

Preventing a Nationally-Significant Oil Spill on the Grand Banks of Newfoundland**CDR Gabrielle G. McGrath**

United States Coast Guard International Ice Patrol

1 Chelsea Street

New London, CT 06320

ABSTRACT 300321:

As the Arctic becomes more heavily populated and more open to commercial shipping operations, the threat of an oil spill increases. On the Grand Banks of Newfoundland, both fixed and mobile oil rigs drill for the region's highly lucrative natural oil resources. This region also happens to be one of the most dangerous shipping areas in the world. The cold Labrador Current travels south from the Arctic bringing with it icebergs calved from the glaciers along the Western Greenland coast. As these icebergs travel south, they intersect directly with the transatlantic shipping lanes following the Great Circle route just south of Cape Race, Newfoundland. The cold waters of the Labrador Current interact with the warm waters of the Gulf Stream to create extensive regions of fog with little to no visibility. As the Arctic Ocean becomes more accessible to shipping, vessels will not only transit this region travelling east and west, but also north and south to new production areas in the Arctic. Any vessel entering or exiting the Northwest Passage must transit through this region. An oil spill caused by an explosion on one of the Grand Banks' oil rigs, an allision of an iceberg with one of the rigs, or a collision of a commercial tank vessel with an iceberg are just a few of the possible scenarios that could cause a devastating incident in this region. Pervasive fog limiting aerial and satellite coverage, the diverse seabird, fish, and marine mammal population, and the presence of sea ice and icebergs during more than half of the year would result in one of the most challenging responses in the world. Transport Canada, the Canadian Coast Guard, and the Canadian Association of Petroleum Producers have conducted extensive preparations for an oil spill response in this region. However, a more far-reaching response plan must be created through consultation between government and industry stakeholders, using lessons learned from the Deepwater Horizon incident in the Gulf of Mexico to prepare for an internationally-significant event. With the opening of the Arctic Ocean and the increase in the shipping and offshore drilling in this area, a comprehensive plan must be developed before an internationally-significant oil spill occurs.

INTRODUCTION:**Meteorological and Oceanographic Conditions**

The Grand Banks of Newfoundland is one of the harshest operating environments in the world. Extremely cold temperatures persevere for much of the year. The cold Labrador Current, originating off of the west coast of Greenland flowing north then back south, brings cold water to the region. This current interacts with the warm Gulf Stream which flows north along the east coast of the United States and breaks off to the northeast near Cape Hatteras, North Carolina. This interaction of cold and warm currents results in a persistent fog in the region that is a significant danger to shipping and a limitation to visual aerial reconnaissance in the event of an emergency at sea. Figure 1 illustrates the current structure on the Grand Banks.

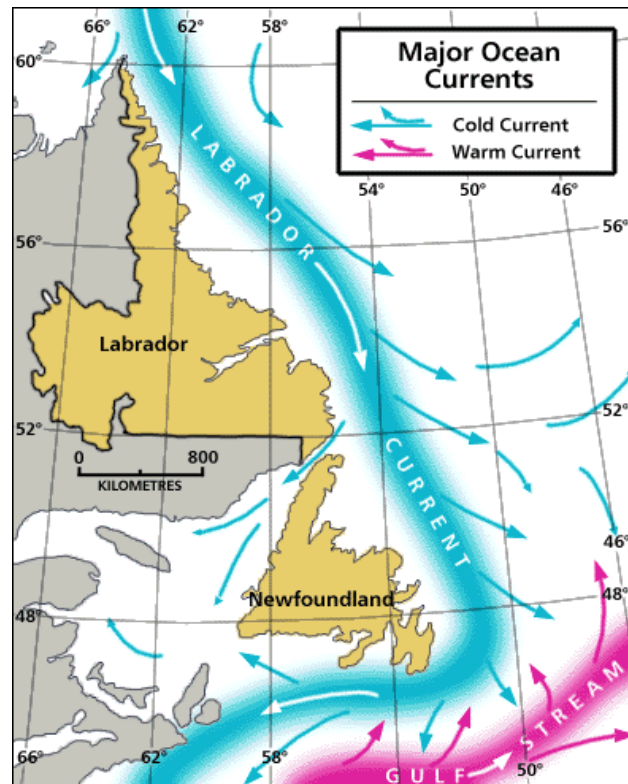


Figure 1. Grand Banks Current Structure (McManus and Wood, 1991)

Ice

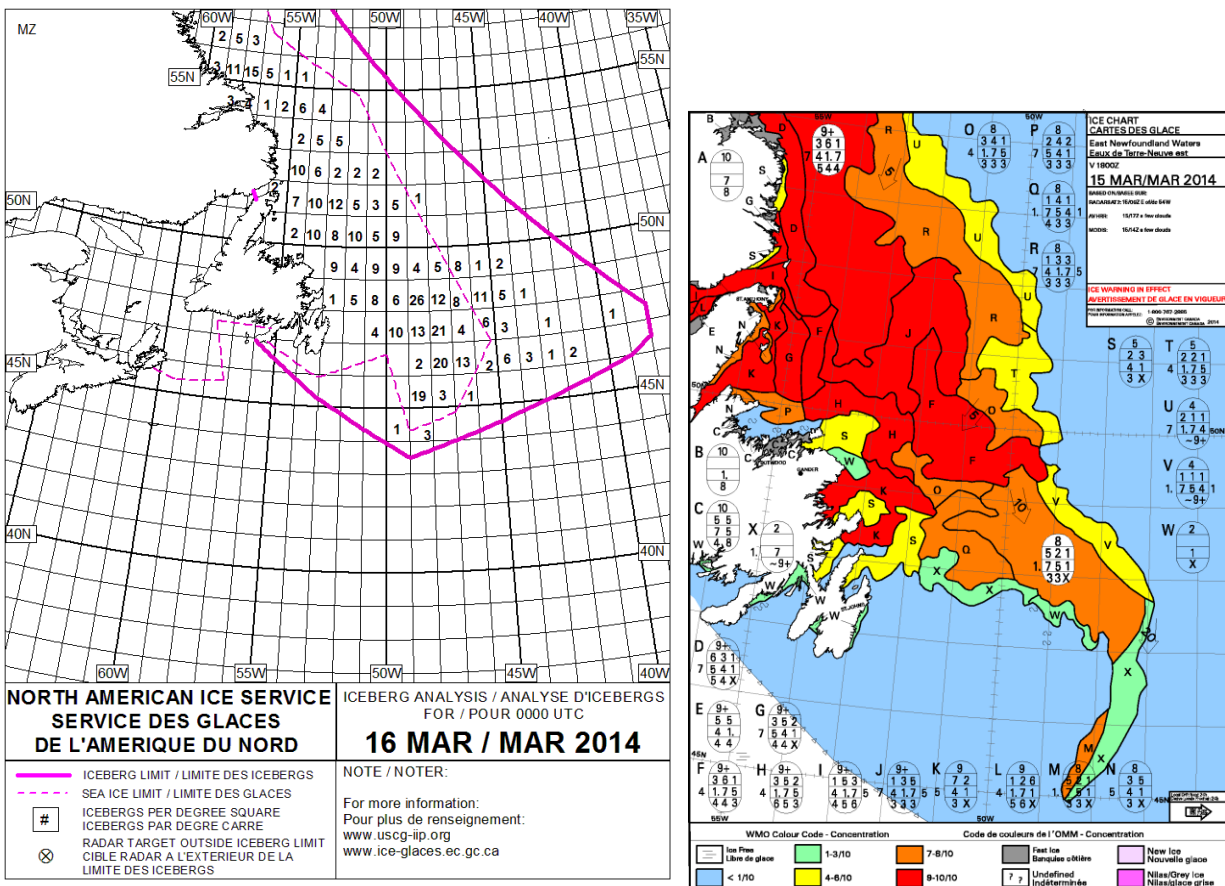
Icebergs are also a challenge to the operating environment of the Grand Banks. Not only does the Labrador Current bring cold water to the region, but it also serves as a constant throughput of icebergs calved from Greenland's glaciers. The four outlet glaciers, Petermann, Kangerdlugssuaq, Helheim, and Jakobshavn Isbræ, collectively drain over 22% of the Greenland ice sheet with the Jakobshavn glacier alone producing about 10% of Greenland's icebergs (Gautier, 2013). While only one to two percent of the icebergs birthed by these glaciers actually survive the two to three year journey to the Grand Banks, the ones that do pose a major risk to shipping and offshore operations.

On April 14, 1912, the RMS TITANIC struck an iceberg just south of the tail of the Grand Banks and sank in the early morning hours of April 15, 1912 with over 1,500 lives lost. After this tragic incident, the international community recognized this dangerous shipping region and held the first Safety of Life at Sea (SOLAS) Convention to enact international shipping regulations to prevent future incidents. Part of these regulations included the establishment of the North Atlantic Ice Patrol that would be operated by the United States government to monitor the danger of iceberg collision on the Grand Banks of Newfoundland and to distribute the iceberg limit to the maritime community. Under the provisions of U.S. Code, Title 46, Sections 738, 738a through 738d, the Commandant of the United States Coast Guard is designated by Congress to carry out the North Atlantic Ice Patrol mission. The Commandant executes this mission through the International Ice Patrol (IIP). IIP provides a daily text bulletin and ice chart to vessels operating in the region to warn operators of the locations of icebergs. Figure 2a is an

2014 INTERNATIONAL OIL SPILL CONFERENCE

example ice chart from the 2014 Ice Season. No vessel heeding the IIP warnings has struck an iceberg in the 101-year history of IIP operations.

Sea ice also poses a danger to shipping in this region. Sea ice typically reaches its minimum global coverage in September and builds to its furthest extent in mid-March. Sea ice promotes the movement of icebergs into the transatlantic shipping lanes. When sea ice surrounds an iceberg, the iceberg is protected from deterioration from the waves. This protection enables the iceberg to drift further to the south and to the east, resulting in a higher risk to shipping and to the offshore oil industry. Growing quickly during extreme cold conditions, sea ice, in itself, is a danger to shipping and can easily entrap an unsuspecting vessel. In 2013, the OOCL BELGIUM became engulfed in sea ice in the Strait of Belle Isle just north of the island of Newfoundland. The Canadian Ice Service (CIS) provides daily products indicating the extent and concentration of sea ice throughout Canadian waters and on the Grand Banks of Newfoundland throughout the year. Figure 2b is an example CIS sea ice chart.



Figures 2a (left) and 2b (right): North American Ice Service Ice Chart produced by the International Ice Patrol on March 16, 2014 and Canadian Ice Service Sea Ice Chart from March 15, 2014.

For any incident in the Arctic, the access to daily ice information on sea ice and icebergs is critical to the response effort. On the Grand Banks, CIS would provide the sea ice information

while the IIP would provide the North American Ice Service daily iceberg warnings when icebergs threaten the oil rigs. In other regions of the Arctic, numerous other ice services of the world provide these daily reports of ice conditions. All of these ice services work together within the International Ice Charting Working Group (IICWG) to provide the highest quality ice information to the global maritime community. This information on ice would be critical to any large-scale oil spill response effort.

Offshore Oil Industry

There are numerous operational oil production fields in the Northwest Atlantic Ocean. Hibernia, the world's largest offshore oil platform, is a concrete gravity-based structure located 170 nautical miles east of St. John's, Newfoundland. Hibernia became operational in the fall of 1997 (McClintock, 2007) and has produced 61% of all oil on the Grand Banks since it began production (Turner, 2010). The Terra Nova field is located 21 nautical miles southeast of Hibernia and became operational in January of 2002. This site is operated through the use of a Floating, Production Storage and Offloading (FPSO) double-hulled, ice-reinforced vessel (Suncor, n.d.). The White Rose oil field is also operated by an FPSO vessel, the Sea Rose, similarly to Terra Nova. It is located 30 nautical miles northeast of Hibernia and became operational in 2005 (Offshore Technology, n.d.). All three of these production operations are located in the Jeanne D'Arc Basin of the Grand Banks. In 2009, the cumulative productions for all three sites exceeded one billion barrels (Turner, 2010).

In October 2013, the Newfoundland and Labrador government voted to extend production in the Jeanne D'Arc basin and to potentially build a concrete gravity based structure at the site (CBC News, 2013a). The oil platform, Hebron, is currently being constructed in Bull Arm, Newfoundland to be installed in deep water approximately 35 km southeast of Hibernia in 2016 and to become operational in 2017 (Gronewold, 2013). Statoil also plans to drill three new sites on the Grand Banks, including the Bay du Nord field in Flemish Pass (Fitzpatrick, 2014). Figure 3 shows the location of these highly productive oil fields.



Figure 3. Oil Fields on the Grand Banks of Newfoundland (Newfoundland and Labrador, 2010)

2014 INTERNATIONAL OIL SPILL CONFERENCE

The oil fields on the Grand Banks sustain the economy of Newfoundland and Labrador. Since the overfishing of the region's cod stock, the oil and gas industry has taken over as the main source of income for the region (Gronewold, 2013). It is currently estimated that this industry contributes 8-12 billion Canadian dollars to the province's economy each year. In addition, Newfoundland and Labrador have strict rules requiring that its residents receive the primary benefits from all offshore oil operations. Therefore, on the new Hebron project, over 90% of the employees are locals (Gronewold, 2013). Any disruption to this industry caused by an oil spill from any of these oil rigs on the Grand Banks would quickly damage the economy of the region.

The oil and gas industry pays close attention to the iceberg distribution and forecast during the Ice Season. Provincial Aerospace Limited (PAL), a commercial aerial reconnaissance provider based in St. John's, Newfoundland, conducts flights for this industry to document any icebergs that may threaten the oil rigs. In a severe Ice Season, PAL will conduct multiple flights per day to monitor this risk. If an iceberg is nearing one of the rigs, a vessel will be dispatched to attempt to lasso the iceberg and tow it away from the rig. This operation is not full-proof, however, and can result in only a slight alteration of the iceberg's course. With smaller icebergs, this operation is more likely to be successful. However, a large iceberg could cause a significant challenge to a vessel attempting to complete the tow. Figure 4 shows an iceberg being towed away from an oil production site on the Grand Banks.



Figure 4. A vessel towing an iceberg away from an oil production site (Canadian Association of Petroleum Producers, n.d.).

Another option to protect the rigs is to actually move them out of the path of the icebergs. Because Hibernia is a permanent structure, it cannot be moved. However, the other Grand Banks rigs can be relocated in the case of an emergency. These mobile rigs typically require a minimum of 60 hours of notice to be able to conduct the operation.

Although blowout preventers and specially-designed offloading systems are installed on offshore drilling platforms, human error, equipment failure, or environmental factors can lead to a devastating accident. The Deepwater Horizon spill in the Gulf of Mexico is a tragic example of how an incident on an offshore drilling unit can lead to loss of life and environmental destruction. On April 20, 2010, the Mobile Offshore Drilling Unit (MODU), owned by Transocean and operated by British Petroleum, was working on Block 252 of an exploratory well known as the Macondo Project when it exploded and sank 77 kilometers off of the state of Louisiana, killing eleven workers. Occurring at 1,500 meters of water with an approximate discharge of 60,000 barrels per day, this incident was the largest oil spill in United States history and one of the largest worldwide (Turner, 2010).

The Grand Banks region previously experienced its own tragedy on the offshore drilling platforms. The Japanese-built and American-owned ODECO Ocean Ranger Semi-Submersible drill platform was drilling in the Hibernian field when she was struck by a devastating winter storm, capsized, and sunk in the early morning hours of February 15, 1982, killing all 84 crew members on board. Although several vessels on scene tried to rescue the crew, the harsh conditions prevented the rescues of any survivors. Despite being built for unrestricted open ocean operations and designed to withstand 100 knot winds and 110 foot waves, the harsh environment was too much for the Ocean Ranger (Oil Rig Disasters, n.d.). Although no oil was released, a similar accident in the future could cause a significant oil spill and possibly a loss of life.

Shipping

The Great Circle route across the Atlantic Ocean which provides the fastest transit for shipping goods between the European and North American continents crosses just south of the island of Newfoundland. Based on Automated Information Systems (AIS) data, over 50 million gross tons of shipping transited along the transatlantic shipping lanes on the Grand Banks of Newfoundland in 2012. The intersection of these vessels in this harsh operating environment of fog, sea ice, and icebergs with offshore oil drilling operations creates one of the riskiest environments in the world for an oil spill.

In September 2012, the Arctic experienced a historical minimum in sea ice coverage at 3.41 million square kilometers, 760,000 square kilometers below the previous record set in 2007 (National Snow and Ice Data Center, 2012). Although the ice recovered slightly in 2013, all indications are that the world is headed for an open Arctic where Atlantic-Pacific shipping lanes will be a reality. In September 2013, the Danish vessel, NORDIC ORION, became the first-ever bulk freighter to transit through the Northwest Passage. She transited from Vancouver, British Columbia, through the Passage, out past Greenland, and on to Finland. The vessel had an ice-strengthened hull to deal with the conditions in the Arctic. Utilizing the Northwest Passage enabled the vessel to shorten her voyage by approximately four days compared to a transit to the south through the Panama Canal. In addition, the Nordic Orion was able to carry 25% more coal without the shallow draft restrictions of the Canal. The vessel operators estimated that they saved approximately \$200,000 by utilizing the Northwest Passage (Fox News, 2013). With the predicted continue decline of Arctic sea ice, more vessels will begin to take advantage of the cost savings offered by a transit through the Northwest Passage and the Northern Sea Route. However, declining sea ice does not mean “ice free.” Vessels will continue to encounter regions

of high concentrations of sea ice as well as icebergs which will result in a considerable risk of an incident in this region.

Resources At Risk

Numerous resources would be threatened by an internationally-significant oil spill on the Grand Banks. Historically, this region was mostly well-known for its extensive cod fishery. Unfortunately, cod, haddock, and redfish were overfished in the 1960s and 1970s which resulted in a complete collapse of the Grand Banks fishery (Encyclopedia of Earth, n.d.). The major cod and flounder fisheries were closed by 1995, and other fisheries were severely strained. However, crabs, clams, and scallops grow in abundance and have become the most popular fisheries on the Bank over the past 20 years (Government of Newfoundland and Labrador, n.d.). The region is also home to numerous species of marine mammals. These marine mammals include six types of baleen whales, thirteen types of toothed whales and dolphins, and four types of true seals, including the extremely rare North Atlantic right whale, Killer whale, and Risso's dolphin (Canada-Newfoundland and Labrador Offshore Petroleum Board, 2010).

In addition, the most diverse seabird population in Canada exists off of Newfoundland on the Grand Banks. Most seabirds that breed in the Eastern Atlantic, including murre, kittiwake, gull, and Dovekie, spend the winters in the shallow waters of the Bank. The 17 marine bird breeding colonies near the Grand Banks are considered to be globally-significant (Fraser et al., 2006). During the summer, millions of Southern Hemisphere seabirds come to the Bank during their non-breeding season. Therefore, the seabird population is significantly greater than the local breeding population (Gaston, 2013) and approximately 40 million marine birds use the region during the year (Fraser et al., 2006). An oil spill on the Grand Banks that would harm the seabird population would have catastrophic and worldwide effects. In fact, Gatson (2013) stated that "the health of the marine ecosystem off Newfoundland and Labrador is important for seabirds from the entire Atlantic Ocean."

Current Regulations, Plans, and Resources

Canada has worked for many years to prepare for an oil spill. Transport Canada (TC) is identified as the lead federal agency for all marine oil spill preparation and response in the Canada Shipping Act of 2001 and the Arctic Waters Pollution Prevention Act. The Environmental Prevention and Response National Preparedness Plan documents the preparedness activities that have already been completed. Based on current regulations, there is a \$30 million cap on a company's potential liability for damages caused by an oil spill on the East Coast. This limit is very low considering the potential response costs of a spill of national significance and is much less than other developed countries. Canada established a National Advisory Council in 2006 mandated with preparing the nation for a major oil spill. The National Council set up six Regional Advisory Councils required to represent the communities who could be affected by an oil spill (Turner, 2010).

The Canadian Coast Guard (CCG) acts as the lead federal response agency and fills the role as the federal On Scene Commander for all oil spill responses (Canada, 2013). The CCG operates a Branch Office in St. John's, Newfoundland as well as eight depot sites of staged response equipment throughout the island of Newfoundland (Canadian Coast Guard, 2013). The CCG also establishes the National Marine Spill-response Exercise Program (NEP) which was

developed between government and industry and mandates exercises with participation from vessels, oil-handling facilities, response organizations, and the CCG. The CCG is required to conduct annual response exercises (Turner, 2010). However, the CCG does not currently conduct any training for a response management system (Turner, 2010).

The Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) provides regulatory oversight for the environmental protection, worker safety, and resource management for offshore drilling operations off of Newfoundland and Labrador (Canada-Newfoundland and Labrador Offshore Petroleum Board, May 2010). This Board conducts Environmental Assessments of areas prior to allowing offshore drilling operations to be conducted. These assessments include analysis of winds, waves, sea ice, icebergs, fisheries, marine mammals, and geology of the region. By utilizing these assessments, extensive planning for an oil spill response can be conducted (LGL Limited Environmental Research Associates, 2003). Offshore drilling operators must submit ice management plans to the C-NLOPB prior to being allowed to conduct operations (Canadian Association of Petroleum Producers, n.d.). However, there are no specific regulations in Canada indicating required response efforts or specific timeframes required for a response. Although Hibernia, Terra Nova, and White Rose have a 24-hour standby vessel with containment and recovery capabilities that could conduct a limited response quickly, Canada has not established any federal requirements for the timing or actions conducted during this response (Turner, 2010).

The Canadian Association of Petroleum Producers (CAPP) represents about 90% of the companies who explore for, develop, and produce natural gas and crude oil resources in Canada (Canadian Association of Petroleum Producers, 2014). CAPP works as the industry-lead to prepare a tiered response plan for oil spills. It works to develop safe and environmentally responsible offshore drilling operations to prevent spills.

Under the Canadian response system, there are four certified response agencies. The Eastern Canadian Response Corporation Limited (ECRC), based out of Ontario, would respond to an incident on the Grand Banks. Owned by several major Canadian oil companies, they would operate under the direction of the responsible party or the CCG to conduct the response. ECRC operates a staffed and equipped response center in St. John's, Newfoundland. The response center includes equipment such as containment boom, skimmers, boats, storage barges, communications equipment, and support equipment (East Coast Response Coordination, n.d.).

Comparison to the United States

The United States and Canada regulate oil spill response similarly, but there are several significant differences. One of the greatest differences between the oil spill response legislation in Canada and the legislation in the United States is the role of the Federal On-Scene Coordinator. Under the United States Oil Pollution Act of 1990 (OPA 90), the United States Coast Guard (USCG) is designated as the lead federal agency for all oil spill responses in the coastal zone. For a spill where there is no responsible party (RP) identified or where the RP is not taking appropriate action, in both Canada and the United States, the respective Coast Guard takes charge of the response efforts. However, the difference between the two nations occurs when the RP is taking responsibility for the response. In the United States, the USCG remains a member of the Unified Command within the Incident Command System (ICS) response

organization, even when the RP is funding and leading the response. For an oil spill response in the coastal zone, the Unified Command is typically comprised of the USCG, a state environmental agency, and the RP. The USCG participates and oversees the entire response effort, ensuring that the RP is taking the appropriate actions. In Canada, the CCG does not participate in the response at all when an RP is identified.

The second major difference between the oil spill response regulations of the two nations involves planning and response requirements. As noted, Canada does not require any specific actions or any specific timeline for a response effort. In the United States, federal regulations mandate oil spill response plans for all vessels operating in U.S. waters, all designated waterfront facilities, and all offshore oil drilling operations. These plans must include details for the response to a worst-case discharge from the respective platform's operations. The regulations actually provide mathematical formulas to calculate how much equipment would be required for different incidents (Turner, 2010). In addition to outlining requirements for a worse-case discharge, the United States' regulations also outline specific actions and a specific timeline for the response.

DISCUSSION:

Canada is not currently prepared to handle an internationally-significant incident on the Grand Banks. Although TC completed an Environmental Oil Spill Risk Assessment for the South Coast of Newfoundland in 2007, the assessment only addressed spills close to shore. It did not cover a large, internationally significant incident on the Grand Banks. However, this study did note that there is a lack of infrastructure along the south coast of Newfoundland to support a large-scale cleanup (Transport Canada, 2007). Most of the oil spill response planning that has been conducted to date focused on oil spills from vessels near shore (Transport Canada, 2007, Wiese, 2002). In fact, the Risk Assessment for Marine Spills in Canadian Waters did not address the Grand Banks as a potential high risk area for an incident (Canada, 2013). In addition, the 2010 Fall Report of the Commissioner of the Environment and Sustainable Development from the Office of the Auditor General of Canada noted that the CCG is not prepared for an oil spill response (Office of the Auditor General of Canada, 2010). Response organizations in Canada agree that the current system is not working. Western Canada Marine Response Corporation (WCMRC) noted in a recent inquiry that government and industry coordination is lacking. ICS is not mandated for training or for managing a response operation (Western Canada Marine Response Corporation, 2013).

A federal panel was established in June of 2013 to review the nation's ability to respond to a major oil spill. Noting that spill response in Canada "lacks federal leadership" (O'Neil and Hoekstra, 2013), the panel found many discrepancies in the overall preparation for a response, including the lack of preparation for worst-case scenarios, the lack of ability to respond quickly to incidents, the overly-reliant focus on mechanical recovery efforts, and the confusion about "who is responsible for what" between TC, CCG, and Environment Canada with no clear indication of who is in charge. Southern Newfoundland was also recognized by the panel as an area of highest probability for a large spill (O'Neill and Hoekstra, 2013). In addition, an internal audit conducted by the Canadian government in 2013 found that the CCG's system of response to a marine oil spill was "outdated, disorganized and in need of an overhaul." The audit detailed

that about 83% of the CCG's oil spill response equipment around the county averaged 25 years or more in service and are either obsolete or nearly obsolete (CBC, 2013b). The current oil spill response regime would result in a significant failure of an attempted response to a major incident on the Grand Banks.

Due to the harsh operating environment, the resources at risk, and the potential for an incident from one of the numerous drilling platforms in the region, the Canadian government must enact more detailed oil spill response legislation, and government and industry must conduct more extensive preparations for an oil spill in this region. Canada must learn from the lessons that the United States discovered during the Deepwater Horizon incident to be well-prepared for a devastating incident. For instance, following the Deepwater Horizon incident, the United States took immediate legislative action and broke up the Minerals Management Service into three independent agencies in order to require a stronger focus on safety in the offshore oil industry (Turner, 2010). There is potential for Canada to similarly distribute the overall requirements for oil spill planning and response between TC, CCG, and Environment Canada and to more clearly designate each agency's responsibilities.

Part of the response planning must also consider the logistical challenges associated with a major spill on the Grand Banks. The development of the Bay du Nord region in Flemish Pass is particularly concerning. This location exists directly in the path of the icebergs flowing south in the Labrador Current in an area known as "iceberg alley." This region is far offshore and outside of the endurance capabilities for monitoring by PAL aerial reconnaissance assets. The IIP monitors this region, but not on a daily basis. A response in this region would be extremely difficult to logistically support based on the harsh environment and the distance from shore.

The operations in response to Deepwater Horizon were conducted in warm temperatures, with clear skies, and with no risk of icebergs or sea ice to hamper the response. On the Grand Banks, the extreme winter storms, pervasive fog, and the possibility of extensive sea ice and icebergs would severely restrict even a standard response effort. In fact, the sea ice conditions in the region in 2014 were so severe that vessels would not have been able to operate in and out of St. John's, the largest city on the entire island, to respond to any type of offshore incident due to being trapped inport by the ice. In addition, the Gulf Coast of the United States is much more developed than Newfoundland. A response staged from Cape Race, Newfoundland would not have access to the support facilities available in a location such as New Orleans, Louisiana.

The Canadian government should pass legislation to require that the CCG act as the federal On-Scene Commander for all oil spill responses, not only responses where no RP is identified. This legislation would also require that the CCG, the C-NLOPB, and the local oil and gas industry under the CAPP work cooperatively to establish responses worst-case scenario discharges from each of the oil fields. This entity would work similar to the Area Committees in the United States which bring together all facets of the response community to prepare for an incident. This preparation would include factoring in how ice information would be accessed throughout a response.

An incident from one of the wells on the Grand Banks is a real possibility, and a risk that must be managed. It poses a danger to personnel safety and to the marine environment.

CONCLUSION:

Ultimately, the Grand Banks of Newfoundland presents a unique environment for an oil spill response. With the lucrative oil fields in the region that only continue to be further developed, a high potential exists for a devastating, internationally-significant oil spill. When factoring in the risks of the region, including severe weather, icebergs, and sea ice with the pristine marine environment and sensitive fish, mammal, and seabird populations, it becomes clear that preparing for an incident in this region extremely critical. Expanding government legislation to more clearly delineate the responsibilities of TC, CCG, and Environment Canada, including regulations to require industry oil spill response plans detailing a worst-case discharge scenario, increasing the role of the CCG in the response, and establishing requirements for the CCG, the C-NLOPB, and the CAPP to work together under one umbrella to prepare for the identified worst-case discharge scenarios will allow the Grand Banks region to be well-equipped to deal with such a potentially destructive event.

REFERENCES:

- Canada, 2013. Tanker safety and spill prevention. Transport Canada. <http://www.tc.gc.ca/eng/marinesafety/menu-4100.htm#j> (last accessed 25.03.14).
- Canadian Association of Petroleum Producers, 2014. Canadian Association of Petroleum Producers' mission. <http://www.capp.ca/aboutUs/mission/Pages/default.aspx> (last accessed 25.03.14).
- Canadian Association of Petroleum Producers. n.d. Spill prevention and response in Atlantic Canada. <http://www.capp.ca/GetDoc.aspx?DocID=105603>. (last accessed 25.03.14).
- Canadian Coast Guard, 2013. Preparedness. http://www.ccg-gcc.gc.ca/eng/Ccg/er_National_Response_Plan/s3. (last accessed 25.03.14).
- Canada-Newfoundland and Labrador Offshore Petroleum Board, 2010. Frequently asked questions: Well control, spill readiness and emergency response. http://www.cnlopb.nl.ca/pdfs/spill_faq.pdf. (last accessed 25.03.14).
- Canada-Newfoundland Labrador Offshore Petroleum Board, 2010. Southern Newfoundland Strategic Environmental Assessment – Final. <http://www.cnlopb.nl.ca/pdfs/snsea/snseach3pt56.pdf>. (last accessed 25.03.14).
- CBC News, 2013a. CBC News: Newfoundland and Labrador. Government, Husky signs extension agreement to White Rose: \$3 billion expected in royalties, equities, corporate, corporate income taxes for province. <http://www.cbc.ca/news/canada/newfoundland-labrador/government-husky-sign-extension-agreement-to-white-rose-1.1958550>. (last accessed 25.03.14).

2014 INTERNATIONAL OIL SPILL CONFERENCE

CBC News, 2013b. CBC News: Newfoundland and Labrador. Canada's offshore oil spill response outdated audits found. <http://www.cbc.ca/news/canada/calgary/canada-s-offshore-oil-spill-response-outdated-audits-found-1.1369587>. (last accessed 10.4.14).

East Coast Response Coordination, n.d. ECRC profile. http://www.ecrc.ca/en/about_ecrc/ro_role.asp. (last accessed 25.03.14).

Encyclopedia of Earth, n.d. Newfoundland-Labrador shelf large marine ecosystem. <http://www.eoearth.org/view/article/154840/>. (last accessed 25.03.14).

Fitzpatrick, A., 2014. Business Advertiser. Statoil secures West Hercules for offshore N.L. <http://www.gfwadvertiser.ca/News/Local/2014-03-13/article-3646960/Statoil-secures-West%E2%80%88Hercules-for-offshore-N.L./1>. (last accessed 25.03.14).

Fox News. 2013. Danish-owned coal cargo ships sails through the Northwest Passage from Canada to Europe. <http://www.foxnews.com/world/2013/09/27/danish-owned-coal-cargo-ship-sails-through-northwest-passage-from-canada-to/>. (last accessed 25.03.14).

Fraser, G. S., J. Russell, and W.M. Von Zharen. 2005. Produced Water from Offshore Oil and Gas Installations on The Grand Banks, Newfoundland and Labrador: Are The Potential Effects To Seabirds Sufficiently Known? *Marine Ornithology*. 34: 147-156.

Gaston, T., 2013. Hinterland Who's Who Seabirds. <http://www.hww.ca/en/species/birds/seabirds.html>. (last accessed 30.3.14).

Gautier, A., 2013. National Snow and Ice Data Center. Are Greenland's galloping glaciers slowing down? <http://nsidc.org/icelights/2013/06/26/are-greenlands-galloping-glaciers-slowing-down/>. (last accessed 17.3.14).

Gronewold, N., 2013. Energy Wire. Offshore Drilling: In North Atlantic, world's largest platform is getting a twin. <http://www.eenews.net/stories/1059990179>. (last accessed 10.3.2014).

Government of Newfoundland and Labrador, n.d. The Grand Banks. <http://www.exec.gov.nl.ca/exec/premier/gbanks.htm>. (last accessed 10.3.2014).

LGL Limited Environmental Research Associates, 2003. Orphan basin strategic environmental assessment. http://www.cnlopb.nl.ca/pdfs/ob_ea.pdf. (last accessed 17.3.14).

McManus, G. and Wood, C., 1991. Atlas of Newfoundland and Labrador. St. John's, Newfoundland: Breakwater, MUNCL. Plate 5.2.

McClintock, J., McKenna, R., and Woodworth-Lynas, C., 2007. Grand Banks Iceberg Management. PERD/CHC Report 20-84. Report prepared for PERD/CHC, National Research Council Canada, Ottawa, ON. Report prepared by AMEC Earth & Environmental, St. John's, NL, R.F. McKenna & Associates, Wakefield, QC, and PETRA International Ltd., Cupids, NL.

2014 INTERNATIONAL OIL SPILL CONFERENCE

National Snow and Ice Data Center, 2012. National Snow and Ice Data Center. Arctic sea ice extent settles at record seasonal minimum. <http://nsidc.org/arcticseaicenews/2012/09/arctic-sea-ice-extent-settles-at-record-seasonal-minimum/>. (last accessed 25.3.14).

Newfoundland and Labrador, 2010. CBC News. \$70 million N.L. offshore oil contract awarded. <http://www.cbc.ca/news/canada/newfoundland-labrador/70m-n-l-offshore-oil-contract-awarded-1.943977>. (last accessed 25.3.14).

Office of the Auditor General of Canada, 2010. Report of the Commissioner of the Environment and Sustainable Development to the House of Commons.

Oil Rig Disasters, n.d. Ocean Ranger. http://home.versatel.nl/the_sims/rig/o-ranger.htm. (last accessed 25.3.14).

Offshore Technology, n.d. White rose oil and gas field, Canada. http://www.offshore-technology.com/projects/white_rose/. (last accessed 25.3.14).

O'Neill, P. and Hoekstra, G., 2013. Vancouver Sun. Canada's tanker spill response system needs upgrading.

<http://www.vancouversun.com/news/Canada+tanker+spill+response+system+needs+upgrading+expert+panel/9242415/story.html>. (last accessed 10.4.14).

Suncor, n.d. Suncor Energy Inc. Terra Nova. <http://www.suncor.com/en/about/4001.aspx>. (last accessed 10.4.14).

Transport Canada, 2007. Synopsis Report – Environmental Oil Spill Risk Assessment for the South Coast of Newfoundland.

Turner, M., 2010. Review of Offshore Oil-spill Prevention and Remediation Requirements and Practices in Newfoundland and Labrador.

Weise, F., 2002. World Wildlife Fund Canada. Seabirds and Atlantic Canada's Ship-Source Oil Pollution: Impacts, Trends, and Solutions.

Western Canada Marine Response Corporation, 2013. Canada's Marine Oil Spill Preparedness and Response Regime. http://www.tc.gc.ca/media/documents/mosprr/Western_Canada_Marine_Response_Corporation.pdf. (last accessed 10.4.14).