

# REPORT HIGHLIGHTS

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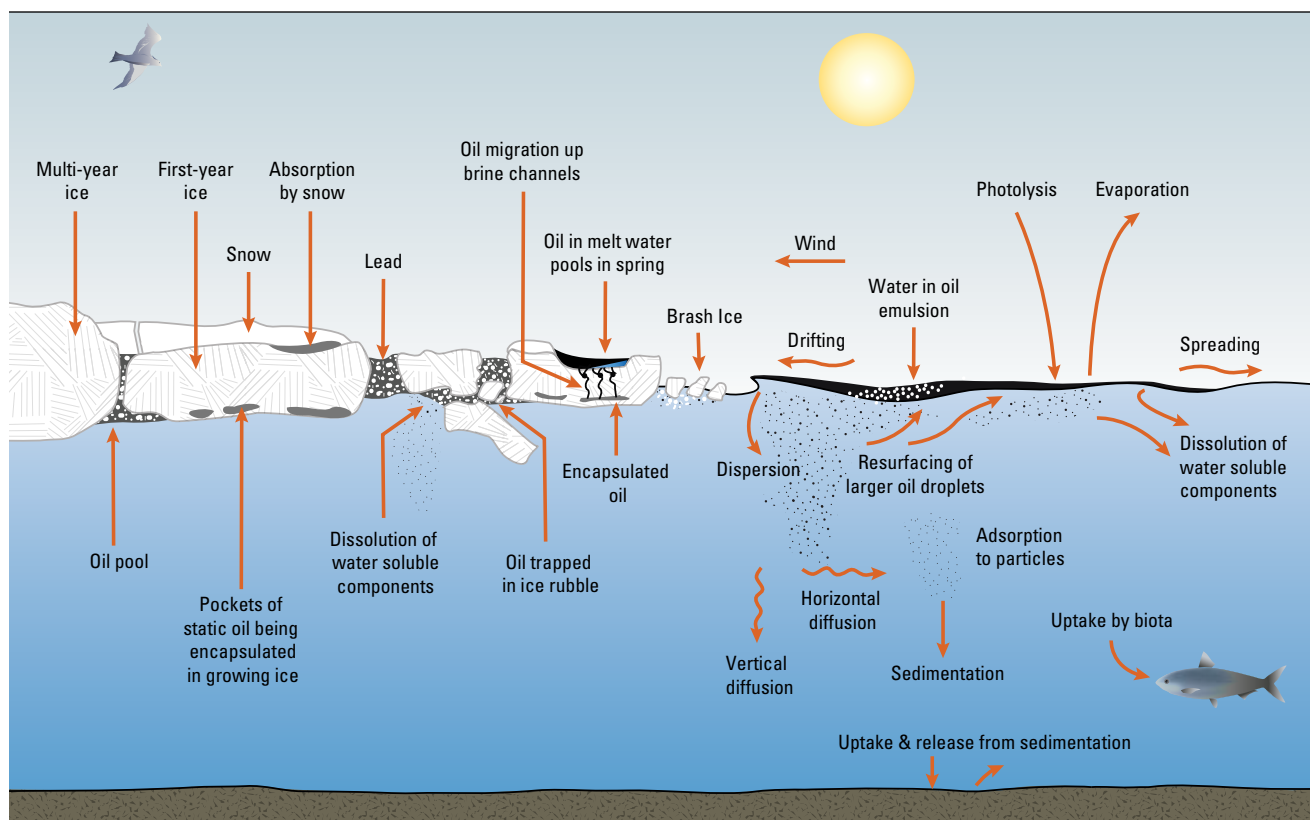
OCEAN STUDIES BOARD, POLAR RESEARCH BOARD, MARINE BOARD

APRIL 2014

## Responding to Oil Spills in the U.S. Arctic Marine Environment

### Oil Spill Response Research

**AS THE RISK OF A SERIOUS OIL SPILL INCREASES,** research is needed to build a toolbox of proven Arctic oil spill response technologies that together provide the flexibility needed to mount an effective response effort.



**Figure 1.** Environmental processes that affect oil behavior and weathering in open water and in ice. Modified from Daling et al., 1990, A. Allen.

**Laboratory experiments, field research,** and practical experience gained from responding to past oil spills have built a strong body of knowledge on the properties of spilled oil and response techniques. However, much of this work has been done for temperate regions,

and additional research is needed to make informed decisions about the most effective response strategies for Arctic spills. Processes that control oil behavior and weathering, in both open water and ice, are shown in Figure 1.

This is one of four Report Highlights documents presenting information from the National Research Council report *Responding to Oil Spills in the U.S. Arctic Marine Environment*. They are “Understanding the Arctic Marine Environment,” “Oil Spill Response Research,” “Operations, Logistics, and Coordination for an Arctic Oil Spill,” and “Strategies for Response and Mitigation.”

There is also a need to validate current and emerging oil spill response technologies in Arctic environmental conditions on operational scales. Carefully planned and controlled field releases of oil in the U.S. Arctic would improve the understanding of oil behavior in the Bering Strait and Beaufort and Chukchi Seas and allow for the evaluation of new response strategies specific to the region. Scientific field releases that have been conducted elsewhere in the Arctic demonstrate that such studies can be carried out without measurable harm to the environment.

### **The Oil Spill Toolbox**

Spill response options will vary depending on the oil type and volume, the location of the spill, and environmental conditions. Other considerations include the proximity of the spilled oil to sensitive marine ecosystems, populations of marine organisms, and culturally sensitive sites. The report reviews key oil spill countermeasures, which, together with the option of “no response,” make up the oil spill toolbox. Though much is known about oil behavior and response technologies in ice-covered environments, there are areas where additional research is needed to make informed decisions about the most effective response strategies for different Arctic situations.

### **Biodegradation and Dispersants**

The degradation of oil by naturally occurring microbial communities (biodegradation) is an important process controlling the weathering and removal of oil in the sea. Chemical dispersants promote biodegradation by breaking up oil droplets in the water column. There has been considerable debate over the effectiveness of chemical dispersants at low seawater temperatures, but recent studies show dispersants can be effective on



**Figure 2.** Dispersant is applied to an oil spill caused when the Tank/Barge DBL152 and the T/V Rebel impacted an obstruction off the Louisiana Coast in November 2005. Credit: NOAA Office of Response and Restoration.



**Figure 3.** In situ burning was one technique used to remove oil from the surface of the water after the Deepwater Horizon oil spill in the Gulf of Mexico in April 2010. Credit: NOAA Office of Response and Restoration.

non-emulsified oil at freezing temperatures if viscosity (resistance to flow) does not increase significantly.

Using subsea injection to apply dispersants directly to the blowout site could disperse oil at higher rates and with higher efficiency than aerial dispersant application. This technique can be employed even in darkness, extreme temperatures, strong winds, rough seas, or the presence of ice. However, more work needs to be done on the effectiveness, systems design, and short- and long-term impacts of subsea dispersant delivery.

#### *Research and Development Needs*

- Determining and verifying biodegradation rates for hydrocarbons in offshore environments
- Evaluating the toxicity of dispersants and dispersed oil on key Arctic marine species
- Improving methods for dispersant application for oil spills in ice

### **In Situ Burning**

In situ burning—the controlled burning of oil at the site of the spill—can significantly reduce the amount of oil on the water and minimize the adverse effect of the oil on the environment. With relatively fresh oil that is wind-herded against an ice edge or collects in melt pools

in the spring, in-situ burning can remove a majority of spilled oil. However, in open ocean conditions, oil can rapidly spread as thin slicks or films, becoming too thin to ignite.

#### *Research and Development Needs*

- Mapping the usefulness of chemical herders at different spatial scales, oil types, and weathered states, and in conjunction with other methods such as in situ burning
- Improving ignition methods for in situ burning

#### **Mechanical Containment and Recovery**

Mechanical containment and recovery removes oil without adding chemicals to the water or creating burn residue. Small oil spills can be contained within some types of ice; however, large offshore spills can quickly spread to a thin sheen, which severely limits recovery. Oil slicks would need to be concentrated using equipment such as containment booms, vessels, and skimmers. The lack of approved disposal sites on land for contaminated water and oily waste, a lack of port facilities, and limited airlift capability make large-scale mechanical containment and recovery operations difficult in the Arctic.

#### *Research and Development Needs*

- Better knowledge of the limitations of mechanical recovery in both open water and ice

#### **Detection, Monitoring, and Modeling**

Knowing the location of spilled oil is critical to mounting an effective response. Over the past decade, several



**Figure 4.** A vessel skims oil spilled after the Deepwater Horizon oil spill in the Gulf of Mexico in April 2010. Credit: NOAA Office of Response and Restoration.



**Figure 5.** The crew of the Coast Guard Cutter Healy prepare to lower an unmanned underwater vehicle, operated by the Woods Hole Oceanographic Institution, into the Beaufort Sea during a simulated spilled oil response and recovery exercise. Credit: U.S. Coast Guard, Petty Officer 3rd Class Grant DeVuyst.

government and industry programs have evaluated rapidly developing remote sensing technologies for detection and tracking—for example, sonar, synthetic aperture radar, infrared, and ground-penetrating radar. In addition, the use of unmanned aerial vehicles and autonomous underwater vehicles to detect, track, and monitor oil has grown. However, aerial observers to map oiled areas and transmit critical information to response crews will continue to be needed.

Improvements in oil spill trajectory modeling will be needed to more accurately predict the movement of spilled oil. Promising advances in modeling better account for the incorporation of oil into brine channels and freezing into ice, although under-ice roughness still requires further attention. Investment in detection and response strategies for oil on, within, and trapped under ice is needed for contingency planning. In addition, robust operational meteorological-ocean-ice and oil spill trajectory forecasting models for the U.S. Arctic would further improve oil spill response efforts.

#### *Research and Development Needs*

- Improving under-ice oil detection and response strategies
- Integrating remote sensing and observational techniques for detecting and tracking ice and oil

## RECOMMENDATIONS

- Pre-approval for the use of dispersants in Alaska should be based on sound science, including research on fates and effects of chemically dispersed oil in the Arctic environment, experiments using oils that are representative of those in the Arctic, toxicity tests of chemically dispersed oil at realistic concentrations and exposures, and the use of representative microbial and lower-trophic level benthic and pelagic Arctic species at appropriate temperatures and salinities.
- A comprehensive, collaborative, long-term Arctic oil spill research and development program needs to be established. The program should focus on understanding oil spill behavior in the Arctic marine environment, including the relationship between oil and sea ice formation, transport, and fate. It should include assessment of oil spill response technologies and logistics, improvements to forecasting models and associated data needs, and controlled field releases under realistic conditions for research purposes. Industry, academic, government, non-governmental, grassroots, and international efforts should be integrated into the program, with a focus on peer review and transparency. An inter-agency permit approval process that will enable researchers to plan and execute deliberate releases in U.S. waters is also needed.
- Priorities for oil spill research should leverage existing joint agreements and be addressed through a comprehensive, coordinated effort that links industry, government, academia, international and local experts, and non-governmental organizations. The Interagency Coordinating Committee on Oil Pollution Research, which is tasked to coordinate oil spill research and development among agencies and other partners, should lead the effort.

Locate additional information, including related reports, at <http://dels.nas.edu/osb>  
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**Committee on Responding to Oil Spills in Arctic Marine Environments:** **Martha R. Grabowski** (*Chair*), Le Moyne College/Rensselaer Polytechnic Institute; **Thomas Coolbaugh**, ExxonMobil Research and Engineering; **David F. Dickins**, DF Dickins and Associates, LLC; **Richard Glenn**, Arctic Slope Regional Corporation; **Kenneth Lee**, Commonwealth Scientific and Industrial Research Organisation; **William (Lee) Majors**, Alaska Clean Seas; **Mark D. Myers**, University of Alaska, Fairbanks; **Brenda L. Norcross**, University of Alaska, Fairbanks; **Mark Reed**, SINTEF; **Brian Salerno\***, BIMCO; **Robert Suydam**, North Slope Borough; **James M. Tiedje** (NAS), Michigan State University; **Mary-Louise Timmermans**, Yale University; **Peter Wadhams**, Cambridge University; **Deborah Glickson** (*Senior Program Officer*), **Lauren Brown** (*Associate Program Officer, Polar Research Board*), **Stacey Karras** (*Research Associate*), **Heather Chiarello** (*Senior Program Assistant, until April 2013*), **Payton Kulina** (*Program Assistant, from June 2013*), National Research Council. *\*Resigned from the committee.*

The National Academies appointed the above committee of experts to address the specific task requested by the U.S. Arctic Research Commission; American Petroleum Institute; U.S. Coast Guard; U.S. Department of the Interior, Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement; Marine Mammal Commission; National Oceanic and Atmospheric Administration; Oil Spill Recovery Institute; National Academy of Sciences. The members volunteered their time for this activity; their report is peer-reviewed and the final product signed off by both the committee members and the National Academies. This report brief was prepared by the National Research Council based on the committee's report.

For more information, contact the Ocean Science Board at (202) 334-2714 or visit <http://dels.nas.edu/osb>. Copies of *Responding to Oil Spills in the U.S. Arctic Marine Environment* are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; [www.nap.edu](http://www.nap.edu).

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