NRC·CNRC

ARCTIC PROGRAM NEWS

Increasing the quality of life for Northerners through research

MARCH 2020

PROJECT UPDATES

WHAT'S NEXT?

The National Research Council of Canada's (NRC) Arctic Program, with our partners from governments, Indigenous and northern communities, industry and academia, seeks to address opportunities and challenges to support sustainable and low-impact development of the North, while increasing the quality of life for Northerners. Read through this year's snapshots to learn about our progress and accomplishments in our four research streams: northern transportation, marine safety, resource development and community infrastructure.

MESSAGE FROM THE PROGRAM LEAD

ANNE BARKER

With only one year left in the current program's research plan, 2019 was a busy year of moving projects into full-scale pilot demonstrations, expanding research uptake, and bringing new partners onboard to help deliver relevant and meaningful research.

We were very pleased that the Canadian Arctic Shipping Risk Assessment System (CASRAS) was selected as a project under the National Trade Corridors Fund and we are looking forward to working with our northern partners to ensure this system is relevant for their use and implementation.

The NRC's research into oil spill detection and bioremediation has been expanding, both into new geographic regions, and by scaling up the technologies. Other research projects have also expanded, including reinforcing winter roads and mitigating permafrost degradation, as well as our patented, scalable and energy-producing sewage treatment technology. We have also shared some of our research with the International Maritime Organization (IMO) to provide input into the Polar Code on how countries can quantify time until rescue in an Arctic marine emergency, and to better understand ventilation requirements for lifeboats. Read on to find out more about these exciting projects underway through the program.

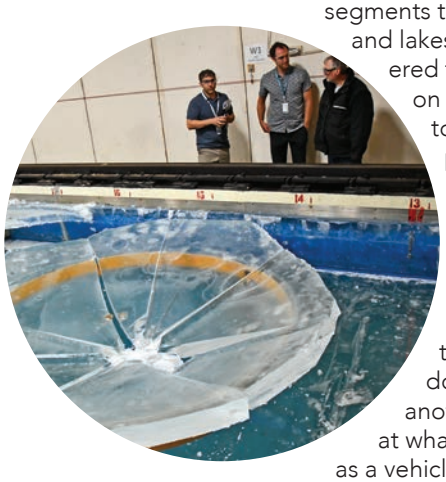
We are also starting the process of looking forward and determining what's next for Arctic and northern research at the NRC. Stay tuned for more information, as we begin to reach out to stakeholders to co-develop the next wave of relevant research that will bring impactful results and support multiple levels of government objectives and northern community priorities. We're very excited to get that process underway, and we hope that you will share your own enthusiasm for research when we reach out to you!

If you're interested in being part of this important research, please contact us to learn how we can partner on research projects, or help identify solutions for your R&D needs. If you'd like more information on our past research efforts, please visit the NRC's publication archive (NPARC) for research papers on these and other related topics.

PROJECT UPDATES

NORTHERN TRANSPORTATION

Reinforcing winter roads in the context of climate change



Operational only in the coldest months of the year, winter roads are used to bring fuel and bulk goods to northern communities. Generally running over land, winter roads can also include segments that run over floating ice on rivers and lakes. These sections are often considered the weak links, because they rely on temperatures being cold enough to achieve a safe thickness and prevent breakthroughs.

NRC researchers are testing if steel cables and a polypropylene geogrid could be used to reinforce ice plates and strengthen the over-ice portions of winter roads. Although further testing is planned, preliminary results document a clear improvement. In another project, researchers are looking at what happens when a heavy load, such as a vehicle, is left on ice over time. Although it is safe for a short period of time, eventually the vehicle is likely to suddenly, and unexpectedly, break through the ice. In collaboration with the Royal Military College in Kingston, Ontario, NRC researchers are testing how reinforced ice plates could also be beneficial in this situation. Both projects are being done through a multi-year collaboration with Transport Canada and Crown-Indigenous Relations and Northern Affairs Canada. **Learn more: nrc.canada.ca/en/research-development/research-collaboration/programs/project-reinforcing-ice-roads**

MARINE SAFETY TECHNOLOGIES

Understanding the influences on lifeboat ventilation requirements

Many different factors can influence the interior environment of enclosed lifeboats carrying passengers in harsh environments. The outside temperature, the number of people inside, even the size of the individuals and what they are wearing can impact the ventilation requirements of lifeboats. Working with Transport Canada, NRC researchers reviewed existing literature and our own research to better understand how these factors can impact the survivability of occupants due to the level of carbon dioxide that can build up in the enclosed environment.

Researchers determined that the clothing worn by a lifeboat's occupants would be the driving factor in determining the best interior air temperature, and that this in turn would impact the required ventilation levels. The type of

clothing worn by occupants would vary significantly depending on the vessel's purpose (e.g. military exercises, cargo, cruising), which makes general ventilation rate requirements difficult to pinpoint. The NRC provided recommendations for monitoring and ventilation systems that could be used on lifeboats, and shared their final report at a meeting of the International Maritime Organization (IMO). The report generated significant discussion on the topic of lifeboat survivability and encouraged the IMO to consider methods for addressing the issue at an international level. **Learn more: nrc.canada.ca/en/research-development/research-collaboration/programs/project-reviewing-lifeboat-ventilation-requirements**

RESOURCE DEVELOPMENT

Studying oil-degrading marine bacteria

With the increase in marine traffic in Arctic waters, there is a corresponding increase in the risk of oil spills. The NRC is conducting research to identify if there are areas of the Northwest Passage that are better equipped to deal with an oil spill and others that might have a higher risk for more environmental consequences.

Using a genomics-based approach, NRC researchers are studying microbes living in Arctic waters to determine their natural capacity for oil-degradation. This project is in collaboration with Fisheries and Oceans Canada, Department of National Defence, Environment and Climate Change Canada, McGill University, University of Manitoba, Aarhus University (Denmark), SINTEF (Norway), and CSIRO (Australia).

Researchers are deploying microcosms in different locations in the Arctic for different amounts of time to assess the oil biodegradation potential of the local microbial communities.

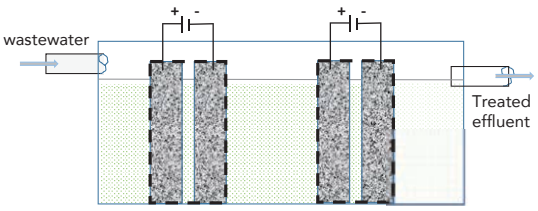
These studies have identified several types of bacteria that respond immediately to the presence of oil products, and have determined that oil degradation in Arctic seawater is surprisingly rapid. Additional studies are now needed to evaluate the effects of various treatments that could be added to enhance the natural oil degradation capabilities of these microbial communities. **Learn more: nrc.canada.ca/en/research-development/research-collaboration/programs/project-study-oil-degrading-marine-bacteria**

COMMUNITY INFRASTRUCTURE

Effective and robust sewage treatment in the Arctic

The proper treatment of sewage is an essential element of community health and well-being in the Arctic. Most Arctic communities in Canada use lagoons to treat their sewage. Although they are robust and relatively simple and inexpensive to operate, most lagoons do not meet Environment and Climate Change Canada's quality standards. The few mechanical treatment plants that do meet these standards are complex and costly to operate and maintain. To address this challenge, the NRC has developed the BioElectrochemical Anaerobic Sewage Treatment (BEAST) technology. It uses a biological process to biodegrade organic waste through a simple, low-energy process that harnesses electroactive bacteria to consume waste and produce energy-rich methane gas. The technology is completely scalable and can be applied to a single home and to an entire community.

Researchers are testing the BEAST system in a variety of conditions and geographic locations in northern Canada, as well as in Alaska and Greenland. Tests are underway to examine the potential for this technology to treat other water-related scenarios, such as removing heavy metals, metalloids (selenium, arsenic), and hydrocarbons from contaminated waters. **Learn more: nrc.canada.ca/en/research-development/research-collaboration/programs/project-bioelectrochemical-sewage-treatment-arctic**



WHAT'S NEXT?

NORTHERN TRANSPORTATION

Improving the Arctic supply chain through CASRAS

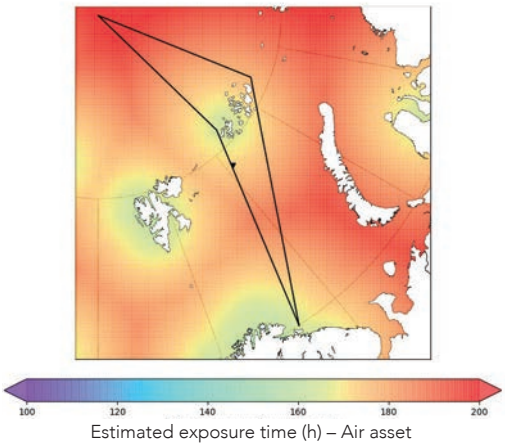
Deliveries made by commercial ships are crucially important and highly anticipated for residents of northern communities who rely on them for general cargo, fuel, and food. Ensuring the safety, efficiency, and reliability of these sea-lift operations during the short marine shipping season is of strategic and economic benefit to all Canadians. However, marine hazards such as sea ice can significantly impact the Arctic supply chain by creating bottlenecks, which can also affect both trade and tourism, industries that are growing in the region.

Transport Canada's recent investment through the National Trade Corridors Fund will help compile environmental data and mariner knowledge using the NRC's Canadian Arctic Shipping Risk Assessment System (CASRAS). Using this information, NRC researchers will validate and implement novel sea-ice forecasting tools and data products into the CASRAS software platform. This will allow stakeholders in the Northwest Territories to make evidence-based risk assessments and infrastructure planning for shipping operations based on historic, current, and future climate trends. **Learn more: nrc.canada.ca/en/research-development/products-services/technical-advisory-services/canadian-arctic-shipping-risk-assessment-system-casras**

MARINE SAFETY TECHNOLOGIES

Estimating exposure time in polar regions

Areas that were once considered some of the harshest environments on Earth, have become desirable destinations for high-capacity



Estimated exposure time (h) – Air asset

cruise ships filled with people who want to visit these off-the-beaten-path areas. There is also a noticeable increase in cargo traffic in some northern regions. The increase in maritime traffic in the area comes with an increased risk of accidents and the need to be prepared for such an event. Survival in polar regions after a maritime incident is becoming a hot topic of discussion for many nations.

If people need to evacuate a vessel in the North, they will rely on life-saving appliances like an enclosed lifeboat to protect them from the harsh environment until rescue teams arrive. The length of time a rescue crew takes to arrive will determine the approximate length of time a lifeboat will need to function properly to ensure the survival of its occupants. The NRC has previously conducted research that estimated exposure time for select locations in the Canadian Arctic. Working with Transport Canada, the NRC is now generalizing this methodology for estimating exposure time. The methodology will be submitted to the International Maritime Organization (IMO) to enable other countries to estimate exposure time. **Learn more: nrc.canada.ca/en/research-development/research-collaboration/programs/project-estimating-exposure-time-polar-regions**

RESOURCE DEVELOPMENT

Photo-acoustic underwater oil spill detection

Global climate change is resulting in diminishing sea ice in the Arctic, which in turn is increasing the demand for marine transport, tourism, and community services. This puts the very fragile Arctic environment at an increased risk for oil spills. However, most detection and tracking techniques are not designed for oil spills that occur under ice, which means new methods will need to be developed.

NRC researchers in Boucherville, Quebec have developed a new technology based on photo-acoustics, to detect and monitor oil spills using underwater vehicles, such as remote-operated vehicles or autonomous underwater vehicles. This new technique combines an underwater pulsed laser and ultrasonic transducers for the generation and detection of ultrasonic waves that detect and characterize oil spills. This technology provides great contrast, easy-to-interpret information, is not very sensitive to misalignment, and should be effective in mapping moderately-complex oil spills. The results to date are very promising, providing clear results for response to oil spills and monitoring. The NRC is looking to advance this technology through collaboration to further develop, validate, and deploy the technology in real-life conditions. **Learn more: nrc.canada.ca/en/research-development/research-collaboration/programs/project-photo-acoustic-underwater-oil-spill-detection**

COMMUNITY INFRASTRUCTURE

Mitigating permafrost degradation

In partnership with Wilfrid Laurier University, the NRC is developing a cooling device that is showing considerable promise in reducing permafrost degradation for key infrastructure locations. Using a liquid-filled freezing system with a snow-deflecting cone, this novel technology is able to remove more of the heat that is threatening the permafrost during summer months than previous techniques. At the same time, this method is also helping accumulate cold temperatures during winter months in the form of latent energy of frozen pore ice in soils. This combination will help sustain frozen ground temperatures within a specific area and distribute low ground temperatures along highway embankments or building foundations, for example.

Called 'inter-seasonal cold redistribution', this type of method can provide direct and reliable cooling effects that stabilize ice-rich soils, moderate surface settling, and cool down the heat transferred to the frozen ground through groundwater, all of which help to mitigate the degradation of permafrost and its subsequent impacts on infrastructure in the Arctic. **Learn more: nrc.canada.ca/en/research-development/research-collaboration/programs/project-mitigating-permafrost-degradation**

At the NRC, our Research Centres offer partners specialized applied research services across many disciplines. The multi-disciplinary nature of the NRC links Arctic-based engineering activities to key sectors, including transportation, infrastructure, the environment, renewable energy, and safety. Our scientists, engineers and technologists provide innovative tools and services that support Canadian industry, regulators, and stakeholders by reducing risk and improving the longevity and performance of Arctic infrastructure. Our unique expertise and comprehensive tools and facilities combined with customizable service options and high ethical standards make us an ideal partner to support your vision.

If you would like further information or if you are interested in partnering on any of these projects, please contact us. We are excited to discuss your ideas and to help you solve your most challenging technical problems.

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