AMSA Recommendation III(A) by USA

AMSA Recommendation III(A) – Agenda item 4.8 (a)
Gaps and Opportunities in Arctic Ice Products and Services

Arctic Marine Shipping Assessment (AMSA) Report Recommendation III(A) provides:

> *That the Arctic states should recognize that improvements in Arctic marine infrastructure are needed to enhance safety and environmental protection in support of sustainable development. Examples of infrastructure where critical improvements are needed include: ice navigation training; navigational charts; communications systems; port services, including reception facilities for ship-generated waste; accurate and timely ice information (ice centers); places of refuge; and icebreakers to assist in response.*[1]

Background

The projected decline of Arctic sea ice in extent and thickness in the coming years will likely lead to greater marine access and longer navigational seasons, but not necessarily easier conditions for marine operations in the region.[2] As the least sampled of the world's oceans,[3] the Arctic has insufficient infrastructure to support safe marine operations and adequately respond to the full range of potential emergencies and incidents. Infrastructure gaps include inadequate hydrographic data for primary shipping routes, incomplete meteorological and oceanographic data,[4] and insufficient ice information and services. As discussed in the 2009 Arctic Marine Shipping Assessment (AMSA) Report, there is a profound lack of data, monitoring systems, and support services in ice-covered waters, making emergency response for ships more difficult in the Arctic than in other marine environments.[5] Accordingly, in light of the strong potential for "expanded marine use of the Arctic Ocean,"[6] it is important to address the gaps in ice products and services to adequately support the safety and environmental sustainability of marine operations in the region.

Availability and Geographic Scope of Ice Services

Information services regarding sea ice are a crucial component of operational vessel safety in the Arctic. Most Arctic states operate national ice services that provide weather and ice monitoring and information. Examples include the Finnish Meteorological Institute,[7] the U.S. National Ice Center,[8] the Russian Federal Service for Hydrometeorology and

[1] Protection of the Arctic Marine Environment Working Group, *Arctic Marine Shipping Assessment 2009 Report* at 26, 92, 154, ARCTIC COUNCIL (April 2009), *available at* http://www.pame.is/amsa-2009-report [hereinafter AMSA Report].
[2] AMSA Report at 26, 92 & 154.
[3] *Id.* at 16.
[4] *Id.* at 154.
[5] *Id.* at 5
[6] *Id.* at 28
[7] The Finnish Meteorological Institute web site is found at http://en.ilmatieteenlaitos.fi/.
[8] The U.S. National Ice Service web site is found at http://www.natice.noaa.gov/mission.html?bandwidth=high.

Environmental Monitoring,[9] the Norwegian Meteorological Institute[10] and the Canadian Ice Service.[11] The several national ice services typically provide more information about ice conditions for Arctic regions closest to them. For example, the Russian Service has a long history of assessing ice conditions along the Northern Sea Route,[12] while the Canadian Ice Service has expertise in Arctic waters off of Canada's shores. The U.S. National Ice Center provides a somewhat broader range of services.[13]

Collection methods of ice information include satellite remote sensing, microwave data, visible and infrared range satellite imagery, unmanned aerial vehicles (UAVs), autonomous underwater vehicle (AUVs), drifting sensors, surface-based radar systems, and local and indigenous knowledge.[14] The U.S. National Aeronautics and Space Administration (NASA) uses satellite data and imagery to provide maps showing the extent of sea ice.[15] NASA scientists are also working on "Operation IceBridge," a multi-year mission to study changing ice conditions at the poles which is developing a new product that will increase the viability of seasonal ice forecasts.[16] Ice charts, sea ice maps and sea ice atlases have also been produced for specific regions within the Arctic, such as for Canadian waters,[17] Russian waters,[18] and U.S. waters.[19]

Local and indigenous knowledge of ice movements and patterns is also available in the Arctic. In living near and depending on an ecosystem based around sea ice through the marine mammals they hunt, indigenous peoples "typically observe and keep track of a range of different phenomena, processes, and animals as they relate to the specific services derived

[9] The Russian Federal Service for Hydrometeorology and Environmental Monitoring web site is found at http://government.ru/eng/power/49/.
[10] The Norwegian Meteorological Institute web site is found at http://met.no/English/.
[11] The Canadian Ice Service web site is found at http://www.ec.gc.ca/glaces-ice/.
[12] Hajo Eicken, L. Lovecraft and M. Druckenmiller., *Sea-Ice System Services: A Framework to Help Identify and Meet Information Needs Relevant for Arctic Observing Networks*, 62 ARCTIC 119, 125 (June 2009), available at http://arctic.synergiesprairies.ca/arctic/index.php/arctic/article/view/126. In this article, Eicken's phrase "observing networks" refers to those who use and provide sea ice services. For example, a marine operator who uses ice forecasts is an observer as is an indigenous ice expert providing information about ice patterns.
[13] *Preparing for Offshore Drilling in the Arctic: Lessons Learned from the First Season*: *Field Hearing Before the S. Comm. on Commerce, Science, and Transportation*, 112th Cong. 4 (2012) (written statement of Laura Furgione, Acting Director, National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce), *available at* http://www.legislative.noaa.gov/Testimony/Furgione101112.pdf [hereinafter NOAA Statement]. NOAA offices in Alaska and Maryland collaborate to provide information to the U.S. Arctic on ice conditions five days a week. *Id.*
[14] *See* Hajo Eicken, et al., *Environmental Security in Arctic Ice-Covered Seas: From Strategy to Tactics of Hazard Identification and Emergency Response*, 45 MARINE TECH. SOC'Y J. 37 (2011), available at http://seaice.alaska.edu/gi/publications/eicken/11EJRK.pdf.
[15] *See* Maria-José Viñas, *Arctic Sea Ice Hits Smallest Extent in Satellite Era*, U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (Sept. 16, 2012), at http://www.nasa.gov/topics/earth/features/2012-seaicemin.html.
[16] George Hale, *NASA's IceBridge Seeking New View of Changing Sea Ice*, U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (Aug. 12, 2012), http://www.nasa.gov/mission_pages/icebridge/news/spr12/arctic-seaice.html.
[17] http://atlas.nrcan.gc.ca/auth/english/maps/environment/seaice
[18] http://nsidc.org/data/g02176.html
[19] http://www.aoos.org/ice-atlas/.

from sea ice."[20] Their knowledge thus contains nuanced explanations for sea ice which can "confirm, challenge, and augment scientific information."[21] For example, it has been suggested that the memories of Inuit and Yup'ik elders may help fill gaps in scientific ice information from before the 1950s when modern ice sensing technology became available. Since ice monitoring in the Arctic is sparse and can sometimes be hindered by inclement weather conditions, indigenous people who "regularly travel the ice for hundreds of kilometers beyond their communities, in all directions" and seasons may be able to help fill in the gaps of scientific ice monitoring with their experiences and observations.[22]

While anthropologists have long understood the significance of indigenous knowledge, scientists have also begun to recognize the potential of indigenous contributions to ice monitoring and services. In the U.S., Canada and Russia, scientists have partnered or collaborated with indigenous "sea-ice experts" to gather data and information on ice patterns. For example, in the U.S., the Seasonal Ice Zone Observing Network (SIZONET) consists of Inuit ice observers in Alaska collaborating with scientists from NASA, the U.S. Army Corps of Engineers' Cold Regions Research and Engineering Laboratory, and the University of Alberta in Canada, among others.[23] In Canada, the Arctic Eider Society in partnership with Environment Canada and the Sanikiluaq Hunters and Trappers Association is engaged in a community based research and education program to monitor sea ice ecosystems and conditions in Hudson Bay.[24]

The Sea Ice Knowledge and Use (SIKU) Project is another collaboration among U.S., Canadian and Russian scientists and Inuit residents that gathers and publishes indigenous knowledge about ice.[25] SIKU has issued a number of papers on the topic since it was started as an International Polar Year project in 2007. SIKU also produced a sea ice atlas for the Nunavut coastal area in Canada, using Inuit expertise to map sea ice hazards and develop means of harmonizing community-based sea ice monitoring with Global Position System (GPS) and satellite weather indicators to improve ice-related weather forecasts.[26] SIKU has also worked under the auspices of the Shared Beringian Heritage Program, a program administered by the U.S. National Park Service that studies the natural resources and cultural

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[20] Hajo Eicken, *Indigenous Knowledge and Sea Ice Science: What Can We Learn from Indigenous Ice Users? in* SIKU: KNOWING OUR ICE, 357, 360 (I. Krupnik et al. eds., 2010), available at http://www.cimes.hawaii.edu/sites/www.cimes.hawaii.edu/files/10E.pdf.

[21] *Indigenous People: Knowledge*, NATIONAL SNOW & ICE DATA CENTER (Oct. 22, 2012), at http://nsidc.org/cryosphere/seaice/environment/indigenous_knowledge.html.

[22] *Id.*; *see also* Henry Huntington, *Native Observations Capture Impacts of Sea Ice Changes*, 8 WITNESS THE ARCTIC 1 (2000), *available at* http://www.arcus.org/files/witness-the-arctic/2000/1/pdf/wta2000_v08i01.pdf; *see also* Eicken, *Sea-Ice System Services* at 126-27 ("[L]ocal knowledge can also achieve significant success in forecasting, particularly where wind and currents interact with the topography and bathymetry to generate complex patterns of ice movements.")

[23] *See Description of Research*, SEASONAL ICE ZONE OBSERVING NETWORK, http://www.sizonet.org/research-home.

[24] *See* Arctic Eider Society, at http://www.arcticeider.com/donate/standard.html.

[25] *See Sea Ice Knowledge and Use: International Polar Year*, INUIT SEA ICE USE AND OCCUPANCY PROJECT, http://gcrc.carleton.ca/siku; Igor Krupnik, *The Ice We Want Our Children to Know: SIKU Project in Alaska and Siberia, 2007-2008*, 8 ALASKA PARK SCIENCE 2, *available at* http://www.nps.gov/akso/nature/science/ak_park_science/PDF/2010Vol8-2/Krupnik.pdf.

[26] *See, Inuit siku (sea ice) Atlas*, SEA ICE KNOWLEDGE AND USE, http://sikuatlas.ca/index.html.

heritage shared by Russia and the U.S. in the Bering Strait region.[27] Through an award from the U.S. National Park Service, SIKU gathered ice data from indigenous peoples in Russian Chukotka from 2010-2012.[28]

Partnerships

Encouragingly, there is significant collaboration on ice services among nations. For example, there is a strong bilateral relationship between the U.S. and Canada. The two countries have:

- jointly acquired hydrographic and geological data using the U.S. Coast Guard Cutter *Healy* and the Canadian Coast Guard Ship *Louis S. St-Laurent;*[29]
- undertaken four joint missions since 2008 to gather data for the purposes of delineating the outer limits of the U.S. and Canadian extended continental shelves in the Arctic;[30]
- partnered to record ice characteristics and deploy ice buoys to track water currents and ice movements;[31] and
- formed the North American Ice Service (NAIS) in 2010, a collaborative agreement among the Canadian Ice Service, the U.S. National Ice Center, and the U.S. Coast Guard International Ice Patrol, to "create a harmonized suite of products and services for ice information for North American and global waters to serve the needs of users for safety of navigation and informed decision making."[32]

There are also strong bilateral relationships between the U.S. and Russia, as Russia's Arctic and Antarctic Research Institute and the U.S. National Ice Center collaborate on the joint production of ice charts.[33]

The International Ice Patrol, operated by the U.S. Coast Guard, monitors the iceberg danger near Newfoundland and provides the iceberg limit to the maritime community through daily iceberg charts and bulletins.[34] These services are delivered year-round in partnership with the Canadian Ice Service under the NAIS Agreement. The International Ice Patrol operates near Newfoundland from February 1 to August 31 and the Canadian Ice Service takes over patrol duty for the rest of the year.[35]

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[27] Shared Beringian Heritage Program, *About the Program*, NATIONAL PARK SERVICE, http://www.nps.gov/akso/beringia/about/index.cfm.
[28] Shared Beringian Heritage Program, *SIKU – Sea Ice Knowledge and Use*, NATIONAL PARK SERVICE (April 6, 2012), http://www.nps.gov/akso/beringia/about/news/2012-April-6.cfm.
[29] NOAA Statement, *supra* note 13, at 6.
[30] *2010 Extended Continental Shelf Survey*, EXTENDED CONTINENTAL SHELF PROJECT (Jan. 14, 2011) http://continentalshelf.gov/missions/10arctic/welcome.html.
[31] *Id.*
[32] North American Ice Service Collaborative Agreement, June 15, 2010, available at http://nsidc.org/noaa/iicwg/docs/IICWG_2010/NAIS_Annex_Final_English.pdf.
[33] 13th Meeting of the IICWG, *Executive Summary Report*, IICWG (Oct. 19, 2012), *available at* http://nsidc.org/noaa/iicwg/.
[34] http://www.navcen.uscg.gov/?pageName=iipProducts
[35] Navigation Center, *About International Ice Patrol*, U.S. DEPARTMENT OF HOMELAND SECURITY UNITED STATES COAST GUARD (Oct. 19, 2012), http://www.navcen.uscg.gov/?pageName=IIPHome.

There are also multilateral collaborations among Arctic states on ice services, with national ice services participating in the World Meteorological Organization (WMO) and Intergovernmental Oceanographic Commission's (IOC) Joint Technical Commission for Oceanography and Marine Meteorology Expert Team on Sea Ice (JCOMM ETSI) to establish and maintain international standards for ice information such as ice nomenclature.[36] The formal international coordination framework for weather and sea ice safety services for marine operations is through WMO/JCOMM. In 2011, WMO, in collaboration with the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO), formally established five new operational METAREAS for the Arctic Ocean.[37] Each METAREA has a specific designated "Issuing Service" committed to provide operational weather and sea ice information to ensure safety of marine operations.

Representatives from the various national ice services are also part of the International Ice Charting Working Group (IICWG), a body that advises the JCOMM ETSI and enables cooperative information sharing between national ice services on sea ice and icebergs.[38] The IICWG has been working with JCOMM ETSI to improve the availability of ice information in Electronic Navigation Charts (ENC) over the years and is now exploring new software that can convert national ice service charts into the ENC format.[39]

In addition, the WMO, through its Executive Council on Polar Observations, Research, and Observations (EC PORS),[40] is in the process of developing a Global Integrated Polar Prediction System (GIPPS), which will strive to enhance existing services to meet new user requirements in the Arctic.

Arctic states have also collaborated in the establishment of the Arctic Regional Hydrographic Commission (ARHC) under the auspices of the International Hydrographic Organization. Citing the significance of increased vessel traffic due to diminishing ice conditions, the U.S., Canada, Denmark, Norway, and Russia established the Commission "in a mutual effort to develop nautical charts that will improve the safety of mariners transiting the Arctic."[41] Since the ARHC's establishment in 2010, member states have shared information with each another on matters such as tides under ice and ice charts.[42] Iceland and Finland are observers to the ARHC.[43]

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[36] AMSA Report at pp. 160-61. *See also* http://www.jcomm.info/index.php?option=com_oe&task=viewGroupRecord&groupID=114&Itemid=37.
[37] *See* http://weather.gmdss.org/General_Arctic_Announcement_final-advance_notice.pdf.
[38] International Ice Charting Working Group, *Overview*, NATIONAL SNOW & ICE DATA CENTER (Oct. 22, 2012), http://nsidc.org/noaa/iicwg/.
[39] 13th Meeting of the IICWG, *supra* note 32.
[40] http://www.wmo.int/pages/prog/www/WIGOS_6_EC_PORS/EC_PORS1_en.html.
[41] *U.S. Collaborates with Arctic Coastal States to Improve Nautical Charts*, NOAA (Oct. 6, 2010), http://www.noaanews.noaa.gov/stories2010/20101006_arctic.html.
[42] *See* Arctic Regional Hydrographic Commission, *3rd ARHC Meeting*, INTERNATIONAL HYDROGRAPHIC ORGANIZATION (Oct. 10, 2012), http://www.iho.int/mtg_docs/rhc/ArHC/ArHC3/ArHC3Docs.htm.
[43] Regional Hydrographic Commissions, *Arctic Regional Hydrographic Commission*, INTERNATIONAL HYDROGRAPHIC ORGANIZATION (Sept. 6, 2012), at http://www.iho.int/srv1/index.php?option=com_content&view=article&id=435&Itemid=690.

Gaps in Service

Information Services

Despite the variety in types of ice information available in the Arctic, the dynamic nature of sea ice in the Arctic creates serious difficulties for ensuring the safety of marine operations. NOAA has noted that the Arctic region has "very little of the information infrastructure needed to provide weather forecast and warning services of a caliber comparable to the mid-latitudes."[44] A major issue with much of the available information is the time lag between when the information is collected and when it is made available. For example, NOAA provides sea ice information for the U.S. once a day, five days a week,[45] but one can imagine how such frequency would be insufficiently helpful in regions of the Arctic where ice can cover "several to tens of kilometers" of distance during a stretch of several hours.[46] Geostationary satellite coverage is not available in large areas of the Arctic, so U.S. search and rescue programs must rely on polar-orbiting satellites to receive signals from marine operations in distress.[47] NOAA is attempting to bridge this gap in data through funding the Joint Polar Satellite System, data infrastructure which aims to provide real-time forecasting and warning of among other things, rapid sea ice formation in the U.S. Arctic.[48]

The Arctic region's volatile weather also hinders methods of ice information collection. Cloud cover in the region often limits the usefulness and reliability of satellite imagery, while summer surface melt prevents radar sensors from picking up ice wavelengths and determining the presence of isolated ice floes. Additionally, extreme weather conditions and poor visibility prevent unmanned aerial vehicles and autonomous underwater vehicles from gathering necessary data.[49]

Local and indigenous knowledge of ice conditions can be of great value in conducting hazard assessment and conducting emergency responses, especially where scientific models or remote sensing may lack the necessary details of the ice environment. However, formal integration of the knowledge into the Arctic response process is still in its "infancy."[50] Indeed, other than the existence of Inuit-owned shipping companies,[51] or the hiring of local guides, there does not seem to be a formal method of linking indigenous peoples' experiences with day-to-day marine operations. In light of the knowledge and experience that many locals and indigenous peoples have with ice patterns and movements in the various areas of the Arctic, such a lack of integration presents a notable gap.

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[44] NOAA Statement, *supra* note 13, at 2.
[45] *Id.* at 4.
[46] Eicken, *Environmental Security*, *supra* note 14, at 41.
[47] NOAA Statement, *supra* note 13, at 4.
[48] *Id.*
[49] Eicken, *Environmental Security*, *supra* note 14, at 41-43.
[50] *Id.* at 43.
[51] *See e.g.*, NUNAVUT EASTERN ARCTIC SHIPPING, http://www.neas.ca/.

Potential Partnerships

Diminishing Arctic ice underscores the need for stronger international partnerships. Already, the varied initiatives of the Arctic Council and its working groups – such as PAME's production of the 2009 AMSA Report – have shown what can be accomplished when Arctic states collaborate. However, as evidenced by the gaps identified in this report, there is room for additional collaboration and cooperation in Arctic ice services. Despite the wide array and delivery methods of ice information available, there is still no completely integrated and comprehensive ice information service available to support marine operations in the Arctic.

There is also an opportunity for cooperation, collaboration and/or partnerships available at the State and non-State level for collecting, analyzing, and sharing local and indigenous Arctic sea ice knowledge. Indigenous marine stakeholders have contributed knowledge and information to initiatives such as the Arctic Council's Arctic Monitoring and Assessment Program (AMAP). Additionally, the Inuit Circumpolar Council's Canada branch submitted a report on Inuit use and observances of sea ice to PAME for inclusion in the AMSA.[52]

Indigenous knowledge of Arctic ice conditions has yet to be fully leveraged in an immediately useful way for marine operations in the region and State response processes. In many ways, this is understandable due to the difficulties of translating indigenous knowledge into scientific and technical results. The participation of the Arctic Council's Permanent Participants in previous information gathering initiatives such as the AMSA and the Circumpolar Biodiversity Monitoring Program[53] indicates a willingness by indigenous peoples to share their knowledge. While the politics between each State and its indigenous populations are different, transnational indigenous groups such as the Inuit Circumpolar Council offer an avenue by which the use and incorporation of indigenous Arctic sea ice knowledge into national response processes and/or made available to the commercial shipping industry might be explored.

ICC has not directly offered to share its members' ice knowledge to marine operations in the past and has been more focused on transmitting information on sustainable and environmentally friendly use of marine areas close to its members' coastal communities. Yet its involvement with Arctic Council initiatives and past offers to share knowledge[54] indicate the potential for it to serve as a coordinator of an indigenous-to-marine operations process, or possibly interested in selling information to commercial marine operators.[55]

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[52] ICC Canada, *The Sea Ice is Our Highway: An Inuit Perspective on Transportation in the Arctic (A Contribution to the Arctic Marine Shipping Assessment*, INUIT CIRCUMPOLAR COUNCIL (March 2008), *available at* http://inuitcircumpolar.com/index.php?auto_slide=&ID=439&Lang=En&Parent_ID=&current_slide_num=.
[53] *See* Arctic Biodiversity Portal, *Monitoring: The Circumpolar Biodiversity Monitoring Programme*, CONSERVATION OF ARCTIC FLORA AND FAUNA, http://www.caff.is/monitoring.
[54] *See, A Circumpolar Inuit Response to the Arctic Marine Shipping Assessment*, Inuit Circumpolar Council (Jan. 2012), *available at*
[55] ICC Alaska, *What about Traditional Knowledge?*, 5 DRUM 2 (March 2012), *available at* http://www.iccalaska.org/servlet/content/newsletter__drum_.html.

Recommendations

Marine operations are a crucial factor affecting the future health and sustainability of the Arctic marine environment and in turn, would benefit from a better understanding of the risks of operating in the Arctic environment. The following U.S. recommendations identify several possible options and approaches for improving the provision of ice services and products in the Arctic for marine operations and other purposes:

1. Currently, there are many different organizations addressing the provision of ice services and products. To leverage limited resources and prevent or mitigate any overlap or duplication of effort, thought should be given to a one-time workshop or setting up a series of meetings – under the auspices of the appropriate organization(s) -- for interested entities willing to work together and share information on the development and maintenance of Arctic ice products and services. Such a workshop or meetings could serve as a catalyst for future partnerships.

2. PAME should invite a representative of WMO/JCOMM and/or WMO ECPORs to a future PAME meeting to learn more about their efforts, initiatives, programs and projects for providing Arctic maritime safety service information and products (weather, ocean and sea ice), including the Global Integrated Polar Prediction System (GIPPS).

3. PAME should explore creation of a web page with links to Arctic state national ice services and other select ice products, services and information, including those made available by, or as a result of collaboration with, local and indigenous peoples.

4. PAME should encourage research and development that will lead to increased frequency, accuracy, and comprehensiveness of Arctic ice information and forecast product and service delivery.

5. PAME should encourage Permanent Participants to identify approaches for strengthening existing and building new relationships with national ice services and for offering indigenous Arctic sea ice knowledge and experience to marine operators and others.