

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

Understanding the Arctic Marine Environment

ANTICIPATED ARCTIC DEVELOPMENT is driving a need to build a stronger understanding of the Arctic environment, in order to minimize impacts on people and sensitive ecosystems in the event of an oil spill. This knowledge is essential to guide oil spill prevention, response, and restoration efforts and to prioritize sampling and monitoring needs.

As well as framing the environmental context of the region, information on physical processes—including ocean circulation, marine weather, and sea ice—can help responders predict where oil will spread and how weathering might change its properties. Shoreline mapping and high-quality bathymetry provide context for the marine environment as well as important logistical information during response. From a biological perspective, understanding the Arctic food web helps identify key species for monitoring in the instance of an oil spill. Key areas for study include:

Ocean Processes and Characteristics

Ocean circulation, currents, and storm surges are important factors in supporting safe marine operations in the Arctic and for understanding the pathways and fate of spilled oil.

Marine Weather and Sea Ice Processes

Key weather parameters in the Beaufort and Chukchi region, including air and water temperature, winds, visibility, and hours of daylight, can impact oil spill response and marine and air operations. Factors such as ice thickness, concentration, and extent are critical to understanding how oil might behave in, on, and under the ice and to understanding operating limits for marine and air activities (see Figure 1).

Coastal Processes and Characteristics

High-quality bathymetry, nautical charting, and shoreline mapping data are needed for managing marine



Figure 1. Understanding sea ice processes in the Arctic environment is important for predicting how spilled oil may behave, and for understanding the limitations to response efforts in an ice covered environment. This satellite image from June 25, 2005 shows almost complete ice clearing in the Chukchi Sea. In contrast, the Beaufort Sea to the east of Barrow (the most northerly point of land in the image) is still choked with very close pack ice. Source: NASA.

traffic and coordinating oil spill response. Regular updating will be necessary due to the rapid pace of coastal erosion.

Ecology and Community Structure

Knowledge of the current ecosystem structure is crucial to understanding how it may change over time

or be impacted in the event of an oil spill. This data informs the identification of key species and areas of biological significance—for example, important foraging areas; places for spawning, nesting, or calving; or migration routes—that can then be used to prioritize research and monitoring.

An Observing Network is Needed to Support Oil Spill Response

Early warning is the key to rapid intervention in the event of an oil spill. Efforts are underway to monitor physical processes and ecosystem components in the Arctic—including, for example, community-based programs that collect information on ocean conditions or environmental parameters such as walrus populations, and data gathering projects organized by the Alaska Ocean Observing System and the Arctic Observing Network. However, each of these projects has different datasets, contributors, and potential or current users.

A community-based, multiuse observing network in the Arctic that provides a wide range of long-term, accessible benchmark information could bring these disparate data together in an integrated fashion to support oil spill response and other activities. Such a system could be a collaboration of federal, state, and tribal governments, non-governmental organizations, and maritime and oil and gas industries and could be organized by the Interagency Arctic Research Policy Committee (IARPC).



Figure 2. The NOAA Ship Rainier, which operates off the U.S. Pacific Coast and in Alaskan coastal waters, is designed and outfitted primarily for conducting hydrographic surveys in support of nautical charting. Credit: NOAA Ocean Service.

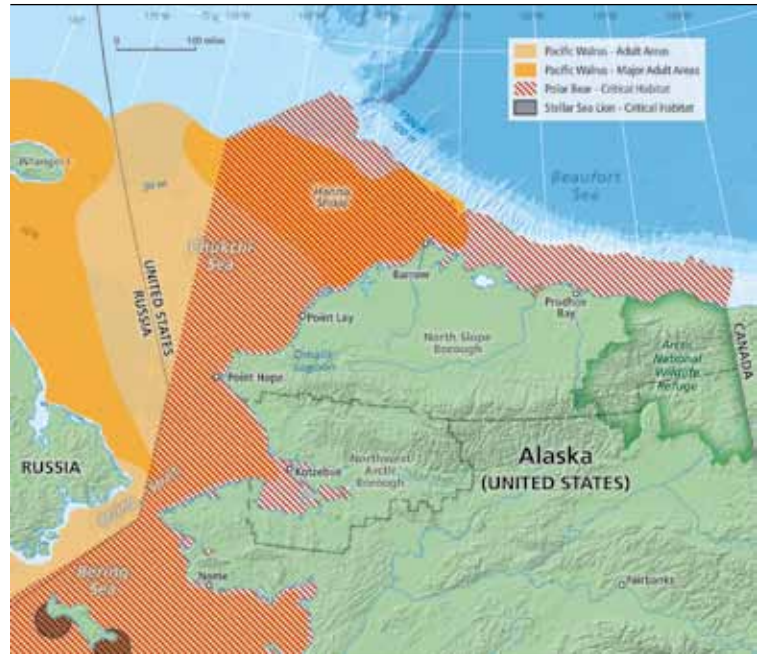


Figure 3. Gathering benchmark data on populations of Arctic fish, birds, and marine mammals is crucial to understanding how these populations might change in the event of an oil spill. This map shows the distribution of walrus, sea lions, and polar bears in U.S. Arctic waters. Data from the Arctic Environmental Response Management Application (ERMA), attributed to Audubon Alaska (Pacific walrus), NOAA (Stellar sea lion), and U.S. Fish and Wildlife Service (Polar bear).

Box 1. Benchmark Data Needs

Baseline data are critical to assess changes over time. The Arctic environment is changing, due to seasonal and year-to-year variability, but also due to the impacts of climate change. That means historical data do not provide reliable baselines to assess current environmental or ecosystem states. Instead, benchmark data (reference points measured over time) would provide a more reliable monitoring approach to assess ecosystem status. Critical types of benchmark data for oil spill response in the Arctic include:

- Populations of fish, birds, and marine mammals and their distribution over space and time;
- The use of marine organisms, including fish, birds, and mammals for subsistence and for cultural reasons;
- Identification and monitoring of areas of biological significance (e.g., important foraging areas; places for spawning, nesting, or calving; or migration routes);
- Rates of change for key species (e.g., to the number of births and deaths or to life span);
- Sensitivity of key Arctic species to hydrocarbons;
- High-resolution coastal topography and shelf bathymetry to monitor rapidly eroding coastlines;
- Measurements of sea ice cover, thickness, and distribution.

Additional research and development needs include meteorological models to more accurately forecast the extent and thickness of sea ice and assimilation of traditional knowledge of sea state and ice behavior into forecasting models.



Figure 4. A walrus on the ice in the Arctic Ocean north of western Russia.
Credit: Mike Dunn, NC State Museum of Natural Sciences/NOAA

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RECOMMENDATIONS

- High-resolution satellite and airborne imagery needs to be coupled with up-to-date high-resolution digital elevation models and updated regularly to capture the dynamic, rapidly changing U.S. Arctic coastline. Nearshore bathymetry and topography should be collected at a scale appropriate for accurate modeling of coastline vulnerability and storm surge sensitivity. Short- and long-term Arctic nautical charting and shoreline mapping that have been identified in NOAA and USGS plans should be adequately resourced, so that mapping efforts can be initiated, continued, and completed in timescales relevant to anticipated changes. To be effective, Arctic mapping priorities should continue to be developed in consultation with stakeholders and industry and should be implemented systematically rather than through surveys of opportunity.
- A real-time ice and meteorological forecasting system for the Arctic is needed to account for variations in sea ice coverage and thickness; it should include patterns of ice movement, ice type, sea state, ocean stratification and circulation, storm surge, and improved resolution in areas of increased risk. Such a system requires robust, sustainable, and effective acquisition of relevant observational data.

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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.

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