OIL SPILL RESPONSE CAPACITY IN NUNAVUT AND THE BEAUFORT SEA

RESPONDING TO ARCTIC SHIPPING OIL SPILLS: RISKS AND CHALLENGES

As the Arctic warms and sea ice diminishes, the biggest threat to the Arctic marine environment from ships is from an oil spill. Less summer sea ice has already led to increases in ship traffic, yet significant legislative, capacity, information and funding gaps exist in the current spill response framework in both Nunavut, and in the Beaufort region.

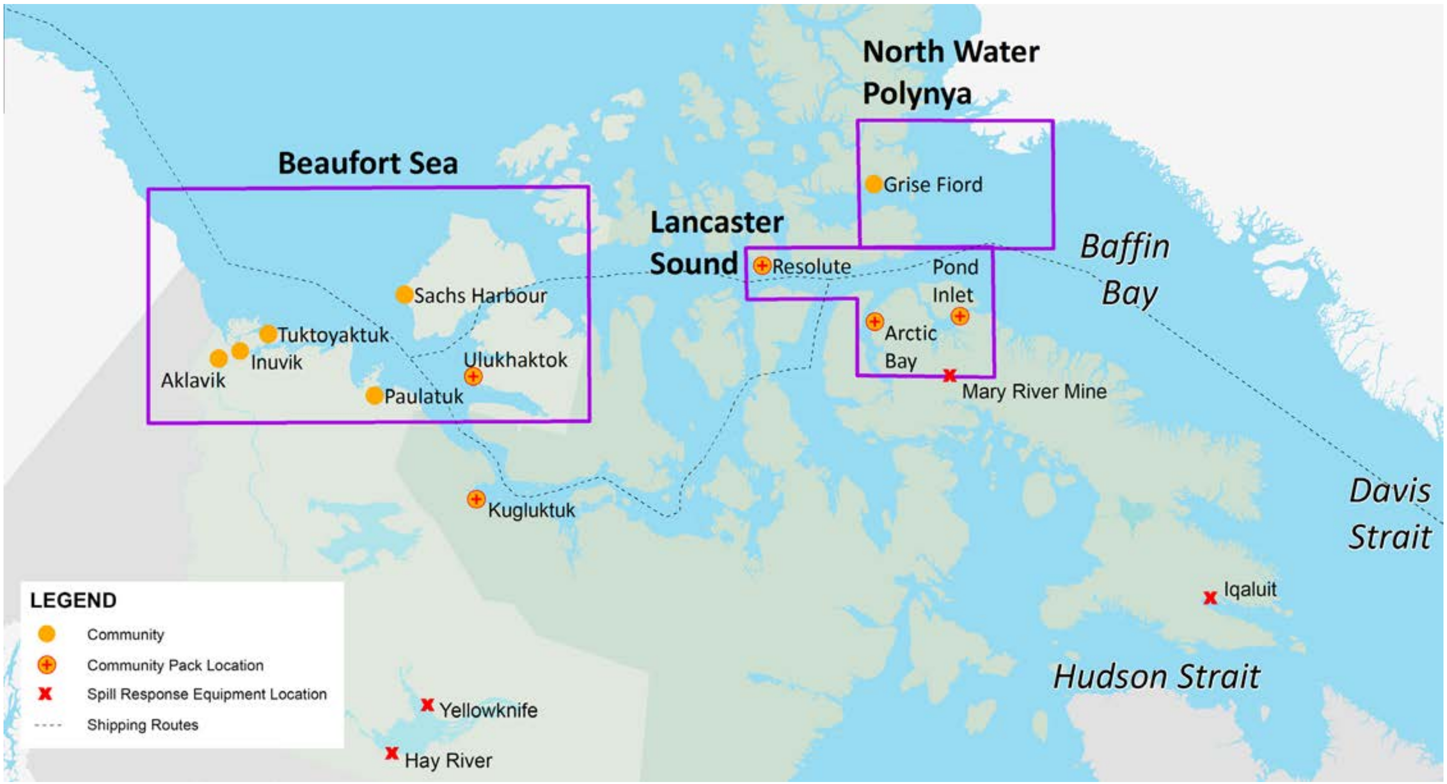
Although the Canadian Coast Guard has developed national, regional, and area response plans, these plans rely on capacities and methods that may not exist or cannot be adapted in remote communities to respond to a ship-based spill.

An Arctic shipping oil spill would devastate the surrounding marine environment, including the destruction of habitat for polar bears, seals, walrus, sea birds, as well as beluga, narwhal and bowhead whales. These consequences would be mainly borne by the communities, not the responsible parties. Arctic communities depend on healthy and clean waters for much of their food, and their cultural and spiritual well-being is tied to their environment.

WWF-Canada commissioned a series of reports to identify barriers that will prevent northern communities from effectively responding to a ship-based oil spill. Parallel reports for the western Beaufort region and Nunavut outline these barriers, and are summarized below. A third report provides a framework for developing realistic oil spill response plans for Nunavut communities. To effectively address the issues of oil spill response capacity in the North, engagement with communities is crucial to developing a framework that works within the Arctic context.

GEOGRAPHY AND POPULATION

The reports focus on remote regions above the Arctic Circle in Nunavut and the Northwest Territories, where communities generally rely on a mixed subsistence and market economy. Many people spend time harvesting land and sea mammals to supply a significant portion of their diet. Traditional knowledge is passed from generation to generation, and is an important element of northern Indigenous culture. When the environment is disrupted, it will undoubtedly have a significant impact on communities.



BEAUFORT REGION

The Beaufort region includes more than 7,500 kilometres of coastline. The area roughly corresponds with the Inuvialuit Settlement Region (ISR), one of the four Inuit regions of Canada. This region is also considered part of the southern route of the Northwest Passage.

In the Beaufort Region, the major communities are Inuvik, Tuktoyaktuk, Aklavik, Paulatuk, Kugluktuk, Sachs Harbour and Ulukhaktok. The total population of the communities is 5,767 people, of which more than half are Inuvialuit.

NUNAVUT

This report focuses on the four northernmost communities in Nunavut. Above the Arctic Circle, much of Nunavut's territory is a series of islands that make up the Arctic Archipelago. The largest of these is Baffin Island, which is home to the Mary River iron ore mine. All four communities are either on or close to the northern route of the Northwest Passage.

The total population of the four Nunavut communities is just over 2,800 people, with more than half of those living in Pond Inlet, the closest community to the Mary River mine. The vast majority of Nunavut residents are Inuit.

EXISTING ARCTIC SHIPPING OIL SPILL RESPONSE FRAMEWORK AND STANDARDS

The reports describe the framework that is in place to ensure that ships travelling through the Arctic have the capability to respond to an oil spill. It shows that while there are plans and standards in place, there are also gaps and uncertainties.

NATIONAL/INTERNATIONAL

- Canadian law requires ships to contract with a response organization that can provide equipment and personnel sufficient to clean up the amount of oil a ship is carrying, up to 10,000 tonnes. However, ships travelling north of 60 degrees' latitude are exempt from these provisions.
- Under Canadian and international law, all tankers over 150 tonnes and all other vessels over 400 tonnes must have a Ship Oil Pollution Emergency Plan (SOPEP), which includes reporting procedures, authorities to be contacted and actions to be taken. Currently, SOPEPs are not Arctic-specific and may not account for communications challenges that could arise in attempting to report a spill in the Arctic.
- Canada also has the National Marine Spills Contingency Plan, which includes a Central and Arctic Regional Plan that details the procedures, resources and strategies to be used in the event of spill.

BEAUFORT REGION

The **Canada/United States Joint Marine Pollution Contingency Plan** includes a **Joint Response Team** for both countries to co-ordinate when necessary. It also sets out procedures for Arctic nations to notify and request assistance from each other in the event of a spill, and includes commitments to maintain a national oil spill response plan.

The **Beaufort Sea and Amundsen Gulf Area Plan** identifies specific geographical priority areas and proposes tactics to protect these areas in the first 12 to 24 hours after a spill.

NUNAVUT

As part of the **Nunavut Agreement**, the **North Baffin Regional Land Use Plan** prohibits ships from coming within 10 kilometres of coastlines, and within 25 kilometres from the coastlines of Lancaster Sound, one of the most biologically productive areas of the Canadian Arctic.

The **Nunavut Land Use Plan** is expected to be completed by the end of 2017. The 2016 draft of the plan identifies several other protected areas with seasonal restrictions to protect wildlife habitat such as sea ice crossings and calving grounds.

GAPS IN OIL SPILL RESPONSE FRAMEWORK

PHYSICAL ENVIRONMENT

Arctic conditions limit the effectiveness of response equipment and often prevent any response at all. The Arctic climate is defined by major seasonal changes and sea ice for nine out of every 12 months. Cold air temperatures persist for much of the year, with most communities experiencing at least 250 days below freezing. Rain, blowing snow, fog, gale-force winds and prolonged periods of darkness limit visibility.

The presence of sea ice is the largest limiting factor in an adequate oil spill response.

During the small window when a response would be possible, several other environmental factors would impede an adequate oil spill response:

- High waves and strong winds common to Arctic waters make it impossible to contain oil using a boom, a critical tool used to prevent oil from reaching the shoreline.
- If visibility is less than one kilometre, it is extremely difficult to find and recover oil slicks.
- Recovery cannot take place during darkness, which persists through most of the winter months.
- Response ships can become unsafe to operate due to ice buildup.

The type of oil used by the majority of ships, heavy fuel oil (HFO), is also extremely difficult to remove from the environment, even in ideal conditions.

EQUIPMENT

What Exists

The Canadian Coast Guard (CCG) is the primary source of spill response in the Arctic. Community packs containing basic equipment designed for small near-shore spills (up to one tonne of oil) have been placed in Resolute, Arctic Bay and Pond Inlet in Nunavut, and in Kugluktuk and Ulukhaktok in the Beaufort region.

Both Iqaluit and Tuktoyaktuk have stockpiles of equipment, as does the Mary River Mine on Baffin Island. Additional oil spill resources are available from the CCG base in Hay River, south of Yellowknife.

Remnants of sea ice in late summer in Resolute Bay, Nunavut

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WWF staff and volunteers practising the use of a boom to catch oil spills on water at the NordNorsk Beredskapssenter in Fiskebol, a training centre where people learn how to clean up oil and gas spills in water and along the coast. Lofoten Islands, Nordland, Norway.

Capacity Limits

Inadequate equipment

The largest equipment available in the Arctic can recover up to 1,000 tonnes of oil. However, tankers carrying fuel to the Mary River Mine can carry up to 4,500 tonnes of diesel, and community resupply vessels carry up to 18,000 tonnes of fuel oil.

Maintenance

Maintenance of community packs has been inconsistent. The Arctic environment renders mechanical equipment inoperable if it isn't properly maintained, so it is unknown whether the community packs are functional.

Access

Assuming the equipment is functional, accessing it would be another challenge. Some communities don't have a key for the locked storage containers because the CCG is concerned about maintaining responsibility for the equipment inside.

Transport to spill site

Even if the community can access the equipment, and it is functional, the small aluminum boats provided may not be sufficient to transport the equipment to the spill site in poor weather conditions. Larger boats better able to withstand harsh weather would then need to be located.

If the spill occurred in a community without a pack, the hamlet would need to arrange for an airplane to deliver the equipment from a nearby community and transport it from the airstrip to the spill site.

Storage and disposal

No hazardous waste facilities exist in the Arctic; all materials must be stored and transported south. Though response equipment in Iqaluit and Tuktoyaktuk is designed to recover up to 1,000 tonnes of oil, the containers in Tuktoyaktuk can only store up to 275 tonnes, with capacity in Hay River for an additional 240 tonnes. Oil cannot be removed from the environment if there is nowhere to store it.

People

The number of trained responders in northern communities is limited due to several factors. The communities are small, so there are only so many people to draw upon. In addition, people are often away from the community for long stretches, like during subsistence harvesting times, meaning a larger number would need to be trained to ensure there are always enough people available (anywhere from five to 16 community responders are necessary, depending on the equipment).

Government funding for training is currently well below what is necessary to recruit and train an appropriate number of community members. And even if enough people could be found and trained, there is little opportunity to practise or maintain skill levels.

Finally, in the event of a large spill, many responders would need to be flown in from larger centres. Small communities will likely not have the resources to house, feed and support the influx of people.

OTHER FACTORS THAT LIMIT RESPONSE

OIL SPILL BEHAVIOUR

Heavy fuel oil (HFO) is the fuel most often used by large shipping vessels. Of all the marine fuel options, it is also the most damaging in the event of a spill. The use of HFO is banned in the Antarctic, and several organizations (including WWF) are working with the International Maritime Organization to phase out the use of HFO in the Arctic.

The spreading and weathering of oil, and whether it comes in contact with ice, affects the way and the extent to which it can be recovered. Unfortunately, it is very difficult to conduct in-the-field research on how oil spills behave in the Arctic environment, so most of the information that exists is inferred from lab research.

COMMUNICATIONS INFRASTRUCTURE

Reliable communications infrasrtucture capable of providing information on weather and sea conditions, maintaining contact with on-the-ground and incoming responders, as well as being able to monitor the spill are all essential to an effective response.

The community nearest to the spill would serve as an important communications hub. However, in the Arctic, cellphone and Internet networks are quickly overwhelmed, slowing Internet speeds, preventing phone calls, and potentially leading to a complete breakdown in emergency response protocol.

It is also critical for incoming responders to have information about safe maritime routes, including the presence of sea ice and inclement weather. If communications systems are inoperable, area surveys may be needed before vessels can assist, leading to more response delays.

RESPONSE TIME

Canadian law provides response times for different levels of spills, which must be adhered to by regional response organizations. However, these standards are not in line with current response capabilities in the Arctic:

Response Equipment Type	Response Standard South of 60	Estimated Response Time North of 60
Oil spill up to 150 t	Six hours	48 hours
Oil spill up to 1,000 t	12 hours	One week

If a CCG icebreaker was in the region, it could provide additional assistance, but there are only three ships responsible for the whole of the Northwest Passage.

In 2008, the Baffin Regional Area Plan identified specific geographical priority areas (including Lancaster Sound) and proposed tactics to protect these areas in the first 12 to 24 hours after a spill. However, there are very few details or recommendations in the plan, and the CCG cautions that the strategies it outlines are untested and require an on-site assessment to confirm their validity.

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A Canadian coast guard ship and a Russian converted research vessel carrying tourists in Resolute Bay, Qikiqtaaluk Region, Nunavut

CONCLUSIONS AND RECOMMENDATIONS

Shipping in the Canadian Arctic is a dangerous and precarious endeavour. Navigation is challenging, weather and visibility are often poor, sea ice is difficult to detect and the waters are inadequately charted. Yet, as sea ice melts, shipping is only increasing in the region, along with the risk of oil spills that threaten the sensitive Arctic ecosystem and the wildlife and communities that depend on it.

The extreme Arctic climate makes a successful oil spill response enormously challenging, even with unlimited personnel and equipment. However, there are several measures that could provide added safety and reduce the risk of spills, as well as increasing response capabilities:

1. Incorporate Inuit organizations into the Northern Marine Transportation Corridors Initiative

Inuit and Inuvialuit should have a greater role in decision-making that shapes the future of Arctic shipping. The Northern Marine Transportation Corridors Initiative is a CCG and Transport Canada program tasked with identifying specific shipping routes through the Arctic to improve safety. Arctic Indigenous peoples should be fully incorporated into this process.

2. Increase preventative measures

Shipping lanes should be identified using information on subsistence use and environmentally sensitive habitats. Transport Canada should then designate preferred routes, as well as areas to be avoided, and take these routes and areas to the International Maritime Organization.

3. Eliminate the use of heavy fuel oil in the Arctic

The Government of Canada, under the jurisdiction of Transport Canada, should implement a ban on HFO through national legislation, with a phase-out period to allow industry and re-supply vessels time to build new ships and integrate lighter fuels into their business models.

4. Strengthen oil spill response plans

Response plans should be made Arctic-specific and address the logistical challenges of a spill response. Ships should be required by international and Canadian law to carry equipment for an initial response to a spill, and should have effective damage control measures in place to help mitigate the longer response times often encountered in the Arctic due to extreme weather.

5. Implement southern response standards in the North

Indigenous communities in the North should not receive a lower level of protection from spills simply because there are fewer ships in the region and communities are less populated. Standards for contracting with response organizations south of 60 degrees' latitude should also be implemented in the North.

6. Develop local capacity to respond to spills

The CCG should develop a list of trained individuals in each community, and incorporate training for oil spill response in schools and community organizations. Funding is also required to develop local training organizations and advisory boards, and to ensure Indigenous voices are heard in the decision-making process. Additional resources are also needed for oil recovery storage, response boats, harbours, boat ramps and on-shore response equipment.

7. Integrate Arctic-specific measures into Canada's Oceans Protection Plan

Canada's Oceans Protection Plan commits to improving Canada's oil spill preparedness. The Government of Canada should commit to making the Arctic a top priority, and should be held accountable.

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Ship-Based Oil Spill Response Capacity in the Beaufort Sea

Report to WWF-Canada

Prepared by Layla Hughes

WWF

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SHIP-BASED OIL SPILL RESPONSE CAPACITY IN THE BEAUFORT SEA

Report to WWF Canada

Prepared by Layla Hughes

Executive Summary

The purpose of this report is to examine the risks and challenges with responding to a ship-based oil spill in the Canadian Beaufort Sea. Diminishing sea ice in the Arctic has led to increased shipping, which in turn leads to an increase in the risk of spills from ships.[1] The impacts of a spill would be particularly detrimental to this region which is already experiencing serious impacts from climate change, including coastal erosion, increased and intensified storms, and diminishing sea ice.

The most significant threat to the Arctic marine environment from ships is from an oil spill.[2] In light of often prevailing harsh weather, limited visibility, and sea ice, the lack of transportation and communication infrastructure, and the limited human resources and environmental response equipment, it would be extremely challenging to mount a response and recover oil from a spill in the Beaufort Sea.

In 2012, WWF-CA commissioned RPS Applied Science Associates, Inc. to evaluate different types of oil spills most likely to occur in the Beaufort Sea. That report and the interactive website developed from it demonstrate possible trajectories of oil spills and the important environmental resources that could be affected by a spill.

To provide a more complete understanding of the oil spill risk in the Canadian Beaufort, this report assesses the oil spill response capacity and efficacy in the region. An understanding of the resources at risk as well as the existing ability to protect those resources demonstrates a more comprehensive picture of the risk posed by Beaufort Sea shipping traffic.

This report finds that very little response capacity exists in the Canadian Beaufort Sea and that successful recovery of oil from a ship accident is highly unlikely. The

[1] Ellis, B. and Brigham, L., co-editors, *Arctic Marine Shipping Assessment 2009 Report* (Arctic Council, 2009), p. 168.
[2] *Id.*, p. 5.

impacts of a spill would be borne by the communities in the region, who depend on healthy and clean marine waters for the majority of their food and whose cultural and spiritual well-being are tied to their environment.

Despite the severe consequences of a spill to local communities, the people in the Beaufort Sea region have little control or input into governing how shipping activities take place or what measures are implemented to protect the region's environmental resources from spills. The communities also have little to no capacity to respond to a spill, despite the fact that they would be able to most quickly access a spill and that they have the deepest understanding of the environmental conditions and the sensitive resources that would influence response operations.

This report concludes with recommendations that would provide greater involvement by the communities, improve both oil spill prevention and response in the Beaufort Sea, and strengthen protection of the important cultural and environmental resources in the region.

I. Background

The Canadian Beaufort Sea is a part of the Arctic Ocean that lies north of Canada's Yukon and Northwest Territories and west of its Arctic Archipelago. It includes around 400,000 square kilometers of water and an extensive coastline of more than 7,500 kilometers. The area corresponds roughly with the Inuvialuit Settlement Region, one of the four politically established Inuit regions of Canada. In the eastern part of the Beaufort Sea is the Amundsen Gulf, which lies between the mainland coast and Banks and Victoria Islands. These waters are at the western end of the Northwest Passage. In the western part of the Canadian Beaufort Sea, the Mackenzie River and its large delta flow north into the sea.

Physical Environment[3]

The extreme climate of the Beaufort Sea includes major seasonal changes and sea ice for much of the year. The arctic ice pack, which is multi-year ice, is present year-round and continuously circulates in the Arctic Ocean. The degree to which the pack ice extends south into the Beaufort Sea depends on the winds, but at its furthest, is around 200 kilometers north of the mainland coast during the late summer and early fall. The ice coverage starts to grow in the fall. It begins in early October with ice growing along the ice pack and along the coast as shore-fast ice, and by the end of the month the remaining open water is frozen with first year ice.

The Beaufort Sea remains completely frozen until late May, when the Mackenzie Delta begins to melt and the water becomes open off the delta. In late June, the ice in the Amundsen Gulf begins to fracture and drift, with polynya and leads opening off Banks Island. By the end of July, an open water route typically exists between Mackenzie Bay and Cape Bathurst. In July, a lead also opens along the mainland coast to the west of the Mackenzie Delta.

In addition to the sea ice, cold air temperatures also characterize the area for much of the year. Temperatures are below freezing for over 250 days a year. From June until mid-September, the average air temperature is seven degrees Celsius above freezing. The average temperature falls below freezing after the first week of October, and it averages 13 degrees below freezing by the end of the month.

[3] Weather and sea ice data was collected from Environment and Climate Change Canada and weatherspark.com.

Rain, snow, and wind are common throughout the year. It rains on half of the days in July and August, it snows or rains on two-thirds of the days in September, and it snows four out of every five days in October and November. Throughout the summer and fall, winds average around 20 kilometers per hour. The fall brings intense storms, with gusts to 60 kilometers per hour or higher, and gale-force winds for three to four days per month.

Clouds, fog, or darkness often limit visibility in the region. The region experiences 80-95 percent cloud cover from June until December, and visibility is significantly impaired (less than 1.6 kilometers or a ceiling under 300 meters) for 60 percent of the days in September and 70 percent of the days in October. In summer, the sun is continuously above the horizon for 65 days, until July 23. After September, the days become shorter than the night, until November 28, when the sun completely sets.

The Beaufort Sea has some of the most difficult environmental conditions throughout the entire Arctic. An assessment by Chevron Corporation comparing operational challenges around the Arctic (including the length of open water season, pack ice, and iceberg conditions) concluded that only northern Greenland was a more difficult place to operate than the Beaufort Sea.[4]

Coastal Geography and Oceanography

The Mackenzie River Delta encompasses over 13,000 square kilometers and includes plains, wetlands, river channels, and over 24,000 lakes.[5] The Mackenzie River is the largest river in North America that flows into the Arctic Ocean, and it drains approximates 1.8 million square kilometers of land.[6] As the Mackenzie River melts each summer, it deposits large amounts of fresh water into the Beaufort Sea. The river flow and the annual growth and decay of ice in the Beaufort Sea strongly influence the salinity and temperature of the upper layer of the seawater. These conditions create a productive coastal estuary.[7]

Much of the land along the coast is tundra and marsh and experiences a high rate of erosion.[8] Extending from the coast, a shallow, relatively narrow shelf gradually

[4] Chevron presentation at US DOE/Norway Arctic Workshop, Tromso (Jan. 21, 2009).
[5] Cobb, D., et al., *Beaufort Sea large ocean management area: ecosystem overview and assessment report* (Fisheries and Oceans Canada, Central and Arctic Region Freshwater Institute, 2008), p. 17. [*Beaufort Sea LOMA*].
[6] Mackenzie River Basin (World Wildlife Fund-Canada, 2008).
[7] *Beaufort Sea LOMA,* p. 46.
[8] Lemmen, D., et al, editors, *Canada's Marine Coasts in a Changing Climate* (Government of Canada, 2016), pp. 35, 56.

slopes north to a depth of 200 meters before rapidly dropping off to thousands of meters. Currents along the coast and over the shelf flow to the east, while farther offshore, the clockwise Beaufort Gyre causes a slow westward current.[9]

Climate Change

Climate change is a defining feature of the Beaufort Sea region. Some areas in the Western Canadian Arctic have experienced a 2.2° C rise in temperature over the past 50 years – almost 1° C higher than the average increase for the country as a whole over roughly the same period.[10]

As the sea level rises, the risk of flooding increases. There is already clear evidence of the slow inundation of tundra along the Beaufort Sea coast and in the outer Mackenzie Delta.[11] Rising sea levels will eventually threaten the viability of communities such as Tuktoyaktuk.[12]

Additionally, the seasonal duration of sea ice is decreasing in the region.[13] As the sea ice decreases, the fetch for waves increases, leading to larger waves and more storm surges.[14] Storms are also becoming more intense, compounding the impacts of erosion on the Beaufort Sea shores.[15] For example, a single storm eroded 20 meters of coastline in the Beaufort region.[16]

The changes in the climate are altering ecosystem that have supported traditional Inuit activities and life for centuries.[17] Animal migration times and locations are changing, the ice is becoming less safe to travel on, and weather is less predictable, making subsistence hunting, trapping, and fishing more difficult.[18]

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[9] *Beaufort Sea LOMA,* p. 3.
[10] Fournier, S. and Caron-Vuotair, M., *Changing Tides: Economic Development in Canada's Northern Marine Waters* (Conference Board of Canada, 2013), p. 6 [*Changing Tides*].
[11] *Canada's Marine Coasts in a Changing Climate*, p. 55.
[12] *Id.*, p. 11.
[13] *Id.,* p. 44.
[14] *Id.* pp. 9, 54, 55, 163.
[15] *Id.,* p. 169.
[16] *Changing Tides,* p. 8.
[17] *Unikkaaqatigiit: Putting The Human Face On Climate Change* (Tapiriit Kanatami, Université Laval, and National Aboriginal Health Organization, 2005), p. 4.
[18] *Id.*

Infrastructure and population[19]

The Beaufort Sea region is sparsely populated, remote, and generally inaccessible. The major communities along the Beaufort Sea are Inuvik, Tuktoyaktuk, Aklavik, Paulatuk, Kugluktuk, Sachs Harbour, and Ulukhaktok (Holman). These communities are predominately Inuvialuit who rely on a mixed subsistence and market economy. Many people spend time hunting, whaling, and fishing to supply a significant portion of their diet. The environmental knowledge and survival skills required by these activities are important elements of Inuvialuit culture, passed down from generation to generation. "Consuming country foods is important to Inuvialuit identity, and the culmination of a series of cooperative activities - harvesting, processing, distributing, and preparing - that require behaving in ways that emphasize Inuvialuit values of cooperation, sharing, and generosity."[20]

The communication and transportation infrastructure in the Beaufort region is minimal. Except in Inuvik, no roads connect the communities. Small planes using gravel airstrips and small docks or boat ramps serve as the primary mode of transportation. Local travel is by snow machines (snowmobiles), ATVs, and cars on local dirt roads. Travel beyond the local roads on the tundra is difficult in the summer, but it is possible on the snow and ice during the winter. Generally, internet and telephone bandwidth is low, except in Inuvik, and there is limited VHF coverage offshore.

Besides a shallow port in Tuktoyaktuk, transportation by water is limited to shallow-draft boats. Large vessels bring supplies to the hamlets during the summer and must remain offshore, transferring the goods to shallow draft barges and landing craft that land on the beach. No hazardous waste facilities exist in the entire region.

The largest town and regional administrative hub, Inuvik, is about 100 kilometers inland from the Beaufort Sea coast, on the East Channel of the Mackenzie Delta. The town has a population of around 3000, two-thirds of whom are Aboriginal. Forty-five percent of the population is subsistence hunters/fishers, and 23 percent get at least half of their food from subsistence.

Over 80 percent of the people in Inuvik have internet. The town is the only Beaufort Sea community currently connected to the road system, via the Dempster Highway, a 740-kilometer gravel road that begins east of Dawson and ends in Inuvik. The road is open year-round, except for three to four weeks in the spring and fall, when

[19] Demographics and infrastructure information from Northwest Territories Bureau of Statistics; Government of Nunavut.
[20] Inuvialuit Regional Corporation.

the highway north of the Peel River is inaccessible as the river freezes and melts. The Inuvik airport has a paved runway over 1500 meters long, which is the only paved runway in the region.

Tuktoyaktuk is located on the coast at Kugmallit Bay, near the Mackenzie River Delta. The population is 965, of which 90 percent are Aboriginal. Two-thirds of the people are subsistence hunters, and 60 percent of the population gets at least half of their foods from subsistence. About half the people in Tuktoyaktuk have an internet connection. The town has an airport with a 1329-meter gravel runway. The town also has a harbor with a cargo pier depth of 3.4 - 4.6 meters and an oil terminal depth of 4.9 - 6.1 meters. A year-round road connecting Tuktoyaktuk and Inuvik will be completed in 2017 or 2018.

Aklavik is around 50 kilometers west of Inuvik, on the Peel Channel of the Mackenzie Delta. The population is around 650, over 90 percent of whom are Aboriginal. Sixty percent of the community hunts and fishes, and nearly three-quarters of the people get over half of their foods from subsistence. About half of the community is connected to the internet. The town has an airport with a 914-meter gravel runway and a seaplane base that is open during the summer months.

Paulatuk is along the Beaufort Sea coast at Letty Harbor, some 350 kilometers east of Tuktoyaktuk. The population is around 300, nearly all of whom are Inuvialuit. Over 70 percent are subsistence hunters/fishers, and three-quarters of the people get at least half of their foods from subsistence. The hamlet has a 1000-meter gravel runway and seasonal sea-plane base.

Another 400 kilometers east of Paulatuk, the hamlet of Kugluktuk is located on the mainland coast at the mouth of the Coppermine River at Coronation Gulf, which is the body of water separating Victoria Island and the mainland. Kugluktuk, which is part of Nunavut, has a population of around 1500. The town has internet service and a 1457-meter gravel runway.

Sachs Harbour is on the southwest coast of Banks Island, around 400 kilometers northeast of Tuktoyaktuk. The population is around 100, most of whom are Aboriginal. Over two-thirds are subsistence hunters and fishers and get the majority of their food from the country. The community is well-connected to the internet and served by a 1000-meter gravel airstrip.

Ulukhaktok (formerly known as Holman) is on the west coast of Victoria Island, 600 kilometers east of Tuktoyaktuk. The population is around 400, most of whom are Inuvialuit. Eighty percent of the population hunt and fish, and over half get the majority of their foods from subsistence. Around half of the people have internet, and the hamlet has a 1136-meter gravel runway.

II. International and domestic legal requirements for shipping spills in Beaufort Sea

Oil spill response capacity is governed by laws and regulations that require oil spill response plans and set out response planning standards. The response plans outline the entities responsible for cleaning up a spill and how they will accomplish the response. The response standards identify specific amounts of oil and time periods within which the oil must be recovered. In the Arctic region, response plans exist but no response standards apply.

Response Planning

A well-designed oil spill response plan is the first step to ensuring adequate response capabilities. This is particularly true for Arctic operations where response logistics are challenging and response resources may be far from where the spill occurs.[21]

Under Canadian and international law, all tanker ships that are of at least 150 gross tonnage and all other vessels that are of at least 400 gross tonnage must have a Ship Oil Pollution Emergency Plan (SOPEP).[22] A SOPEP outlines steps that must be taken if a ship-based spill occurs, including reporting procedures, authorities to be contacted, and actions to be taken by crew. Currently, SOPEPs are not Arctic-specific and therefore a SOPEP may not account for communications challenges that could arise in attempting to report a spill in the Arctic.[23] The degree of planning outlined in a SOPEP is rudimentary, as it does not require the identification of where response equipment in or outside the region might come from, nor does it require planning for the response-related logistical issues that arise after the authorities are notified.

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[21] *A Review of Canada's Ship-source Spill Preparedness and Response, Phase II* (Tanker Safety Expert Panel, 2014), p. 29 [*Tanker Safety Expert Panel, Phase II*].

[22] Vessel Pollution and Dangerous Chemicals Regulations, SOR/2012-69, subsection 27(1); MARPOL annex 1.

[23] However, the Polar Code now requires, "Operation in polar waters shall be taken into account, as appropriate, in the Oil Record Books, manuals and the shipboard oil pollution emergency plan or the shipboard marine pollution emergency plan as required by MARPOL Annex I." Part IIA, section 1.1.4. Thus, Canadian regulations may be updated to implement this provision.

Canada has national, regional, and local area spill contingency plans that provide additional requirements for spill response planning. The National Marine Spills Contingency Plan outlines the responsibilities of various government agencies, response organizations, and ships. Below 60 degrees north latitude, the operators of a ship are responsible for responding to a spill and are required to contract with a Response Organization that supplies the equipment and personnel to conduct the response.[24] The Canadian Coast Guard (CCG) ensures that the response is adequate. In the Arctic, the CCG is responsible for both responding to a spill and for ensuring an appropriate response occurs.[25]

The National Marine Spills Contingency Plan sets out overarching policies, guidelines, and responsibilities for oil spill response operations, and it requires each CCG response region to detail the procedures, resources, and strategies that will be used to respond to a spill.[26] The National Plan also provides for activation of a National Response Team when insufficient resources exist in the affected region.[27]

The Central and Arctic Regional Plan covers an extensive area, including all Canadian waters from the Alaska-Yukon boundary east to the Nunavut-Greenland boundary, as well as Hudson and James Bays, the Great Lakes, the St. Lawrence River, and the internal waters of Northwest Territories, Nunavut, Alberta, Saskatchewan, Manitoba, and Ontario.[28] This plan details the procedures, resources, and strategies that will be used for a response in the region. However, there is no process in place that assures that the requirements of these plans are in place or that the CCG is prepared to respond effectively.[29]

The Beaufort Sea and Amundsen Gulf Area Plan identifies specific geographical priority areas and proposes tactics to protect these areas in the first 12-24 hours of a spill. The priority areas include concentrated wildlife areas and sensitive coastlines. The suggested tactics include using boom to protect small areas and hazing by local hunters or helicopters to keep wildlife away from oiled areas. These strategies are untested and require site visits and deployment exercises to confirm their viability.[30]

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[24] Canadian Shipping Act, 2001, section 171.
[25] *Oceans Act*, 1996, section 41(1).
[26] *Marine Spills Contingency Plan – National Chapter* (Canadian Coast Guard Environmental Response, 2011), pp. 1-6 to 1-7.
[27] *Id.,* p. 4-7.
[28] *Central and Arctic Regional Response Plan* (Canadian Coast Guard, 2008), p. 1-1.
[29] *Report of the Commissioner of the Environment and Sustainable Development to the House of Commons, Chapter 1, Oil Spills from Ships* (Office of the Auditor General, 2010), p. 2 [*CESD Oil Spills from Ships*].
[30] *Beaufort Sea and Amundsen Gulf, N.W.T. Area Plan* (Canadian Coast Guard, 2005).

The Canada/United States Joint Marine Pollution Contingency Plan provides for a Joint Response Team from both countries to facilitate a coordinated response when necessary. Similarly, the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic sets out basic procedures for Arctic nations to notify and request assistance from one another in the event of a spill and commits Arctic states to maintaining a national oil spill response plan.

Response Standards

Response standards establish concrete requirements for cleaning up a spill. Yet, in the Arctic none of these requirements are applicable. In southern waters, to ensure the appropriate level of response equipment and personnel exist in the event of a spill, Canadian law requires ships to contract with a Response Organization that can provide equipment and personnel sufficient to clean up the amount of oil that a ship is carrying, up to 10,000 tonnes, within a certain amount of time.[31] However, ships traveling north of 60 degrees latitude are exempt from these provisions.[32]

The rationale for an absence of response standards in the Arctic is based on the lack of adequate funding, due to an insufficient number of ships that could contribute to the formation of an Arctic Response Organization. Perceptions about the relative risk of ship-based oils spills in the Arctic may also be limiting support for Arctic response standards. A Transport Canada commissioned risk assessment asserts that "the risk of oil spills in Canadian Arctic waters is significantly lower than in the rest of Canada as a result of low probability of spills, lower level of traffic and low volumes of oil transported over the last 10 years."[33] However, the study did not account for the heightened risks from navigation nor the heightened costs of spill response in the Arctic.[34] Although the study incorporates an Environmental Sensitivity Index and a Human-Use Resource Index (HRI), the particular importance of subsistence in the health and wellbeing of northern communities was not considered. Instead, the HRI accounted only for commercial losses that would be caused by a spill.[35] A Coastal Population Index was used as a proxy for subsistence values based on the assumption that non-commercial hunting and fishing activities would increase commensurate with increased population densities.[36] Yet this

[31] Canadian Shipping Act, 2001, section 167(1); Environmental Response Arrangements Regulations, SOR/2008-275.
[32] Environmental Response Arrangements Regulations, SOR/2008-275.
[33] *Risk Assessment for Marine Spills in Canadian Waters, Phase 2, Part B: Spills of Oil and Select Hazardous and Noxious Substances Transported in Bulk North of the 60th Parallel* (WSP Canada Inc., 2014), p. iii.
[34] *Id.,* pp. 9, 60.
[35] *Id.,* p. 11.
[36] *Id.,* p. 16.

approach devalues the risks to individuals, especially those living in small communities who are heavily dependent on subsistence hunting.

Under international law, no response planning standards exist. In addition, SOPEPs are not required to include or identify a minimal level of oil spill response equipment on the ship.

The CCG has the responsibility for responding to spills north of 60 degrees and aims to maintain a national capacity to respond to a spill of 10,000 tonnes through a collection of spill response equipment depots throughout the country. Although Transport Canada certifies that regional Response Organizations maintain the capacity to respond to ship-source oil spills of up to 10,000 tonnes, similar procedures and criteria for ensuring readiness are not in place for the CCG.[37] The CCG is still building a national response capacity, and equipment requirements and placement are determined on an ad hoc regional basis.[38]

Advisory and policy bodies

Various advisory bodies provide input into the development of Arctic oil spill response capacity laws and policies:

- The Northwest Territories/Nunavut Spills Working Group is an inter-agency group that provides coordination for spill reporting and response.
- The Arctic Regional Advisory Council is comprised of representatives from local government, Aboriginal interests, the fishing industry, commercial shipping, conservation groups, and others. The Advisory Council makes recommendations to the Ministry of Transport on policy issues affecting regional preparedness and response.[39] Although the Advisory Council could provide future guidance for local oil spill response planning, it is unclear how active or authoritative the Advisory Council is at this point.[40]
- Regional Environmental Emergencies Teams make recommendations regarding contingency plans and regional preparedness issues, and other issues related to emergency events and risks to the environment.[41]

[37] *CESD Oil Spills from Ships*, p. 22.
[38] *Audit of The Canadian Coast Guard Environmental Response Services* (Department of Fisheries and Oceans, 2010).
[39] Canada Shipping Act, 2001, section 172.
[40] Although the Tanker Safety Panel's second report, which addresses Arctic shipping, did not reference Regional Advisory Councils, the first report recommended that they be disbanded.
[41] *Central and Arctic Regional Response Plan*, p. 3-6.

III. Shipping in the Beaufort Sea

Navigating the Beaufort Sea is particularly risky due to the presence of sea ice, the low visibility from fog and from short daylight hours in the fall, and the lack of information and communication support for ships. Despite these risks, shipping activity in the Beaufort Sea is increasing. Most of the increase in ship traffic is from adventure tourism, resource development, and community re-supply, although some large vessels are now using the Beaufort Sea for transarctic shipping. As the number and size of ships using the Beaufort Sea increases, the potential for spills and the consequences of these spills also increases.

Information and communication support for ships

Safe navigation in the Beaufort Sea is challenging due to a number of factors including the presence of sea ice, limitations of navigational and on board communication equipment, extreme weather conditions causing equipment malfunctions, and inadequate hydrographical surveys and charts in parts of the Arctic.[42]

As described above, sea ice is present in the Beaufort Sea for most of the year. Even during periods of open water, sea ice, growlers and icebergs are present, can be difficult to spot and can cause significant damage to a ship's hull.

Navigation is difficult because gyro and magnetic compasses have limited effectiveness in the north. Aids to navigation can help, but their coverage is not comprehensive. Around 15 radar beacons operate in the Beaufort Sea on a seasonal basis, with a range of up to 20 nautical miles, enabling ships to take bearings.[43] Equipment used for electronic position fixing, such as global positioning system (GPS), is also limited by satellite coverage in the north. Extreme weather conditions can cause icing and freezing spray, which limits machinery and equipment reliability on board.

Navigation is also difficult because of the poor quality of charts. The Canadian Hydrographic Service (CHS) produces navigational charts for the region, which provide essential information to ships such as water depths and hazards. The CHS has incomplete hydrographic data for most of the Beaufort Sea, and this data is

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[42] Parsons, J., *Benchmarking of Best Practices for Arctic Shipping* (WWF, 2012), p. 23.
[43] *Radio Aids to Marine Navigation, Pacific and Arctic* (Canadian Coast Guard, 2015), Part 2, pp. 36-37.

necessary to create accurate charts.[44] Some of the Beaufort Sea has been surveyed to "adequate" standards, and a very small portion has been surveyed to modern standards, using multi-beam sonar. In the rest of the Beaufort Sea, hydrographic data is deficient.[45] The charts for the region are therefore not very detailed or accurate. For example, the charts are at a larger scale than along any other coastline in Canada, providing insufficient detail, and they have a "high likelihood of undetected hazards."[46] For instance, in 2010 while traveling about 100 kilometers east of Kugluktuk, the passenger ship Clipper Adventurer was following a single line track that indicated a water depth of 68 meters when it grounded on a rock.[47] Although the shoal had been identified earlier and reported in a Notice to Shipping, the charts had not been corrected.[48]

The Canadian Coast Guard has begun the process of designating shipping corridors through the Northern Marine Transportation Corridors Initiative. The goal of the initiative is to provide greater predictability for mariners, reduce risk of incidents, and create a pragmatic planning framework for future Arctic infrastructure investments. The initiative will identify routes within which key navigational information services will be prioritized, such as hydrography, icebreaking, and aids to navigation.[49]

Information for ships about sea ice and weather is also limited, making navigation more difficult. The Canadian Coast Guard Marine Communications and Traffic Services (MCTS) is based in Iqaluit, nearly 3000 kilometers away, but it maintains ship/shore radio communications on a seasonal basis out of Inuvik. The base in Inuvik provides information on wind and ice conditions and broadcasts recent Notices to Shipping, which contain information about navigation in the region.[50] In addition, Environment Canada's Meteorological Service of Canada provides, on a seasonal basis, daily weather and ice information based on imagery from satellites. However, malfunctioning satellites have made it difficult for the Canadian Ice Service to get consistent and reliable data.[51]

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[44] *Report of the Commissioner of the Environment and Sustainable Development to the House of Commons, Chapter 3, Marine Navigation in the Canadian Arctic* (Office of the Auditor General, 2014), p. 6 [*CESD Marine Navigation*].
[45] *Tanker Safety Expert Panel, Phase II,* p. 24.
[46] *CESD Marine Navigatio*n, p. 6.
[47] Stewart, E. and Dawson, J., *A Matter of Good Fortune? The Grounding of the* Clipper Adventurer *in the Northwest Passage, Arctic Canada*. Arctic, Vol. 64, No. 2 (June 2011).
[48] *Grounding of the Passenger Vessel Clipper Adventurer*. Marine Investigation Report # M10H0006 (Transportation Safety Board of Canada, 2012), p. 25.
[49] Dawson, J., et al., *Proceedings of the Northern Marine Transportation Corridors Workshop* (December 8,2015), p. 2.
[50] *Central and Arctic Regional Response Plan*, p. 3-3.
[51] *CESD Marine Navigation,* p. 13.

On board communications equipment is also limited. Cell phone service is available in each of the communities but it does not extend far beyond each community. Satellite phone services provide limited voice and data transfer capability, which can be inconsistent due to masking, poor elevation and shadow sectors of satellites. The Canadian Beaufort is outside the range of the Global Maritime Distress and Safety System (GMDSS), an international system for satellite and ship-board radio systems.[52] The Canadian government has initiated a "Polar Communications and Weather space mission for Canada's North," which will provide two-way satellite communications for data transmission, communications, and meteorological information, but this system is still in the development stage.[53]

Shipping trends in the Beaufort Sea

By comparison to other areas in Canada, shipping traffic in the Canadian Beaufort is still relatively low. Between 21 and 50 boats transit the Canadian Beaufort annually.[54] However, shipping activity in the region, mostly related to community re-supply and adventure tourism, has increased.[55] Re-supply ships now commonly serve western arctic communities from the east.[56]

Increased activity from passenger and re-supply vessels, natural resource projects, and an expanding fishing industry is expected to grow in the future. As marine activity continues to expand in the Arctic, the potential risk of vessel accidents and oil spills also increases. Changing sea-ice conditions due to climate change, including calving of ice islands (from ice shelves) and more abundant small icebergs, also make the region increasingly hazardous to navigate.[57]

Ships currently transporting hydrocarbons in the Beaufort Sea carry only refined petroleum products, such as marine diesel, gasoline, and jet fuel.[58] None transport crude oil, although this could change if offshore development proceeds or if onshore projects use rivers and the ocean as a means of transport.

The ships transiting the Beaufort use a variety of fuel types, with the larger ships typically using heavy fuel oils (HFOs), which pose the greatest risk. HFOs are 50

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[52] *Radio Aids to Marine Navigation*, part 4, p. 51.
[53] Canadian Space Agency, Polar Communication and Weather Mission, http://www.asc-csa.gc.ca/eng/satellites/pcw/.
[54] *Tanker Safety Expert Panel, Phase II*, p. 8.
[55] Kravitz, M. and Gastaldo, V., *Emergency Management in the Arctic: The context explained* (Munk-Gordon Arctic Security Program), p. 14. [*Emergency Management in the Arctic*].
[56] *Changing Tides,* p. 32.
[57] *Canada's Marine Coasts in a Changing Climate*, p. 181.
[58] *Tanker Safety Expert Panel, Phase II*, p. 2.

times more toxic than medium and light crude oil spills and persist in cold environments such as the Arctic.[59] Currently, almost a third of the ships throughout the Arctic use HFOs, although that proportion is lower in the Beaufort Sea.[60] The vessels that typically use HFOs are chemical/product tankers, passenger vessels, bulk carriers, container vessels, and refrigerator container ships.[61] Barring international agreement to ban HFO use in the Arctic, ship traffic fueled by HFOs is likely to increase in the Beaufort Sea.

As information and response services are further developed along the corridor, the use of this passage is likely to increase. For example, in the spring of 2016, the Chinese government published Northwest Passage shipping operating manual to support Chinese cargo vessels traveling from China to the Northeast coast of North America.[62] The Canadian Coast Guard has begun the process of designating shipping corridors through the. The initiative will identify routes within which key navigational information services will be prioritized, such as hydrography, icebreaking, and aids to navigation. The Northern Marine Transportation Corridors Initiative identifies the Northwest Passage, through the Beaufort Sea, as a primary corridor.[63] The establishment of the corridors may lead to increased traffic, as part of the objective of establishing the corridors is to incentivize their use.[64]

In addition to increasing traffic, ships are using and will continue to use the Beaufort Sea for longer periods each year because the sea freezes over later each season. Ships are therefore in the Beaufort Sea in the fall, when daylight hours are quickly diminishing and reduced visibility becomes an additional risk factor.

Potential spill volumes from a ship in the Beaufort Sea

The size of an oil spill could range from a few liters spilled by a small boat to thousands of tonnes of oil spilled by an oil tanker or a large commercial vessel. For example, typical dry cargo vessels currently in the Canadian Arctic probably carry less than 1,000 tonnes of fuel,[65] but the average general cargo vessels carry around

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[59] Bornstein, J., et al, “Effects-driven chemical fractionation of heavy fuel oil to isolate compounds toxic to trout embryos.” *Environmental toxicology and chemistry* 33.4 (2014): 814-824.
[60] *HFOs in the Arctic – Phase 2* (DNV, 2013), p. 6.
[61] *Id.,* figure 5-12, p. 32.
[62] The People’s Republic of China, China Daily, *China charting a new course for maritime transportation* (April 20, 2016) http://english.gov.cn/news/top_news/2016/04/20/content_281475331301933.htm
[63] *Northern Marine Transportation Corridors Initiative* (Canadian Coast Guard, 2015).
[64] *Proceedings of the Northern Marine Transportation Corridors Workshop*, p. 4.
[65] Typical dry cargo vessels today carry around 12,000 DWT. Wright, C., *Navigability Of The Canadian Arctic* (2012), p. 8. These ships are likely to have tank capacities that are less than 1,000 tonnes.

2,000 tonnes of fuel.[66] Fuel tankers transiting in the Beaufort Sea carry around 1,800 tonnes of HFO.[67] Overall, the typical bunker oil capacity for oceangoing ships on the Great Circle Route ranges from 1,000-8,000 tonnes.[68] Thus, while some ships carry less than 1,000 tonnes of fuel, most carry much more. This is important because, as discussed below, the in-region capacity for a response is capped at 1,000 tonnes.

Not all commercial boats in the Arctic are ice-strengthened, which increases the risk of a spill. In addition, these ships pose a particularly high risk to the Arctic environment because only a single hull plate separates the oil from the sea, rather than a double hull, as is the case with oil tankers.

Bulk carriers and cruise ships pose some of the more immediate threats to the Beaufort Sea. For example, the Nordic Orion, a ship carrying coal from western Canada to Finland, became the first bulk carrier to transit the Northwest Passage in the summer of 2013.[69] This ship carried around 2,200 tonnes of fuel.[70] In 2014, the Nunavik, an ice-strengthened ore carrier, made the first unsupported trip from near Deception Bay, in Quebec's Nunavik region, to northeastern China. The ship carried around 2,020 tonnes of intermediate fuel oil (a blend of marine gas oil and heavy fuel oil).[71] In the fall of 2016, the first full-sized cruise ship will transit the Northwest Passage through the Beaufort Sea. The Crystal Serenity will voluntarily run on low sulfur fuel, although most large passenger ships do not, and can hold thousands of tonnes of HFOs.[72]

If crude oil tankers begin to use the Beaufort Sea, the amount of oil that could be spilled could be even higher. For example, the *Exxon Valdez* spilled over 40,000 tonnes of crude oil into Alaska waters, and in 1970, the *Arrow* spilled 10,000 tonnes of bunker fuel in the waters off Nova Scotia.

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[66] *Aleutian Island Risk Assessment, Task 2A: Marine Spill Frequency and Size Report* (DNV and ERM-West, 2010), p. 9. [*AIRA Spill Frequency and Size*].
[67] *Navigability Of The Canadian Arctic*, p. 10 (showing *Torm Lotte*, 53,160 DWT, anchored in Wise Bay near Paulatuk). This ship has a fuel tank capacity of 1,824 tonnes. http://torm.com/Q88Servlets/GetQ88?VesselName=Torm%20Lotte&CargoHistory=Call%20for%20Details.
[68] *AIRA Spill Frequency and Size*, pp. 9-10.
[69] O'Rourke, R., *Changes in the Arctic: Background and Issues for Congress* (Congressional Research Service, 2016), p. 21.
[70] The ship carries around 75,000 DWT. http://www.nordicbulkcarriers.com/ice-bulk-carriers. The typical fuel capacity for bulk carriers this size is 2,200 tones. *See* Rauta, D., "Protection of Bunker Tanks" *The 24 International Bunker Conference, Rotterdam* (9 May 2003), p. 8. [*Protection of Bunker Tanks*].
[71] Fednav: Nunavik. http://www.fednav.com/en/nunavik.
[72] The average fuel capacity for passenger ships transiting the Aleutian Islands, for example, is 1,750 tonnes. *AIRA Spill Frequency and Size,* p. 9.

IV. Responding to an oil spill in the Beaufort Sea

A response to oil spills in the sea includes a number of basic requirements, each of which would be challenging in the Beaufort Sea:

- The ship must be able to communicate the spill to emergency services, and communications networks between responders and with incident command must be sufficient to execute the response,
- Response equipment and trained responders must be transported to the spill location
- Responders and equipment must be able to access the spill,
- Responders must be able to continually track the spill,
- The response equipment must be able to recover the oil in the existing sea and weather conditions,
- Vessels and aircraft must be able to operate safely,
- The environmental and oil spill conditions must be safe enough for responders to conduct response operations, and responders must be protected from weather or harmful health effects of responding to the spill,
- There must be accommodation, water, and food for response personnel,
- The recovered oil must be transported and disposed in an approved location, and
- The shoreline must be protected, assessed, and monitored and oiled shores must cleaned.

If an oil spill occurred in the Beaufort Sea, the success of a response would be determined by the behavior of the oil after it spilled, the time that passed between the spill and the response, and the effectiveness of the response mechanisms. The environmental conditions in the Beaufort would likely significantly affect each of these factors.

Behavior of spills in Arctic waters

The behavior of oil spilled in water influences how and whether the oil can be cleaned up. When oil spills into water, it immediately starts to spread and will continue to do so until the slick reaches a thickness of ~0.1 mm.[73] Spreading does not occur uniformly, and the slick will have some thicker patches and some thinner sheens. The direction the slick travels is influenced by currents, wind, and waves,

[73]National Academy of Sciences, Ocean Studies Board, *Understanding Oil Spill Dispersants: Efficacy and Effects*, (National Academies Press, 2005), p. 136. [*Dispersants: Efficacy and Effects*].

which also break the slick into different patches. The oil viscosity and the temperature of the water and air also influence spreading.[74] For example, light crude oils spread on water more readily, whereas heavier oils spread more slowly and may sink.[75] The degree of sedimentation in the water and the water salinity will also influence whether the oil stays on the surface or sinks.[76]

As the spill spreads, the oil also begins to weather, which changes the composition and behavior of the oil. Weathering is influenced greatly by the type of oil spilled. Some of the components of the oil will evaporate, while other components of the oil will dissolve into the water. Evaporation and dissolution are also strongly influenced by the type of oil that is spilled.[77] As the wind and waves break up the oil, small droplets will form and disperse vertically into the water column. Heavy fuels oils emulsify more slowly and do not readily disperse into the water column.

Depending on the water temperature, wind, waves, and the type of oil, different emulsions of oil and water will form, increasing the volume of the spilled oil, decreasing evaporation, and reducing spreading.[78] As the oil emulsifies, it becomes more difficult to recover.[79] Although heavy fuel oil spreads more slowly, it is slower to evaporate and can therefore travel hundreds of miles in the form of patches and tarballs.[80]

An important factor that affects the behavior of oil spilled in Arctic marine environments is sea ice. When the oil encounters ice, it may move above, below or through the ice.[81] Oil trapped in ice can be transported great distances as wind and currents move the ice. As the ice melts to release the oil, oil is spread over a wide area.[82] Oil trapped under the ice can pool in some places or be transported a long way under the ice by currents.[83]

Lower air and water temperatures will increase the viscosity of oil, leading it to spread more slowly. Low temperatures will also slow evaporation, dissolution, and

[74] Lee, K., et al, *Expert Panel Report on the Behaviour and Environmental Impacts of Crude Oil Released into Aqueous Environments* (Royal Society of Canada, 2015), p. 77. [*Behaviour and Environmental Impacts of Crude Oil*].
[75] *Id.* p. 76.
[76] *Id.* p. 87.
[77] *Id.* pp. 78, 85.
[78] *Id.* p. 82.
[79] *Id.*
[80] NOAA, Office of Response and Restoration. http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/no-6-fuel-oil-spills.html.
[81] *Id.* pp. 96-97.
[82] National Academy of Sciences, Ocean Studies Board, *Oil in the Sea III: Inputs, Fates, and Effects* (National Academies Press, 2003), p. 105. [*Oil in the Sea III*].
[83] *Id.*

dispersion. The presence of sea ice may contain the oil and keep it from spreading.[84] Sea ice will also dampen wave action, slowing dispersion. Biodegradation in Arctic waters is likely to be slower in low temperatures.[85]

Oil that is on top of ice and snow will spread more slowly than oil on the surface of water.[86] Oil that adheres to ice edges will no longer spread or emulsify.[87] Ice edges in the Arctic often correspond to highly productive areas and therefore the oiling of ice edges can pose heightened risks to environmental resources.

Other conditions such as salinity and wind, air and water temperature will also affect what happens to oil when it is spilled in Arctic waters.[88] The seasonal fluctuations in the Beaufort Sea's salinity and temperature will affect the behavior of oil differently at various times throughout the open water season, making the behavior of oil more difficult to predict.

In sum, Arctic conditions can affect the behavior of oil, making it unpredictable and that will in some cases extend the time during which it can be recovered but will often make recovery much more difficult.

Oil spill response mechanisms

Oil spill response methods are generally divided into three main categories: mechanical recovery, in situ burning, and chemical dispersant application. Each method has limitations, and none of the methods, even when used in combination, are very effective at cleaning up oil spilled into marine environments. The behavior of oil in water, including how it spreads and weathers, will determine how or whether the oil can be recovered by any of the available recovery mechanisms.

Mechanical recovery involves the use of containment barriers such as boom to contain the spilled oil, collection of the oil with a recovery device such as a skimmer, and storage of the recovered oil and water using a container. These primary components require additional equipment and resources such as vessels, pumps, anchors, decanting (oil/water separation) systems, sorbents,[89] and trained

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[84] *Behaviour and Environmental Impacts of Crude Oil*, p. 97.
[85] *Id.*
[86] *Id.*
[87] *Oil in the Sea III*, p.105.
[88] *Id.,* p. 104.
[89] Although they may be used as the sole cleanup method in small spills, sorbents are most often used to remove final traces of oil, or in areas that cannot be reached by skimmers. https://www.epa.gov/emergency-response/sorbents.

personnel.[90] The oil must be contained to a certain thickness for it to be removed by the skimmers. Thus, as time passes and the oil spreads, containment and recovery become more difficult. Boom are deployed from vessels or anchored to fixed structures or land. A number of different kinds of skimmers exist; they use suction, oleophilic materials, or weirs to remove oil from the water's surface. Skimmers do not work well with emulsified oil. Once the oil has been recovered, it must be transferred using pumps and hoses to temporary storage until it can be properly disposed of.

In-situ burning of spilled oil on the water's surface involves a controlled burn of floating oil that is contained to the appropriate thickness. As with mechanical recovery, oil containment to achieve adequate thickness for ignition can be accomplished either with natural barriers or man-made fire-resistant boom. The oil is ignited by releasing a burning, gelled fuel from a helicopter onto the oil, or by releasing an ignition device from a vessel or other access point.

The materials required for in situ burning are not readily available in the Beaufort Sea region, and the window of opportunity for attempting a burn is fairly limited. In addition to requiring that the slick have a certain thickness, successful ignition requires minimal wind and waves and oil that has not emulsified. During the Gulf of Mexico blowout, where materials and equipment were readily available, in situ burning treated only five percent of the oil.[91] Given the ineffectiveness and the lack of in situ burning materials in the region this response method is unlikely to play a role in response to a ship-based spill in the Beaufort Sea.

Chemical dispersants are used with the objective of driving oil from the water surface into the water column and reducing shoreline fouling and harm to marine mammals and seabirds. Another objective is to facilitate biodegradation by naturally occurring hydrocarbon-metabolizing microbes. Successful dispersion requires the correct application of the chemicals, adequate wind or waves, and underwater currents that can transport the droplets so that non-toxic levels of oil in the water are achieved.

Currently available dispersants have limited effectiveness, especially in Arctic conditions.[92] Dispersants are not readily available in the region, and the window of opportunity during which dispersant application can be successful is narrow –

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[90] *Oil Spill Prevention and Response in the U.S. Arctic Ocean* (Pew Environment Group, 2010), p.73.
[91] Lehr, B., et al., *Oil Budget Calculator, Deepwater Horizon* (2010), p. 40.
[92] Lewis, A., and Daling, S., *JIP Report No. 11, A Review of Studies of Oil Spill Dispersant Effectiveness in Arctic Conditions* (SINTEF Materials and Chemistry, 2007).

perhaps as short as 24 hours.[93] During the Gulf of Mexico blowout, where materials and equipment were readily available, chemical dispersants treated around 16 percent of the oil.[94] Given the lack of regional stockpiles and the ineffectiveness of dispersants, this response method is unlikely to play a role in response to a ship-based spill in the Beaufort Sea.

Mechanical recovery is also limited in its effectiveness. Even on a perfect day in calm water with maximum resources, operators only expect to mechanically recover up to 20 percent of the volume of oil. During the Gulf of Mexico blowout, about three percent of the oil was removed by mechanical recovery.[95] During the Exxon Valdez spill, eight percent was skimmed from the water.[96]

Arctic conditions make it much more difficult to clean up spilled oil. Ice is a significant limitation for successful response. "No current cleanup methods remove more than a small fraction of oil spilled in marine waters, especially in the presence of broken ice."[97]

Mechanical response equipment has very low effectiveness in waters with more than 30 percent ice coverage in the spill area. This is because the effectiveness of a skimmer relies on its ability to encounter oil efficiently, which is difficult due to the slow speed that must be used with a skimmer and to the ice, which blocks the skimmer. In addition, the low temperatures can make the oil too viscous for the pumps.

Mechanical recovery relies on boom to concentrate and contain oil to a sufficient thickness to allow recovery by a skimmer. Sea ice also reduces the effectiveness of containment boom by interfering with the boom position, allowing oil to entrain or travel under the boom, or causing the boom to tear or separate. [98] Ice-capable vessels and active ice management to keep ice away from the vessels and equipment are therefore required.

An additional difficulty is that when oil mixes into the ice, it must be separated from the ice and water, which requires the response vessel to have a heating system.

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[93] *Dispersants: Efficacy and Effects*, p. 66.
[94] *Oil Budget Calculator, Deepwater Horizon*, p. 40.
[95] *Id.*
[96] Wolfe, D., et al. "The fate of the oil spilled from the Exxon Valdez." *Environmental Science & Technology* 28.13 (1994): 560A-568A.
[97] National Academy of Sciences, *Cumulative Environmental Effects Of Oil And Gas Activities On Alaska's North Slope* (National Academies Press, 2003), p. 7.
[98] *Arctic Oil Spill Response Research and Development Program: A Decade of Achievement*, (Minerals Management Service, 2009), p. 15. [*Arctic Oil Spill Response Research and Development Program*].

Even trace amounts of ice (less than 1/10 ice coverage) can cause significantly reduced efficiencies in mechanical recovery.[99] For example, during the spill from the *Godafoss* off the coast of Norway in 2011, the seawater started to freeze, trapping the oil in the ice and making recovery very difficult.[100]

When oil travels under the ice, it is very difficult to detect. To clean up this oil, the ice must be thick enough for personnel and equipment to stand on top so that they can cut holes into the ice and attempt to pump or skim oil out of drill holes. The process is slow, tedious, labor intensive, very inefficient and produces low oil recovery rates.[101]

In addition to ice, other conditions in the Arctic including extreme cold, limited visibility, rough seas, and wind make oil spill clean-up very challenging. As discussed above, these conditions are common in the Beaufort Sea. The following table summarizes the effects that these Arctic conditions would have on a mechanical response, which is the primary response mechanism for a ship-based spill in the Canadian Beaufort Sea.

[99] *Arctic Oil Spill Response Research and Development Program*, p. 14.
[100] Centre of Documentation, Research and Experimentation on Accidental Water Pollution, *Godafoss* (2012).
[101] *Not so Fast: Some Progress in Technology, but US Still Ill-Prepared For Offshore Development* (WWF, 2009).

Effect of Arctic conditions on mechanical oil spill response[102]

Condition	Limitation on response
Sea Ice	Ice can impede access to the spill area, making it difficult to track and encounter oil. Oil is difficult to detect under the ice. Ice can impede or limit vessel operations, especially for smaller work boats, and make boom and skimmer placement more difficult. Containment boom can be moved, lifted or torn by ice. Skimmer encounter rate may be reduced by ice chunks, and skimmers and pumps may clog. Attempts to deflect the ice from recovery areas may also deflect the oil. Ice must be separated from recovered oil.
Wind	High winds can make it difficult to deploy the crew, vessels, and equipment required for a response. High winds can make air operations difficult or unsafe. High winds can move boom and vessels off station or tear boom off the anchor point.
Temperature	Prolonged periods of sub-freezing temperatures can impact personnel safety or require more frequent shift rotations. Cold may cause brittle failure in some metals. Cold air may freeze sea spray, creating slick surfaces. Icing conditions may make vessels unstable. Skimmers freeze up. Freezing sea spray can accumulate on boom and cause it to tear, fail or overwash. Increased viscosity makes oil difficult to recover and pump. Seawater can start to freeze, trapping the oil in the ice.
Limited visibility	Reduced visibility may preclude or limit oil spill response operations, particularly any involving aircraft or vessel operations. Limited visibility may make it difficult or impossible to track the spill location and movement. Fog banks make vessel or aircraft operations extremely dangerous.
Sea state	Boom and skimmers do not function well at high sea states. Fast currents, changing tides and short period waves can make it difficult to keep boom and vessels on station.

All oil spill response technologies require surveillance and spill tracking to identify the location, spreading, and condition of the spilled oil in order to select and apply the appropriate response equipment and tactics. All methods also require logistical support to transport equipment and trained personnel to the spill site, deploy and operate the equipment, store and dispose the recovered oil and water, and decontaminate the equipment when response operations are complete. These logistical issues are discussed in more detail, below.

Response gap

Arctic conditions can make the recovery of oil spilled from a ship in the Arctic much more difficult but they can also completely preclude any response efforts at all. A "response gap" exists when activities that may cause an oil spill are conducted during times when an effective response cannot be achieved, either because technologies available will not be effective or because their deployment is precluded due to environmental conditions or other safety issues.[103]

Environmental conditions that can prevent an attempted response include wave height, wind speed, air temperature, visibility, cloud ceiling, daylight, vessel superstructure icing, and ice coverage. For example, boom will only work in waves up to one meter high, or two meters if the waves are sufficiently spread out. Wind more than 15 meters per second will also make it impossible to contain the oil with boom. If visibility is less than one kilometer, it is extremely difficult to find and recover oil slicks, and no recovery can take place during darkness. If too much ice builds up on the boats or equipment, they will not be safe to operate.[104]

A study commissioned by Canada's National Energy Board assessed the response gap in near and far offshore of the Canadian Beaufort Sea. The study found that during periods of open water in the near Beaufort Sea, mechanical recovery would not be possible for 20 percent of the time in June, 41 percent of the time in August, and 85 percent of the time in October.[105] If chemical dispersion and in situ burning were available options, they would somewhat reduce the response gap in October, from 85 to 65 percent of the time.[106]

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[102] Modified From Nuka Research And Planning Group, *Oil Spill Response Challenges In Arctic Waters* (WWF, 2008), pp. 16-18.
[103] Robertson, T., *Response Gap Estimated for Two Operating Areas in Prince William Sound* (Prince William Sound Regional Citizens Advisory Council, 2007).
[104] Ross, S., *Spill Response Gap Study for the Canadian Beaufort Sea and the Canadian Davis Strait* (2011), pp. 8-10. [*Spill Response Gap Study*].
[105] *Id.*, p. 22.
[106] *Id.*

These response gap assessments do not account for sea ice. Because there are many days throughout the season when ice coverage would preclude response, the response gap is actually much greater. When ice coverage is considered, no response is possible in the near offshore area for 54 to 81 percent of the time during the open water season.[107] In the far offshore area, no response is possible for 65 to 84 percent of the time.[108] Thus, if an oil spill occurred in the Beaufort Sea, response operations would be possible in the near offshore area for anywhere from one in five days to half of the days, depending on the time of the open water season. In the far offshore area, response efforts would only be possible from one in five days to one in three days. As discussed above, operations during those days when response was possible would be very difficult, and clean up would be very inefficient.

V. Existing capability to respond to a spill in the Canadian Beaufort

Arctic conditions seriously limit the effectiveness of response equipment and often preclude any response at all due to the operating limits of the equipment and the personnel. These same environmental conditions, as well as the lack of infrastructure, response equipment, and ice-class vessels, and the remote location of the Beaufort Sea, also impose significant constraints on the logistical factors involved in mounting a response. Any one of these limitations can prevent an adequate response, because in any spill response scenario, the weakest link in the response chain will limit the overall response capability.

Very little equipment and personnel are available for a response in the Beaufort Sea. From the 1970s to the 1990s, the Beaufort Sea had many more oil spill response resources, including equipment and trained personnel, funded by oil operators through the Beaufort Sea Oil Spill Cooperative.[109] The cooperative was disbanded when offshore drilling in the region ceased. Since that time, the CCG provides the only marine response resources available in accordance with the National and Regional Response Plans discussed above.

As outlined by those plans, an oil spill response follows a tiered structure. Thus, a response to a ship-based oil spill begins with the ship and expands to additional

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[107] WWF-Canada, Letter of Comment, S.L. Ross Spill Response Gap Study for the Canadian Beaufort Sea and the Canadian Davis Straight, submitted to NEB, Arctic Offshore Drilling Review, NEB File: OF-EP-Gen-AODR 01 (September 7, 2011), p.2.
[108] *Id.*
[109] Beaufort Regional Environmental Assessment, *Study on Inuvialuit Community Spill Response Training in the Beaufort Region: Current Capacity, Projected Need, Realistic Roles and Gap Identification* (2013), p. D-5. [*Study on Inuvialuit Community Spill Response Training*].

resources, depending on the size of the spill. If a ship in the Beaufort Sea spilled oil and did not have sufficient resources to respond to the spill on its own, the next line of resources would be from the nearest "community pack," which is a container of response equipment distributed among coastal towns throughout Canada. In the Beaufort Sea region, community packs are located in Kugluktuk and Ulukhaktok.[110] If the resources in a community pack were not sufficient, the next option would be to fly in response equipment that is kept at the Coast Guard base in Hay River. After that, a larger stockpile of equipment could be transported by barge from Tuktoyaktuk. The combined capacity of CCG response equipment in the Beaufort Sea, including the equipment in Kugluktuk, Ulukhaktok, Hay River, and Tuktoyuktuk, can be used to clean up a spill of up to 1,000 tonnes. If these resources were not sufficient, the final option would be to transport additional resources from a variety of other national inventories outside the region.[111]

Logistics for a small spill

Although the CCG identifies the ship as the first response, the ship would be unlikely to be able to respond to anything more than a spill on deck. Since SOPEPs do not require ships to have any spill response equipment, the Central and Arctic Regional Response Plan points out that the "ship's ability to respond in a practical manner is greatly reduced."[112] However, the CCG recommends that the master of the vessel consider using available materials to contain the spill, for example by using mooring rope or air filled hoses as makeshift boom.[113]

As these efforts are unlikely to be sufficient to contain the oil and would do nothing in terms of recovering it, the next level of response would be to enlist the help of the CCG and use the equipment from the nearest community pack. Out of a total of 80 community packs across the country and 22 in the Arctic, only two are in the Beaufort Sea. These packs contain basic spill control equipment designed for use in near-shore areas,[114] and they can be used to clean up one tonne of oil.[115] This is equivalent to about seven barrels.

[110] *Central and Arctic Regional Response Plan*, p. 4-16.
[111] Canadian Coast Guard Arctic Response Strategy, Presentation to Arctic Council Emergency Prevention, Preparedness, and Response Working Group (November 2009). [*CCG EPPR Presentation*].
[112] *Central and Arctic Regional Response Plan*, p. 5-1.
[113] *Id.*
[114] *Review of offshore drilling in the Canadian Arctic* (National Energy Board, December 2011), p. 50.
[115] *CCG EPPR Presentation.*

This equipment would be transported by boat to the spill site, which in itself could entail a number of logistical challenges. If the spill occurred near Kugluktuk or Ulukhaktok, where the Community Packs are located, the equipment would be loaded onto the aluminum boat that is also kept in the storage container.

However, depending on the weather and sea conditions and the distance to the spill site, these boats may not be sufficient and there may not be alternative boats available to transport the equipment to the spill. The region's lack of ports and vessel repair services would add additional challenges. Thus, gaining access to and deploying this equipment "without full logistical support on site would prove extremely challenging."[116]

For a spill that was close to one of the Beaufort Sea communities without spill response equipment, it would be necessary to identify an airplane that was available to fly to Kugluktuk or Ulukhaktok, wait for the plane to arrive, transport the equipment from the beach to the airstrip, load the equipment onto the plane, fly the equipment to the community nearest the spill, and transport the equipment from that community airport to the beach.

A third, and larger, Beaufort Sea equipment depot is in Tuktoyaktuk. Because of the size of this equipment, it cannot be transported by plane. Therefore, the equipment would be transported to the Tuktoyaktuk port and then loaded onto a barge.[117]

A number of challenges could arise in deploying the equipment that is stored in the three Beaufort Sea communities. One of the initial challenges would be actually accessing it. Some communities do not have the ability to open the locked storage containers because the CCG is concerned about maintaining responsibility for the equipment inside.[118]

Another challenge is that the equipment in the Beaufort Sea communities may not be in useable condition. Although the National Response Plan aims to maintain "a proper state of readiness through a pro-active approach using work orders and preventative maintenance,"[119] the system for assuring the upkeep and maintenance of the equipment has not been consistent.[120] For example, years after the Community Pack was placed in Iqualuit, the CCG had not conducted any critical

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[116] *Tanker Safety Expert Panel, Phase II*, p. 10.
[117] *Central and Arctic Regional Response Plan*, p. 5-13.
[118] Benoit, L., *Perspectives on Emergency Response in the Canadian Arctic, Part C: Findings of the Hypothetical Scenario*, pp. 10-12. [*Perspectives on Emergency Response*].
[119] *Marine Spills Contingency Plan – National Chapter,* p. 3-4.
[120] *CESD Oil Spills from Ships*, p. 21.

maintenance.[121] The Arctic environment renders mechanical equipment inoperable if it is not maintained, and therefore some of the equipment in the Community Packs may no longer be functional.

Outside of the Beaufort Sea, additional oil spill resources are staged in Hay River.[122] This equipment would be transported by air to the Beaufort Sea airstrip nearest to the spill site. Once the equipment was flown in; it would also need to be transported from the airstrip to the beach.

Once the equipment was staged on the beach, it would need to be loaded onto boats and transported to the spill site. Outside of Kugluktuk and Ulukhaktok, or if more than one boat was needed, the transport of the equipment to the site of the spill would depend on community members offering their boats for use. If a CCG boat were in the region, it may be able to provide additional response equipment. However, because space on a vessel is at a premium, ships will not always have this equipment on board.[123]

The Mackenzie Delta Spill Response Corporation (MDSRC), based in Inuvik, and Alaska Clean Seas, based in Prudhoe Bay, Alaska, have some response equipment that is not designed for offshore spills but might be helpful, depending on the sea conditions and the location of the spill. As with the CCG equipment, this equipment would have to be transported by air to the nearest community, and then by boat to the spill site. Because there is no preexisting agreement for the equipment to be used for an offshore spill, the CCG and the corporations would have to reach an agreement before it could be used.

[121] *Perspectives on Emergency Response*, p. 11.
[122] *Central and Arctic Regional Response Plan*, p. 5-12.
[123] *CCG EPPR Presentation.*

Trained personnel

Another serious limitation to successfully responding to even a relatively small spill would be assembling a sufficient number of people who know how to use the equipment. It would take 11 CCG and 16 community responders to use the equipment from Hay River.[124] It would take 14 CCG employees, 13 contractors, and 13 community responders to use the response equipment stored in Tuktoyaktuk.[125] Yet, most communities have only one or two people who are trained to use oil spill response equipment. "This training is often at a relatively basic level and with little opportunity for practice or maintaining the skills learned."[126]

The limited number of trained responders in the Beaufort Sea region is due to a number of factors. First, because the communities in the Beaufort Sea are small, there are a limited number of people to draw upon. In addition, these people are not always available. If a spill occurred during subsistence harvesting times, for example, many people from the community would be absent. Second, people are reluctant to take spill response training courses without being compensated, but the government has limited funds to provide compensation and training.[127] Third, when spills and training do not occur regularly, it is difficult to maintain skill levels.[128] Communication and cultural barriers may also impede the successful implementation of training programs for local people.[129]

The CCG anticipates that some community members could be trained on the spot,[130] but especially in small communities, it is unclear whether the CCG would be able to find enough people to train, how much time it would take, and whether response would be effective and safe if training occurred in this manner. As one federal employee living in the Arctic observed, "I think the question is how is this equipment going to be used and who is going to use it and how long will it take to use it."[131]

Depending on the number of people who were available in the community for ad hoc training, somewhere between 30-40 people with more expertise, including contractors and CCG employees, would still have to be flown in from outside the

[124] *Central and Arctic Regional Response Plan*, p. 5-13.
[125] *Id.,* p. 5-14.
[126] *Study on Inuvialuit Community Spill Response Training,* p. 3-6.
[127] *Id.,* p. 3-7.
[128] *Id.,* p. 3-2.
[129] *Perspectives on Emergency Response*, p.12.
[130] *Central and Arctic Regional Response Plan*, p. 5-12.
[131] *Perspectives on Emergency Response*, p. 12.

region and transported to the spill site to respond to a spill of less than 1,000 tonnes.

The arrival of these responders would have a major impact on the community. Most ccommunities can only support 10-15 additional people at a time,[132] although the ability of the community to support the responders would depend on the needs of the responders (such as accommodation, food, fuel, medical services, specialized or heavy equipment, local transportation, etc.).[133] However, even providing sufficient food for the responders would be difficult because food supply in Beaufort Sea communities is "just in time." One Arctic resident explains, "You add a number of people into the community, you've overwhelmed their ability to supply themselves with basic items . . . If we miss flights for two days, we're on bread and water."[134]

Weather

The weather could be a significant limitation in getting any of the personnel or equipment into the region. Because of the fog and clouds that are so common in the summer, flights are often cancelled. Weather and sea ice could also limit the ability to transfer equipment and personnel by water from the nearest community to the spill site. Boats such as the 16-foot skiff accompanying the equipment in Kugluktuk and Ulukhaktok cannot travel in high winds or waves, nor can they travel for extended distances.

During October, the sea can freeze quickly, making a response effort by boats that are not ice-capable very dangerous. Extreme storms are also common during the fall, which would make response efforts dangerous or impossible.

Communications, Sea and Weather Information, and Monitoring

Reliable communications, sea and weather information, and the ability to monitor the spill are essential components of oil spill response and could also significantly limit an effective response in the Beaufort Sea.

During an emergency, communications are fundamental to the initiation and administration of an effective response.[135] "Communications infrastructure of

[132] *Central and Arctic Regional Response Plan*, p. 5-12.
[133] Funston, B., *Emergency Preparedness In Canada's North: An Examination Of Community Capacity*, p. 21.
[134] *Perspectives on Emergency Response*, p. 14.
[135] *Emergency Management in the Arctic*, p. 6.

Canada's Arctic communities is fragile and is heavily dependent on only a few centralized points, which decreases stability."[136] Communication challenges could be a significant impediment to mounting and sustaining a response in the Beaufort Sea.[137]

The nearest community would serve as an important hub for the transfer of equipment and people, and the ability to communicate with that community would therefore be crucial.[138] Yet, cellphone and internet networks can be quickly overwhelmed, slowing the speed of the internet, preventing phone calls, and potentially leading to a breakdown in proper emergency response protocol. For example, during an emergency exercise in Iqualuit in 2009, the influx of people in the community overloaded the local cellphone and internet networks, making it impossible to carry out the emergency protocol.[139]

To access and recover the oil, it is necessary for responders to have information about safe maritime routes and conditions, including information regarding the presence of ice and weather conditions. This information must be transmitted by the limited communications infrastructure, and the "lack of access to bandwidth that permits timely downloading of live information aboard vessels is one of the issues currently facing navigators in the North."[140] In addition, because inadequate hydrological information exists for much of the region, it may be necessary to conduct area surveys before other vessels can provide assistance.[141]

Once a spill occurs, it quickly begins to travel with currents and wind, and tracking the spill is therefore essential to being able to find the oil and recover it. The National Aerial Surveillance Program has one Dash 7 airplane that could be used to monitor the spill.[142]

However, clouds and fog could limit the airplane's ability to fly or identify the oil. In addition, it would be difficult to distinguish between oil slicks and other features such as silt on ice, cloud shadows on water, and wind patches, which may appear similar to oil. If the spill occurred near areas of high ice concentration, the side-looking airborne radar (SLAR) would not be impeded by visibility but would have difficulty distinguishing the ice from oil.

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136 *Id.*
137 *Changing Tides*, p.12.
138 *An Assessment of the Socioeconomic Impact of Internet Connectivity in Nunavut* (Strategic Networks Group, 2012), p. 30.
139 *Emergency Management in The Arctic,* p. 6.
140 *Tanker Safety Expert Panel, Phase II*, p. 12.
141 *CESD Marine Navigation*, p. 8.
142 *Id.,* p. 18.

Satellite imagery could also be used to track a spill. Environment Canada has an Integrated Satellite Tracking of Pollution (ISTOP) program to identify spills, but the satellite information could be limited if the key satellites that have ceased operating have not yet been replaced. In addition, clouds and darkness also block satellite data.[143]

The spill could also be tracked by visual observations, but as the spill spread, tracking buoys would be necessary, and they would have to be brought in from outside the region and dropped onto the spill. Fog and clouds would also limit observations of the buoys.

Limitations of response equipment

The transportation and logistical issues of getting equipment to a spill site in the Beaufort Sea are enormous. Yet, even if these challenges were overcome, the response equipment itself comes with serious limitations, because none of the equipment is intended for use in offshore water. Thus, any amount of wind or waves could quickly render the equipment ineffective.

Another major limitation of the response equipment stockpiled in the region is that the volume of oil it can recover, 1,000 tonnes, is limited. Ships powered by HFO typically have fuel capacities far greater than 1,000 tonnes.[144] Because distillate evaporates so quickly, a timely response to a spill of these fuels is even less feasible. Thus, the oil spill response equipment would be most useful with crude oil and HFO spills, but the capacity of the equipment within the region is not commensurate with the quantities of these fuels that are typically transported.

In addition, the storage and disposal capacity would be a limiting factor. The equipment in Tuktoyaktuk includes containers that can store a total of 275 tonnes.[145] The equipment from Hay River can store an additional 240 tonnes.[146] Yet, the liquid in these containers would be water mixed with oil, thus the actual amount of oil recovered would be much less. As time passes, the water content of recovered oil will increase: after a few days, most HFOs have emulsified and include 40 – 80 percent water.[147] In the grounding of the *Full City* cargo ship off the coast

[143] Barber, D., *Research Gaps in Scientific Understanding of Oil in Sea Ice*, Submitted to Tanker Safety Expert Panel Phase 2 (May 16, 2014).
[144] *AIRA Spill Frequency and Size*, p. 10.
[145] *Central and Arctic Regional Response Plan*, p. 4-17.
[146] *Id.*
[147] *Heavy fuel in the Arctic (Phase 1)* (DNV, 2011), p. 38.

of Norway in 2009, for example, around 2,000 tonnes of waste was collected, of which only 103 tonnes was oil.[148]

Thus, once the available containers were filled with the oily water mixture, they would have to be transported to an incinerator (which is included with the Hay River equipment), or another temporary storage container would have to be found, before the original containers could be put to use again. All of the recovered oil not incinerated would have to be transported south, as there are no hazardous waste disposal sites in the region.

Challenges in protecting important environmental resources

Another difficulty in executing a successful response in the Beaufort Sea would be the challenges involved in protecting important biological resources. The Beaufort Regional Coastal Sensitivity Atlas has been recently updated, which provides baseline coastal information such as shoreline form, substrate and vegetation type.[149] This information should help prioritize the areas that should be protected first, if community members and outside responders have access to it.[150]

Yet, protecting wildlife would still be difficult. Deterring animals from entering oiled areas and capturing and rehabilitating oiled wildlife is "complicated by remote locations, lack of response equipment, concerns over subsistence use of potentially oiled animals, and safety considerations when dealing with large animals."[151] Environment Canada's Wildlife Service would provide advice on wildlife protection, rescue and rehabilitation. The agency would also issue permits for wildlife hazing and capture, if necessary. However, the agency has no wildlife treatment capabilities.

Environment Canada's Shoreline Cleanup and Assessment Teams (SCAT) are responsible for shoreline cleanup. The response equipment and personnel that would be needed to address oiled coastlines would face the same limitations as in the initial response.

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148 Bergstrøm, R., *The Full City and Godafoss, Lessons Learned* (Norwegian Coastal Administration).
149 Beaufort Regional Coastal Sensitivity Analysis (Environment Canada, 2015).
150 *Study on Inuvialuit Community Spill Response Training,* p. 3-5.
151 National Academy of Sciences, *Responding to Oil Spills in the U.S. Arctic Marine Environment* (National Academies Press, 2014), p. 12.

Response time

Response time is a critical factor in an oil spill response. As discussed above, Canadian law provides response times for different levels of spills that regional Response Organizations must be able to meet. However, these standards do not apply to response capabilities in the Arctic. The CCG estimates that equipment from community packs in Kugluktuk and Ulukhaktok could be on scene within the first 48 hours. In addition, the CCG estimates that it would take 48-96 hours to have equipment from Hay River on scene. By comparison, response organizations operating south of 60 degrees must be able to deploy the same level of response equipment (capable of responding to up to 150 tonnes of oil) within six hours. Additionally, because more time could be necessary to fly the 40 or so people needed to operate the Hay River equipment into the region, and because delays due to weather are a very real possibility, the first response could be delayed even longer.

It would likely take even longer for the equipment from Tuktoyaktuk to arrive. The CCG estimates a general timeframe of one week for deployment of the barge in Tuktoyaktuk to a spill site.[152] By comparison, Response Organizations operating south of the Arctic must be able to deploy the same level of response equipment (capable of responding to up to 1,000 tonnes of oil) within 12 hours. Depending on where CCG boats were at the time of the spill, it could take days for the boat to reach the spill site as well. For example, during the grounding of the *Clipper Adventurer* in Coronation Gulf, it took four days for the first oil pollution response assistance to arrive.[153]

Additional delays could occur once the people and equipment are staged in the nearest community. One resident explained that a response to an emergency can be jeopardized by the lack of snowmobiles, ATVs, boats and motors, gas and oil, which "greatly hampers our response time. We spend the time trying to find people to volunteer their equipment."[154]

The retrieval and transport of equipment and trained personnel, as well as the risk of delays caused by a lack of transportation infrastructure and weather, would seriously inhibit a successful response. The more time that passes, the more the oil travels and spreads. This makes recovery more difficult because there is a larger area that is covered in oil and there are smaller patches that are thick enough to be picked up by skimmers. As the spreading increases, weathering will also increase,

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[152] *Central and Arctic Regional Response Plan*, p. 5-13.
[153] *Grounding of the Passenger Vessel Clipper Adventurer*, p.9.
[154] *Emergency Management in the Arctic*, p. 17.

making the oil more difficult to contain and recover. High winds and rough seas would make matters worse. In addition, the longer the response time, the greater chances of the oil stranding onshore or mixing with or migrating under ice. Thus, "the lack of an immediate response likely means an ineffective response."[155]

Cascading resources for a spill of more than 1,000 tonnes

As discussed above, most ships that carry crude oil or are powered by HFO generally will have far more than 1,000 tonnes of oil on board. However, the resources within the region are unable to address spills greater than 1,000 tonnes. For larger spills, the National Response Plan relies on equipment that would be cascaded from other regional and national inventories. All of that equipment, along with the additional personnel needed to operate it, would have to be brought in from outside the region, either by air or by sea. The remoteness of the Beaufort Sea and the lack of infrastructure would make the cascading of people and equipment extremely challenging.

The nearest CCG airplane is stationed at Hay River, 1200 kilometers from the Beaufort Sea. The CCG estimates that it would take 48 hours to assemble and transport responders to the region.[156] However, the size of CCG planes based at Hay River would limit their capacity to carry personnel and equipment. The RCAF C-130, which can carry significantly more equipment and personnel, is based in Trenton, ON. The flight alone would take at least six hours, but the total time to assemble people and equipment and transport them to the spill site could be days.[157]

In addition to CCG planes, commercial planes could be used to transport people and equipment into the region. However, because all of the runways except the one in Inuvik are gravel, it is necessary to have a plane that is capable of landing on a gravel airstrip. The Boeing 737-200 series is the last commercial jet aircraft of its size with this capability, and newer models of this aircraft cannot be modified for gravel use. Thus, the availability of larger commercial planes could be seriously constrained.[158] In addition, the small size of the landing strips limits the size of the planes that can land there.

Another challenge with using airplanes to transport large numbers of people and extensive equipment from outside the region is that airstrips may lack electronic

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[155] *Spill Response Gap Study*, p.13.
[156] *Central and Arctic Regional Response Plan,* p. 5-12.
[157] *Emergency Management in the Arctic*, p. 10.
[158] *National Roundtable on Arctic Emergency Preparedness: Report of Proceedings* (Munk-Gordon Arctic Security Program, 2014), p. 35.

navigation support and field lighting, and there is no 24 hour weather information, which makes flying in low visibility or poor weather very difficult.[159] In addition, there are no hangars in the villages where the planes could be kept to prevent icing.

Helicopters could also be used to transport people and response equipment into the region and to haze wildlife from polluted areas. However, the nearest CCG helicopter is in Prince Rupert, 1576 kilometers away, and an additional CCG helicopter is kept in Victoria, 2294 kilometers away.[160] These distances would impose additional logistical and time delays in getting the helicopters to the region.

CCG boats could also be used to transport personnel and equipment from outside the region. Five to six CCG icebreakers are spread across the Arctic during the summer, with two or three typically covering the entire region outside of Quebec. The CCG predicts that its icebreakers can be available to vessels needing icebreaking services in the Canadian Arctic within 10 hours. [161] However, this time frame varies depending on ice conditions. Marine support can take multiple days if the weather and location of resources are unfavorable.[162]

Also, depending on when a spill occurred, none of the icebreakers may be present. Since 2007, commercial vessels have entered the Arctic earlier and departed later than the CCG icebreakers. In addition, the number of days that CCG operates in the Arctic is decreasing. Since 2011, for example, CCG presence in the Arctic has decreased by 33 days.[163]

Other CCG boats may be available for assistance, and the CCG estimates that it would take a minimum of 48 hours for these boats to arrive on scene. The use of boats to supply people and equipment would be complicated by the lack of deep-water ports and harbors in the region. The only port in the region is in Tuktoyuktuk, which has a limited draft. Thus, the exchange of people, supplies, equipment, and recovered oil between the spill location and the nearest community would require shallow draft barges and landing craft.

Resources from the Response Organizations in the south may be made available for use north of 60°, but they must obtain the necessary approvals to move equipment from their designated area of response.[164]

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[159] *Id.,* p. 34.
[160] Canadian Coast Guard Helicopter Fleet. http://www.ccg-gcc.gc.ca/Fleet/Helicopters.
[161] *CESD Marine Navigation,* p. 15.
[162] *Emergency Management in the Arctic*, p. 10.
[163] *CESD Marine Navigation*, p. 16.
[164] *Central and Arctic Regional Response Plan,* p. 3-11.

Equipment and people from outside the region could travel overland as far as Inuvik via the 700 kilometer Dempster Highway, provided the spill did not occur during the time of freeze up of the Peel River, when the highway is closed. From Inuvik, air and boat travel would still be necessary to transfer the people and equipment to the spill site. However, communities would not be able to support the additional number of people that would be brought into the region in the event of a larger spill. Instead, accommodation and food for these people would have to be provided by a CCG icebreaker or rented camp barge.[165]

In sum, potential weather and logistical delays would likely lead to a slow response for any spill over 1,000 tonnes and make any response ineffective.

VI. Conclusion

Shipping in the Beaufort Sea is a dangerous and precarious endeavor. Navigation is challenging in often-poor weather and visibility, in sea ice that can be difficult to detect, and through waters that are poorly charted. Information to support navigation and weather forecasts can be difficult for ships to acquire, given the weak and unreliable communications systems in these waters. Yet shipping in the region is increasing and will continue to grow in the coming decades. The risk of oil spills from ships is also growing, threatening the unique and sensitive resources of the Arctic ecosystem and the Aboriginal people who depend on these resources for their livelihood and well-being.

A successful response to an oil spill from a ship would most likely be impossible in the Beaufort Sea, due to the extreme climate, including the sea ice, freezing temperatures, fog and clouds – and in the fall - limited daylight, storms, and high winds. Even with unlimited personnel and equipment, these environmental conditions would impose serious risks to the people attempting a clean up and would render the oil recovery equipment inoperable or highly ineffective.

Yet, very few people in the region have oil spill response training and very limited equipment is stored there. The extreme weather conditions and the lack of transportation infrastructure would make it very difficult to bring resources into the region quickly. This time lag would almost certainly render any response efforts meaningless. Once oil is spilled into the ocean, it spreads and weathers quickly, and as time passes it becomes more and more difficult to recover the oil. When oil mixes with ice, effective recovery is essentially impossible.

[165] *Id.,* p. 5-13.

In the Canadian Arctic, there are no legal requirements to ensure that sufficient people and equipment could respond to a spill from a ship, nor any requirements that such a response would occur within a certain amount of time. Although the CCG has national, regional, and area plans that outline how a response should take place, these plans reveal the delays that would be likely in getting even the small amounts of in-region response equipment to a spill site.

The history of oil spill response efforts in the Arctic demonstrates the challenges and concerns for potential spills in the Beaufort Sea region. The CCG does not maintain records documenting the degree to which oil spill response efforts were successful.[166] However, information from spills in other parts of the Arctic is illustrative. For example, data on spill response over the past 20 years in the Aleutian Islands have shown that "almost no oil has been recovered during events in which recovery attempts have been made by the responsible parties or government agencies and that in many cases, weather and other conditions have prevented any response at all."[167] For instance, in 2004, the M/V *Selendang Ayu* grounded off Unalaska Island and spilled around 1,000 tonnes of HFO. No attempt was made to contain the spill or recover oil on the open water.[168]

A response would be very difficult even if the accident occurred close to a larger community such as Tuktoyuktuk. For example, in 1997, the M/V *Kuroshima,* a 368-foot frozen-seafood freighter, grounded on Unalaska Island in the Aleutians and spilled around 120 tonnes of heavy fuel oil.[169] Even though the spill was adjacent to the communities of Dutch Harbor and Unalaska, and the grounded vessel and oil pollution were relatively accessible, the cleanup effort lasted more than a year.

In an area with far more infrastructure, off the coast of Norway in 2009, the *Full City* cargo ship grounded. The ship was carrying around 1,100 tonnes of HFO, 300 tonnes of which were spilled. Only about 1/10 of the spilled oil was recovered at sea. An additional 74 tonnes were eventually cleaned up from beaches.[170]

In sum, if an oil spill were to occur in the Beaufort Sea, the communities and ecosystems would bear the full brunt of the impacts, as mitigating the effects would most likely be impossible.

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[166] *CESD Oil Spills from Ships*, p. 24.
[167] *Risk of Vessel Accidents and Spills in the Aleutian Islands: Designing a Comprehensive Risk Assessment* (National Transportation Safety Board, 2009), p. 4 [*Risk of Vessel Accidents and Spills in the Aleutian Islands*].
[168] Parker, W. *Report on the Selandang Incident* (2005).
[169] *Risk of Vessel Accidents and Spills in the Aleutian Islands,* p. 22.
[170] *The Full City and Godafoss, Lessons Learned.*

VII. Recommendations

Although improvements in infrastructure and technology can help ships and oil spill responders contend with the harsh and remote environment of the Beaufort Sea, these factors are likely to remain significant barriers to reducing the risk of spills from ships in the region. However, other measures could provide important added safety and reduce the risks of a spill, including greater local community input and capacity, the design and implementation of cost-effective prevention measures, and targeted, increased response capabilities.

First, for all of these measures, greater community involvement is essential. As the people who know the environment and its resources best and who have the most to lose from damages caused by a spill, Inuvialuit should have a greater role in decision-making that shapes the future of shipping in the Beaufort Sea. For example, the CCG has initiated the Northern Marine Transportation Corridors Initiative, which will establish a system of voluntary marine corridors and identify priorities to support vessel safety in the Arctic. Inuit organizations should be fully incorporated into this process.

Second, given the overwhelming logistical and environmental challenges to responding to an oil spill in the Beaufort Sea, prevention measures are undoubtedly the most effective way to protect the Beaufort Sea's communities and environmental resources. Some of the most effective prevention measures to protect areas from acute spills are ship routing and designation of areas to be avoided.[171] Indeed, according to DNV, traffic limitations such as these and slower steaming speeds are also the most cost effective risk reduction options, providing the highest potential return on investment.[172] In consultation with local communities, Transport Canada should identify shipping lanes in the Beaufort Sea based on information about subsistence use and environmentally sensitive and important areas. In addition to identifying these preferred routes, Transport Canada should designate areas to be avoided. Once identified, these routes and areas to be avoided should also be designated as IMO measures.

Third, another important preventative measure would be to eliminate the use of HFOs in the Arctic.[173]Currently, Antarctica and off the shores of Norway restrict the

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[171] *HFOs in the Arctic – Phase 2*, p. 11.
[172] *Id.,* p. 12.
[173] Heavy fuel oil use by vessels in Arctic waters, MEPC 69/20/X (Feb. 12, 2016). http://pacificenvironment.org/downloads/eNGO%20submission%20HFO%20to%20MEPC69_FINAL%20%281%29.pdf

use and carriage of HFO. In the Polar Code, the IMO encourages countries to voluntarily restrict the use of HFO in the Arctic. The federal government under the jurisdiction of Transport Canada could implement a ban on HFO through national legislation, with a phase out period to allow industry and most importantly re-supply vessels time to switch and build in the use of lighter fuels into their business models.

Fourth, response equipment and capacity in the region should be strengthened. SOPEPs should be Arctic-specific and address the logistical challenges of a spill response, and ships should be required by international and Canadian law to carry equipment for an initial response to a spill. Vessels should also have portable pumps and hoses on board to allow a stricken vessel to pump off as much of the oil remaining in its tanks onto assisting vessels. In addition, ship crews should be trained to provide effective damage control and minor hull repairs.

The Beaufort Sea and Amundsen Gulf Area Plan should be updated based on the new The Beaufort Regional Coastal Sensitivity Atlas, and more detailed geographic response strategies should be developed for each environmentally sensitive site. These map-based strategies show responders where sensitive areas are located and where to place oil spill protection resources.[174] Canada's Wildlife Service should develop wildlife response plans based on the Coastal Sensitivity Atlas. These plans minimize impacts to wildlife through various actions including preventing oil from reaching critical habitats, preventing animals from entering oiled environments, pre-emptively capturing and removing wildlife, rehabilitating oiled wildlife, and removing dead and dying wildlife. The plans can also include the identification and documentation of oiled wildlife and the collection of scientific data to provide information about impacts.[175]

Additionally, the same response standards that apply in the south should apply in the Arctic. Aboriginal communities in the north should not receive a lower level of protection from spills simply because there are fewer ships in the region and the communities are less populated than in the south. In the U.S., for example, ships traveling in the Arctic are not exempt from response standards.[176] Instead, for ships traveling in areas where meeting these standards is not possible, ships must submit an alternative planning criteria request that provides "for an equivalent level of

[174] See, e.g., State of Alaska, Division of Spill Prevention and Response, https://dec.alaska.gov/spar/ppr/grs/home.htm.
[175] *A Guide to Oiled Wildlife Response Planning* (IPIECA, 2004), p. 10.
[176] 33 C.F.R. part 155, subpart J.

planning, response, or pollution mitigation strategies," and these plans must be approved.[177]

To meet the same or equivalent response standards, the CCG could station permanent assistance vessels along the shipping routes in the Beaufort Sea, and more equipment could be stockpiled along these corridors. The location and contents of the stockpiles should be based on local input and a risk assessment that considered sensitive areas and feasibility of mounting an effective response within reasonable timeframe. The CCG could also negotiate agreements with the Mackenzie Delta Spill Response Corporation and Alaska Clean Seas for those companies to provide response equipment if needed.

Finally, a local capacity to respond to spills should be developed. In 2013, the Beaufort Sea Regional Environmental Assessment conducted a study on community oil spill response training in the region. The study was focused on response training for offshore oil and gas activities, rather than on shipping.[178] However, many of the recommendations from the study are equally relevant to training needs for response to ship-based spills, including: developing a list of trained individuals in each community, training Inuvialuit for oil spill response in schools and other locales, identifying sources of funding for training, developing a means for Inuvialuit to be part of the response decision-making process, developing an Inuvialuit advisory board, and establishing an Inuvialuit organization to conduct response training and activities.[179] An update on the status of these recommendations noted that because of lack of interest by oil and gas companies in the Beaufort Sea at this time, it was premature to begin implementing the recommendations.[180] The CCG should work in collaboration with local communities to identify ways in which these recommendations can be implemented to address the risk of spills from ships, whether or not the oil and gas industry return to the Beaufort Sea.

[177] Id. §155.5067.
[178] *Study on Inuvialuit Community Spill Response Training,* p. 1-1.
[179] *Id.,* p. 4-2 to 4-6.
[180] *Report on the Status of the Recommendations in the Study on Inuvialuit Community Spill Response Training in the Beaufort Region.*

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