# The Multi-Partner Research Initiative: A Scientific Research Network to Support Decision Making in Oil Spill Response

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**ABSTRACT:**

The Government of Canada's Oceans Protection Plan (OPP) is a comprehensive, transformative $1.5 billion strategy to build a world-leading marine safety system to protect marine ecosystems, while enabling inclusive economic growth. A key component of the OPP is the Multi-Partner Research Initiative (MPRI), led by Fisheries and Oceans Canada (DFO) in collaboration with other federal agencies (Environment and Climate Change Canada, Canadian Coast Guard, Natural Resources Canada, and Transport Canada), that aims to advance oil spill research by fostering a national/international research network that brings together scientific experts in the field. The core studies under this program are focused on the provision of scientific knowledge to support the development, validation and regulatory approval of Alternative Response Measures (ARMs) that include: spill treating agents, in situ burning, oil translocation and decanting/oily waste disposal. Additional research includes studies on key "cross-cutting" issues, such as natural attenuation and bioremediation of oil, assessment of toxic impacts associated with oil spills and the application of oil spill countermeasures, and oil detection and mapping by autonomous underwater vehicles (AUVs). The deliverables from this research program will provide essential information to support Net Environmental Benefit Analysis (NEBA) for decision making to select the optimal oil spill response option(s) to protect the marine environment and its living resources. With an emphasis on supporting the development of the next generation of scientists in the field through engagement with the private sector (i.e., spill response organizations and oil industry partners) and other international (e.g., USA, Norway, France, Australia, China) government agencies, MPRI is anticipated to have a profound influence on the oil spill research community and emergency response agencies within Canada and abroad.

**INTRODUCTION:**

Canada has the longest coastline in the world. The coasts play a key role in supporting Canada's economy, including the fisheries and other industries (e.g. recreation and tourism), the way of life and culture of Indigenous communities, and overseas foreign trade. In 2017, ports and marine shipping handled $101 billion (19%) of Canada's exports to world markets and $116 billion (21%) of Canada's total imports by value. Petroleum products represented the largest marine export and import commodity travelling through Canadian ports and on Canadian waters - 24% of our marine exports and 17.8% of our marine imports by value were petroleum products. Marine trade employs approximately 250,000 Canadians and injects more than $25 billion to Canada's economy.

In 1995, to ensure safe and environmentally responsible shipping, Canada established the Marine Oil Spill Preparedness and Response Regime (https://www.tc.gc.ca/eng/marinesafety/oep-ers-regime-menu-1780.htm) with shared responsibilities between the shipping industry and the Government of Canada to protect its marine environments and communities from the risk and impacts of oil spills from ships and their oil handling facilities. This Regime has three components: 1) Prevention: avoiding accidents and incidents; 2) Preparedness and response: being ready and able to quickly and effectively respond to a pollution incident; and 3) Liability and compensation: based on the polluter pays principle.

The number and volume of ship-source oil spills in Canadian waters have been declining consistently since the 1980s due to improvements in vessel design, technology, shipping practices, and the establishment of Canada's Marine Oil Spill Preparedness and Response Regime. However, vessel traffic and cargo volumes have grown, and are expected to continue to



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grow over the next few years on all of Canada's coasts as overseas trade and the movement of goods and cargo continues to increase. Marine traffic is also expanding in Canada's Arctic waters due to urban/industrial growth, ecotourism and the extension of the open water season due to climate change. With increases in vessel traffic and cargo volumes, as well as the expansion of the offshore oil and gas industry, there may be increased risk of marine safety accidents and pollution incidents.

To deal with potential future increases in marine oil spills, in 2016, the Prime Minister of Canada announced a 5 year $1.5 billion national Oceans Protection Plan (OPP), the largest investment the Government of Canada has ever made to protect its coasts and waterways. With over 50 initiatives led by federal agencies, including Fisheries and Oceans Canada (DFO), the Canadian Coast Guard, Environment and Climate Change Canada, Transport Canada and Natural Resources Canada, OPP has a goal to: 1) Improve marine safety and responsible shipping; 2) Protect Canada's marine environment; 3) Strengthen partnerships with Indigenous communities; and 4) Invest in science for evidence-based decision making.

To assure its citizens that Canada has the knowledge, expertise and capacity to handle a "worst case scenario spill", the OPP includes a number of initiatives that will enable Canada to compare favourably with the best international marine safety regimes in the world and to address gaps in Canada's current regime. Identified key measures constituting a world-leading regime under the program include: 1) Leading-edge research on oil spill cleanup technologies; 2) Enhanced oil spill preparedness and response through area-based planning; 3) Partnerships and continuous improvements to our understanding of how oil spills behave, what impacts they may have and how best to mitigate impacts to achieve ecological recovery; and 4) A greater role for Indigenous groups in the marine safety regime.

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Under the leadership of DFO in collaboration with other Government of Canada Departments (Environment and Climate Change Canada, Canadian Coast Guard, Natural Resources Canada, and Transport Canada), the Multi-Partner Research Initiative (MPRI) is a key component of the OPP which aims to advance oil spill research by fostering and leveraging funding of a national/international research network that brings together scientific experts in the field from academia, industry and other government agencies.

**MPRI PROGRAM DEVELOPMENT AND DESIGN:**

Recommendations from Transport Canada’s Tanker Safety Expert Panel review of Canada’s ship-source oil spill preparedness and response regime (Houston et al., 2013; 2014) and a Royal Society of Canada (RSC) Expert Panel on the behaviour and environmental impacts of crude oil released into aqueous environments (Lee et al., 2015) provided guidance for the selection of research priorities for the MPRI program. The Tanker Safety Panel noted that while Canada’s current oil spill response regime was fundamentally strong, response planning could be improved by providing a greater emphasis on spill response strategies identified for potential high-risk geographic areas that will most effectively limit the environmental and socio-economic impacts. The RSC Panel noted that there are a multitude of crude oil types transported in Canada representing a continuum from light oils to bitumen and heavy fuels, each with unique properties (chemical ‘fingerprints’) that determine how readily spilled oil spreads, sinks, disperses, impacts aquatic organisms, including wildlife, and what proportion ultimately degrades in the environment. However, despite the importance of oil type, the Panel concluded that the overall impact of an oil spill, including the effectiveness of an oil spill response, depends mainly on the environment and conditions (weather, waves, etc.) where the spill takes place and the time lost before remedial operations are undertaken.



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Based on a review of case studies, the Panel noted that a major factor controlling the success of spill response operations would be the provision of timely evidence-based advice for decision making on the types and selection of available cleanup strategies. The Panel recommended concentration of research on seven high-priority areas: 1) The environmental impact of spilled crude oil in high-risk and poorly understood areas, such as Arctic waters, the deep ocean, shores, and inland rivers and wetlands; 2) The effects of oil spills on aquatic life and wildlife at the population, community and ecosystem levels; 3) A national, priority-directed program of baseline research and monitoring to develop an understanding of the environmental and ecological characteristics of areas that may be affected by oil spills in the future and to identify any unique sensitivity to oil effects; 4) A program of controlled field research to better understand spill behaviour and effects across a spectrum of crude oil types in different ecosystems and conditions; 5) The efficacy of spill responses and how to take full advantage of 'spills of opportunity'; 6) Improve spill prevention and develop/apply response decision support systems to ensure sound response decisions and effectiveness; and 7) Update and refine risk assessment protocols for oil spills in Canada.

Implementation of the OPP supports the Government of Canada's consideration of changes to key pieces of legislation, including the *Canada Shipping Act, 2001* and the *Marine Liability Act*, to enhance marine ecosystem protection, strengthen environmental response, modernize Canada's Ship-Source Oil Pollution Fund, and support research and innovation. To enhance Canada's "oil spill response tool box" there is currently a need for legislative amendments to lift legal prohibitions to using Alternate Response Measures (ARMs) during emergencies, and to clarify the Canadian Coast Guard's authority to use ARMs to reduce the environmental impact of ship-source oil spills. While a number of these technologies have been

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approved for use and have been deployed with success in other countries, as noted by the Tanker Safety Expert Panel (Houston et al., 2013), mechanical recovery (booming and skimming) is the predominant spill response measure used in Canada as a number of federal laws currently limit the use of ARMs, such as spill treating agents (e.g. oil dispersants), even though using these tools could provide a net environmental benefit if applied under the right circumstances.

As science-based evidence is needed to support decision making for the needed changes in policies and regulations and the selection of optimal spill response protocols, and following extensive consultation with key clients and stakeholders in the oil spill response community, government regulatory agencies and the scientific community, it was decided that MPRI would focus its research efforts on supporting the development, validation and regulatory approval of ARMs that include: 1) spill treating agents; 2) in situ burning (ISB), 3) oil translocation, and 4) decanting/oily waste disposal. In addition, as oil spill response technologies will never be 100% effective, research would also need to be conducted on key "cross-cutting" issues, such natural attenuation and *in situ* bioremediation of residual oil, assessment of toxic impacts associated with oil spills, and oil detection/mapping (including the use of autonomous underwater vehicles [AUV]). It's important to note that the use of ARMs will provide an expanded range of options to be used alongside conventional containment and recovery techniques to enhance the effectiveness of the response. Scientific deliverables from MPRI will provide essential information to support Net Environmental Benefit Analysis (NEBA) for decision making to select the optimal oil spill response option(s) to protect the marine environment and its living resources.

As noted, the goal of MPRI is to build a research network that brings together the best scientific expertise in oil spill research, both nationally and internationally, from the academic,



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industry and government sectors to advance scientific knowledge in multiple fields to address major gaps in oil spill response and remediation strategies. This initiative contributes towards Canada's goal of establishing a "world-class" oil spill response regime that would also support the development, validation and Canadian regulatory approval of ARMs on the operational scale. To date, over $35 million in grants and contributions have been awarded by DFO to 35 research projects/partnerships involving over 90 researchers and 39 institutions (project descriptions can be found at: https://www.dfo-mpo.gc.ca/science/rp-pr/mpri-irmp/index-eng.html). In the future, amendments and new projects will be funded to ensure optimal progress under the program based on the availability of additional funds (including the procurement of leveraged external funds), the results of preliminary work, and identified emerging issues of concern. The MPRI science management team is also supporting a number of its Principal Investigators to acquire the legal authority to conduct field trials (controlled experimental releases of oil) to demonstrate and evaluate spill response technologies on an operational scale under realistic environmental conditions.

## PROJECT GOALS AND ACTIVITIES:

MPRI has established a governance system whereby projects are coordinated under five research program elements that have oversight provided by a Technical Advisory Committee (comprised primarily of scientific and industry experts) that reports to an Advisory Committee (key national/international clients and stakeholders in government and industry) which provides recommendation to a Steering Committee (senior representatives of the federal agencies under the OPP).

### MPRI Program Area 1: Spill treating agents



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Dispersants attract the most public attention of all the ARMs due to the controversy over their effectiveness and environmental safety. MPRI is supporting a comprehensive review on the history and future direction of oil dispersant testing. To provide supporting information for decision making during oil spill response operations, research is being conducted to evaluate the effectiveness of the principal dispersant formulations for future use in Canada for treating a range of crude oils (from condensate to diluted bitumen) and refined products (e.g., Bunker C, marine diesel and new low sulphur fuel oils[LSFO]) under various conditions. Studies are being conducted to better understand oil droplet formation with various types of oil and how dispersants and physical oceanographic factors may influence its subsequent transport, fate (e.g., biodegradation) and toxicity. MPRI is also evaluating the potential use of less toxic, more biodegradable bio-surfactants as a substitute for petroleum-based surfactants and the use of artificial energy (e.g., propeller wash, water flushing) to expand the "window-of opportunity" for use of dispersants in calm conditions with little natural wave turbulence.

In terms of subsurface releases of oil and the application of subsea dispersant injection (SSDI) as an active countermeasure, predictive models are being developed that consider the key factors that influence the entrapment of oil and gas, including: release depth, release orifice size, petroleum flow rate, petroleum type, and the influence of site-specific (e.g., off the coast of Newfoundland, Canada) environmental conditions. To elucidate the significance of oil particle interactions on the fate, behaviour and environmental impacts of oil spilled at sea, MPRI is investigating the partitioning of oil between the dispersed and aggregated phases, and the consequences of this partitioning (e.g., consumption of oil by zooplankton, the degradation of oil trapped within aggregates during their sedimentation).

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In addition to dispersants, MPRI is also evaluating the effectiveness of chemical herders to contract and thicken surface oil slicks (including photo-chemically weathered crude oils) so that they can be more easily burned or physically removed and thus improve the efficacy of ISB and booming and skimming operations.

Projects include:

- Comprehensive analysis of technical effectiveness for using dispersants for marine oil spills in Canadian waters
- Effects of crude oil properties, dispersants and weathering on the breakup of plumes and slicks
- Development of numerical model simulations to forecast potential risks, needs and challenges for response to diverse offshore oil spill scenarios
- Oil droplet formation from underwater releases without and with the presence of gas at various dispersant to oil ratios: Implications on herders and dispersant effectiveness when the oil reaches the surface
- Capturing the behaviour of oil at the meter scale: Oil convergence due to water fronts and vertical advection. A modelling effort improved by satellite and drone observations
- Artificial energy by water flushing after dispersant treatment in calm seas or ice-infested waters
- Effectiveness assessment of bio-based agents for oil spill treatment in Arctic/Subarctic environments
- Understanding the interactions between oil, dispersants, exopolymers and particles for the improvement of marine oil spill response

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- Quantifying the effect of oil photo-chemical oxidation on the performance of chemical herders in Canadian waters

**MPRI Program Area 2: Oil translocation**

Understanding oil translocation pathways and processes on shorelines is critical in deciding whether intervention is appropriate to promote natural breakdown/shoreline cleanup, reduce environmental risk and accelerate recovery of the environment. MPRI is supporting research to review current and potential oiled shoreline treatment strategies and tactics using oil translocation. Studies also involve designing and conducting meso- and laboratory-scale tank tests to address knowledge gaps in the oil translocation processes and pathways associated with the interaction of fine-grained sediments (clays) and accelerated biodegradation. To aid in the prediction of Oil Particle Aggregate Formation (OPA) and its influence on oil fate (i.e., biodegradation), researchers will also evaluate the likelihood of OPA for different particle properties (shape, affinity to water) and oil properties (thick oil, light oil, sticky oil, etc.) with the aim to develop a predictive model that can provide guidance to oil spill response operations. To further advance our knowledge of potential oiled shoreline cleanup strategies, another goal of this program is to evaluate the efficacy of existing and new shoreline surface washing agents. Outputs from the research will include an "oil spill shoreline response decision tool" for regulators, decision makers and responders to assist understanding of the potential consequences of shoreline treatment options on Canadian coasts. This decision tool will be geographically-, seasonally- and environmentally-based to support its application across Canadian coastline types at all times of the year.

Projects include:

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- Shoreline/marine oil translocation: Review of state-of-the-art and gap analysis of oil translocation pathways and oil attenuation and weathering processes in Canadian coastal and marine environments and shoreline types
- Impact of particles shape and hydrophobicity on the formation of oil particle aggregates (OPA): A combined experimental/numerical investigation leading to the formation of a predictive model
- Oil translocation project: Washing agent-aided shoreline treatment tool sets – evaluation, improvement and development

**MPRI Program Area 3: In situ burning**

The goal of this research area is to investigate the effectiveness of burning oil as an ARM to remove and clean spilled oil on Canadian waters. Burning oil on the water can rapidly remove significant amounts of oil from the marine environment. However, this combustion technique results in burn residues, black carbon soot and other emissions from unburned oil and incomplete combustion.

Outputs of this research range from literature reviews and workshops on the state of knowledge and public concerns and perceptions, to methods development and validation for characterizing the chemical composition of burn residues, to small-scale laboratory tests on the efficacy of ISB using fire booms or herders with 15 types of oil that are transported in Canada, to full-scale field trials (pending approval) to demonstrate the effectiveness of improved fire booms, aerially-applied herding agents and other ISB techniques developed under this research program. Experiments will measure the oil removal efficiency of burns, the amount and quality

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of smoke emitted, and the amount and physical, chemical and toxicological properties of the residue remaining.

Projects include:

- ISB as a response technique for oil spills in Canadian waters: Progress, perceptions and recommendations
- Small-scale testing of alternative response options for spilled conventional oils and unconventional oils transported in Canada
- Experimental field study of ISB with fire booms to reduce burn residues
- Experimental field study of aerial herder and igniter use for ISB in drift ice and open water
- Better characteristics of burned residues from field- and laboratory-generated ISB studies

**MPRI Program Area 4: Decanting and oily waste management**

Conventional mechanical oil spill cleanup operations used in Canada, such as booming and skimming and the use of absorbent materials, will typically generate large volumes of oily waste that can range from 10 to 40 times more than that of the actual oil spilt. Under current Canadian regulations, in the case of booming and skimming, the mixture of oil and water recovered needs to be transported to shore for proper disposal. To significantly increase the efficiency of these operations, MPRI is supporting a number of projects to provide improved technologies and the scientific evidence to support regulatory changes required to allow for the disposal of the treated (i.e., decanted) wastewater at sea. Research includes: a comprehensive review of existing international marine oil spill decanting and wastewater management technologies, practices and regulatory requirements; Laboratory and meso-scale tank tests to

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refine existing and/or new prototype decanting systems that can be used for oil spill response at sea; and State-of-the-art material science studies to evaluate the efficiency of new materials (e.g., graphene/metallic oxide formulations, polymer-based sponges and metal organic frameworks) to remove polyaromatic hydrocarbons from oily wastewater. Endpoints include the analysis of ecotoxicity and biodegradation potential of decanted water. The research will support an integrated oily waste management system for the Canadian environment that identifies optimal waste-generation-allocation-disposal schemes (i.e., “the best” management alternative) based on a holistic consideration of environmental, technological, economic, social and regulatory factors.

Projects include:

- Improved decanting and oily waste management strategies for marine oil spill response
- Development of improved adsorption technologies for oil spill response

**MPRI Program Area 5: Natural attenuation**

Oil spill response strategies are not 100% effective and in many cases are not deployed at all due to cost and logistical limitations. To address concerns over the fate and effects of unrecovered oil spilled at sea, MPRI is supporting a number of studies using “*in situ* microcosms” and other tools to explore the natural attenuation of oil in various marine locations across Canada. Natural attenuation involves a number of processes that impact the fate of oil spilled into the environment, including evaporation, dissolution, dispersion, photodegradation and biodegradation. Biodegradation is a particularly important process because it results in the permanent removal of oil components through the action of microorganisms, mainly bacteria, that are able to use many of the compounds present in oil as a food source. Results from season and region specific studies conducted in the water column and on beaches under realistic conditions will provide the decision makers leading response operations with a better



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understanding of what can be expected (ultimate fate and effects of the oil) should the cleanup of an oil spill be left to nature.

The risk of oil spills in the Canadian Arctic is rising due to increases in marine vessel traffic associated with urban and industrial growth and a longer open water season for the Northwest Passage due to climate change. There is now a need for a greater understanding of the abilities of cold water microbes to degrade oil compounds under the extreme conditions found in the Arctic, such as low temperatures, sea ice, the physical oceanography, the oligotrophic environment, poor microbial adaptation to degrading oil compounds and the occurrence of massive phytoplankton blooms. Through a suite of chemical and molecular analyses and biofilm profiling and imaging techniques, MPRI researchers are acquiring a better understanding of the controls on, and microbiology of, oil biodegradation under Arctic conditions. In addition, researchers are monitoring for genomic profiles and oil fingerprints in Arctic high traffic areas to enable the discrimination between natural background and contaminant hydrocarbon concentrations and provide a "baseline" database to support future oil spill damage assessments and evaluations of spill mitigation strategies.

Projects include:

- Natural biodegradation of oiled substrates and impacts of oil droplet size and aggregates on a predictive model development
- Baseline monitoring of hydrocarbon contaminants and microbial genomics along the Kivalliq transportation corridor
- *In situ* and *ex situ* investigation of oil biodegradation potential in Arctic marine environments

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- Controlled experimental oil spill in Canadian waters to evaluate remediation strategy readiness
- Natural attenuation and trajectory forecasting of marine spilled dilbit in Chinese and Canadian waters
- Oil spill alternative response measures: Toxicity and biodegradation of treated petroleum oils

## MPRI Program Area 6: Cross-cutting research

There are a number of cross-cutting research initiatives that may support and/or benefit more than one of the previous spill countermeasure research areas.

### *Oil detection, characterization and mapping*

MPRI is supporting seven initiatives to improve understanding of the composition, fate and behaviour of oil. First, to ensure continuity and enable comparison of results between the various projects, and to train future experts in the field, MPRI has contributed towards a national hydrocarbon laboratory inter-calibration exercise and the development of a Canadian academic “centre of excellence” for the chemical characterization of petroleum oil, its weathered and degraded products, and the products generated from spill response techniques. This team has the responsibility to provide analytical support and “standard analytical protocols” to all MPRI projects, as required.

Second, as future legislative changes are forcing the shipping industry to use LSFO, MPRI is supporting a research project focused on enhancing our understanding of the variability in weathering properties, toxicity, fate and behaviour of spills of this type of oil at sea, especially in cold water environments, and the effectiveness of different oil spill response options.



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Third, MPRI is funding work to enhance capability to determine floating oil thickness, which is a critical parameter required by modellers to predict the fate and transport of oil at sea and an important factor in determining the most appropriate response activity for specific site conditions.

Fourth, MPRI is supporting the development and use of a web-accessible chemical properties database that is compatible with the National Oceanic and Atmospheric Administration’s Automated Data Inquiry for Oil Spills (ADIOS) models, as well as others in the private sector, academia and other government agencies. Information from the application of these models on how different types of oil undergo physical and chemical changes (weather) in the marine environment is essential for evidence-based decision making for the selection and application of the optimal spill response option(s).

Fifth, collecting undersea data from a ship is difficult and expensive. MPRI is funding two projects focused on the development of *in situ* sensors and the use AUVs as a cost-effective platform to remotely monitor oil concentration, thickness, type and suspended particle size, and to collect water column samples at sea. Data will be used to develop computer models, including a framework for assimilating real-time satellite, drone and autonomous surface vehicle data on the movement pattern of oil on the water surface to predict the trajectory of oil and its ultimate fate.

Finally, in support of oil spill response operations on shore, MPRI is co-funding a project to advance the ability of oil spill responders to analyze, interpret and share data collected from Shoreline Cleanup and Assessment Techniques (SCAT). The volume of data collected during and after an oil spill has increased dramatically over the last 20 years. Development of software tools to access and analyze data derived from SCAT will improve the management of large data

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sets to enable operationally meaningful analysis and interpretation in a response-relevant time frame.

Research outcomes from all these initiatives will provide oil spill responders with more information on the nature, depth and spread of the oil spill, and will thus allow more appropriate, data-driven mitigation and management strategies to be delivered which can help minimize environmental damage.

Projects include:

- Chemical analysis of oil and oil products for the Multi-Partner Oil Spill Research Initiative
- Hydrocarbon Inter-Calibration Exercise (HICE)
- ADIOS oil database enhancements
- Low sulphur fuels – a new generation of marine fuel oils
- Comparing recent advances in estimating and measuring oil slick thickness
- Oil spill reconnaissance and delineation through robotic autonomous underwater vehicle technology in open and iced waters
- Combined microbial sampler and physical sensor payload for rapid oil spill surveillance at depth
- SCAT and clean up termination enhancements

**Toxicology**

The goal of MPRI's toxicology studies is to provide real-world data and insights on the potential effects of ARMs under environmentally-relevant concentrations and exposure durations on Valued Ecosystem Components including commercially- and societally-important species, such as American lobster, Atlantic herring, Atlantic cod, Green sea urchin and marine algae. A



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focus of the studies is on developing and refining toxicological methods for risk assessments on the use of ARMs to identify sub-lethal effects on "non-standard" indigenous species and vulnerable life stages.

Projects include:

- Essential aquatic toxicology data collection associated with deployment of Alternate Response Measures using non-standard species and customized methods and biological endpoints

**Risk assessment models**

MPRI is funding two projects working on developing risk assessment models in support of NEBA. In the future, both of these models can be used to assess hypothetical spill response scenarios. The first involves refinement of the "Atlantis Ecosystem Model" to factor in oil spill response data. Application of this predictive holistic ecosystem-based model would provide insights on the dispersion of oil, contaminants, nutrients and species, the impacts of spills and cleanup operations on fish, habitats and other aquatic organisms, and how those effects influence the rest of the system (e.g. fisheries and other users). The second is focused on the Canadian Arctic Archipelago, an ecologically important area deemed to be at risk of future oil spills due to increased ship traffic through the Northwest Passage as a result of significantly reducing sea ice coverage from climate change. To aid in the assessment of future risks and environmental impacts within the region, a high resolution circulation model is being coupled with an oil spill trajectory model to provide maps in support of preparedness and decision making on the type and level of remediation required in the event of a spill.

Projects include:

- Direct and indirect ecosystem responses to oil spills and options for interventions



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- Risk assessments of potential oil spills in the Canadian Arctic Archipelago

**CONCLUSIONS:**

Under Canada's OPP, the MPRI program was developed to address major knowledge gaps in oil spill response and remediation strategies to support the development, validation and Canadian regulatory approval of ARMs on the operational scale. By establishing a research network and leveraging funding, resources and expertise of national and international (e.g., USA, Norway, France, Australia, China) government agencies, academia, Indigenous & coastal communities and the private sector (i.e., spill response organizations and oil industry partners), MPRI is optimizing research capability and capacity by: reducing a duplication of effort; advancing our global understanding on the fate and effects of spilled oil; and developing and identifying best methodologies to clean oil spills to minimize their environment impacts and to enhance habitat recovery. In terms of investment in the future, the program is currently supporting development of approximately 90-100 highly qualified personnel (technicians, co-op students, post-graduates and post doctoral fellows) including 10-15 new academic faculty members in oil spill directed research. Science deliverables from the program will provide a stronger evidence base to support decision making in oil spill preparedness and response operations and increased community participation and public awareness of our ability to respond to and remediate oil spills. In summary, it is anticipated that MPRI will have a profound influence on the oil spill research community and emergency response agencies within Canada and abroad and improve the level and quality of advice, expertise and support during oil spill response operations.

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