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Incorporating Traditional Knowledge and Subsistence Mapping into the Arctic Environmental Response Management Application

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ABSTRACT 300193:

Access to information from local and indigenous communities is vital to improving oil spill preparedness and response, and to ensuring efficient prioritization and protection of subsistence and culturally sensitive areas. The Environmental Response Management Application (ERMA®) is an online mapping tool that integrates both static and real-time data, such as Environmental Sensitivity Index maps, ship locations, weather, ocean currents, and more in a centralized format for environmental responders and decision makers. This allows for high-impact and fine-resolution visualization of data for solving complex environmental response and resource issues. As part of the overall ERMA project, baseline datasets have been collected from government sources, private corporations, universities, local entities, and non-governmental organizations (NGO). Arctic ERMA—a regional instance of the ERMA application—covers the U.S. high Arctic, with use in all of Alaska as well as internationally.

To identify and gather Arctic-specific data, workshops were conducted in the Northwest Arctic Borough (NWAB), North Slope Borough (NSB), and Edmonton, Canada focusing on oil spill scenarios that could affect villages in each region, and developing prioritized datasets needed to support planning, response, and natural resource damage assessment (NRDA) work. As part of the overall ERMA project, baseline datasets have been collected from government sources, private corporations, universities, local entities and non-governmental organizations. Most of these datasets are publicly available. ERMA has been tested in Arctic drills and was used to support the USCG's "Arctic Shield" exercise, September 2013. Through this exercise, ERMA was able to incorporate onboard ship information, field-collected data, photos, sensor data and other scientific input collected during the USCG Cutter *Healy* cruise. The exercise identified some of the challenges the response community could face during a spill in the Arctic and the region's dependence upon local knowledge in successfully minimizing environmental effects and human-dimension impacts. This presentation will discuss collaborations and next steps.

INTRODUCTION:

The potential for oil spills in Arctic waters is expected to increase with the predicted and observed environmental shifts associated with climate change. A decrease in ice cover will increase ship traffic, though, at least over the near-term, ice hazards will remain high (AMSA, 2009 and USARC, 2012). Melting permafrost in areas supporting pipelines or oil exploration infrastructure, and an increase in oil and gas exploration and development will also increase incident risk, putting further pressures on Arctic habitat, species, and coastal communities that depend on healthy natural resources. For these reasons, proactive actions that help prevent, plan for, and mitigate future losses are a high priority for NOAA.

Traditional local knowledge is critical for improving planning around oil spill response strategies. Many of the federal, state, and regional data sets are too coarse for spill response decision-making. Local expertise is imperative in defining and procuring logistics; siting areas that can be accessed; participating on teams performing reconnaissance; shoreline assessment; shoreline cleanup; sampling activities; and restoration planning.

Through NOAA's and the Coastal Response Research Center's (CRRC) focus on oil-in-ice research and scenario planning (CRRC, 2009), as well as NOAA's overall Arctic priority, it became clear that tighter connections with Arctic communities and traditional local knowledge expertise needed to happen and that improved platforms for data delivery and transparency would be beneficial (Huntington and Noongwook, 2013).

In 2010, ERMA was named as the federal government's official common operational picture (COP) (www.gomex.noaa.gov) for the BP Gulf of Mexico Oil Spill, and was highlighted as a critical asset to the National Incident Commander (US House of Representatives, 2011; USCG 2012). Because of the experience gained by working in the Arctic, and the methods developed by implementing a Web site for the public during the Gulf spill, the ERMA development paradigm shifted. Rather than focusing internally on the response community, ERMA became a more holistic tool for all communities to use. Following the BP Gulf of Mexico Oil Spill disaster, even more emphasis was placed on Arctic oil spill prevention and preparedness (NRC, 2012), and a common data sharing platform was recommended by both the U.S. Commission to the President and the U.S. Arctic Research Commission Annual Report (U.S. Commission, 2011 and U.S. ARC, 2011). Furthermore, near misses during the 2012 drilling season in the Chukchi Sea punctuated the need for a common data platform in the Arctic (*Eos*, 2012).

In 2009, NOAA initiated the online Arctic ERMA regional application (located at: https://www.erma.unh.edu/arctic) as a way of better preparing for and understanding Arctic spills, and to provide information and tools to support decision making for oil spills in Arctic and sub-Arctic waters. The bulk of the data in Arctic ERMA were acquired from 2011-2013 through a series of community workshops in Anchorage, AK (2011), Kotzebue, AK (2012), Barrow, AK (2012), and Edmonton, Canada (2013), and the computer code and functionality were transferred from the Gulf of Mexico to the Arctic site. This paper will summarize the methods and results of these workshops and provides recommendations based on these results.

METHODS:

NOAA and the CRRC conducted a series of workshops to identify critical data sets for Arctic oil spill preparedness and response, including injury assessment and restoration activities (CRRC 2011, 2012, 2013 a and b):

Workshop 1 - Anchorage, AK, 2011:

Arctic ERMA was developed, in part, with the collaboration of a diverse and large organizing committee consisting of representatives from the Northwest Arctic and North Slope Boroughs in Alaska and other Alaskan agencies, federal government organizations, academia, industry, and NGOs. Environment Canada and the U.S. Head Delegate of the Arctic Council's Emergency Prevention, Preparedness, and Response (EPPR) working group also participated. This committee selected the workshop participants and shaped the agenda for the first Arctic ERMA workshop (CRRC, 2011). Participants consisted of representatives from U.S. Coast Guard Sector Anchorage and District 17, several Arctic nations, the State of Alaska, federal and state trustees, industry, academia, Alaska Native organizations, and NGOs.

Goals/Outcomes: The workshop was designed to identify available data sets, data gaps, and to identify priorities and sources. Workshop participants were also asked to comment on functionality and user experiences. All of the data sets and functionality issues were cataloged and the feedback has contributed to the data and functionality in the current version of the Arctic ERMA application. Some of the issues (e.g., polar projections) remain on the list of future enhancements for ERMA.

As a result of this initial workshop, Inupiaq elders and borough representatives invited us to introduce Arctic ERMA to their communities. We developed a strategy for funding and conducted two workshops focused specifically on the concerns of the Arctic communities. These workshops concentrated on subsistence data, understanding the Inupiaq way of life, and ideas for how local communities could use ERMA to share their data.

Workshops 2 and 3: NWAB and NSB Workshops

Each workshop began with a plenary session that outlined the goals and expectations of the meeting and those of the participants, as well as an introduction to Arctic ERMA (NOAA, 2013). Participants also had several opportunities to use ERMA throughout the workshops.

The bulk of the time during the workshop was spent in breakout groups consisting of eight-to-ten people. Each breakout group discussed the same questions, providing data from replicate groups. At a minimum, each group consisted of an ERMA practitioner, at least one community elder, several community members (borough representatives), an incident responder, and a NRDA practitioner. At both workshops, representatives of the villages as well as borough officials from a variety of departments participated and were evenly distributed into breakout groups, to insure balanced input.

During the first breakout group session, groups discussed their reactions to Arctic ERMA, its potential for use during an oil spill response, and the information they would like to see included in ERMA. During the second breakout session, groups discussed how ERMA could be useful for evaluating the effects of spills and the information needed to support such an evaluation. In the third session, groups discussed the information Arctic ERMA needed to be useful in restoration planning. Results were reported out during plenary sessions.

The NWAB workshop was attended by more than 50 participants, representing the 11 villages as well as approximately 20 agency and NGO representatives. More than 60 people participated in the NSB workshop, including residents of all villages and approximately 20 agency and NGO representatives. Written reports on each of the workshops are available on the CRRC Web site (www.crrc.unh.edu).

Workshop 4: Canadian/International Workshop

The goals of this meeting were to: bring together data providers and users to improve oil spill preparedness in the Arctic; identify data sources/priorities for Arctic ERMA; and improve joint preparedness and response strategies in the Arctic.

The opening plenary session included a description and demonstration of Arctic ERMA. Each breakout group of six-to-eight people was dedicated to discussing the data needs and tools for using ERMA in a specific scenario: a search, rescue, and salvage incident; a search, rescue, and pollution incident; a fire and spill incident; and a fishing vessel/tanker collision. Thirty-six people attended the workshop, including representatives from various branches of the Joint Secretariat (an organization providing technical and administrative support to some of the co-management bodies of the Inuvialuit Settlement Region of Canada), NOAA's Office of Response and Restoration (OR&R), industry, Canadian federal agencies (Ice Service, Environment Canada, Department of Fisheries and Oceans, Transport Canada), and NGOs.

In all of the workshops, the need for an Internet-independent version of ERMA was highlighted. With the help of the Bureau of Safety and Environmental Enforcement (BSEE), NOAA developed Stand-alone ERMA for the Arctic and remote areas.

Stand-alone ERMA

In an increasingly digital world, one of the largest challenges for incident response in the Arctic is disseminating information in a region with unreliable Internet connectivity. To meet this challenge, OR&R developed Stand-alone ERMA, a portable instance offering the same comprehensive toolset and experience as the Internet version, without an Internet connection. All static layers found in the Internet version are available, while selected Web services can be tiled and cached for use offline as well. Software contained on a high-speed, (USB 3.0- or Serial ATA-supported), external hard drive connects through a dedicated laptop and broadcasts over an off-the-shelf wireless router. Responders access Stand-alone ERMA from personal computers through a Web browser (Figure 1). The entire package is small enough to be carried with response personnel to an incident response.

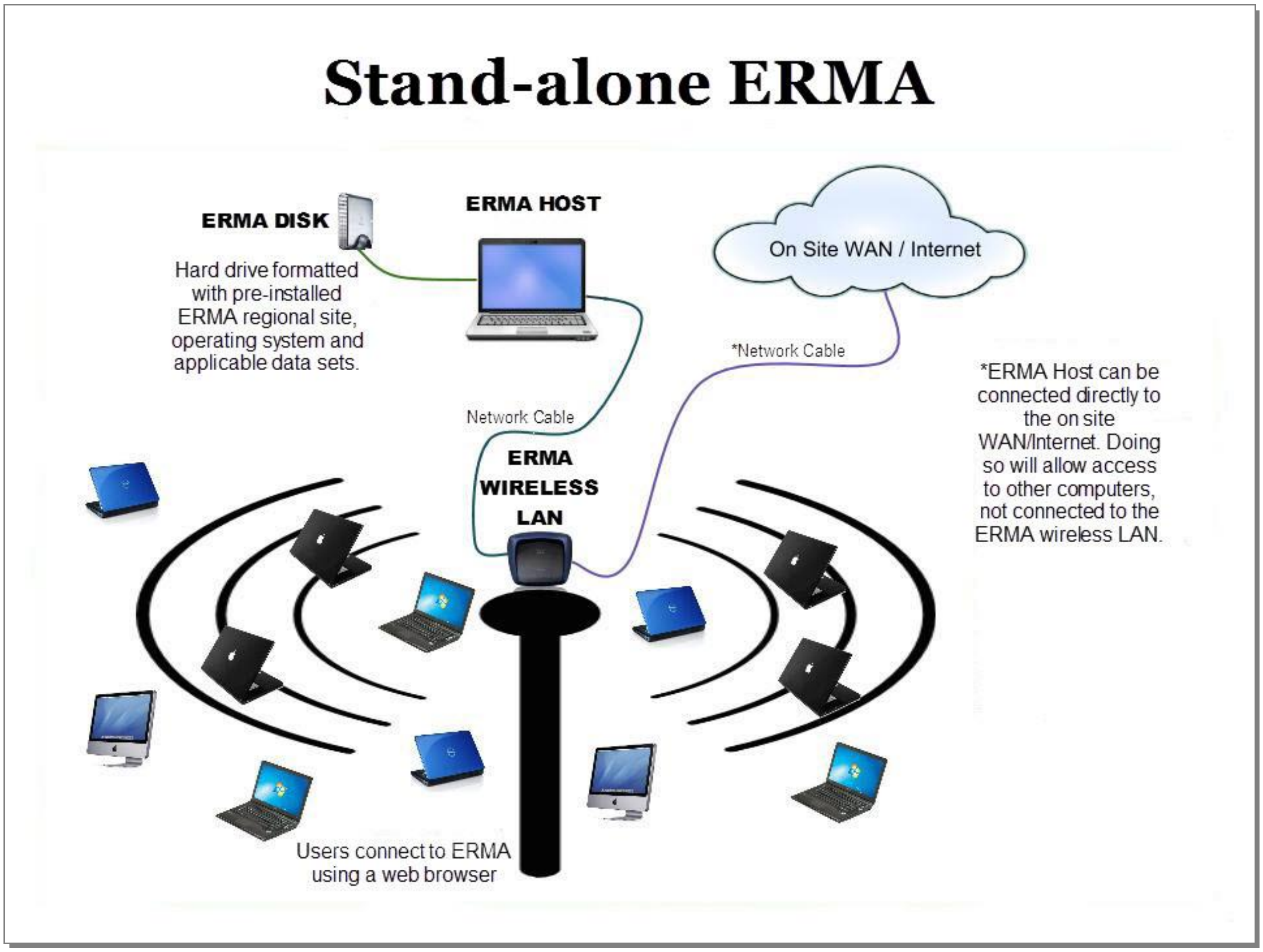

Figure 1 – Diagram of the Stand-alone ERMA system depicting hardware requirements and connectivity.

Stand-alone ERMA was field tested in the Arctic aboard the U.S. Coast Guard Cutter *Healy* in September, 2013 during Arctic Shield, a technology demonstration of the U.S. Coast Guard Research and Development Center (RDC). During Arctic Shield, Stand-alone ERMA was used to visualize observational data outputs produced from two unmanned technologies:

NOAA's "Puma" unmanned aircraft system (UAS), and the Woods Hole Oceanographic Institute's autonomous underwater vehicle (AUV), the "Jaguar." Spatial data and still photography were extracted from the Puma's imagery payload, geo-tagged onsite and quickly loaded into Stand-alone ERMA as proof-of-concept for the U.S. Coast Guard, and to mimic a post-field operation, decision-making scenario (Figure 2). Similar methods were used with sensor data extracted from the "Jaguar" to display the unit's path, environmental variables of the sea water, as well as sea ice thickness—a measure of variability where oil could potentially collect.

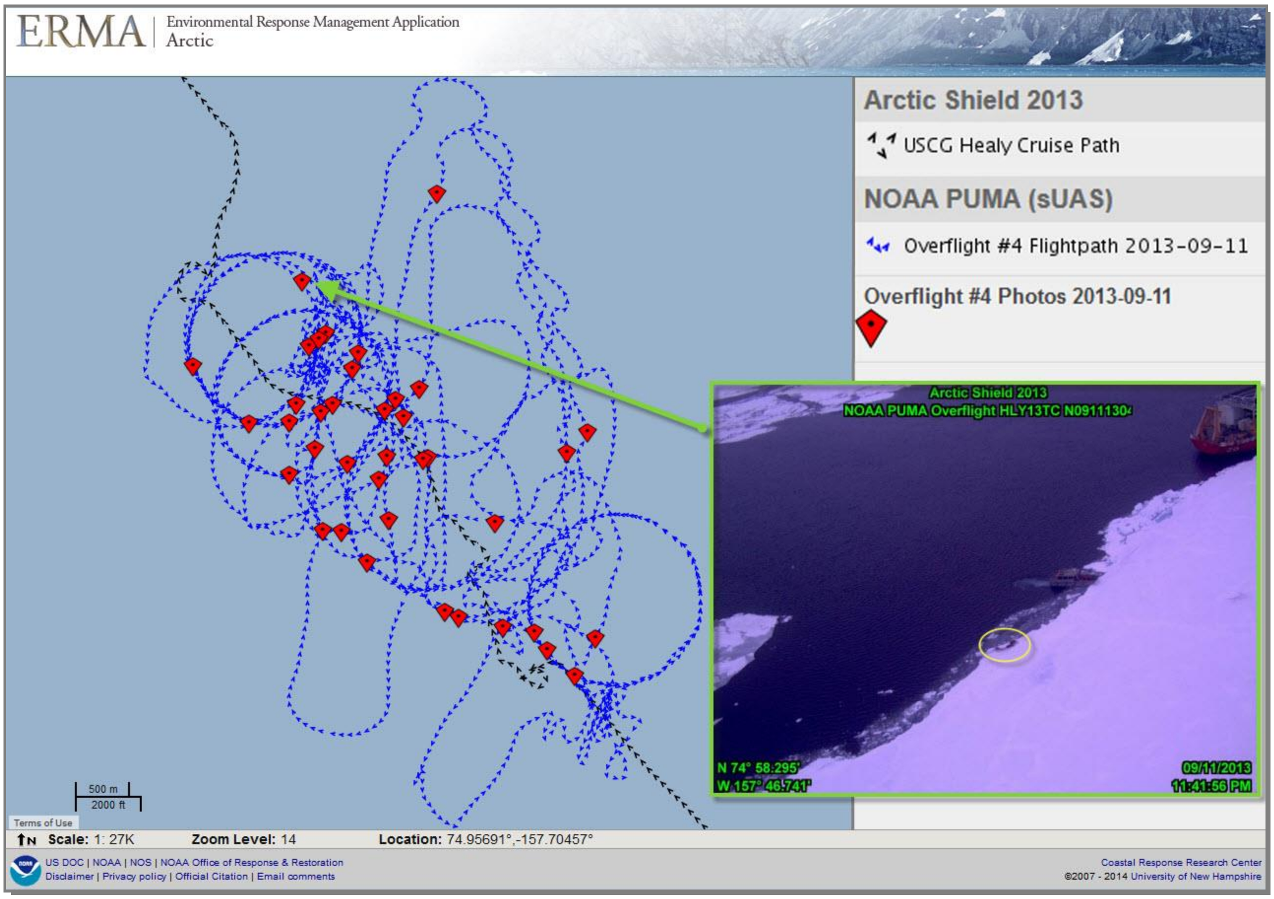

Figure 2: Stand-alone ERMA displaying UAS "Puma" field photography, flight path, and onboard tracking data during the Arctic Shield demonstration.

Considering the increased, oil-related activity and international interest in the Arctic region, Arctic Shield stands out as a unique and relevant endeavor that could serve to build trust between federal agencies and local communities. Results from the exercise could be used to inform the villages on the various technologies being demonstrated, challenges faced and lessons-learned that could be incorporated into the next annual exercise. Local experts could then provide feedback and recommendations that could enhance future best practices, thereby creating a cycle that would continue to increase the knowledge base for incident response in the Arctic.

DISCUSSION:

Outcomes and Recommendations from the NWAB

As a result of our workshops, the consensus was that Arctic ERMA has potential to improve communications and information sharing among communities and agencies. Local people and Inupiaq leaders are interested in contributing to ERMA and other planning efforts because it helps protect their communities and their subsistence way of life. A stand-alone version of ERMA for community use would be beneficial, since local Web access is not reliable or robust. Coordinating with existing and prior mapping efforts (including NWAB Subsistence Mapping projects) could make data gathering for ERMA more efficient and usable. Local and traditional knowledge should also be included in ERMA. The NWAB is working on a data sharing agreement that would protect sensitive local knowledge from unauthorized and inappropriate use. Providing peer review of data, perhaps through village advisory committees, would also improve accuracy of information. The display of metadata and the ability to upload and report observations was also of interest to community members. Training at the village level (e.g., in schools), and working with multiple existing committees, councils, and meetings was also recommended. Suggestions about specific data sets to add included: land ownership and access points, shelter locations, snow machine routes, small boat routes, place names (in both English and Inupiaq), vegetation types, watershed information, and intertidal zones.

Outcomes and Recommendations from the NSB

The consensus of the NSB workshop attendees was also that Arctic ERMA has potential to improve communications and information sharing among and between communities and agencies. As with the NWAB, local people and Inupiaq leaders are interested in contributing to ERMA and other planning efforts because it helps protect their communities and subsistence way of life. Attendees provided feedback on how the Arctic ERMA project could be useful for their participation in spill response and NRDA. A low band-width or stand-alone version of Arctic ERMA for community use would be beneficial since local Web access is neither reliable nor robust. Coordinating with existing and prior mapping efforts in the NSB could make the project more efficient and useful. Mechanisms for protecting proprietary data are needed. Local and traditional knowledge on other topics should also be included in ERMA. Once again, the importance of local peer review of the data, perhaps through village advisory committees, was noted. The display of metadata and the ability to upload and report observations were also of interest to community members. Recommendations and ideas related to Arctic ERMA outreach included: conducting training at the village level including schools, and working with multiple existing committees, councils, and meetings including co-management groups in the NSB.

Further, it was suggested that NOAA should better communicate what Arctic ERMA is. Perhaps NOAA can work with village representatives and schools to develop and deliver training on Arctic ERMA specific to the interests of the community.

In addition to the information suggested at the NWAB workshop, the NSB participants wanted Arctic ERMA to include data on: staging locations, including airfield information; traditional use areas; historical and archaeological information; Russian data; Bureau of Ocean Energy Management (BOEM) and industry data (including real-time high resolution ice observations); concentrations of contaminants in sediment and biota; historical ice observations; real-time marine mammal migrations/animal telemetry; geographic response strategies; locations of staged response equipment; real-time currents and weather; and conceptual models, spill scenarios, restoration concept visualizations.

Outcomes and Recommendations from the Canadian/International Workshop

Each breakout group created a spreadsheet of information needs related to their scenario in the categories of biological populations, habitats, infrastructure, navigation and communication, response and logistics, physical/chemical conditions, and human dimensions. The priority for having these data available was ranked (high/medium/low). If the data existed, their current location, point of contact (POC) and extent (local, national, international) were noted. Data gaps were also identified and prioritized for each scenario. Within the framework of our workshop scenarios, common conclusions regarding the use of ERMA: the need for data sharing agreements to insure accessibility during emergencies, especially for sensitive information, and getting ERMA into the cloud to minimize bandwidth. Recommended additional features for ERMA included: a chat function, embedded videos, environmental data POCs; translation into French or other languages; and geo-referencing. As a result of this workshop Canada and the U.S. have continued to work together to populate and further develop Arctic ERMA.

CONCLUSIONS:

Although the workshops were remarkably successful at identifying data sources, gaps, and needs, maintaining long term connections with Arctic communities has been challenging due to distance and limited travel budgets. Traditional knowledge holdings have been especially difficult to access due to: 1) not being available in a GIS format, 2) the highly sensitive nature of cultural data, and 3) limited metadata. When traditional knowledge observations and data can be tied into ERMA, the information creates a more accurate picture of the sensitive resources and lifestyles at risk in the Arctic. Having traditional knowledge information would provide more relevance to planning and response, as well as allowing the communities to see their respective data in the context of other information, giving everyone a more holistic picture.
Should a spill or other incident occur, traditional knowledge holders will be essential for informing response strategies and asset allocation for protection of subsistence areas and resources. These data sets will also better aid the affected communities on status of trajectory information, assessment findings, and impacts because they will be put into a local context.

Capitalizing on the initiative created during the community workshops, ERMA was demonstrated as a tool to integrate traditional knowledge and science in a collaborative environment in March 2013 during the “Experts Workshop to Comparatively Evaluate Coastal Currents and Ice Movement in the Northeastern Chukchi Sea” facilitated by the University of Alaska Fairbanks. Workshops were held in the villages of Barrow and Wainwright, AK with community members from Point Lay, AK and Nuiqsut, AK also in attendance. At each workshop, indigenous experts sat down with government agency and industry scientists to transfer knowledge of currents and ice movements in the area (Johnson et al., Forthcoming 2014). Laminated nautical charts were used to transcribe the observations of the local experts.

Both localized currents and convergence zones were described, digitized and uploaded to ERMA onsite (Figure 3). There is a marked lack of comprehensive current data available for the North Slope of Alaska. Having the ability to overlay traditional knowledge of observed current patterns, with sensor data such as high frequency radar, expands our collective knowledge in the realms of oceanography, ecology, and incident response. As demonstrated during these community workshops, traditional knowledge can also serve as the only source of information when western scientific data do not exist for the region or at the necessary scale. Conversely, descriptive traditional knowledge may not be transcribed or documented and is highly-sensitive in nature, often making it unavailable. ERMA contains a wealth of data from a wide variety of sources providing a framework for collaboration and data standardization as traditional knowledge sources are identified, documented and shared.

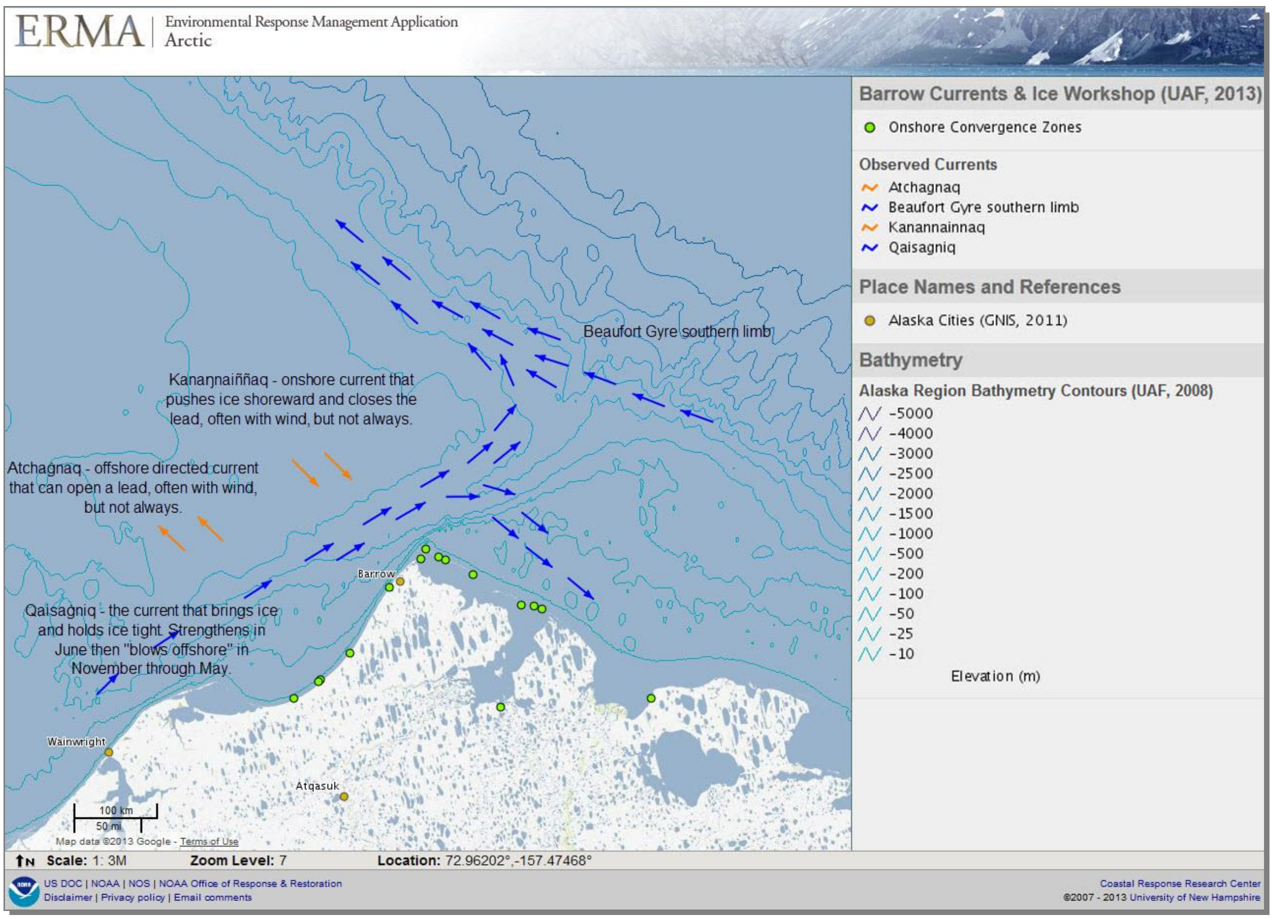

Figure 3 - (Currents & Ice) - Ocean current structure off Barrow showing Qaisabniq and onshore/offshore currents influencing ice.

The ERMA database is organized using standard categories, consistent across the country. The ERMA team continues to develop working relationships with data providers and working to reduce confusion and duplication of effort among other mapping entities like the Alaska Ocean Observing System (AOOS), the Geographic Information Network of Alaska

(GINA) through the University of Alaska Fairbanks, the Pew Charitable Trusts/Audubon Society's Arctic Atlas, NASA/DoD's Arctic Collaborative Environment (ACE), and the Arctic Portal. Baseline data sets are accessed through BOEM's Multipurpose Marine Cadastre and www.arctic.data.gov. If data sets are publicly available, ERMA displays those layers without requiring log-in credentials. The layer identifies the source and the date, provides a brief description of the data and then links to the Federal Geographic Data Committee (FGDC)- or International Standard for Organization(ISO)-standard metadata. Accepted ERMA data formats include open geospatial consortium (OGC)-standard formats including shape files, Web-mapping services, geo-rss feeds, and others. Often data are proprietary, sensitive, or inadequately vetted for quality assurance. Those data are protected and shared with the users that the data provider specifies. This level of credentialing may also require data sharing and use agreements (e.g., National Automatic Identification System, Homeland Security Infrastructure Program, and traditional knowledge).

The abundance of sources and data requires a great deal of management. ERMA is not a data portal, but an operational tool offering the ability to view datasets that are useful for response planning, incident response, injury assessment and restoration activities. NOAA works with workshop organizing committees, participants, and other stakeholders who vet priority data sets, find the authoritative source, and ensure proper attribution and display. For data to be publicly available in ERMA, the data layer must have FGDC- or ISO-compliant metadata. Obtaining the proper metadata can be a time-consuming process and limits sharing if it cannot be obtained or developed.

Access to decision-support tools and information is another challenge, one that is especially important for the coastal subsistence villages in the Arctic that could be affected by an oil spill and the resulting influx of responders into their community. Subsistence hunters are sensitive about non-native operations that could change the behavior of the animals they depend on for food and for trade with other subsistence communities. To help mitigate these effects, incident responders will need to develop and implement the appropriate measures to collaborate with designated officials in the community during the decision-making process. ERMA was designed as a data sharing and visualization tool to aid this collaborative process. Furthermore, Stand-alone ERMA can help facilitate this process where Internet access is unreliable. In remote communities, GIS experts can add data into the community's own copy of Stand-alone ERMA, vet the data from within the community and decide which data would be transferred to the online version of ERMA. Outreach to introduce ERMA as an accessible tool that can empower Arctic communities has already begun as a component of the workshops, but significant challenges still remain in terms of maintaining relationships, accessing data and ensuring readiness.

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