Research Plan

2021-2025

PRINCE WILLIAM SOUND
OIL SPILL RECOVERY INSTITUTE

Established by Congress, OSRI supports research, education, and demonstration projects that improve understanding and response to oil spills in Arctic and Subarctic marine environments.

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Oil Spill Recovery Institute

OSRI Research Plan 2021-2025

I. Purpose of this Document

This document provides guidance for the development of annual work plans by describing funding focus areas and the context for specific projects and partnerships, although it does not commit the Prince William Sound Oil Spill Recovery Institute (OSRI) Board to support any of the projects described. It is also intended to provide a structure that OSRI's partners can use to identify opportunities for collaboration.

II. Program Introduction

A. Background

The Prince William Sound Oil Spill Recovery Institute 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 Subarctic 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)." As legislated, OSRI functions to "*conduct research and carry out educational and demonstration projects designed to 1) identify and develop the best available techniques, equipment, and materials for dealing with oil spills in the Arctic and Subarctic marine environment; and 2) complement Federal and State damage assessment efforts and determine, document, assess, and understand the long range effects of Arctic or Subarctic oil spills on the natural resources of Prince William Sound and its adjacent waters, (as generally depicted on the map entitled "Arctic or subarctic oil spills dated March 1990") and the environment, the economy, and the lifestyle and well-being of the people who are dependent on them, except that the Institute shall not conduct studies or make recommendations on any matter which is not directly related to Arctic or Subarctic oil spills or the effects thereof."* In 1996, the act was amended to expand the area of emphasis from the Exxon Valdez oil spill region to the Arctic and Subarctic marine environments. A 2005 amendment extends OSRI programs to continue until one year after the completion of oil exploration and development efforts in Alaska.

The Oil Pollution Act of 1990 (OPA 90) identifies the Prince William Sound Science and Technology Institute (known as the Prince William Sound Science Center, PWSSC) in Cordova, Alaska, as administrator and home for OSRI. Between 1992 and 1995, Congress appropriated $500,000 for the OSRI program. 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 2012, the amount that OSRI receives interest from was raised to $35.3 million.

OPA 90 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 OSRI Advisory Board meets at least twice each year to set policies and review the implementation of OSRI programs. The Advisory 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 outline 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. Recognizing the Global Ocean Ecosystem Dynamic (GLOBEC) program's conclusions about our weakness in making physical and biological predictions, and the consequential impact on our understanding of damages caused by oil spills, the OSRI program incorporated GLOBEC's goals and approach to improve prediction of natural changes. This approach also improves our assessment of costs, a key element in identifying the best oil spill prevention and response technologies. The mission and goal statements of the OSRI strategic plan were reviewed and modified in 2002, 2008, 2015, and 2019. Five-year research plans have been developed based on each of the strategic plans.

OSRI solicited its first proposals for grant projects in late 1997. Since 1998, OSRI has awarded approximately $800,000 a year to support a wide range of projects. The projects awarded funds in any given year are outlined in the annual work plan. The work plans have been based on the five-year Research Plan. The Research Plan is organized around four strategic goals: Understand, Respond, Inform and Partner.

B. Mission Statement, Goals, and Objectives

The OSRI Advisory Board reviewed and revised the mission and goals during a strategic planning session on September 10 and 11, 2019.

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Mission Statement

OSRI supports research, education, and demonstration projects that improve understanding and response to oil spills in Arctic and Subarctic marine environments.

Goals and Objectives

UNDERSTAND

Attain an interdisciplinary understanding of Arctic and Subarctic marine environments as it pertains to: the baseline; the sources, 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, lifestyle and well-being of people, and resiliency of communities
- Identify and improve new methods for assessing transport, fate, and effects

RESPOND

Enhance oil spill response and mitigation capabilities in Arctic and Subarctic marine environments.

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

INFORM

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

- Publish scientific and technical results in open literature
- Brief the response, assessment, and restoration communities on OSRI efforts
- Facilitate the exchange of information and ideas through workshops and other forums
- Educate future researchers and responders through K-12 programs, undergraduate internships, and graduate fellowships
- Convey information to the general public through various media
- Serve as a source of expertise

PARTNER

Partner with others to take advantage of shared funding, facilities, knowledge, and experience.

- Coordinate with other efforts related to OSRI's mission
- Seek out new partnership opportunities

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C. R&D Grant Policies and Procedures

OSRI adopted a research and development grant program based on policies and procedures used by the National Science Foundation (NSF), National Oceanic and Atmospheric Administration's (NOAA) National Undersea Research Program and the *Exxon Valdez* Oil Spill Trustee Council. The basic document that governs the OSRI program is the Grant Policy Manual (GPM). The GPM undergoes periodic updates to make the program run as efficiently as possible. The last update was in October 2016. The GPM provides guidance on the various provisions of program management. All OSRI staff, committee members, and Advisory Board members will follow the guidelines contained in the GPM when processing and managing OSRI grants. The OSRI GPM and other OSRI documents and forms, including application packages, are available on the OSRI web site at www.pws-osri.org, or by request.

D. Roles and Responsibilities

The Oil Spill Recovery Institute is housed within the Prince William Sound Science Center, which has fiduciary responsibility for OSRI. The staff structure of OSRI is related to the PWSSC as shown in Fig. 1.

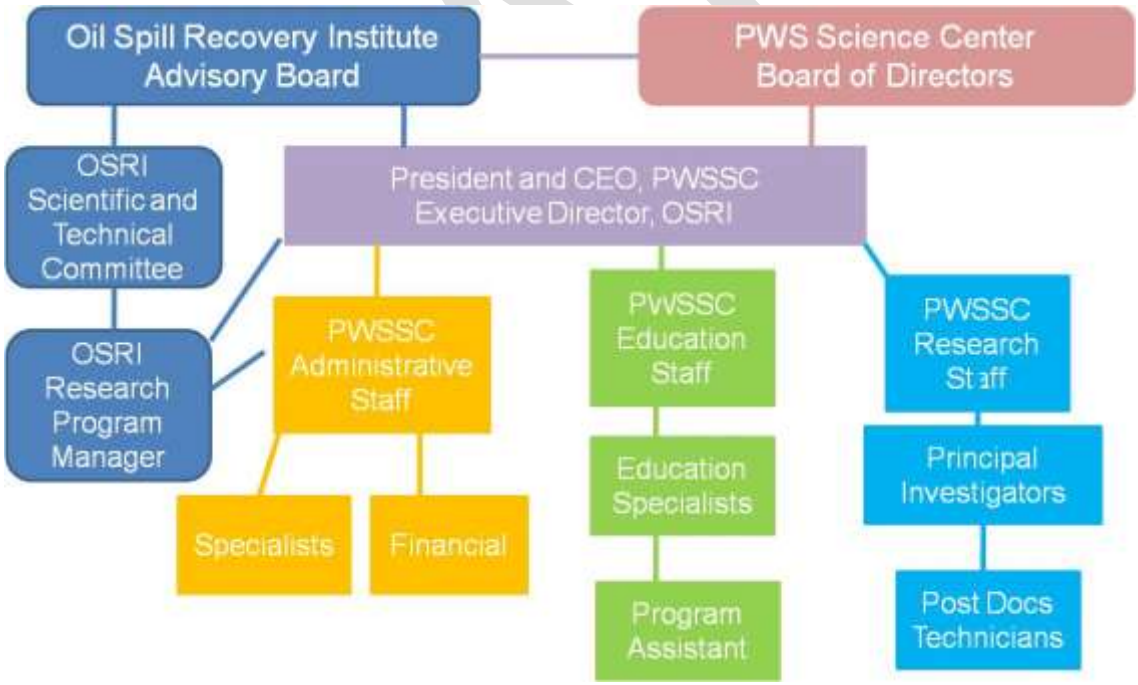

Figure 1. OSRI and PWSSC staff chart and relationship between the organizations

The following roles and responsibilities are defined to be:

1. **Advisory Board** – Set strategic direction, review progress toward accomplishing strategic goals, promote OSRI program results and products to the oil spill and

marine science communities, define duties of OSRI director and other staff, appoint and evaluate director, establish subcommittees, approve bylaws, set broad annual scientific priorities, approve annual program plan and large grant awards, seek operational coordination with the Prince William Sound Science Center and its Board of Directors, resolve complaints and financial award issues, act to fill vacancies on the Board, review fiscal reports, and assist the OSRI Executive Director and Research Program Manager with partnerships.

2. **Executive Director** – Supervises the OSRI Research Program Manager and assists with administrative support to implement OSRI programs, promotes OSRI programs through outreach efforts (e.g. web page, annual report, meetings, etc.), and communicates with the Advisory Board on a regular basis concerning administrative and fiduciary issues.
3. **Research Program Manager** – Plans research programs, prepares annual work plans in consultation with the Work Plan Committee and the Advisory Board, works with OSRI Executive Director on fiduciary issues, and implements the work plan as approved by the Advisory Board. Coordinates proposal reviews, works with the Scientific and Technical Committee on future research direction, proposal selections and recommendations to the Advisory Board, and ensures compliance with all policies and procedures of the Grant Policy Manual.
4. **Scientific and Technical Committee** – Provides advice and recommendations to the Research Program Manager, Executive Director, and Advisory Board regarding the direction, selection, and support of research projects related to Arctic or Subarctic oil spills. Acts as the proposal selection panel using review comments and recommendations submitted by technical peer reviewers. Provides recommendations to the Advisory Board on program plans, proposal and fellowship awards.
5. **Clerical Staff** - provide administrative support to the Research Program Manager and Executive Director to carry out the OSRI Program.

E. Application and Award Process

OSRI staff, STC, and Advisory Board members will follow the guidelines and procedures detailed in the Grants Policy Manual (GPM). The OSRI GPM and the annual OSRI program descriptions are available on the OSRI web site at www.pws-osri.org, or by request from the Research Program Manager.

III. Programming by Goal

The specific programmatic focus areas will be described by the primary goal that each area fits under. Most programs address more than one goal. For instance, a workshop that facilitates the exchange of information (Inform goal) may address identifying new response technology (Respond goal). Or environmental research may address both the Understand and Respond goals. And the Partner goal applies to all goals.

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

a. Evaluate short and long-term effects.
b. Identify chemical, biological, and physical impacts and consequences.
c. Identify baseline conditions including the natural variability and their drivers
d. Evaluate impacts from oil spills on the economy, food security, subsistence activities, life-style and well-being of people and the resiliency of communities.
e. Identify and improve new methods for assessing transport, fate, and effects.

Three research program areas have been identified as focal areas for the Understand program.

1. Food safety

Ensuring food is safe to consume is important to the regional economies and subsistence lifestyles found in Arctic and Subarctic regions. Oil spills disrupt the gathering of seafood, birds, and mammals for subsistence and commercial purposes. If food items are suspected of being exposed to oil the response managers will need to determine if the food is tainted (smells or tastes like a petroleum product) or contaminated to levels that have expected human health impacts when consumed for prolonged periods. The calculations for estimating the risk exposure may not be appropriate for subsistence lifestyles common along the coast in Arctic and Subarctic regions. It may also be difficult to gain acceptance that a food may be safe after a spill.

Currently a mix of sensory analysis and chemical analysis of tissue are used to determine food safety following a spill. The capabilities to rapidly identify tainted food and determine hydrocarbon loading are necessary to gain acceptance of foods following a spill.

Potential projects include:

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

in this plan, we recognize that the actual projects pursued may be different because of the input received. We expect this effort to cost $50K-$100K depending on the methods used to collect the desired input and the scope of information sought. Additional food safety projects will be generated by this project.

- *Background levels of hydrocarbons in subsistence foods*. To identify the impact of an oil spill it is important to understand background levels of hydrocarbons within existing food sources. Contaminants may be from natural sources or human activities. This means that background levels can be stable or variable through time so it may be important to analyze historic samples as well as current conditions. This may be accomplished by partnering with native organizations, tribes, and federal and state subsistence programs to synthesize existing data or through the collection of new data. We anticipate a single project of $100K - $150K.

2. Degradation and Toxicity

The use of dispersant, chemical herders and degradation enhancing substances are a part of the array of oil spill response options that may be considered during a spill. Some products have not been tested by an independent lab to determine the resulting efficacy or toxicity. The ones that have been tested generally have not included Arctic species or environmental conditions. Before using any additive during an oil spill response, it is important to understand the probable ecological benefits and harm that may come about from its application.

Many treatments are designed to enhance natural degradation by stimulating bacterial growth or altering oil to allow more effective consumption of the oil by the bacterial community. We desire to understand how rapidly degradation takes place, how completely the oil degrades, and the toxicity of the remaining oil.

When considering toxicity, we desire to understand not only the historical measures of acute toxicity, but the sublethal effects as well. Sublethal but significant effects of prolonged or acute exposure to additives, oil, and the combination of the two on critical biological functions in organisms are of great concern. It is important to evaluate the sublethal effects, including delayed responses, and to tie those effects to changes in the individual organism's ability to survive as well as to population level effects. We would like to know the duration of sublethal effects or whether they can be reversed. Toxicological studies can evaluate these effects on reproduction, immune function, and other useful endpoints. Testing should include both the additive by itself and combined with oil, and oil alone.

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Of particular interest to OSRI is to conduct toxicity testing on organisms important to the food web and people of Arctic and Subarctic regions. The testing of toxicity and degradation must use environmental conditions representative of the area. We desire tests that replicate the expected concentrations and exposure that would occur in ocean conditions.

Potential projects include:

- *Additive effectiveness*. Several products have been proposed as additives to spilled oil to speed up the natural degradation of oil by microbes. Few have been tested in conditions expected in the Arctic or Subarctic. Some have not been tested by independent parties. We desire to test the efficacy of these agents prior to a spill so we can understand their potential for spill remediation and their potential effects on the environment. There is a need to understand what the natural response time is to the additive and what end and intermediate products are produced. Linking the efficacy to toxicity is also desirable for understanding the impact of using these products. We expect the tests to cost $50K-$100K depending on the scope and complexity of the testing.
- *Sublethal toxicity*. Sublethal effects, such as alteration in immune function, fertility, or organ function are potential effects of low concentrations of oil in the water column. Exposure of individuals to a sublethal dose of oil could have long-term detrimental effects on the health and sustainability of that population. This may occur because of reduced immunological function or reproductive potential. Sublethal exposure at the egg or larval stage may also cause deformities or reduced heart function that can reduce survival at these stages. Sublethal toxicity studies are expected to require 2-4 years to complete and cost $100K-$150K per year to run.
- *Oxidation*. There is evidence that photo-oxidation and other oxidative mechanisms can change the toxicity of oil. The presence of these oxidized compounds is becoming more evident with newer testing capabilities. We desire to learn more about the toxicity of hydrocarbons after being oxidized. We are also establishing if there are existing background levels of oxidized compounds. Studies are expected to require 2-4 years to complete and cost $100K-$150K per year to run.
- *Degradation*. The final removal of a large portion of any oil spill is through degradation. It is important to understand degradation mechanisms and rates to understand the impacts of oil spills. There is a need to understand both natural degradation and the impact of degradation additives to the process. Studies are expected to require 2-4 years to complete and cost $100K-$150K per year to run.
- *Hydrocarbon impact*. There are many gaps in our understanding of the impacts of hydrocarbons. Some of the gaps are sublethal impacts, seasonality of potential

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impacts, connectivity between the water column and benthic environments, as well as impacts on specific organisms. Much remains to be understood about the effects of low levels of hydrocarbons on primary and secondary productivity. There is much to learn about the sublethal effects of hydrocarbon exposure on intertidal and planktonic communities and the time required for those communities to recover from exposure to hydrocarbons. We need to begin to understand the seasonality of potential impacts and connections between the pelagic and benthic environments. Such studies are expected to cost $100+K per year and, to be successful, are likely to require partnerships with other funding entities.

3. Ecological Research

Understanding impacts of spills begins by understanding the ecology of the area. This ranges from understanding circulation and other environmental drivers to predict areas likely to be impacted, to understanding the species that are present at various times of year. In a large spill, prioritization must occur to determine where to deploy resources in order to protect areas that may be difficult to clean, have resources that are harvested, or have key ecological function. Decisions will also need to be made on the response options to protect organisms on or in surface waters. Knowing what organisms can be found at any time and their location is therefore important.

Certain geographic regions may need additional attention for understanding the impact of a spill. Shipping across the Great Northern Route and along the Great Circle Route will both pass through portions of the Aleutian Islands where there is little information available that is needed to understand the potential impacts of an oil spill. This is particularly true in the western Aleutians. There continues to be interest in changing shipping patterns through the Arctic and the oil spill hazards associated with that shipping.

Partnership opportunities are expected to arise with the North Pacific Research Board (NPRB) through the existing joint funding program with OSRI, which focuses on the annual NPRB Request for Proposals. OSRI will continue to seek out partnership opportunities for research, such as working with the North Slope Science Initiative or with the Alaska Ocean Observing System. In other regions there are also potential connections with *Exxon Valdez* Oil Spill Trustee Council sponsored research, Prince William Sound Regional Citizens' Advisory Council, and the Cook Inlet Regional Citizens' Advisory Council.

Potential projects include:

- *Synthesis of existing information*. In order to develop predictive models that can

allow us to estimate what species should be expected in a given habitat at any given time of year, we need to establish what is known about those organisms (as to when and where they can be found), their environmental correlates, and subsistence and commercial uses. That knowledge must be on a scale appropriate for habitat association and spill response. We envision supporting that summarize the existing knowledge about a group of organisms including human uses. These are expected to cost $25K - $50K each and would take less than a year each to produce. This type of effort will be linked to efforts to develop spill response information tools such as environmental sensitivity index maps or guides for responders as described under the Respond goal.

- *Species surveys*. Based on the results of the white papers (described above), research is planned to fund mapping of spatial or temporal variability in key species. Two very likely gaps to emerge are the need to understand the seasonal patterns of larval fish and invertebrates, which would be affected by dispersed oil, and seasonal patterns of intertidal fish, which are commonly forage items for higher trophic levels. Past experience suggests such studies will cost between $75K and $100K per year and will require two to three years to complete. These studies may also be of interest to NPRB and EVOS.
- *Regional studies*. If shipping occurs along the Great Northern Route, it will intersect shipping following the Great Circle Route in the Western Aleutians. This puts the area at high risk for a spill and yet there is little information about the oceanography and ecology of the Western Aleutians. The Arctic is another area that has an increasing risk of spills due to shipping and oil and gas exploration and development. OSRI will seek partnerships to support synthesis of existing knowledge or new research and data collection in areas at higher risk from oil spills. OSRI expects that it would need to contribute $100K per year for two to five years for such efforts. Partnerships will need to be sought because the areas with the greatest needs are the hardest to access.
- *Environmental variability*. Baseline conditions are not simple snapshots of conditions. There is environmental variability that would need to be considered when trying to understand recovery from a spill. Environmental variability can be caused by short-term events such as ice scour or heat snaps or longer acting drivers such as climate change. Being able to identify the drivers of variability is also important. We expect a range of projects that could examine new approaches to monitoring and analyzing historic data to identify a range of variability. Projects may range from $50K in a single year to $125K/year for two or three years.
- *Habitat mapping*. Habitat mapping programs such as ShoreZone mapping of the intertidal zone provides critical information necessary for understanding oil spill impacts. It would now be helpful to extend the habitat maps into the sub-tidal

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zone so that all habitats that might be impacted by an oil spill are mapped. It is also necessary to develop predictive tools that associate organisms with habitat types. OSRI is not able to afford mapping large areas but may be able to partner with other organizations to collect the desired information. As was shown with the ShoreZone project, large areas can be mapped through partnerships. OSRI may be able to contribute $50K-$100K to a partnership effort for habitat mapping or tying species use to mapped habitats.

- *Spill trajectory*. Spill response is heavily dependent on accurate predictions of the oil trajectory. In the Arctic and Cook Inlet there is also the interaction of oil with ice. Cook Inlet also has extreme tides with significant intertidal lands that require wetting and drying algorithms and small-scale features such as tide rips that are expected to be important to oil spill transport. OSRI has supported several studies of ocean circulation and model development. Other modeling efforts, such as freshwater input model improvements, also need to be incorporated into the oil spill modeling to determine if they advance our understanding of oil spill trajectories. We need to identify where the existing modeling efforts work well and where they struggle. Projects that build upon the previous research to enable more accurate predictions of spill trajectory and interaction of oil and ice will be considered. We are also interested in projects that demonstrate the current capabilities of oil trajectory models. Projects lasting one to two years with budgets of $50K to $100K per year will be considered.

B. Respond: **Enhance oil spill response and mitigation capabilities in Arctic and Subarctic marine environments.**

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

Five research program areas have been identified as focal areas for the Respond program. These program areas and the projects included within them are based on building upon the work being done by NOAA, BSEE, USCG, Regional Citizen Advisory Councils, and industry. We anticipate being able to partner with many of these organizations to address our goals.

1. Prevention

Response to the remote locations in the Arctic and Subarctic is difficult. Prevention is key in reducing the potential of an oil spill. We will seek opportunities to support projects that will help prevent oil spills, particularly in the remote locations. Work may be conducted in partnership with other organizations, such as the Alaska Maritime Prevention and Response Network. It will be guided by existing risk assessment

documents, such as the Aleutian Islands Risk Assessment. This is a new direction for OSRI funding and we expect that the projects may be identified during the period of this research plan. We anticipate beginning our efforts through an analysis of casualties.

- *Analysis of casualties*. It may be possible to identify areas to apply new prevention techniques through the analysis of prior casualties. Syntheses of information from casualties will be sought. This work may be part of developing new risk assessments for areas of interest to OSRI. Results from this work will help guide additional prevention projects. We anticipate providing $25K-$75K for the development of syntheses.
- *Areas at risk.* Another tool for supporting the need for new prevention measures is the identification of areas at risk. New vessel location reporting requirements allow large vessels to be tracked. That information can then be used to identify areas where increased prevention measures may be required. There currently are systems for examining vessel traffic in the Arctic and Aleutian Island areas. Potential work may be in the analysis of changes in traffic patterns or analysis of vessel traffic in other areas. We anticipate providing $25K-$50K for such work.

2. Spill Response Information Tools

Several products useful to spill responders have been developed in the recent years. These include the ShoreZone maps, the Geographic Response Strategies, the Geographic Resource Information Network, Alaska Oil Spill Permits Tool, and the Alaska Ocean Observing System. With so many areas where information is available, some personnel may not be aware of these and other local resources. This leads to different groups involved in the spill response using different sources of information and different tools to visualize it. In order to assure that such resources are readily available during an emergency, OSRI would like to support the work that helps gather needed information and provide it in an easy to visualize manner or allow existing tools to work together better. OSRI looks to support tools that use open data standards and will avoid developing proprietary systems.

One commonly used tool is the Environmental Response Management Application (ERMA), which was developed through a grant from the Coastal Response Research Center. It is a geographic information tool that contains historical and real-time information for spill responders with mechanisms to input information during a spill. It appears that NOAA's Emergency Response Program will be adopting this tool for application throughout the country in the future. Any tools developed in this program will need to be compatible with ERMA.

During a spill, the incident command structure includes a number of different sections that all require specific types of information to be available. The Operations Section

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needs to know how their teams can access areas or conditions that may limit recovery operations. The Planning Section needs to understand which resources are most at risk, and the weather and currents to predict where the spill may spread. The Logistics Section needs to know what resources are available for recovery, medical facilities, and housing facilities. It is important to work with each of these sections to determine exactly what type of information they need, if new information tools are necessary, if there are important pieces of information available that are not currently being used, and if new information needs to be collected to demonstrate the capabilities of the existing systems.

Potential projects include:

- *Data products*. Some existing data sets have limitations and we may decide additional information is needed. For example, the pictures and video associated with the ShoreZone mapping effort may be of interest to several groups in the operations and planning sections; however, those images are all taken at low tide during the summer (so that the biology and geology of the intertidal can be mapped). In areas with large tides, the shoreline may not be recognizable at high tide to a person who only has a picture of it at low tide. Also, the access to the beach may be very different in winter and summer. Having imagery from high tide and in the winter may be important to some of the sections. Such imagery would be collected under this section. In some cases, the new high-resolution satellite data may provide a means to address the mapping needs. We anticipate funding up to three efforts to collect additional information necessary to complete an information tool. The costs of projects are anticipated to range from $25K to $75K.
- *New tools*. New information tools will be developed and demonstrated to make the existing information easier to access for individual response sections. Such efforts may include making it easier for people to access the complete ShoreZone image archive in their area, indexing of that imagery to allow rapid access to a particular location, and the development of tools that combine existing information into a simple access point. We anticipate providing $25K-$75K for the development of new spill response information tools.
- *Updating existing tools*. The Environmental Sensitivity Index (ESI) maps are a prime tool for spill responders to determine what resources may be at risk. These maps often need to be updated. As mapping becomes more on-line we expect that the ESI maps will transition out of their existing paper-copy format to a more electronic living-format system. As NOAA decides on how they want to move these maps in the future there will be a need to both update and transition the existing maps to the new format. Similarly, the Geographic Response Strategies (GRS) require updating as coastal morphology changes and testing determines that changes in the GRS are required. OSRI would like to contribute to updating

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and testing the existing spill response information tools. The OSRI contributions are anticipated to range from $50K to $150K per year and may last up to three years.

3. Oil Spill Detection and Tracking

The rapid and efficient response to oil spills requires being able to detect and track them. Detection commonly relies on aerial over-flights for visual detection. This is not practical at night, during inclement weather, and in ice, all common conditions in Arctic and Subarctic environments. It may not be observable if the oil is subsurface as well. Several new approaches for detection at night and during inclement weather (such as infrared and x-band microwaves) are being tested and shifted into an operational mode. Some of the systems are designed for specialized aircraft, which may be too large, expensive, and technical to transition to individual oil spill response organizations. OSRI will focus on adapting or testing technologies designed for a variety of vessels and aircraft that may be used for spill response in Alaska. It will also be important to develop systems that can help guide responders to the thickest portions of the oil by providing a measure of oil thickness. There is also interest in being able to identify the components of oil, not just bulk hydrocarbons, within the water column.

Spill detection in and under ice has made advances recently. The use of microwave radar, acoustic systems, and optical sensors have been tested and have demonstrated potential for detecting oil in and under ice. To date, the work has focused on proving the ability to detect oil in and under flat sea ice. The inclusion of rafted and ridged ice is a natural extension of that work. Work remains on detection in frazil, slush, and grease ice as well.

Tracking of oil spills can be accomplished using visual observations, tracking buoys, and, in some cases, remote sensing techniques. For spills in ice, it may be necessary to track the ice for a long time period before a response option becomes feasible. Because of the divergence of ice over time, it will be necessary to deploy a large number of buoys or develop other techniques for monitoring the ice location. For open water spills, it is desirable to reduce the size and cost of the buoys, and increase the probability that the buoy will remain with the oil.

Potential projects include:

- *Development of airborne systems for detection of oil in ice.* Normal airborne surveillance techniques for detecting oil spills will not work for spills under ice. There are currently efforts to develop microwave radar and nuclear magnetic resonance systems to allow rapid airborne surveys. Other sensors such as radar, infrared, and laser fluorosensors need to be validated for operations in ice conditions. It is expected that some of these sensors will not be able to

discriminate oil contained in leads during portions of the winter or that modifications may be necessary before they can be used in the Arctic. OSRI will consider partnering with other organizations to continue development and testing of airborne systems for detecting oil under snow and ice. Projects are expected to take one to three years and cost $50K-150K per year.

- *Oil thickness estimates.* It is important to know where the thickest oil is located during a spill to optimize cleanup efforts. Oil thickness is also needed to estimate the volume of oil and potential harm to the environment during the natural resource damage assessment. Advances in optical and infrared remote sensing techniques are allowing for thickness estimates. It is desirable to continue the development and testing of remote sensing techniques for determining oil thicknesses from sheens to centimeters of fresh, weathered, and emulsified oils. Projects are expected to take one to three years and cost $50K-$150K per year.
- *Improve oil tracking buoys.* Oil tracking buoys provide a means to mark an oil spill in a manner that can be tracked independently from environmental conditions. There are several issues that need to be addressed, including: reducing cost, improving operational life, and improving the ability to remain with the oil either at the surface or subsurface. These improvements may be made to the existing satellite tracked drifters; through development of systems using alternative communication routes, such as cell phones; and the consideration of passive tags, such as radio frequency identification tags. Projects are expected to last one to three years at a cost of $50K-100K per year.
- *In-situ and remote sensing measurements of oil components.* Advances in measurement technologies are reaching the point where it is not only possible to detect spilled oil but start to determine the components that may be present. These technologies are also being miniaturized enough to be deployed at sea on a variety of platforms. Determining the relative fractions of various components is also needed as inputs to newer toxicology models that separate the toxicology of various fractions of the oil. It will be important to consider how conditions like large sediment loads may affect measurements. OSRI seeks to support demonstrations of technologies that can be deployed in-situ or remote sensing tools that allow for detection of the dissolved components of oil. Projects are expected to last one to two years at a cost of $50K-100K per year.

4. Spill Response Improvements.

Spill response technologies continue to improve. For mechanical recovery there is always a desire to develop tools or approaches that increase the encounter rate or efficiency of the systems. There continues to be a need to find ways to manage ice or debris to allow the systems to operate optimally. And there is a need to produce tools that are easily deployed in the communities along the coast. These communities often have limited

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infrastructure for aircraft or marine vessels that are necessary to handle much of the larger equipment currently used.

There is also a need to continue to improve the non-mechanical approaches to spill response. There is a desire to find ways to increase the efficiency of in-situ burns and reduce the pollutants they generate. New formulations of dispersants should be considered along with means to determine the effectiveness of dispersant applications in the field.

The presence of ice makes spill response much more complicated than in open water. Equipment and tactics need to be developed or modified to allow response during ice formation, on thicker winter ice, in broken thick ice flows, and on pack and landfast ice. The oil may flow below the ice, become encapsulated in the ice for long periods of time, or rise to cover leads in the ice. Different approaches are likely to be needed in the fall and spring transition periods between ice-covered and open waters. The ability to respond to a spill in the ice requires a better understanding of the fate and behavior of oil, the development of means to contain the oil under the array of conditions, and the development of means to recover the oil.

It continues to be important to demonstrate how new technologies or tactics work. This may be achieved using modeling and large-scale laboratory testing, but in the end, it will only be through intentional releases or testing during a spill that we will fully understand the capabilities of any new tool or tactic.

Potential projects include:

- *Improving ice or debris processing capabilities in skimmers.* Ice and floating debris can foul a skimmer reducing the ability of it to recover oil. Means to separate and treat ice or debris are needed to maximize the efficiency of recovery systems. In instances where the skimmers can collect an oil and ice mixture, there remains a need to separate the ice from the oil to reduce the storage capacity requirements. Research is needed to help identify new designs that can efficiently remove oil in the presence of small pieces of ice or debris. Projects are expected to take one to two years and average between $75K and $150K per year.
- *Collection of oil in and under ice.* Current tactics for removing oil under ice involve drilling holes into the oil pool to allow collection at the surface. Newly spilled oil can move along the bottom of the ice to allow a single collection point to retrieve oil from a larger area. If the oil has been exposed to sunlight for a couple days, the oil can melt up into the ice, stopping its ability to flow to a retrieval point. Similarly, ice growth can restrict the movement of oil. New techniques for collecting oil under ice or moving oil to a surface collection point

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could enhance oil recovery. Projects would be expected to demonstrate feasibility of retrieval techniques and typically take one to two years at $50K-$100K per year.

- *Understanding and improving in-situ burns.* Burning of oil should be considered in any oil spill response. In the Arctic, burning may be one the most effective manners to remove oil from the environment, but there are several issues that need to be better understood to improve decision on the use of burning and to improve the techniques used. Improvements include safer ignition systems, improved containment and concentration systems, and more efficient burning techniques to reduce the smoke generated. There have been new developments that warrant further testing to determine if they can lead to cleaner burns. Projects are expected to take one to two years and average between $50K -$100K per year.
- *Determine the fate and behavior of oil in broken ice.* The presence of ice can potentially alter the fate, behavior, and transport of oil. Ice will act as a natural boom in some conditions reducing the spread and transporting the oil. At the same time, strong currents in a lead can pull oil off the water surface and transport it under the ice, or the movement of ice can cause the oil to be pumped into the water column. The problem of modeling the transport of oil in the presence of ice is compounded by the scales that ice and circulation models operate. Merging ice, circulation, and oil spreading models remains to be achieved and testing those models presents another problem. The fate, behavior, and transport of oil in a variety of broken ice conditions needs to be determined. In particular, we seek to understand how that fate and behavior relates to the effectiveness of spill response countermeasures. Projects are expected to take one to three years and average between $100K and $200K per year.
- *Testing the effectiveness of techniques under cold weather conditions.* Many of the technologies and tactics that could be used during a major spill in the Arctic or Subarctic marine waters were developed and tested in more temperate climates or lack enough testing to determine their potential effectiveness. Even tactics that are commonly practiced, such as the gated-U configuration, are not well enough understood to know what the limitations of the tactic are. What is the maximum advance speed of a gated-U configuration before oil becomes entrained under the boom? Chemical formulations meant to disperse or more rapidly degrade oil may need testing under conditions appropriate for the Arctic and Subarctic. Projects examining the effectiveness and efficiency of response options are expected to take one to three years and average between $100K and $200K per year.
- *Equipment appropriate for local use.* Many of the tools that spill responders rely on require vessels larger than are normally available along much of the coast of Alaska. It would be difficult to fly even many smaller systems into coastal Alaskan communities. Because of the distances involved, it may take several days

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for resources to reach a spill. This delay in response time will make recovery more difficult and allow the spill to affect a larger region. We will seek to support the development and testing of equipment that can be rapidly deployed to remote locations and deployed using resources expected to be in the area. Alternatively, we may seek projects that identify new ways to provide rapid response to remote locations. Projects are expected to take one to three years and average between $50K and $100K per year.

5. Health and Safety.

The health and safety of oil spill responders and community members is a prime concern during spill response. Response options may have different impacts on worker health and marine resources used by local communities. We need to be aware of the tradeoffs associated with the different response options.

Exposure to volatile organic compounds (VOCs) and small particulate materials from in-situ burns are considered health risks to spill responders and surrounding communities. Better understanding of the exposure, how response options may change exposure, and the health impacts associated with oil spills is important when deciding when to use different response options.

- *Impacts of response options on health and safety*. The safety of responders and community members is critical during spill response. The application of dispersants has been considered to be important to responder health because of the potential to lower VOCs. It is also considered a risk if people are exposed during the application. Similarly, in-situ burning generates particulates and other compounds that are considered hazardous but can also remove oil rapidly thereby reducing worker exposure to oil. It is often difficult to track worker exposure to be able to analyze if a person was exposed and what activity they were involved in when exposed. Understanding when people, responder or community member, are exposed and levels of exposure under different response options is important during spill response. There are a wide range of possible projects from analyzing historic data to developing new approaches for monitoring. We expect that projects would costs from $50K for a single year to $300K over multiple years.
- *Improving personnel tracking*. A large issue in examining exposure is knowing where the people were at any given time and the likelihood that they may have been exposed to VOCs, smoke plumes, or dispersant applications. Studies that look at human health during an oil spill often have to depend on self-reporting of exposure. We would entertain projects that improved our understanding of the potential exposure of personnel. We expect projects to last one to two years at $50K to $150K per project.

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C. Inform: **Share information and educate the public on the issues of oil spill prevention, response, and impacts.**

a. Publish scientific and technical results in the open literature.
b. Brief the response, assessment, and restoration communities on OSRI efforts.
c. Facilitate the exchange of information and ideas through workshops and other forums.
d. Educate future researchers and responders through K-12 programs, undergraduate internships, and graduate fellowships.
e. Convey information to the general public through various media.
f. Serve as a source of expertise.

This goal is tightly linked with the projects within the other goals and is meant to align with those other priorities. For instance, the objective to publish results in open literature is included in this goal but will be carried out through the efforts funded under the Understand and Respond goals. The briefing of oil spill removal organizations and conveying of information will occur as a result of the development of products under the other goals. Workshops or conferences are a means to convey information or to guide the development of best practices, new techniques, and equipment. Many of the efforts in this section will be guided by a communication plan that is anticipated to be developed in late 2020. It is expected that involvement with the local communities will be important for exchange of information on the areas of interest to those communities and in providing greater information to the communities about what resources are available and the basics of how spill response is expected to work. This goal also encompasses the education component that aims to develop the next generation of researchers and responders and keep the public informed of improvements in response techniques and our understanding of the marine ecosystems potentially affected by oil spills.

1. Workshops and Conferences

Workshops, conferences, and symposia provide forums to inform scientists, spill responders, and other interested parties in the outcomes of OSRI funded activities. They are also locations for gaining input on projects that OSRI should be considering in the future. Workshops are also used to develop products, such as best practices. Conferences, workshops, and symposia with foci that overlap with the OSRI mission will be considered for support. The funding structure for these programs may need to be flexible. Conference sponsorships can be identified relatively far in advance; however, many important workshop opportunities are identified with a shorter lead time and will require a flexible funding structure.

- *Conference sponsorship*. OSRI will look to support the regularly scheduled conferences that are avenues for OSRI-sponsored investigators to present their results, or provide avenues for OSRI to brief potential users of OSRI-funded

products. Sponsorship is expected to be between $2K and $10K per conference.

- *Workshop support.* OSRI will support workshops aligned with OSRI's goals and objectives. Support may range from being the organizer and major sponsor to providing support funding that will assure the completion of reports and/or other aspects necessary to providing a quality final product. Workshops can be useful for the development of best practices, or to convey ecological risks of response options. Workshop support is expected to range from $1K to $50K.

2. Education

Development of future researchers, engineers, and others involved in oil spill response requires an education component that exposes students to the issues important to ecology and technology. OSRI has been a strong supporter of education programs targeting students from kindergarten to graduate school. The existing education programs reach a wide range of ages and provide very good information. These include the Discovery Room program that works with K-6th graders in Cordova. The Discovery Outreach program takes components of the Discovery Room to other communities in Alaska, both in Prince William Sound and beyond. We also support projects to incorporate more technology into the materials available. Higher level education components include an undergraduate scholarship and the graduate research fellowships.

- *Graduate Research Fellowship* program. The Graduate Research Fellowship (GRF) program is designed to provide partial support for students in master's or doctoral programs. It also provides a means to work on the programs outlined in the various goals of this research plan. This program has resulted in numerous peer-reviewed publications. OSRI will solicit proposals for the GRF program subject to available funding. OSRI will strive to maintain at least three students in the GRF program with additional students if funding allows. Fellowships may be funded for up to four years. Doctoral students may apply for a two-year extension during their fourth year for a total of six years of funding. Fellowships will be funded at $30K per year.
- *Undergraduate internship*. There continues to be a desire to prepare more people of the region for work in spill response. Undergraduate internships provide a mechanism to support students who will become the future workforce, but who are not necessarily continuing their education in graduate school. This is particularly true of students getting degrees designed to prepare for jobs with oil spill recovery organizations or agencies involved in spill response. This program will be designed to provide internships for students to work with oil spill response organizations or agencies dealing with Arctic and Subarctic spills. The program is expected to cost $15K per internship.
- *Oil spill response short course.* In addition to internships, it is desirable to develop an oil spill short course that can be taught at community colleges and

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universities throughout Alaska. It is envisioned that the course would combine aspects of the Science of Oil Spill course offered by NOAA and the Hazardous Waste Operations and Emergency Response (HAZWOPER) course needed by spill responders. As this is envisioned as a new college level course, the curriculum and teaching materials will need to be developed and tested through delivery. The program is expected to cost $25K per year for development, then delivery and refinement.

- *K-12 education*. Development of future oil spill responders and ecologists begins early in the education process by getting students interested in science and technology. To help encourage students into these fields, OSRI contributes to the Prince William Sound Science Center's Headwaters to Ocean program. The program is aimed at K-12 students and creates opportunities to get students excited about environmental science and technology by involving the students directly in collecting data, building remotely operated vehicles, and learning about the marine environment. Activities can take place in the classroom or in the field throughout the year. Hands-on activities are expected to be emphasized. There is a desire to continue the program and provide delivery to other areas around the state. It is anticipated that this will be accomplished by developing materials that can be transferred to other education facilities and the partnerships necessary for delivery. This can include traveling to schools around the state to teach, delivering the materials through programs where students from around the state come together, developing distance learning approaches, and partnering with summer education programs for delivery of the materials. It is desirable to ensure course evaluation criteria are developed and tracked. OSRI intends to contribute at a level of $60K per year.
- *New Education Materials*. While the OSRI-sponsored education program has been very strong, there continues to be a need to develop new and improve existing materials related to oil spills. There is also a need to ensure that the materials can be used by other education organizations. Potential efforts include: a workshop with other appropriate education groups to outline methods to transfer ocean science and technology education programs to other regions; development and testing of additional educational materials; and development and testing of ocean science programs targeted at students throughout the Arctic and Subarctic regions. These materials may also be developed for outreach activities to communities. We anticipate projects will be completed within a year with a budget of $15K to $30K.

3. Outreach

Outreach through several mechanisms provides the opportunity to inform members of the public on the research findings and technological developments sponsored by OSRI.

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OSRI outreach efforts are expected to be further guided through the development of a communication plan that is expected to be completed in 2021. OSRI has contributed to a winter lecture series in Cordova, which is also broadcast to a broader audience through Facebook live. Additional support has been given to the *Field Notes* radio program aired throughout Prince William Sound, printed materials developed for visitors, and community events, such as the Shorebird Festival, that involve people from a large geographic area.

- *Outreach*. It is important that the results of OSRI-sponsored efforts are widely distributed to the public. Recently, outreach targeting the oil spill response community has been conducted by the OSRI Research Program Manager through venues such as the International Oil Spill Conference. Conference attendance will remain an important outreach tool. The desire is to disseminate OSRI efforts more broadly through a wide array of media options, such as printed materials, radio broadcasts, and video or computer presentations. These efforts are expected to be guided by a communication plan. There is a desire to expand outreach efforts through visits to coastal communities where balanced information regarding spill response can be presented. The development of a social media presence is also expected to be examined. This may be done by the RPM or contracted out. It is expected to cost $5K-$10K per year to develop outreach materials with additional funding needed for travel to particular events or communities.
- *Materials*. Many organizations have identified the importance of developing unbiased (balanced) information materials about oil spills, oil spill response, and oil spill impacts that can be shared by various means. OSRI is well suited for development and review of such materials. Materials are expected to be developed for delivery through the web, print materials, and potentially radio or video materials. This work may be done through the RPM budget or contracted out depending on the level of complexity. It is expected that the development, review, and distribution of outreach materials will cost $10K-$25K per year.

D. Partner: **Partner with other organizations to take advantage of shared funding, facilities, knowledge, and experience.**

a. Coordinate with other efforts related to OSRI's mission.
b. Seek out new partnership opportunities.

Partnering is the preferred approach to achieving projects. This plan outlines a scope of desired research that is outside the funding capabilities of OSRI alone. Whenever appropriate, partnerships will be developed to help further projects outlined in this plan. OSRI expects to maintain its partnerships with the Alaska Ocean Observing System and North Pacific Research Board to fund projects outlined in the Understand goal. We will seek to develop new partnership opportunities through participation in the efforts of

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groups like the North Slope Science Initiative, the Coastal Response Research Center, Cook Inlet and Prince William Sound Regional Citizens' Advisory Councils, and the *Exxon Valdez* Oil Spill Trustee Council. OSRI will continue to seek opportunities to partner with industry (Shell, Conoco-Phillips, ExxonMobil, American Petroleum Institute and others), government (Interagency Coordinating Committee for Oil Pollution Research, Bureau of Safety and Environmental Enforcement, United States Coast Guard, National Oceanic and Atmospheric Administration, Alaska Department of Environmental Conservation, and others), oil spill response organizations (Alaska Clean Seas, Cook Inlet Spill Prevention and Response Inc., and others), and other interested groups to further the development of new response technologies and tactics. Achieving our inform goal benefits from many partnerships. Symposia and other large meetings are only possible through financial and time contributions from an array of different groups. Funding of graduate students and K-12 education programs will require those efforts to develop partners for covering the full costs. We also anticipate that the education program will work with other educators and native organizations to reach the people of the Arctic and Subarctic coastal communities.

The beginning of this research plan overlaps with the Canadian Multi-Partner Research Initiative (MPRI). The MPRI is a large research program with a potential field release that will be important for testing many of the newly developed technologies. OSRI will seek out other international partnership opportunities. One approach to identifying potential projects is through the Emergency Prevention, Preparedness, and Response (EPPR) Working Group of the Arctic Council. EPPR provides connections to the spill response related work of the Arctic nations.

Nationally, the Interagency Coordinating Committee for Oil Pollution Research (ICCOPR) is a committee with members from federal agencies involved in oil pollution prevention, response, and restoration. They are currently revising their research and development priorities. There is considerable overlap between OSRI and ICCOPR research priorities that can lead to partnerships with the various agencies involved in ICCOPR.

OSRI is willing to consider a variety of roles in partnerships, from serving as a contributing member to leading the development of new programs. We recognize that flexibility in funding allows OSRI to contribute to programs that may need a small amount of funding support to produce a quality product. At the same time, OSRI will provide the leadership necessary to ensure significant gains are made in our ecological understanding of and our capability to respond to oil spills.

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E. Other Programs:

These programs provide oversight for achieving the goals listed earlier. It includes the Research Program Manager position and funding for the Scientific and Technical Committee meetings.

1. Research Program Manager

As described in section II.E.3, the Research Program Manager (RPM) plans research programs, prepares annual work plans in consultation with the Work Plan Committee and the Advisory Board, works with OSRI Executive Director on fiduciary issues, and implements the work plan as approved by the Advisory Board. The RPM also coordinates proposal reviews, works with the Scientific and Technical Committee on future research direction, proposal selections and recommendations to the Advisory Board, and ensures compliance with all policies and procedures of the Grant Policy Manual. Specific tasks are described below.

- Preparation of annual work plan in consultation with the board-appointed work plan committee and in accordance with the five-year research plan. Compile information about potential projects, write brief project descriptions, and prepare project budget estimates.
- Implement the work plan as approved by the Board. This includes drafting requests for proposals based on the annual work plan priorities and coordinating the peer review process with OSRI's Scientific and Technical Committee and with other organizations OSRI partners with for research projects.
- Develop white papers describing the state of knowledge on subjects OSRI is considering funding.
- Coordinate with the chair of OSRI's Scientific and Technical Committee (STC) to assure regular transfer of information between the OSRI Board and the STC. Provide assistance, as requested by the STC chair, in scheduling meetings.
- Meet 2-3 times per month with the OSRI Executive Director (ED) to exchange information concerning program issues and contract awards.
- Assist the ED to ensure compliance with all policies and procedures of the OSRI Grant Policy Manual.
- Coordinate the processing of contracts for successful proposals. Monitor progress and final report deadlines for these contracts.
- Prepare bi-annual reports on OSRI grant awards and research and education programs for distribution to the OSRI Board.
- Prepare and publish an annual report for broad distribution.
- Supervise maintenance of the OSRI website.
- Develop web materials describing our knowledge related to oil spills and their effects.
- Collaborate with the OSRI ED to develop and maintain cooperative agreements

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with other organizations for research and education programs, for example with the North Pacific Research Board, the two Regional Citizens' Advisory Councils, the Alaska Ocean Observing System (AOOS), the Alaska Department of Environmental Conservation, the UNH/NOAA Coastal Response Research Center, US Bureau of Safety and Environmental Enforcement.

- Periodically represent OSRI at professional meetings and workshops.
- Maintain files and a library on oil pollution issues.
- Provide leadership in planning future research programs and work plans.
- Prepare technical reports on OSRI programs.

2. Scientific and Technical Committee

This program provides funding to support the functions of the OSRI STC, and to support board and STC travel-related expenses. The STC generally will meet each year to evaluate proposals and help provide direction for the next year. STC members may meet a second time to develop a work plan for the following year.

E. Timeline and Budget:

The exact amount of funding available each year depends on current interest rates and the amount of principal dedicated to OSRI. Past annual deposits have ranged from $225K to $1,210K. It is anticipated that deposits will be in the $700K to $900K range during this five-year period. To account for the changes in annual funding, the programs to be funded each year are determined by the STC and the work plan committee of the Advisory Board.

The process for developing the annual work plan is as follows: The RPM will meet with the STC in the spring to discuss upcoming partnership opportunities and prioritization of projects within the research plan. From that meeting, the RPM develops a draft work plan. A work plan committee that includes members of the Advisory Board and may include STC members then meets in early summer to review and revise the draft work plan. The revised draft is then presented to the full Advisory Board in September or October for approval.

Once the work plan is approved, then requests for proposals will be developed and released as appropriate. In some cases, partners will release the requests for proposals and OSRI will contribute funding to the program selected by the partner.

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