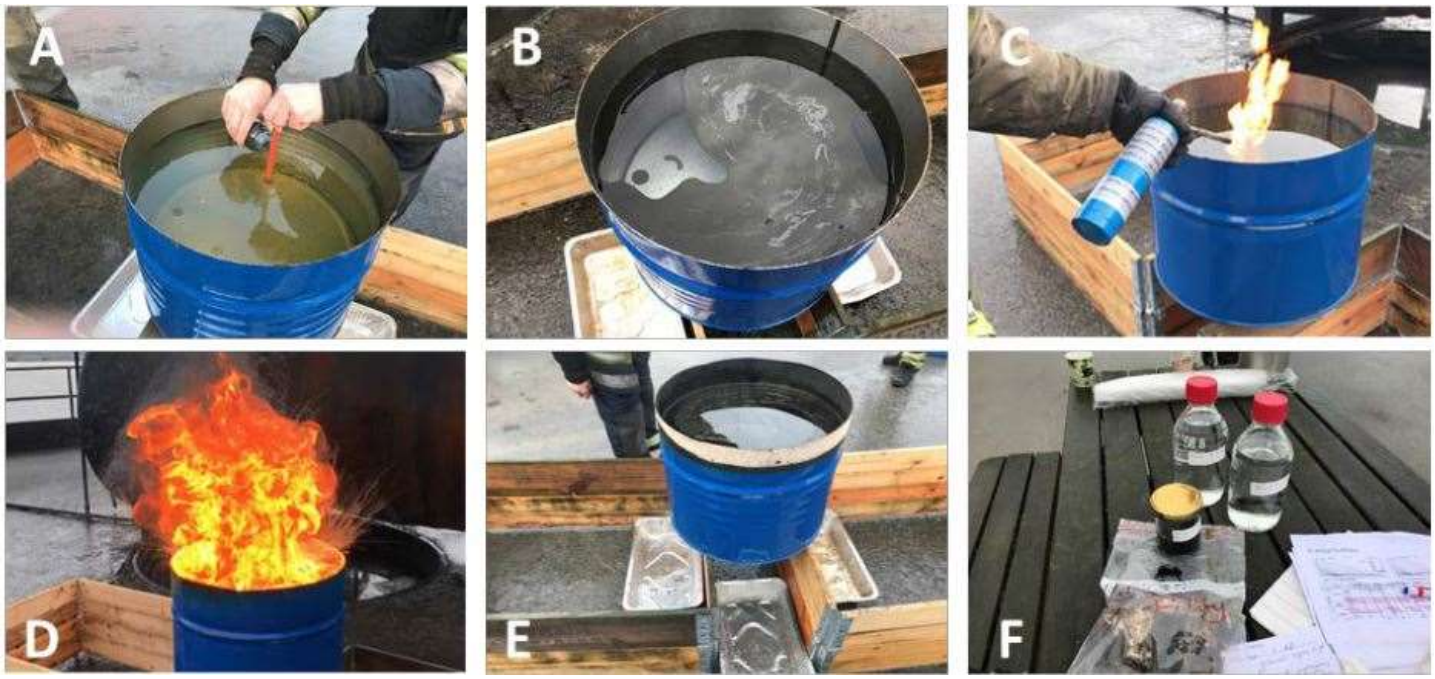
In the last 15 years, oil spill research at NOAA has focused on three major spill events: the 1989 Exxon Valdez spill in Prince William Sound, Alaska, the 2007 Cosco Busan spill in San Francisco Bay, and the 2010 Deepwater Horizon spill in the Gulf of Mexico. However, three key lessons were learned from 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: 1) how oil impacts survival and growth potential, 2) what the minimum effective exposure concentrations are for this species, 3) are these impacts reversible and 4) how do sub lethal impact affect overwintering survival? 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 (<100 ug/L) embryonic exposure to oil.

This is the second of a three-year project led Louise Copeman of Oregon State University with $113,000 provided in FY20. This project has experienced delays associated with the PI taking a position at NOAA and the COVID-19 work restrictions.

TOXICITY OF HERDERS ON COLD-WATER ORGANISMS

The objective of the proposed project is to assess changes in acute and sublethal toxicity due to the use of herders as oil spill response tool. We will address three main topics in the project using a laboratory-based approach. Firstly, we will study oil component dissolution from herder-treated oil slicks into the water phase to better understand temporal variation in dissolved and bioavailable oil components during herder application. Secondly, we will provide acute toxicity data on the two NCP-approved herders Thickslick 6535 and Siltech OP-40 on the key ecological cold-water marine species *Calanus finmarchicus* (copepod) and North East Arctic cod (*Gadus morhua*). Finally, we will prepare burned oil residues from two Alaska North Slope oils with different physico-chemical properties with and without the use of herder. These burned residues will be used for testing acute and sublethal toxicity on the abovementioned species.

This is the second year of a two-year project led by Bjørn Henrik Hansen of SINTEF with $200,000 provided in FY20.



Preparing burn residue for toxicity testing.

STRATEGIC GOAL: RESPOND

Many existing oil spill response technologies are ineffective in harsh environments at high latitudes. Projects funded under this goal aim to enhance oil spill response and mitigation capabilities in Arctic and sub-Arctic marine environments. This can be accomplished by developing or adapting equipment for oil spill response in Arctic and sub-Arctic marine environments, or by improving our understanding of the impacts of different response options.

UNCREWED AIRCRAFT SYSTEM REGULATIONS

The goal of this project is to compile all current working knowledge about the use of uncrewed aircraft systems (UAS) to support all phases of response to Arctic and sub-Arctic oil spills. The study will address UAS usage for Arctic marine oil spills, inclusive of potentially affected coastline environments, and the nuances between UAS flights for oil spill response events, as opposed to oil spill exercises, and UAS training activities.

Specific objectives of this work include working directly with resource trustees in the U.S. Federal realm (NOAA, USCG, USFWS, DOI, BSEE and others), the State of Alaska, municipal governments, and tribal entities to define, clarify and document policies and procedures affecting UAS flights in support of oil spill response activities in America's Arctic. Pathways for real-time observations of potentially impacted marine resources will be described, as well as recommendations for data collection, processing, and integration into the command post, inclusive of long-term archival recommendations for damage assessment support. An examination of UAS-based sensors that can collect data in support of a response will be included, as well as the aircraft requirements for their deployment. The project will characterize the currently available aircraft that can be used to support all phases of an Arctic or sub-Arctic oil spill response or exercise, and the training requirements to safely and legally fly them in advance of, or as part of, a response. Descriptions of airspace regulations, flight limitations, and available protocols for the use of UAS in Arctic oil spill response will be reported. Definition of UAS team integration into the incident command structure of a response will be outlined based upon prior case studies and Federal Emergency Management Agency guidelines.

This is a new project led by Jessica Garron of the University of Alaska Fairbanks, with $40,000 committed in FY20.

OIL THICKNESS MEASUREMENTS

Directing response assets and understanding potential damage caused by an oil spill requires understanding the thickness as well as extent of an oil slick. The Canadian Multi-Partner Research Initiative funded NOAA and the University of New Hampshire to organize testing of existing technologies for determining oil thickness. This work is in partnership with BSEE. OSRI committed funds to several participants to allow them to travel to the experiment. The experiment has been delayed due to the COVID-19 pandemic.

This is a new project with several small contracts provided to various investigators totaling $80,000 committed in FY20.

DEVELOPMENT OF AN INTEGRATED HERDER DELIVERY AND IGNITION SYSTEM

Recent research in in-situ burning of oil spills with herders has shown promise, but there is no single system that can apply the herders and provide an ignition. Thus, either two helicopters would be needed to apply the herders and ignite the contracted slick. The desire is to determine if a single system can be built that can deploy the herder and provide the ignition source to make the use of chemical herders more feasible. In an effort to address the need for a combined system OSRI worked with Exxon Mobil and the Bureau of Safety and Environmental Enforcement to begin a Joint Industry Program (JIP) focused on the issue. In the first phase, OSRI funded an agreed upon contractor to evaluate the state of the technology and explore the applicability of potential system designs. In the current phase a prototype system is being built and tested. Additional partners and contributors include Shell, and Clean Caribean Americas.

This project is led by Tim Thornton of Tactical Electronics. This is a continuing project with $100,000 provided to the JIP to support the development and testing of the new system.

Using a heli-torch to light oil in a test basin. Picture from http://arcticresponse.wpengine.com/wp-content/uploads/2017/09/poker-flats-report-final.pdf.

STRATEGIC GOAL: INFORM

The projects described in this section are designed to share information and educate the public on the issues of oil spill prevention, response, and impacts. OSRI funds projects to educate the public at all ages, support graduate students, support workshops and symposia that allow researchers to present results, and provide direct outreach through the web.

HEADWATERS TO OCEAN

Headwaters to Ocean (H2O) is a collaborative education program developed to provoke inquiry into the natural world, to increase science and ecological literacy and to foster responsible use of natural resources. This proposal addresses the School Year Programs portion of OSRI's Work Plan. *H2O* consists of three tracks that target different sectors of society and our direct engagement track consists of programs (described below) for elementary and high school students in Cordova and other communities in coastal Alaska.

Discovery Room provides hands-on science education to students in Cordova's elementary school with the goal of inspiring life-long passion for science and increasing scientific literacy. PWSSC proposes to further refine, deliver and share lessons and materials related to OSRI's mission of understanding the effects of oil spills and recovery of Arctic and sub-Arctic marine environments. OSRI funding will support program delivery, development of marketing materials, and web-based distribution. These experiences will give students the knowledge and skills needed to understand how natural systems function and respond to climate change and other human impacts.

Outreach Discovery program extends *Discovery Room* programming to audiences outside of Cordova and increases the number of individuals served by Science Center education programs. Many of the students served by the *Outreach Discovery* program qualify as "underserved populations" and often have limited access to science and environmental education resources and opportunities. This request seeks to use OSRI funds to support the continued delivery of marine-themed *Outreach Discovery* programs to youth from northwest Alaska as well as enhancement of our remotely operated vehicles kits.

High School Outreach programs allow PWSSC to keep older students engaged in marine science-centric activities that promote critical thinking, problem solving and ecological literacy skills. OSRI funding will support program delivery of lessons about ocean sciences to high school students in *Outreach Discovery* and *National Ocean Sciences Bowl* programs, as well as preparation of one or more NOSB teams.

This is a continuing program with $60,000 awarded in FY20 to Lauren Bien at PWSSC. Additional funding for this project is provided by BP Alaska, ConocoPhillips, PWSSC, community contributions, and various private entities and foundations.

FELLOWSHIPS

OSRI funds are provided to support graduate student research that will enhance scientific understanding of the marine ecosystem, provide information needed by managers and decision-makers for oil spill response and recovery, and improve public awareness and understanding of marine and estuarine ecosystems. The OSRI Graduate Research Fellowship Program offers qualified master's and doctoral students the opportunity to address scientific questions of significance to Arctic and sub-Arctic regions resulting in high-quality research focused on improving oil spill response and recovery.

Silvana Gonzalez, University of Washington

Doctoral candidate
Advisor: John Horne
Cost-effective monitoring of anthropogenic impacts and environmental change in marine Arctic ecosystems

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 years 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.

This is the third year of the project with $30,000 provided in FY20.

Alexis Walker, University of Alaska Fairbanks

Doctoral candidate
Advisor: Mary Beth Leigh
Investigating microbial degradation of crude oil in Arctic marine sediments via shotgun metagenomics and compound specific hydrocarbon analyses

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 in particular 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.

I propose to expand upon my 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. These objectives will be achieved via shotgun metagenomic sequencing on the Illumina NovaSeq 6000 platform and in-depth mass spectrometry analyses of samples from oiled sediment incubation experiments. The fourth objective will inform mitigation and response decisions by quantifying the

relative importance of seawater and marine sediments as settings for oil degradation. This final objective will be achieved via collaboration with a previous OSRI graduate fellowship awardee Taylor Gofstein.

This is the second year of the project with $30,000 provided in FY20.

Vincent Hickl, University of Illinois at Urbana-Champaign

Doctoral candidate
Advisor: Gabriel Juarez
Describing the effects of bacterial growth on oil transport: Direct visualization of crude oil droplet colonization by oil-degrading bacteria

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. We propose a microscale approach that addresses this shortcoming through the ability to systematically control 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.

This is the first year of the project with $30,000 provided in FY20.

Liza Hassan, University of Alaska Fairbanks

Masters candidate
Advisor: Brenda Konar
Subtidal habitat mapping in the Cook Inlet lease area for current and predictive sea otter associations with habitat

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.

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. ROV surveys, equipped with single beam sonar, will be conducted in areas of high and low sea otter density determined using previously collected data by USGS, USFWS, and NPS. 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 in order to predict potential locations of sea otter expansion.

This is the first year of the project with $30,000 provided in FY20.

Taylor Gofstein, University of Alaska Fairbanks

Doctoral candidate
Advisor: Mary Beth Leigh
Fate and Effects of Petroleum Contamination and Chemical Dispersants in Arctic Marine Environments

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.

This is a continuing project with no new funds provided in FY20.

Marc Oggier, University of Alaska Fairbanks

Doctoral candidate
Advisor: Hajo Eicken
Crude Oil Movement in Sea Ice: Development and Validation of a Parametric Model of Oil Migration

Economic interests of the oil and gas industry as well as the maritime shipping sector have increased in the Arctic over the past few decades. Despite a decline in the summer sea ice extent, Arctic waters will remain infested with sea ice for a significant part of the year in the foreseeable future. Hence, the hydrocarbon industry will need to cope with sea ice during routine operations. Understanding and predicting the fate of oil in sea ice is crucial to assess risks to ecosystems and people and to effectively respond to an oil spill in Alaskan Arctic waters.

The objective of the proposed research is three-fold:

- Development of a simple oil migration model that draws on previous work; the model is run in parallel with an oil spill laboratory experiment for parameterization and validation of predictions of onset and extent of oil percolation (depth penetration, volume of oil pervading ice matrix, expected surfacing time).
- Validation of the model based on observed oil percolation with the aid of X-ray tomography and sea-ice thin/thick optical sections.

- Evaluation of the utility of a portable X-ray tomographer to characterize the oil distribution and support prediction for operational purposes in an experiment setting representative of conditions in the field.

The following methods will be applied:
(1) Development of the oil migration model. The model will run with simple input such as ice conditions (thickness, temperature and porosity), weather variables (temperature, HR …) and oil parameters (volume, physical properties).
(2a) Controlled oil spill simulation in a laboratory experiment under conditions representative of the field with continuous in-situ temperature, relative humidity measurements.
(2b) Simulation of oil percolation with daily update based on measured experimental variables
(3) Comparison between simulation and experiment, based on (1) daily observations (ice surface, temperature) and (3) X-ray tomography data and thin-thick section.

The proposed research is significant in advancing knowledge through better prediction of oil percolation in case of an oil spill. Such understanding and the availability of a model suitable for operation prediction will help recovery efforts, e.g., in determining the most suitable time frame for the clean-up response and the choice of the method applied, and in supporting NRDA exposure evaluation.

This is a continuing project with no new funding provided in FY20.

WORKSHOPS OR SPECIAL PROJECTS

These funds are to support workshops or special projects at the discretion of the OSRI Advisory Board. The following workshops and science meetings were supported in FY20.

Alaska Marine Science Symposium, $5,000. This symposium is the primary facility for disseminating research results related to Alaska's Arctic and sub-Arctic marine environments.

Alaska Forum on the Environment, $5,000. This symposium brings together speakers, panels, and participants to discuss issues related to Alaska's environment, including the impact of oil spills.

Alaska Oil Spill Technology Symposium, $7,500. These funds were provided to support the symposium. The symposium was postponed due to COVID-19 concerns. The funds will remain with UAF until the symposium happens.

OTHER

RESEARCH PROGRAM MANAGER

Funds are provided for the expense of the OSRI Research Program Manager (RPM) to track existing programs, develop new programs, develop partnerships, and outreach OSRI programs. Major activities include implementing the five-year research plan, the development of the FY19 work plan, participating in several workshops, and updating the OSRI outreach materials.

Expenses related to this position are combined with the travel expenses of the Scientific and Technical Committee described below. Total expenses for these two components was $89,335.

SCIENTIFIC AND TECHNICAL COMMITTEE

The Scientific and Technical Committee (STC) meets annually to assist in developing the annual work plan and to advise OSRI on implementation of the work plan. Funding is provided to cover the travel costs of the members of the Scientific and Technical committee.

Financials

Funds for the Oil Spill Recovery Institute were authorized by the United States Congress through the Oil Pollution Act of 1990 (OPA'90) and amending legislation. The Prince William Sound Science Center (PWSSC), a non-profit research and education institute in Cordova, Alaska, administers the OSRI programs as directed by OSRI's Advisory Board. PWSSC receives the interest earnings from a $35.3 million trust managed by the U.S. Treasury and held within the National Oil Spill Liability Trust Fund. These funds originated from the Trans-Alaska Pipeline Authority and are dedicated to financing the OSRI programs.

The following pages include the Statements of Financial Position for the Prince William Sound Science Center and the Financial Position and Statement of Activities related to the OSRI programs for the fiscal year 2020. Fiscal year 2019 data is provided for comparison.

Professional audits of PWSSC's financial records, including the OSRI program fund, are completed annually by a nationally recognized accounting firm. The fiscal year 2020 audits were completed by Altman Rogers & Co., Anchorage, Alaska. Copies of audited financial statements are available upon request to Linnea Ronnegard, Finance Director, PWSSC, P.O. Box 705, Cordova, Alaska, 99574, or email lronnegard@pwssc.org.

Summary of OSRI program expenditures for FY20 and FY19:

Program Areas	**FY20**	**FY19**
Administration	156,869	120,279
Research (Understand)	325,937	151,397
Research (Respond)	49,053	118,560
Public Education & Outreach (Inform)	163,151	117,232
Other Programs	89,335	93,926
TOTALS	784,345	601,395

PWSSC/OSRI building in Cordova, Alaska.

Statement of Financial Position

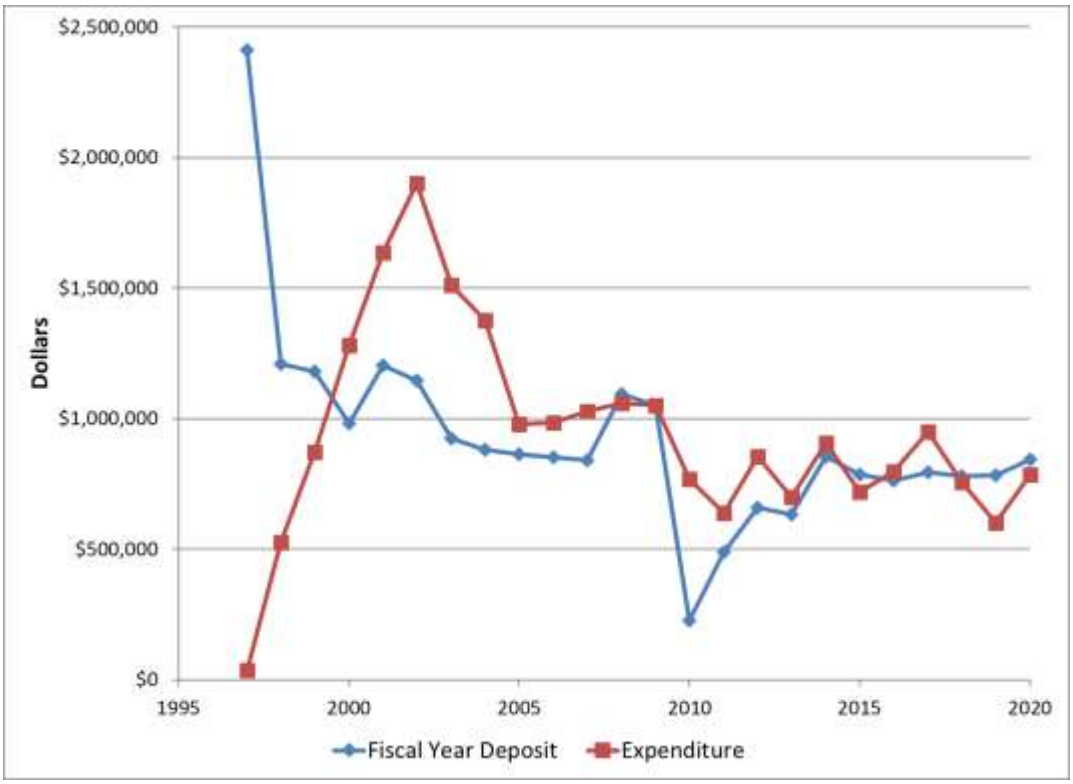
Including the Oil Spill Recovery Institute
Year Ended September 30, 2020
(*with comparative totals for 2019*)

	General Fund	Plant Fund	Program Fund	Totals 2020	2019
Assets:					
Cash and cash equivalents	1,404,644		708,847	2,113,491	742,237
Receivables	853		452,372	453,225	644,275
Prepaids and other assets	71,556			71,556	58,067
Due from other funds	294,870		(294,870)		
Investments			1,301,948	1,301,948	1,351,786
Property and equipment, net of accumulated depreciation		1,092,086		1,092,086	854,508
Total assets	1,771,923	1,092,086	2,168,297	5,032,305	3,650,873
Liabilities:					
Accounts payable	539,193			539,193	530,640
Wages, taxes & benefits payable	264,146			264,146	156,991
Current portion of long-term debt	1,193			1,193	
Deferred to revenue	4,448		501,335	505,783	241,768
Due to other funds					
Long-term debt	148,807			148,807	
Total liabilities	957,787		501,335	1,459,123	929,399
Net assets:					
Unrestricted	814,137	1,092,086	1,666,962	3,573,184	2,721,474
Total liabilities & net assets	1,771,924	1,092,086	2,168,297	5,032,307	3,650,873

Oil Spill Recovery Institute Programs
Combined Statement of Financial Position

Year Ended September 30, 2020
(*with comparative totals for 2019*)

	OSRI Totals	
	2020	2019
Assets		
Cash	708,847	599,441
Investments	1,301,795	1,351,786
Total assets	2,010,795	1,951,227
Liabilities		
Deferred revenue	261,695	202,857
Due to other funds	81,650	152,283
Total liabilities	343,345	355,140
Net assets - unrestricted	1,667,450	1,596,087
Total liabilities and net assets	2,010,795	1,951,227



Deposits and expenditures per fiscal year since the original deposit in fiscal year 1997.

Oil Spill Recovery Institute Programs
Combined Statement of Activities
Year Ended September 30, 2020
(*with comparative totals for 2019*)

	OSRI Totals	
	2020	2019
Revenues:		
Grants and contributions - Federal	784,346	601,395
Interest		
Investment income	71,365	105,652
Other		
Total revenues	855,711	707,047
Expenses:		
Salaries and benefits	112,221	176,963
Travel	9,014	22,949
Supplies	552	609
Professional services	13,472	22,949
Subcontracts and charter costs	44,664	
Insurance		1,498
Network	1,385	10,087
Postage and freight	179	6
Printing, publications and copying	145	1,603
Utilities and rent		
Telephone	676	2,806
Other	1,923	2,328
Grants awarded	424,248	332,249
Total expenses before interfund facility, equipment costs, and indirect costs	608,479	573,331
Interfund facility and equipment costs	1,000	13,296
Interfund research vessel costs		
Indirect costs	174,867	12,820
Total expenses	784,867	599,447
Transfer to Plant Fund		(1,949)
Change in net assets	71,365	105,651
Net assets at beginning of year	1,596,087	1,490,436
Net assets at end of year	1,667,452	1,596,087

Publications

Gofstein, T. R. (2020). Fate and effects of commercial crude oil bioremediation products in arctic seawater. Ph.D. Thesis. Fairbanks, Alaska. University of Alaska Fairbanks. 138 p.

Gofstein, T. R., Perkins, M., Field, J., & Leigh, M. B. (2020). The interactive effects of crude oil and Corexit 9500 on their biodegradation in Arctic seawater. *Applied and environmental microbiology*, *86*(21).

Oggier, M. (2020). Effects of sea ice seasonal evolution and oil properties on crude oil upward migration. Ph. D. Thesis. Fairbanks, Alaska. University of Alaska Fairbanks. 269 p.

Staff

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