OSRI

Annual Report FY 2019

Examining recovered diesel oil for water during skimmer efficiency testing.

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 very meaningful in FY19. This year, we supported a new study at Oregon State University to examine the potential effects of an Arctic oil spill on Arctic cod, which appear to be more susceptible to oil toxicity than some other marine gadids. We also launched a project at SINTEF to evaluate the toxicity of oil herding chemicals on cold water zooplankton and fish species. We are also co-funding, in partnership with the North Pacific Research Board, a project that will evaluate how freshwater runoff is affecting marine waters in the Bering, Beaufort, and Chukchi Seas. We look forward to sharing results of these studies with you in the future.

OSRI is pleased to support another Joint Industry Program with the Bureau of Safety and Environmental Enforcement and several oil and gas producers. The focus of the project is to improve systems for delivering oil herding chemicals in situ and for igniting herded slicks when protocols call for in situ burning. A primary objective of this project is to identify "off the shelf" technologies with the right capabilities to perform these tasks, as materials and supplies can be difficult to source when responding to remote spills, especially in the Arctic.

OSRI emphasizes the importance of workforce development in oil spill-related professions through the extension of competitive Graduate Research Fellowships. In FY19, we were pleased to support a new project by PhD. Candidate Alexis Walker of the University of Alaska Fairbanks. Alexis is investigating the ability of bacteria found in Arctic marine sediments to degrade fresh and weathered oil, and how oil degradation differs in the water column versus the sediments below. She will use genetic sequencing techniques to learn more about the genes involved in oil degradation in relevant microbes.

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 Dr. Todd O'Hara, Professor of Veterinary Pharmacology and Toxicology, who evolved off our Scientific and Technical Committee (STC), and we welcome Dr. Gina Coelho, Principal Senior Scientist at the Sponson Group, as well as Dr. Charles Greer of the Canadian National Research Council to our STC. Appreciation is also due to departing OSRI Advisory Board member USCG Captain Darren McLenon; we welcome aboard his replacement, USCG Captain Kevin Riddle.

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 Darran McLenon
Captain, U.S. Coast Guard, 17th District
Juneau, Alaska
Years of Service: 2017 - 2019

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 - present

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 - 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

Joe Banta
Anchorage, Alaska
Years of Service: 2006 - 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. Sponson Group
Charles Greer, Ph.D. National Research Council Canada
Chris Hall Alaska Clean Seas
Brenda Konar, Ph.D. University of Alaska Fairbanks
CJ Beegle-Krause, Ph.D. SINTEF
Anthony Parkin BP Exploration (Alaska), Inc.
Gary Shigenaka, National Atmospheric & Oceanic Administration
Stacy Studebaker Former teacher
Dick Thorne, Ph.D. Prince William Sound Science Center (retired)
Patrick Tomco, Ph.D. University of Alaska Anchorage

Colored diesel oil was used to test the efficiency of oleophilic skimmers.

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 towing a current buster system 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 $2,287 awarded in FY19 to Micro-Specialties.

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

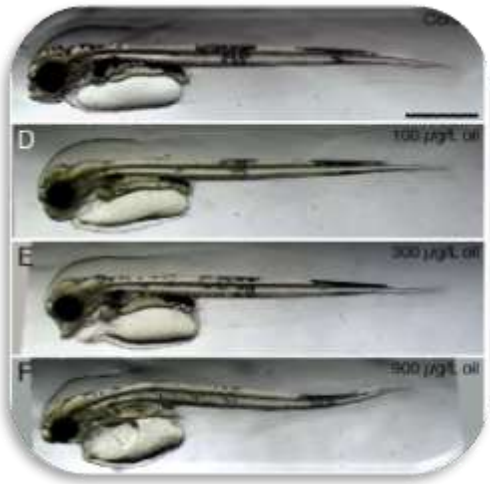
examination of the effectiveness and mode(s) of action of OSEII for biodegrading and detoxifying oil, as well as its impacts on microbial ecology of marine ecosystems, is warranted in order to ensure that this product is effective, properly classified on the NCP Schedule, and that its potential effects 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 FY19.

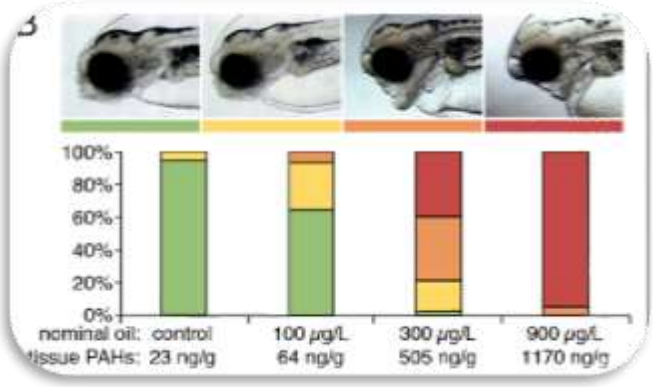
SENSITIVITY OF ARCTIC COD EMBRYOS AND LARVAE TO OIL; DELAYED IMPACTS ON JUVENILE GROWTH AND LIPID CONDITION

Arctic cod (*Boreogadus saida*) are important components of Arctic food webs, channeling lipid-rich energy between plankton and higher trophic levels such as marine mammals and seabirds. Arctic cod have physiology adapted for growing and storing energy in their cold-water environment, but environmental conditions that reduce growth or energy allocation (e.g., temperature, disease, toxins) will likely reduce their overwintering survival in their 1st year of life. The objective of this project is to quantify the delayed impacts of embryonic oil exposure on growth and energetic condition (lipid content) of later larval and early juvenile stages of Arctic cod. By addressing the non-lethal chronic effects of embryonic oil exposure to later life stages in Arctic cod this project will provide an ecologically meaningful measure of injury assessment for this species. Further, this project will deliver information on how low dose oil-exposure (100 µg oil/L) affects Arctic cod quality as a forage fish for higher trophic levels. This will help scientists, industry, and Arctic communities understand the delayed long-range effects of low-dose embryonic exposure to a keystone fish species and indirectly to the health of the Arctic marine ecosystem.



This is a continuing project led by Ben Laurel of the National Oceanic and Aeronautic Administration and Louise Copeman of Oregon State University with no new funds provided in FY19.

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 a new three-year project led Louise Copeman of Oregon State University with $84,135 provided in FY19.

TOXICITY OF HERDERS ON COLD-WATER ORGANISMS

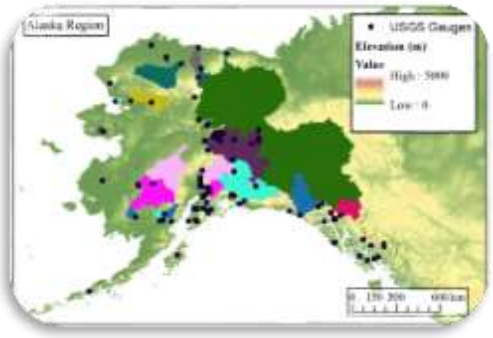
The objective of the proposed project is to assess changes in acute and sublethal toxicity due to the use of herders as oil spill response tool. We will address three main topics in the project using a laboratory-based approach. Firstly, we will study oil component dissolution from herder-treated oil 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 a new two-year project led CJ Beegle-Kraus of SINTEF with $100,000 provided in FY19.

PARTNERSHIP WITH THE NORTH PACIFIC RESEARCH BOARD (NPRB)

The NPRB and OSRI both encourage research partnerships in their science plans, and both organizations have a strong interest in ocean observing, habitat, ecological and socioeconomic studies. In 2005, the two groups signed a partnership protocol to explore research priorities of mutual interest in any given year. The protocol was updated and signed by both parties again in 2018. The OSRI Science Plan committed $100,000 to this partnership in FY19. Continuation of the partnership and the level of funding committed is determined on an annual basis. We agreed to support one proposal in 2019.

Improved Freshwater Runoff Products for Alaskan Waters



Coastal freshwater runoff plays a major role in determining the vertical structure, the chemical composition, and the circulations of Alaskan coastal waters. These characteristics help control the distribution of organisms, nutrients, and contaminants and ultimately play a role in the abundance and distribution of higher tropic levels. Despite its importance, only a small percentage of Alaska's coastal freshwater discharge (FWD) is measured directly. This is because stream gauging is expensive and Alaska's terrain results in a very large number of coastal watersheds that would need to be gauged. To fill the gaps left by the observational network, computer modeling of FWD is needed. Modeling is also required to predict future FWD patterns. Over the past 10 years, there have been several focused modeling studies that have advanced the knowledge of Alaskan coastal FWD. These studies have varied in methodology, but have primarily focused on the Gulf of Alaska (GOA) drainage. The current proposal presents a plan for continuing this advance in several important ways:

1. Modeling that has previously been limited to the GOA will be extended to the Bering, Beaufort, and Chukchi Seas
2. Modeling that has previously been limited to 1980-2014 will be extended through the duration of this project (2022)
3. For southeast Alaska, we will partner with other projects to incorporate very-high-resolution meteorological forcing (historic and forecast)
4. We will develop the capability to provide forecast (9 month) runoff products using the coupled forecast system CFSv2.

These tasks will be accomplished by building on a successful 10-year history of developing and refining runoff products for Alaska. We will continue existing collaborations and cultivate new ones to ensure project success. We will produce freely available and relevant data products.

This project is led by Dr. David Hill of Oregon State University.

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.

ENSURING FOOD SAFETY FOLLOWING AN OIL SPILL IN ALASKA

The goal of this project is to improve the mitigation of food safety impacts resulting from a marine oil spill in Alaska through supporting the ARRT's efforts to develop policy and guidance for On-scene Coordinators regarding food safety during pollution responses.

Project objectives include:

• Identify statutory and regulatory authorities, as they exist, regarding closure/opening of each of the following in the event of contamination from a marine oil spill: commercial, recreational, personal use, and subsistence resources.
• Directly engage ARRT workgroup in project via check-in calls or meetings at three key points in the development of project deliverables.
• Produce concise, thorough, and thoroughly referenced report that will serve as a direct input to the ARRT workgroup's efforts to develop a policy and guidance related to food safety in the event of a marine oil spill in Alaska.

The proposed approach includes a review of statutes and regulations, literature, and documentation from past spills, as well as interviews with subject matter experts and knowledge-holders. Examples of policies or guidelines related to the contamination of commercial, subsistence, recreational, or personal use resources will be drawn from Alaska and elsewhere in the U.S. as well as internationally.

Consumption of contaminated food sources or lack of access to safe food due to actual -- or perceived -- contamination are potential impacts of oil spills in Alaska. Providing clear food safety guidelines will support decision-making in the intense context of a spill response and improve clarity for resource users and markets.

This is a continuing project led by Sierra Fletcher of Nuka Research and Planning Group, LLC., with no new funds committed in FY19.

ASTM SKIMMER TESTS

As new oleophilic skimmers become available it may be necessary to consider new approaches to rating the recovery capabilities of these skimmers. The current process de-rates the skimmer estimated recovery to 20% of the name plate value to approximate the expected recovery in the field. By testing new skimmers in appropriate conditions, it may be possible to demonstrate that higher recovery rates than they are currently estimated to achieve. In this work two oleophilic skimmers will be tested to examine their recovery rates.

This is a continuing project led by Chris Burns with Alaska Chadux with no new funds committed in FY19.

EXPLORATION OF AN IMPROVED 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.

This project is led by Tim Thornton of Tactical Electronics. This is a continuing project with no new funds committed in FY19. This is expected to be the first phase of a multi-year JIP with industry and agency partners and we set aside $100,000 in FY19 for the second phase of the JIP.

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 FY19 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 second year of the project with $30,000 provided in FY19.

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 first year of the project with $30,000 provided in FY19.

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 FY19.

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 FY19.

OSRI 20th ANNIVERSARY OUTREACH

OSRI celebrated twenty years of providing funding in 2018. In order to document the work that occurred during the first twenty years, OSRI contracted to have outreach materials developed. The materials include a short film and a written report of activities. These materials are available on the OSRI website (www.pws-osri.org).

This is a continuing project led by Seth Walker at Curate and Brenden Schild at Ideaville with no new funding provided in FY19.

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 FY19.

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.

Exxon Valdez Oil Spill speakers, $7,400. These funds were used to bring in special speakers to address the 30-11year commemoration of the oil spill.

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 $93,926.

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 finance 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 2019. Fiscal year 2018 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 2019 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 FY19 and FY18:

Program Areas	**FY19**	**FY18**
Administration	120,279	150,769
Research (Understand)	151,397	332,764
Research (Respond)	118,560	19,469
Public Education & Outreach (Inform)	117,232	165,891
Other Programs	93,926	88,387
TOTALS	601,395	757,280

PWSSC building in Cordova, Alaska.

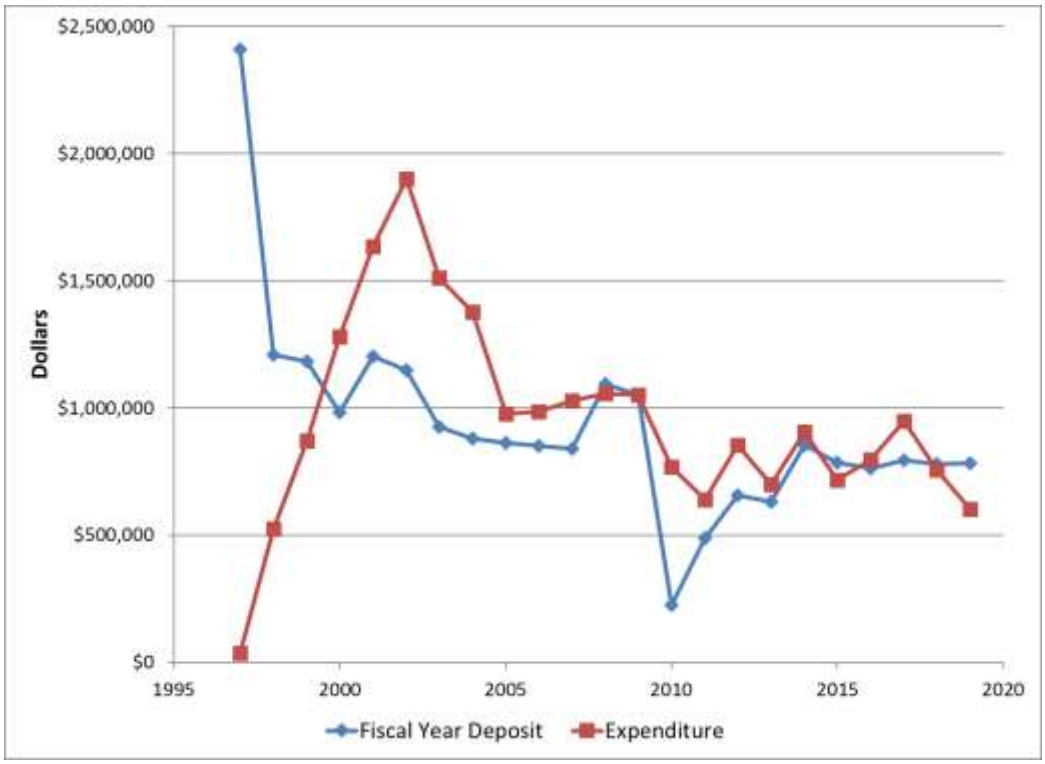
Statement of Financial Position

Including the Oil Spill Recovery Institute
Year Ended September 30, 2019
(*with comparative totals for 2018*)

	General Fund	Plant Fund	Program Fund	Totals 2019	2018
Assets:					
Cash and cash equivalents	142,796		599,441	742,237	1,610,154
Receivables	978		643297	644,275	316,996
Prepaids and other assets	58,067			58,067	66,650
Due from other funds	800,185		(800,185)		
Investments			1,351,786	1,351,786	354,083
Property and equipment, net of accumulated depreciation		854,508		854,508	835,432
Total assets	1,002,026	854,508	1,794,339	3,650,873	3,183,285
Liabilities:					
Accounts payable	530,640			530,640	304,978
Wages, taxes & benefits payable	156,991			156,991	118,816
Current portion of long-term debt					7,559
Deferred to revenue	4648		237,120	241,768	62,419
Total liabilities	692,279		237,120	929,399	493,772
Net assets:					
Unrestricted	309747	854,508	1,557,219	2,721,474	2,689,513
Total liabilities & net assets	1,002,026	854,508	1,794,339	3,650,873	3,183,285

Oil Spill Recovery Institute Programs
Combined Statement of Financial Position
Year Ended September 30, 2019
(*with comparative totals for 2018*)

	OSRI Totals	
	2019	2018
Assets		
Cash	599,441	1,328,173
Investments	1,351,786	354,083
Total assets	1,951,227	1,682,256
Liabilities		
Deferred revenue	202,857	22,620
Due to other funds	152,283	169,200
Total liabilities	355,140	191,820
Net assets - unrestricted	1,596,087	1,490,436
Total liabilities and net assets	1,951,227	1,682,256



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, 2019
(*with comparative totals for 2018*)

	OSRI Totals	
	2019	2018
Revenues:		
Grants and contributions - Federal	601,395	757,280
Interest		
Investment income	105,652	(47,975)
Other		
Total revenues	707,047	709,305
Expenses:		
Salaries and benefits	176,963	209,003
Travel	22,949	26,128
Supplies	609	3,442
Professional services	22,949	11,515
Subcontracts and charter costs		990
Insurance	1,498	1,202
Network	10,087	13,805
Postage and freight	6	83
Printing, publications and copying	1,603	1,350
Utilities and rent		280
Telephone	1,603	1,302
Other	2,328	491
Grants awarded	332,249	458,014
Total expenses before interfund facility, equipment costs, and indirect costs	573,331	727,605
Interfund facility and equipment costs	13,296	14,496
Interfund research vessel costs		
Indirect costs	12,820	14,379
Total expenses	599,447	756,480
Transfer to Plant Fund	(1,949)	(800)
Change in net assets	105,651	(47,975)
Net assets at beginning of year	1,490,436	1,538,411
Net assets at end of year	1,596,087	1,490,436

Publications

Farahani, H.F., Torero, J.L., Jomaas, G. and Rangwala, A.S., 2019. Scaling analysis of ice melting during burning of oil in ice-infested waters. *International Journal of Heat and Mass Transfer*, *130*, pp.386-392.

Laurel, B.J., Copeman, L.A., Iseri, P., Spencer, M.L., Hutchinson, G., Nordtug, T., Donald, C.E., Meier, S., Allan, S.E., Boyd, D.T. and Ylitalo, G.M., 2019. Embryonic crude oil exposure impairs growth and lipid allocation in a keystone Arctic forage fish. *iScience*, *19*, pp.1101-1113.

Oggier, M., Eicken, H., Wilkinson, J., Petrich, C. and O'Sadnick, M., 2019. Crude oil migration in sea-ice: Laboratory studies of constraints on oil mobilization and seasonal evolution. *Cold Regions Science and Technology*, p.102924.

Staff

Katrina Hoffman
OSRI Executive Director
President & CEO, Prince William Sound Science Center

W. Scott Pegau, Ph.D.
OSRI Research Program Manager

Linnea Ronnegard
Finance Director
Prince William Sound Science Center

Rebecca Dodge
Bookkeeper
Prince William Sound Science Center

Arissa Pearson
Administrative Assistant
Prince William Sound Science Center

Based on the initial work sponsored by OSRI, the Herder/Ignitor Joint Industry Program decided to move forward with the development of an unmanned surface vessel that can be winched up under a helicopter for delivery of chemical herders and ignition. We will also be developing a new ignition system that can be carried in the helicopter to use with the existing chemical herder deployment system.

P.O. Box 705
Cordova, Alaska 99574
(907) 424-5800
pwssc@pwssc.org
www.pws-osri.org