PART III

THE FUTURE OF THE ARCTIC OCEAN

The 5+5 Process in Arctic Fisheries

Alf Håkon Hoel

ARCTIC FISHERIES: STATUS AND PROSPECTS

In winter, the Arctic Ocean has a 15-million km^2 ice cover. In late summer, the ice cover is reduced to four million km^2 or less. In a few decades from now, summer ice is likely to be all but gone (Wadhams 2012; Overland and Wang 2013). This rapid change will have multiple impacts on fish populations, which are strongly affected by their physical environment. Changes in water temperatures, salinity, and other environmental factors affect the size and distribution of populations of living marine resources. Global warming already affects fish populations in numerous ways (ACIA 2005; IPCC 2013), and will continue to do so. Globally, it is anticipated that fish populations will expand their geographic distribution away from the equator toward the poles (Cheung et al. 2010), a development which can be observed already and which has implications for food security (Barange et al. 2014). At regional geographical scales the same dynamics are observed, with varying rates of movement among different fish species and stocks (Pinsky et al. 2013).

The Arctic, the area to the north of the Arctic Circle at 66′33″ (which amounts to 4% of the Earth's surface), and the sub-Arctic seas contain major fisheries. These include globally significant fishing grounds in the Bering Sea, the Barents Sea, and the seas around Iceland, Greenland, and east of Canada (Vilhjamsson and Hoel 2005). A substantial part of the global fish catch is harvested from these areas. There are no commercial fisheries in the central Arctic Ocean due to ice cover, ocean temperatures, and other factors. There are, however, some subsistence fisheries, mostly for anadromous fish in coastal areas (Zeller et al. 2011). As a result of reductions in sea ice and warming of the oceans, fish populations that sustain the sub-Arctic fisheries could expand their geographic distribution northward into the central Arctic Ocean.

The central Arctic Ocean consists of areas under the jurisdiction of the five coastal Arctic states (United States, Canada, Denmark/Greenland, Norway and the Russian Federation), as well as a high seas area beyond national jurisdiction (map). Most of the central Arctic Ocean high seas

area (approximately 2.8 million km^2) is still ice covered most of the year or year round. In response to growing evidence that fish stocks are moving north, and as a consequence in some cases also a northward movement of fisheries, the five coastal states met in Oslo in 2010 to discuss options for addressing the issue. This was the start of a process that eventually resulted in a *Declaration Concerning the Prevention of Unregulated High Seas Fishing in the Central Arctic Ocean of 16 July 2015*.[2] Following that declaration, an expanded process was initiated later in 2015, also involving the Peoples Republic of China, the Republic of Korea, Japan, Iceland, and the European Union, seeking to expand the Oslo efforts to prevent unregulated fishing.

The purpose of this perspective is to provide an understanding of the context and background of the issue of fish in the central Arctic Ocean and potential fisheries there, as well as to discuss other elements that are important for future governance of potential resources.

FRAMEWORK OF CURRENT INTERNATIONAL GOVERNANCE

The 1982 Law of the Sea Convention[3] (which went into force in 1994) provides the basic global framework for the management of living marine resources. The Convention gives coastal states sovereign rights over the natural resources within their Exclusive Economic Zones (EEZs), which can extend to 200 nautical miles from a country's baselines.[4] The Convention outlines an obligation of each country to manage and utilize their resources sustainably and to cooperate with other countries in the case of transboundary resources (Hoel and VanderZwaag 2015).

In order to make these provisions more effective, particularly for fisheries on the high seas beyond national jurisdiction, an implementing agreement—the 1995 United Nations Fish Stocks Agreement (UNFSA, which entered into force in 2001)[5]—was negotiated. The UNFSA requires a precautionary approach to be applied in the management of living marine resources, international cooperation in the management of high seas fisheries in accordance with Regional Fisheries Management Organizations or Arrangements (RFMO/As), and enforcement of regulations to be strengthened as necessary.

Following up on this at the global level, the FAO has developed a

number of International Plans of Action and guidelines for implementing the precautionary approach, as well as an ecosystem approach to fisheries. In addition, a Port State Measures Agreement to deter Illegal, Unreported, and Unregulated (IUU) fishing was concluded in 2009[6] (and put into force in 2016). Guidelines for flag state performance were adopted in 2014. At the global level, the UN General Assembly provides annual oversight over the implementation of the Law of the Sea Convention and the UNFSA. Adopting comprehensive resolutions on oceans and the law of the seas and fisheries, respectively, the General Assembly provides guidance for states and international organizations in the management of living marine resources.[7]

At the regional level of governance, existing RFMO/As have been substantially revised over the last two decades, bringing their provisions up to the standards provided by UNFSA. A number of new RFMO/As have been negotiated. Globally, about 20 of these arrangements now exist.[8]

Particular to the North Atlantic, the International Council for the Exploration of the Sea (ICES), established in 1902, draws on the collective scientific capacity of its member countries in providing scientific advice for the management of living marine resources to individual countries as well as to international cooperative bodies.[9] All Arctic states are members of ICES. The North Pacific Marine Science Organization (PICES) plays a similar role in the North Pacific.[10]

In the Arctic, this global framework has been applied extensively (Arctic Ocean Review 2010). All Arctic countries have established 200-mile zones, and all have comprehensive domestic fisheries management regimes.

With regard to international cooperation, a significant number of bilateral arrangements for fisheries cooperation, such as the management of trans-boundary stocks (shared fish stocks, occurring in the waters under the jurisdiction of two states) are in force. These include the Joint Norwegian-Russian Fisheries Commission,[11] which manages fisheries in the Barents Sea, as well as the United States-Russian Federation cooperation through an intergovernmental consultative committee.[12] In the high seas areas of the Arctic and sub-Arctic, a number of regional fisheries bodies exist to address straddling fish stocks (stocks that occur both within EEZs and on the high seas). In the North Atlantic, the Northeast Atlantic Fisheries Commission (NEAFC)[13] is mandated to manage fisheries, including in the Atlantic sector of the high seas area in the central Arctic Ocean. In the Northwest Atlantic, the Northwest Atlantic Fisheries Organization (NAFO)[14] has a similar

mandate. The 1994 Convention on Conservation and Management of the Pollock Resources of the Central Bering Sea[15] establishes the foundations of an RFMO there. The North Atlantic Marine Mammals Commission (NAMMCO)[16] is a forum for cooperation on marine mammals management, and the North Atlantic Salmon Conservation Organization (NASCO) coordinates the management of salmonids.[17]

CURRENT FISHERIES

The central Arctic Ocean coastal states are all major fishing nations, with substantial parts of their harvests coming from sub-Arctic waters. In the central Arctic Ocean, ice cover, lack of nutrients, stratified water masses and other factors explain the absence of fish in commercial quantities, and therefore a dearth of commercial fisheries (Haug et al. 2017). The sub-Arctic Bering Sea and the Barents Sea are globally important fishing grounds, with pollock fisheries in the Bering Sea and cod fisheries in the Barents Sea among the highest yielding whitefish fisheries in the world. The 2015 Total Allowable Catch (TAC) of cod in the Barents Sea was 890,000 tons, while the corresponding figure for pollock in the Bering Sea was 1,310 million tons. There are also major fisheries around Iceland, Greenland, and off eastern Canada. In addition to cod and pollock, important fisheries include haddock, Greenland halibut, redfish, and capelin, as well as shrimp, crabs and shellfish. Several seal species and whales are also harvested.

Key factors in providing for high, sustainable yields over time include extensive scientific efforts to assess the status and extent of fish stocks, the adoption and implementation of long-term management plans with harvest control rules committing managers to precautionary approaches to regulations (Kvamsdal et al. 2016), and robust enforcement of regulations.

Fish populations are affected by their environment (Hjort 1914). Water temperatures and other oceanographic factors influence the growth and distribution of fish populations. Since marine ecosystems are subject to major natural variability, fish populations vary in size as well as in geographic distribution from year to year. For a number of species, populations have been observed expanding northward (Fossheim et al. 2015). This is consistent with global modeling predictions (Cheung et al. 2009) as well as with regional assessments (ACIA 2005), and can be attributed to natural variability as well as to the effects of global warming on the oceans.

DEVELOPING A FISHERIES REGIME FOR THE HIGH SEAS IN THE CENTRAL ARCTIC OCEAN

In 2008, the five coastal states in the Arctic Ocean adopted the Ilulissat Declaration,[18] stating their intent to cooperate on the basis of the United Nations Convention on the Law of the Sea (UNCLOS) in the governance of Arctic marine areas. Following up on this, and in response to concerns regarding fish stocks in the central Arctic Ocean, the five coastal states met in Oslo in 2010. At this first meeting, the coastal states requested their marine research institutes to assess the status of fish populations in the Arctic Ocean and to review relevant research. A scientific meeting to follow up on this took place in Anchorage in 2011, concluding that commercial fisheries were unlikely to emerge in the High Seas area in the central Arctic Ocean in the short term, and underlining the need for research and monitoring in this area.

Representatives of the five governments met again in Washington, D.C. in 2013, asking for additional scientific information on the likelihood of commercial fisheries developing in areas beyond national jurisdiction in the central Arctic Ocean. These representatives also initiated a discussion on interim measures to prevent potential unregulated fisheries. A second meeting of scientists was held later in 2013 in Tromsø, addressing existing efforts to survey marine ecosystems in the Arctic Ocean. The meeting, which included participation from the International Council for the Exploration of the Sea (ICES), the International Arctic Science Committee (IASC),[19] and other international scientific bodies, developed recommendations to enhance scientific monitoring.

Meeting in Nuuk, Greenland in 2014, officials from the five coastal states agreed that interim measures to prevent increases in unregulated fishing in the area beyond national jurisdictions in the central Arctic Ocean should be established. It was also agreed that more scientific research to improve understanding of the fish resources of the Arctic Ocean was needed, and that a scientific program should be established for this purpose. A third outcome, inspired by the realization that other countries/entities were potential flag states for vessels attempting to fish in these areas, was that a broader process involving more countries should be initiated.[20] A third scientific meeting was held in Seattle in April 2014, which included participants from Japan, China, the Republic of Korea, and Iceland, further refining recommendations for future scientific work.

An important step in this process was the adoption by the five coastal states of the *Declaration Concerning the Prevention of Unregulated High Seas Fishing in the Central Arctic Ocean* on 16 July 2015 in Oslo. This Declaration is built on the outcomes of the Nuuk meeting. Essential provisions include an agreement that the coastal states will not permit their vessels to fish in the high seas of the central Arctic Ocean in the absence of an RFMO/A. It also identified a need to establish a Joint Program of Scientific Research, and signaled an intent to work with other states. The parties stated that, "... an extensive international legal framework applies to the Arctic Ocean. These interim measures will neither undermine nor conflict with the role and mandate of any existing international mechanism relating to fisheries, including the North East Atlantic Fisheries Commission."

In December 2015, a new stage in the process was initiated with the inclusion of Japan, the Republic of Korea, China, Iceland and the EU. Meeting in Washington, D.C., initial discussions revolved around considering the format of a possible extended agreement, as well as potential substantive issues to be included. Also, the terms of reference for a fourth scientific meeting were discussed, focusing on the development of a science plan to address the question of whether commercial quantities of fish may emerge in the high seas in the central Arctic Ocean. Meetings of the extended circle have continued in 2016, taking place in Washington, D.C., in Iqaluit, Canada, and in Torshavn in the Faroes. The delegations are committed to preventing unregulated fishing in the High Seas and to promoting conservation and sustainable use of living marine resources. Substantive issues under discussion include the manner in which an agreement addresses exploratory fishing, the conditions under which negotiations on one or more additional regional fisheries management organizations or arrangements should be instituted for the central Arctic Ocean, and decision-making procedures. The discussions also addressed how to proceed with continued scientific cooperation, which now includes participation from all 10 parties. A fourth scientific meeting was held in September 2016, discussing a draft Joint Scientific Research and Monitoring Plan as well as a framework for an Implementation Plan for the assessment of fish stocks in the central Arctic Ocean.

WILL THERE BE FISH?

Numerous studies have projected that various fish species will migrate into the high Arctic (ACIA 2005; Hollowed and Sundby 2014; Hollowed et al. 2013). Fish are parts of complex marine ecosystems, however, and the "borealization" of some regions of the Arctic Ocean and its impacts on fish is not yet well understood (Fossheim et al. 2015). Hollowed et al. (2013) discuss the lifecycle characteristics of 17 fish and shellfish stocks that should be considered when assessing their potential for migrating in response to a changing Arctic climate. Acknowledging that "range expansions and successful colonization of new regions will depend on a complex suite of factors," the authors review the adaptive capacity of these species, suggesting that suitable water temperatures, availability of prey (food), distances to spawning grounds, and ocean floor topography are among the limiting factors. Based on this, it is suggested that species such as beaked redfish, Greenland shark, polar cod (borreogadus saida),[21] and Arctic skate have a high potential to move into the high Arctic. Commercially important species such as Atlantic cod and Alaska pollock have a low potential for such movement.

The findings of the largely theoretical review of Hollowed et al. are supported by data-based observations. In the case of Atlantic cod, for example, the northernmost sighting was made in 2012 at 82 degrees N (Ingvaldsen et al. 2015). Cod are not likely to move further north due to topographic conditions, nor are pollock, due to prey availability and other factors (Hollowed et al. 2013). It is important to note that a documented sighting of a single specimen does not necessarily mean that the species is present in commercial quantities, or even that reports of small catches will translate into commercial fishery opportunities. Capelin, for example, can be readily observed at the ice edge, but the actual fishery for capelin occurs close to the coast.

An additional factor determining the geographic expansion of a fish stock could be stock size. Large fish stocks require more food and space than smaller stocks. It has been suggested that this is an important factor in the changed distribution of capelin, for instance (Ingvaldsen and Gjøsæter 2013), and it is obviously an important explanation for the expansion of mackerel in the northeast Atlantic in recent years (Nøttestad et al. 2016).

While both theory and observations confirm the movement of fish into the high Arctic and the central Arctic Ocean, another question is whether

fish will ultimately occur in commercial concentrations in those high seas. This area is 200 nautical miles (370 kilometers) north of the nearest landmasses and beyond, and is covered with ice all or most of the year.

Scientific meetings that have taken place thus far have concluded that such an expansion into very high latitudes—the high seas in the central Arctic Ocean—is not likely in the near future, and that due to the topographic conditions of these areas (most of them several thousand meters deep) only pelagic species will be able to move into these areas for sustained periods. Another limiting condition is the stratification of water masses in the central Arctic Ocean, with layers of fresh water at the surface and limited vertical mixing. This limits the supply of nutrients and therefore the potential for biological production and the presence of prey (Wassmann et al. 2011).

PROSPECTS

A continued reduction of ice cover in the central Arctic Ocean will likely mean that populations of some fish species, including beaked redfish, Greenland shark and Arctic skate, may have potential to expand their geographic range northwards. It is uncertain whether, and to what extent, these fish species will occur in commercial quantities in these regions. A number of limiting factors are at play, including stratification of water masses and low biological productivity (Arrigo 2013). In the near future, fisheries are likely to remain within the EEZs of the coastal states. To appear in the high seas area, fish would first have to move through waters under national jurisdiction into the central Arctic Ocean, a considerable distance.

The five coastal states are all major fishing nations and have extensive management regimes for their fisheries. When present in the waters under the jurisdiction of the coastal states, domestic fisheries regimes apply to the fish stocks and the fisheries there. Where fish stocks are shared between two countries, bilateral arrangements for cooperation on their management exist, such as the bilateral Joint Norway-Russia fisheries commission. In some cases such bilateral arrangements have not been established and may need to be considered should fisheries emerge in these areas in the future. One example might be for potential trans-boundary stocks in the Beaufort Sea between Canada and the United States.

Given the considerable uncertainties regarding oceanographic, ecological, and biological conditions (Wassmann et al. 2011), scientific research is likely to remain a critical issue in discussions about fish stocks in the central Arctic Ocean. The question of geographical expansion and/or migration of fish species in response to climate change is currently subject to a substantial research effort, which is increasingly reflected in the scientific literature. Real, comprehensive answers to questions about the prevalence of fish in commercial quantities in the high seas area of the central Arctic Ocean can only be provided by carrying out extensive ship-based research surveys. Given the high costs of such operations and the limited prospects of returns on such an investment, it remains to be seen whether such surveys will be funded in the near future. The current political debate in the U.S. on the need for new icebreakers could be taken as an indicator of the obstacles facing the funding of such operations.

Regarding scientific cooperation, the International Council for the Exploration of the Sea is a well-established mechanism for scientific cooperation and consultation regarding the management of fish stocks in the high north. As pointed out above, all Arctic coastal states are party to the ICES convention.[22] The ICES working group for Arctic fisheries has existed for more than 50 years. A new working group for integrated assessments of the marine environment in the central Arctic Ocean is now operative involving also Arctic Council working groups and ICES' North Pacific counterpart, PICES.[23]

From the perspective of marine food production, aquaculture is increasingly important in the Arctic. In northern Norway in particular, but also in northwest Russia, Iceland, the Faroes, and eastern Canada, aquaculture based on Atlantic salmon is growing rapidly in importance, already amounting to several hundred thousand tons per year. With the prospects of warming waters in the high north, it is reasonable to assume that aquaculture will continue to grow there.

In a broader perspective, perhaps the most important thing about the current process of establishing mechanisms for fisheries governance in the high seas of the central Arctic Ocean is that the five coastal states have taken a path based on scientific research and precautionary measures to reinforce and further develop the existing legal-political order in the high Arctic. Current efforts to expand this cooperation and include other parties are likely to build on this standard. However, predictions about how this actually will play out in the future are premature.

Notes

1. Wikipedia: https://en.wikipedia.org/wiki/Arctic_Circle. See also NOAA website: http://ngdc.noaa.gov/mgg/global/etopo1_ocean_volumes.html[Accessed 7 August 2016]
2. Declaration Concerning the Prevention of Unregulated High Seas Fishing in the Central Arctic Ocean. https://www.regjeringen.no/globalassets/departementene/ud/vedlegg/folkerett/declaration-on-arctic-fisheries-16-july-2015.pdf
3. http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm
4. On the continental shelf, these rights extend to the outer limit of the continental shelf, also where this is beyond 200 nautical miles. Cfr. Art. 76 of the Law of the Sea Convention.
5. Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. https://documents-dds-ny.un.org/doc/UNDOC/GEN/N95/274/67/PDF/N9527467.pdf?OpenElement
6. http://www.fao.org/fishery/psm/agreement/en
7. http://www.un.org/depts/los/general_assembly/general_assembly_resolutions.htm
8. https://www.igfa.org/Conserve/RFBs.aspx and www.neafc.org/system/files/types-of-RFMOs-04.pdf
9. http://ices.dk/Pages/default.aspx
10. https://www.pices.int
11. http://www.jointfish.com/eng
12. http://www.nmfs.noaa.gov/ia/agreements/bilateral_arrangements/russia/us_russia.html
13. http://neafc.org
14. http://www.nafo.int
15. http://www.afsc.noaa.gov/refm/cbs/
16. http://nammco.no
17. http://www.nasco.int
18. http://www.oceanlaw.org/downloads/arctic/Ilulissat_Declaration.pdf
19. http://iasc.info
20. To date, Norway is the only country to deny vessels flying its flag to fish in unregulated waters areas beyond national jurisdiction, including those of the

central Arctic Ocean.

21. As opposed to the commercial species Atlantic cod, gadus morhua.

22. http://www.ices.dk/explore-us/who-we-are/Documents/ICES_Convention_1964.pdf

23. http://www.ices.dk/community/groups/Pages/WGICA.aspx

References

Arctic Monitoring and Assessment Programme. 2004. *ACIA 2005: Arctic Climate Impact Assessment*. Cambridge, UK: Cambridge University Press.

Protection of the Arctic Marine Environment (PAME). *The Arctic Ocean Review Phase 1 Report (2009-2011)*. http://www.pame.is/images/03_Projects/AOR/Reports/AOR_Phase_I_Report_to_Ministers_2011_2nd_edition_Nov_2013_b-1.pdf

Arrigo, K.R. 2013. "The Changing Arctic Ocean." *Elementa: Science of the Anthropocene*. DOI:10.12952. www.elementascience.org.

Barange, M et al. 2014. "Impacts of Climate Change on Marine Ecosystem Production in Societies Dependent on Fisheries." *Nature Climate Change* 4(3): 211–16.

Cheung, W.W.L. et al. 2010. "Large-Scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean Under Climate Change." *Global Change Biology* 16(1): 24-35.

Fossheim, Maria et al. 2015. "Recent Warming Leads to a Rapid Borealization of Fish Communities in the Arctic." *Nature Climate Change* 5(7): 673-77.

Haug, T. et al. 2017. "Future harvest of living resources in the Arctic Ocean north of the Nordic and Barents Seas: A review of possibilities and constraints." *Fisheries Research* 188: 38-57

Hjort, J. 1914. "Fluctuations in the great fisheries of Northern Europe. International Council for the Exploration of the Sea." *Rapports et Procés-Verbeaux* Vol. XX, Copenhagen.

Hollowed, A.B. and Svein Sundby. 2014. "Change is Coming to the Northern Oceans." *Science* 344(61880): 1084-1085.

Hollowed, A.B., B. Planque, and H. Loeng. 2013. "Potential Movement of Fish and Shellfish Stocks From the Sub-Arctic to the Arctic Ocean." *Fisheries Oceanography*. doi:10.1111/fog.12027.

Hoel, A.H. and D. VanderZwaag. 2014. "Global Legal Dimensions of Fisheries and Conservation Governance: Navigating the Currents of Rights and Responsibilities." in *Governance in Fisheries and Marine Biodiversity Conservation*, Edited by S.Garcia, A. Charles, and J. Rice. Wiley- Blackwell, 96-109.

Hoel, A.H. and H. Vilhjamsson. 2004. "Arctic Fisheries." *Encyclopedia of the Arctic*. London: Routledge Mental Health, 635-641.

Ingvaldsen, R. and H. Gjøsæter. 2013. "Impact of marine climate variability on the spatial distribution of Barents Sea capelin." *Marine Biology Research* 9: 867-877.

Ingvaldsen, R. et al. 2015. "Sources of Uncertainties in Cod Distribution Models." *Nature Climate Change* 5: 788-789.

IPCC, 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley. eds. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535. DOI:10.1017/CBO9781107415324.

Kvamsdal, S. et al. 2016. "Harvest Control Rules in Modern Fisheries Management." *Elementa*. DOI: 10.12952/journal.elementa.000114.

Overland, J.E. and M. Wang. 2013. "When Will the Summer Arctic Be Nearly Sea Ice Free?" *Geophysical Research Letters* 40(10): 2097-2101. DOI: 10.1002 / grl.50316.

Pinsky, Malin L. et al. 2013. "Marine Taxa Track Local Climate Velocities." *Science* 341(6151): 1239-42.

Rudels, B. 2012. "Arctic Ocean circulation and variability—advection and external forcing encounter constraints and local processes." *Ocean Sci.* 8, 261-286.

Tremblay et al. 2011. "Climate forcing multiplies biological productivity in the coastal Arctic Ocean." *Geophys. Res. Lett. 38*, L18604. DOI:10.1029/2011GL048825.

Wadhams, Peter. 2012. "Arctic Ice Cover, Ice Thickness and Tipping Points." *AMBIO* 41(1): 23-33.

Wassmann, P., C.M. Duarte, S. Agusti, and M.K. Sejr. 2011. "Footprints of climate change in the Arctic marine ecosystem." *Glob. Change Biol.* 17: 1235-1249. DOI: 10.111/j.1365-2486.2010.02311.x.

Wisz, M. S. et al. 2015. "Arctic Warming Will Promote Atlantic-Pacific Fish Interchange." *Nature Climate Change*. DOI: 10.1038/NCLIMATE2500

Zeller, D. et al. 2011. "Arctic Fisheries Catches in Russia, USA, and Canada: Baselines for Neglected Ecosystems." *Polar Biology*, 1–19.

Trans-Polar Shipping

Scott R. Stephenson

INTRODUCTION

In recent years, there has been considerable speculation about the implications of climate change for Arctic shipping. Arctic sea ice has undergone a striking transformation, marked by widespread reductions in extent, volume, thickness and age (Maslanik et al. 2007; Kwok et al. 2009; Comiso, 2012; Stroeve et al. 2012b). As a result, cargo shipping across the Arctic Ocean has become possible for longer periods in summer each year. Travel distances between European and East Asian ports are approximately 40% shorter via Russia's coastal Northern Sea Route (NSR) than by traditional routes through the Suez Canal (Farré et al. 2014). The Northwest Passage (NWP), subject of a centuries-old quest to link East and West, circumvents the Panama Canal to offer new potential linkages between the North Atlantic and North Pacific regions. Compared to these routes, relatively little attention has been given to the possibility of shipping from the North Atlantic to the Bering Strait through the central Arctic Ocean, passing over or near the North Pole. This route, hereafter termed the "trans-polar route" (TPR, or alternatively the trans-polar sea route or North Pole route), represents the most direct passage through the Arctic and therefore the greatest potential distance savings (Humpert and Raspotnik 2012). However, no commercial voyages to date have used the route due to its year-round ice cover and high incidence of hazardous multi-year ice. Even after the Arctic continues its transition to a summer ice-free state, it is unclear whether the economic benefits of the TPR will outweigh the risks.

This perspective will explore the potential of the TPR as a commercial shipping corridor over the next 50 years. First, the paper will examine the future technical accessibility of the route as a precondition for commercial shipping. Sea ice projections from several climate models will be presented to obtain a comprehensive picture of present and future accessibility along the TPR. The paper will then discuss critical non-climatic enabling and constraining factors such as greenhouse gas (GHG) emissions, climate feedbacks, and global trade dynamics to articulate the potential of the TPR within a broader environmental and economic context.

MARITIME ACCESSIBILITY IN A WARMING ARCTIC

In order to assess the future viability of the TPR, it is necessary first to estimate the degree to which the route will become technically accessible in the coming decades. One way to do this is to translate sea ice outputs of global climate models (GCMs) into measures of ship accessibility. Several studies have employed geospatial modeling techniques to project future maritime accessibility in the Arctic (Khon et al. 2010; Stephenson et al. 2011; Smith and Stephenson, 2013; Stephenson et al. 2013; Stephenson et al. 2014; Aksenov et al. 2016). This section examines the results of Stephenson and Smith (2015), as their multi-model approach enables exploration of a wide range of conditions regarding sea ice variability.

Stephenson and Smith (2015) investigated the technical accessibility of the TPR as projected by ten high-performing GCMs from the fifth phase of the Coupled Model Intercomparison Project (Taylor et al. 2012). While climate models generally agree that the overall extent of sea ice will decline in the long term, they differ markedly regarding the timing and spatial distribution of the decline. The GCMs were shown to represent well the historical trend and seasonal climatology of sea ice in multiple independent analyses (Jahn et al. 2012; Massonnet et al. 2012; Liu et al. 2013). To assess the degree of future accessibility of the TPR, vessel transits from the Bering Strait to North America (Halifax) and Europe (Rotterdam) were computed

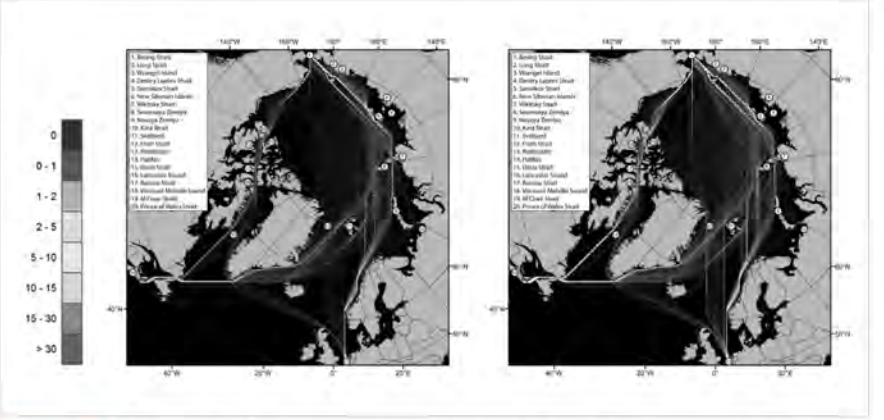

Figure III.1 Density of least-cost navigation routes from Rotterdam (Netherlands) and Halifax (Canada) to the Bering Strait by open-water vessels at early-century (2011-2035; left) and mid-century (2036-2060; right). Values indicate the average of 10 global climate models as computed by Stephenson and Smith (2015).

according to the projected concentration and thickness of ice during two time periods: "early-century" (2011-2035) and "mid-century" (2036-2060). Vessels were assumed to take the fastest route possible given the constraints of their ice class. Ships with medium icebreaking capability ("Polar Class 6") were assumed to be capable of "summer/autumn operation in medium first-year ice which may include old ice inclusions" (Transport Canada, 1998; IMO, 2002), while non-ice strengthened "open-water" vessels were assumed to be capable of operating in "gray ice" (10 cm). Routes were computed monthly from 2011-2060 and aggregated for each climate model to illustrate the spatial "density" of routes projected during early-century and mid-century. The 10-model average of these density maps is depicted in Figure III.1.

The results illustrate a range of possible futures of Arctic shipping accessibility, owing to differences in vessel polar class, greenhouse gas emission scenarios, and model variability. Several spatial patterns can be observed in Figure 1. Most routes originating from the North Atlantic follow the NSR along Russia's Arctic coast, while a minority of transits from Halifax follow the NWP through the Canadian Archipelago (Viscount Melville Sound—M'Clure Strait). The central Arctic Ocean and TPR see very sporadic use before 2035, owing to continued persistence of thick ice even as the proportion of first-year ice grows. Vessel transits are highly concentrated during summer and autumn, with no model projecting year-round access for non-ice strengthened vessels. These observations broadly reflect the current pattern of maritime use of the Arctic. Today, few unescorted voyages by open-water vessels occur in winter, outside of limited regions with ice-free access such as the southwest Barents Sea.

Despite present-day limitations, there are several signs that the TPR will see increasing use as an alternative to the NSR in the coming decades. The majority of routes originating from Rotterdam enter the Kara Sea passing north of Novaya Zemlya rather than via the Kara Strait, indicating that sailing several hundred miles north of the Russian coast is often faster than along near-coastal routes, even before 2035. Many of these routes migrate northward over time with continued retreat of the ice edge, and ultimately coincide with the TPR. Routes originating from Halifax broadly replicate this pattern early in this century, though a majority of these transits switch to the Northwest Passage by 2060. Comparing outputs of individual climate models appears to confirm the robustness of these results. A majority of models project routes across a wide swath of ocean

from the Russian coast to the North Pole, rather than restricting passage to the NSR. Furthermore, only two models project no access in the central Arctic. As a result, it is likely that the TPR will become technically viable by mid-century in all but the most conservative of climate scenarios. With global greenhouse gas emissions currently tracking close to a "business-as-usual" scenario (i.e. IPCC Representative Concentration Pathway [RCP] 8.5) (Peters et al. 2013), the likelihood that the central Arctic will remain accessible year-round by mid-century is looking increasingly high.

It is important to note that the projected shift of the fastest Arctic route from the NSR to the central Arctic will most likely happen gradually. Contrary to evidence of a possible "tipping point" for accelerated ice loss in the near future (Holland et al. 2006), most models show that the central Arctic will remain largely inaccessible before 2040 and will not experience robust rapid northward route migration in any single year. These results align with a future characterized by gradual, sustained change to Arctic physical and human systems that may be anticipated and planned for by maritime regulatory agencies (AMSA 2009). It is also possible that ice decline may be inhibited in the coming decades due to reduced oceanic poleward heat transport stemming from a weakening of the Pacific or Atlantic conveyor (Zhang 2015), slowing ice retreat and dramatically reducing viability of the TPR. In addition, these projections do not account for ice features such as icebergs, growlers, and pressure ridges that pose significant hazards to shipping. Pressure ridges are particularly formidable barriers to navigation and are expected to occur with greater frequency as ice floes become thinner and more mobile (Stern and Lindsay 2009; Kwok et al. 2013; Bourbonnais and Lasserre 2015). With these caveats in mind, however, the likely increase in trans-polar accessibility should not be overlooked: by 2060, the number of routes transiting the central Arctic "high seas" is projected to increase more than 150% relative to Stephenson and Smith's (2015) early-century baseline scenario. Furthermore, it is possible that climate models fail to capture critical feedbacks in the climate system, such as methane release from thawing permafrost (Schuur et al. 2015) and local surface winds (Ogi and Wallace 2012). Such non-linear climate change could increase trans-polar access dramatically in a relatively short period of time.

Perhaps unsurprisingly, the single most important determinant of trans-polar accessibility for the foreseeable future is vessel class. Whereas the central Arctic Ocean will see few transits by open-water vessels before

2040, route possibilities more than double overall when polar-class vessels are assumed. The accessibility afforded by ice-strengthened vessels far exceeds the impact of rapid climate change. While a scenario of severe ice melt (as projected by RCP 8.5) has a significant impact on increasing trans-polar accessibility, this increase is more than ten times larger when using an ice-strengthened vessel. This implies that much of the central Arctic will be off-limits to the vast majority of the global fleet (which is largely not ice-strengthened) for most of the year well into mid-century, even if climate change continues unabated. The need for polar-class vessels will be even greater during winter, when ice is colder and stronger than in summer (Prowse et al. 2009) and prolonged darkness and fewer navigable cracks in the ice (leads) substantially raise the risk of ice encounters. Even during summer, relatively dispersed ice in the marginal ice zone (MIZ) can be dangerous. During the 1990s, ice drift and compression accounted for about half of the recorded shipwrecks along the NSR (Marchenko 2012), and will continue to pose a hazard as ice drift accelerates in the MIZ due to climate change.

Looking beyond mid-century, however, it is likely that polar-class vessels will become progressively less essential for seasonal summer transits. Sometime in the next 10-30 years, Arctic ice extent will drop below one million km^2 for five consecutive summers, signaling the arrival of the first "ice free" Arctic on record (Overland and Wang 2013). Under such conditions, open-water vessels may be able to make unescorted voyages through the central Arctic, depending on the spatial distribution of the remaining ice. While "ice free" summers will be brief initially, lasting for less than one month in September, climate models indicate that they will increase in frequency and may occur nearly every year near the end of the century (Massonnet et al. 2012; Stroeve et al. 2012a). More aggressive climate warming will be a significant contributor to the frequency of ice-free summers, particularly in the latter half of the 21st century, as indicated by the divergence of RCP 8.5 from less aggressive climate scenarios post-2060 (van Vuuren et al. 2011). "Arctic amplification" caused by increased solar absorption by open water will further accelerate ice melt as ice-free summers become commonplace (Barnes and Polvani 2015). These developments suggest that while the TPR is barely accessible at present, climate change will create a very different picture by the end of this century.

EMISSIONS, ECONOMICS, AND CLIMATE CHANGE

Regardless of the rate of future ice melt, the viability of commercial Shipping via the TPR will be determined ultimately by numerous environmental and economic considerations. These determinants arise from both the unique geophysical landscape of the Arctic region and extra-regional processes operating at global scale.

First, the attractiveness of the TPR could be shaped by global efforts to limit GHG emissions within the shipping industry. In December 2015 at the meeting of the UNFCCC Conference of the Parties (COP 21) in Paris, 196 countries reached an agreement to limit global warming to 2°C above pre-industrial levels, with an additional stated goal to "pursue efforts to" limit the increase to 1.5°C. These benchmarks, generally associated with limiting atmospheric CO_2 concentrations to 450 ppm or below, are believed to be necessary to avoid catastrophic climate impacts such as the deglaciation of the West Antarctic ice shelf and the collapse of the Atlantic Meridional Overturning Circulation (IPCC, 2014). Achieving this goal will require widespread and drastic emissions reductions across many industrial sectors, including transportation, which is heavily reliant on fossil fuels. The International Maritime Organization (IMO) estimates that increases in global maritime trade may cause CO_2 emissions from international shipping to grow to 12-18% of the total allowable emissions under a 450 ppm scenario (Heitmann and Khalilian 2011). Achieving stabilization at 450 ppm would require the shipping industry to reduce its emissions by 2.6% per year from 2020 to 2050 (Anderson and Bows 2012; Bows-Larkin et al. 2015). The industry will thus be under pressure to employ a variety of emissions-reductions strategies such as low-emission fuels, novel hull designs, speed reductions ("slow steaming"), and alternative shipping routes. In this context, a distance savings of 40% from using Arctic routes carries significant potential for fuel and emissions reductions of bulk cargo shipments. When combined with fuel efficiency practices such as slow steaming, use of Arctic routes may reduce CO_2 emissions by as much as 78% (Schøyen and Bråthen 2011). As the TPR is the shortest possible passage through the Arctic, it represents the greatest potential emissions savings of any Arctic route. It is therefore conceivable, though ironic, that the TPR will be promoted as means of mitigating the impacts of climate change even as its existence was enabled by those same impacts.

However, environmental concerns could also serve as a deterrent

against future use of the TPR. While Arctic routes may reduce aggregate GHG emissions relative to traditional routes, non-GHG emissions such as sulfate aerosols (e.g. SO_2) and particulates (e.g. black carbon) can produce regional climate effects with powerful radiative feedbacks. Sulfate aerosols reflect sunlight back into space, resulting in a net cooling effect. However, black carbon deposition on high-albedo surfaces such as snow and ice is projected to increase radiative absorption in the Arctic, leading to net warming from shipping in ice-covered areas during this century (Fuglestvedt et al. 2014). Black carbon emissions along the TPR have a high likelihood of falling on ice compared to the NSR or NWP, owing to the fact that a large percentage of the TPR passes through seasonally or year-round ice-covered waters. The "climate penalty" from black carbon emissions is therefore likely to increase as Arctic voyages migrate northward with the retreat of the ice edge. Regardless of climate considerations, shipping along the TPR will carry increased environmental risks from oil spills due to the extreme remoteness from ports, search-and-rescue (SAR) stations, and other spill cleanup infrastructure. Banning heavy fuel oil in the Arctic will mitigate this risk somewhat, though efforts to pursue a ban through the IMO Polar Code have failed thus far due in part to Russian resistance (Weber 2016).

In addition to environmental concerns, numerous economic factors limit development of the TPR and negate the fuel cost savings of shorter sailing distances in the near term. The most important of these are the limited market opportunities available via the TPR and the uncertainty of whether and how long the route will be accessible each year. The TPR's primary advantage over other Arctic routes is as a transit corridor for trade rather than as an alternative pathway for destinational shipping activities such as fishing, resource extraction, tourism, and community resupply (AMSA 2009). While the central Arctic basin is believed to contain significant quantities of oil and gas (Gautier et al. 2009), the costs of extraction in the region are prohibitive, and no state currently has a fully recognized claim to seabed resources beyond its Exclusive Economic Zone (EEZ) (IBRU 2015). The current pattern of maritime use of the Arctic, dominated by transport of onshore or near-coastal offshore oil, gas and mineral resources out of the region, is therefore unlikely to change in response to greater accessibility of the central Arctic Ocean. Fishing in the central Arctic is similarly off-limits following a July 2015 agreement by the five Arctic coastal states (Canada, Denmark/Greenland, Norway, Russia, and the U.S.) to impose

a moratorium until better scientific knowledge of the marine resources in the region is obtained (Rosen 2015). Furthermore, like the NSR and NWP, the TPR makes sense only for bulk cargo shipments that do not operate within a "just-in-time" mode of delivery and therefore are not subject to strict shipping schedules (Lasserre and Pelletier 2011; Lasserre 2014). The economic viability of these shipments is further constrained by the lack of intermediate ports of any kind from the Bering Strait to the North Atlantic and the fact that distance savings may only be realized for voyages between a handful of ports in northern Europe and East Asia. In general, distance savings via Arctic routes are modest or negative for voyages to/from any European port on the Mediterranean Sea and East Asian ports south of Hong Kong (Farré et al. 2014). Barring a geopolitical security crisis at key "choke points" such as the Malacca Strait and Bab-el-Mandeb, it is highly unlikely that the TPR will attract traffic from these ports away from the Suez Canal Route.

At present, all trans-Arctic routes including the TPR traverse areas covered at least partially by first-year ice, except along the western NSR during brief periods in summer (Stephenson et al. 2014). The IMO Polar Code therefore mandates that vessels plying these routes must be polar class, escorted by an icebreaker, or both (IMO 2015). While capital cost premiums for polar-class vessels vary widely (20-40% by most estimates, and as much as 120%), they are often cited as a critical constraint on the economics of Arctic shipping (Lasserre 2014; Lasserre 2015). In addition to capital costs, ice- strengthening results in significantly higher fuel consumption due to the additional hull load (Bourbonnais and Lasserre 2015), rendering polar-class vessels uneconomic in open water. However, one cost factor that may be avoided by using the TPR is the mandatory icebreaker fees levied by Russia's Northern Sea Route Administration. The TPR is the only Arctic shipping route outside of coastal state jurisdiction, and therefore not subject to regulation for the "prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone" under UNCLOS Article 234 (UNCLOS 1982). While icebreaker fees vary with vessel class, season, ice conditions and gross tonnage, current estimates for a full escort of the NSR during summer exceed $800,000 for an open-water vessel greater than 100,000 GT (FTS of Russia 2014). As the maritime shipping industry has remained viable in part through intense cost concentration and razor-thin profit margins (Notteboom and Rodrigue 2009), removing this critical cost

factor could alter the economic calculus in favor of Arctic routes for bulk cargoes in summer. The period of viability for these diverted shipments will be very brief as the central Arctic Ocean will generally be the first area of the Arctic to freeze over in autumn. Outside of summer, the TPR will require icebreaker escort for the foreseeable future, leaving the NSR as the only viable Arctic route from a technical accessibility perspective.

CONCLUSION

In the same way that trans-polar air routes radically transformed air travel in the 20th century (Humpert and Raspotnik 2012), the TPR has the potential to revolutionize international cargo shipping in the 21st century as the single shortest marine link between Europe and Asia. However, the revolution will come slowly, with significant limitations. For the next several decades, multi-year ice and thick first-year ice will remain persistent obstacles for all but the heaviest icebreakers outside of brief periods in summer. Polar-class vessels will be required for the foreseeable future, mitigating the fuel cost and time savings of the TPR relative to the NSR and traditional routes via the Suez Canal. Environmental risks along the TPR are likewise significant, owing to climate feedbacks from black carbon emissions and the ever-present danger of oil spills in remote, fragile areas. Nevertheless, despite the risks and limitations, signs are that the TPR is poised to become the most expeditious Arctic transit route in the long term. As shown here, it is very likely that the TPR will become progressively viable over the next 50 years under all but the highest-mitigation climate scenarios. As the ice edge migrates gradually northward toward a summer ice-free state, we may begin to see the TPR displace the NSR at the center of the debate over the future viability of trans-Arctic shipping.

References

Aksenov, Yevgeny, Ekaterina E. Popovaa, Andrew Yoola et al. 2016. "On the future navigability of Arctic sea routes: High-resolution projections of the Arctic Ocean and sea ice." *Marine Policy 75*. http://dx.doi.org/10.1016/j.marpol.2015.12.027

AMSA. April 2009. *Arctic Marine Shipping Assessment 2009 Report*. Arctic Council.

Anderson, K. and Alice Bows. 2012. "Executing a Scharnow turn: reconciling shipping emissions with international commitments on climate change." *Carbon Management* 3: 615-628.

Barnes, E.A. and L.M. Polvani. 2015. "CMIP5 projections of Arctic amplification, of the North American/North Atlantic circulation, and of their relationship." *Journal of Climate* 28: 5254-5271. DOI: 10.1175/JCLI-D-14-00589.1.

Bourbonnais, P. and F. Lasserre. 2015. "Winter shipping in the Canadian Arctic: toward year-round traffic?" *Polar Geography* 38: 70-88 DOI: 10.1080/1088937X.2015.1006298.

Bows-Larkin, A., K. Anderson, S. Mander, M. Traut, and C. Walsh. 2015. "Shipping charts a high carbon course." *Nature Climate Change* 5: 293-295.

Comiso, J.C. 2012. "Large decadal decline of the Arctic multiyear ice cover." *Journal of Climate* 25: 1176-1193.

Farré, A.B., S.R. Stephenson, L. Chen et al. 2014. "Commercial Arctic shipping through the Northeast Passage: routes, resources, governance, technology, and infrastructure." *Polar Geography* 37: 298-324. DOI: 10.1080/1088937X.2014.965769.

FTS of Russia. 2014. *On approval of the tariff rates for provision of icebreaking pilotage services provided by the FSUE «Atomflot» on the Northern Sea Route water area*. Federal Tariff Service of Russia. Moscow.

Fuglestvedt, J.S., S.B. Dalsøren, B.H. Samset et al. 2014. "Climate penalty for shifting shipping to the Arctic." *Environmental Science and Technology* 48: 13273-13279. DOI: dx.doi.org/10.1021/es502379d.

Gautier, D.L., K.J. Bird, R.R. Charpentier et al. 2009. "Assessment of undiscovered oil and gas in the Arctic." *Science* 324: 1175-1179.

Heitmann, N. and S. Khalilian. 2011. "Accounting for carbon dioxide emissions from international shipping: burden sharing under different UNFCCC allocation options and regime scenarios." *Marine Policy* 35: 682-691.

Holland, M.M., C.M. Bitz, and B. Tremblay. 2006. "Future abrupt reductions in the summer Arctic sea ice." *Geophysical Research Letters* 33: L23503.

Humpert, M. and A. Raspotnik. 2012. "The future of Arctic shipping along the transpolar sea route." *Arctic Yearbook 2012* 1: 281-307.

IBRU. 2015. *Maritime jurisdiction and boundaries in the Arctic region*. Centre for Borders Research, Durham University.

IMO. 2002. *Guidelines for ships operating in Arctic ice-covered waters*.

IMO. 2015. *International Code for Ships Operating in Polar Waters (Polar Code)*. International Maritime Organization.

IPCC. 2014. *Climate Change 2014 Synthesis Report: Summary for Policymakers*. Intergovernmental Panel on Climate Change.

Jahn, A., K. Sterling, M.M. Holland et al. 2012. "Late-twentieth-century simulation of Arctic sea ice and ocean properties in the CCSM4." *Journal of Climate* 25: 1431-1452. DOI: 10.1175/JCLI-D-11-00201.1.

Khon, V.C., I.I. Mokhov, M. Latif et al. 2010. "Perspectives of Northern Sea Route and Northwest Passage in the twenty-first century." *Climatic Change* 100: 757-768. DOI: 10.1007/s10584-009-9683-2.

Kwok, R., G.F. Cunningham, M. Wensnahan et al. 2009. "Thinning and volume loss of the Arctic Ocean sea ice cover: 2003-2008." *Journal of Geophysical Research* 114: C07005.

Kwok, R., G. Spreen, and S. Pang. 2013. "Arctic sea ice circulation and drift speed: decadal trends and ocean currents." *Journal of Geophysical Research* 118: 2408-2425. DOI: 10.1002/jgrc.20191.

Lasserre, F. 2014. "Case studies of shipping along Arctic routes: analysis and profitability perspectives for the container sector." *Transportation Research Part* 66: 144-161 DOI: 10.1016/j.tra.2014.05.005.

Lasserre, F. 2015. "Simulations of shipping along Arctic routes: comparison, analysis and economic perspectives." *Polar Record* 51: 239-259.

Lasserre, F. and S. Pelletier. 2011. "Polar super seaways? Maritime transport in the Arctic: an analysis of shipowners' intentions." *Journal of Transport Geography* 19: 1465-1473. DOI: 10.1016/j.jtrangeo.2011.08.006.

Liu, J., M. Song, R.M. Horton, and Y. Hu. 2013. "Reducing spread in climate model projections of a September ice-free Arctic." *Proceedings of the National Academy of Sciences* 110: 12571-12576. DOI: 10.1073/pnas.1219716110.

Marchenko, N.A. 2012. *Russian Arctic Seas: Navigation Conditions and Accidents*. Berlin: Springer-Verlag.

Maslanik, J.A., C. Fowler, J.C. Stroeve et al. 2007. "A younger, thinner Arctic ice cover: increased potential for rapid, extensive sea-ice loss." *Geophysical Research Letters* 34: L24501. DOI:10.1029/2007GL032043.

Massonnet, F., T. Fichefet, H. Goosse et al. 2012. "Constraining projections of summer Arctic sea ice." The Cryosphere 6: 1383-1394. DOI: 10.5194/tc-6-1383-2012.

Notteboom, T. and J.-P. Rodrigue. 2009. "The future of containerization: perspectives from maritime and inland freight distribution." *Geojournal* 74: 7-22.

Ogi, M. and J.M. Wallace. 2012. "The role of summer surface wind anomalies in the summer Arctic sea ice extent in 2010 and 2011." *Geophysical Research Letters* 39: L09704. DOI: 10.1029/2012GL051330.

Overland, J.E. and M. Wang. 2013. "When will the summer Arctic be nearly sea ice free?" *Geophysical Research Letters* 40: 2097-2101. DOI: 10.1002/grl.50316.

Peters, G.P., R.M. Andrew, T. Boden et al. 2013. "The challenge to keep global warming below 2 °C." *Nature Climate Change* 3: 4-6.

Prowse, T.D., C. Furgal, R. Chouinard et al. 2009. "Implications of climate change for economic development in northern Canada: energy, resource, and transportation Sectors." *AMBIO: A Journal of the Human Environment* 38: 272-281. DOI: 10.1579/0044-7447-38.5.272.

Rosen, Y. 2015. "5 nations sign declaration to protect Arctic 'donut hole' from unregulated fishing." *Arctic Newswire*, July 16.

Schøyen, H. and S. Bråthen. 2011. "The Northern Sea Route versus the Suez Canal: cases from bulk shipping." *Journal of Transport Geography* 19: 977-983. DOI: 10.1016/j.jtrangeo.2011.03.003.

Schuur, E.A.G., A.D. McGuire, C. Schädel et al. 2015. "Climate change and the permafrost carbon feedback." *Nature* 520: 171-179. DOI: 10.1038/nature14338.

Smith, L.C. and S.R. Stephenson. 2013. "New Trans-Arctic shipping routes navigable by midcentury." *Proceedings of the National Academy of Sciences* 4871-4872. DOI: 10.1073/pnas.1214212110.

Stephenson, S.R., L.W. Brigham, and L.C. Smith. 2014. "Marine accessibility along Russia's Northern Sea Route." *Polar Geography* 37: 111-133. DOI: 10.1080/1088937X.2013.845859.

Stephenson, S.R. and L.C. Smith. 2015. "Influence of climate model variability on projected Arctic shipping futures." *Earth's Future* 3: 331-343. DOI: 10.1002/2015EF000317.

Stephenson, S.R., L.C. Smith, and J.A. Agnew. 2011. "Divergent long-term trajectories of human access to the Arctic." *Nature Climate Change* 1: 156-160.

Stephenson, S.R., L.C. Smith, L.W. Brigham, and J.A. Agnew. 2013. "Projected 21st-century changes to Arctic marine access." *Climatic Change* 118: 885-899 DOI: 10.1007/s10584-012-0685-0.

Stern, H.L. and R.W. Lindsay. 2009. "Spatial scaling of Arctic Sea ice deformation." *Journal of Geophysical Research* 114: C10017.

Stroeve, J.C., V. Kattsov, A. Barrett et al. 2012a. "Trends in Arctic sea ice extent from CMIP5, CMIP3 and observations." *Geophysical* Research Letters 39: L16502.

Stroeve, J.C., M.C. Serreze, M.M. Holland et al. 2012b. "The Arctic's rapidly shrinking sea ice cover: a research synthesis." *Climatic Change* 110: 1005-1027 DOI: 10.1007/s10584-011-0101-1.

Taylor, K.E., R.J. Stouffer and G.A. Meehl. 2012. "An Overview of CMIP5 and the Experiment Design." *Bulletin of the American Meteorological Society* 93: 485-498. DOI: 10.1175/BAMS-D-11-00094.1.

Transport Canada. 1998. *Arctic Ice Regime Shipping System (AIRSS) Standards*. Ottawa.

UNCLOS. 1982. *UN Commission on the Limits of the Continental Shelf*. Section 8: Ice-covered Areas. Article 234.

van Vuuren, D.P., J. Edmonds, M. Kainuma et al. 2011. "The Representative Concentration Pathways: an Overview." *Climatic Change* 109: 5-31. DOI: 10.1007/s10584-011-0148-z.

Weber, B. 2016. "Arctic Council urged to ban heavy fuel oil." *The Canadian Press*, Feb. 1.

Zhang, R. 2015. "Mechanisms for low-frequency variability of summer Arctic sea ice extent." *Proceedings of the National Academy of Sciences* 112: 4570-4575. DOI: 10.1073/pnas.1422296112.

Northern Sea Route

Yury Sychev

THE CURRENT STATE OF NORTHERN SEA ROUTE SHIPPING

According to Russian law, the Northern Sea Route (NSR) is an historical national transport route of the Russian Federation (RF) in the Arctic. It is located east of the archipelago of Novaya Zemlya and continues up to the Bering Strait. From the Kara Gates Strait to Providence Bay, the NSR spans 5,600 kilometers, or 3,000 nautical miles.

For the purposes of this perspective, when speaking of NSR development prospects, I assume its boundaries to be the limit of the RF EEZ adjacent to the Arctic zone of the Russian Federation, identified by President Vladimir Putin on May 2, 2014.

Shipping along the NSR has increased substantially recently after a sharp decline in the 1990s. In 2015, 5.4 million tons of cargo was shipped along the NSR (including transit). The volume of traffic has increased by 3.7 times, compared to a low in 1998 of 1.46 million tons. At the same time, transit traffic, which had sustainably increased since 2010 (Table III.1), decreased by 1.2 million tons in 2015—almost by a factor of four.

In sum, the amount of shipping to and from RF Arctic ports more than doubled in 2015. This is associated with changes in the cargo base and, in a more comprehensive sense, with changes in state policy in developing the RF Arctic zone.

Table III.1 Data on Transit Traffic in 2010-2015 (according to published data)

	2010	2011	2012	2013	2014	2015
Total cargo volume, t	111,000	820,789	1,261,545	1,355,897	1,659,207	419,101
Total number of voyages	4	34	46	71	129	44

RUSSIAN FEDERATION DEVELOPMENT PROGRAMS FOR THE ARCTIC ZONE 2014-2030

In conformance with the Strategy of Development of the Arctic Zone of

the Russian Federation (AZRF) to 2020, the RF State Program, "Socio-Economic Development of the AZRF until 2020" was approved in 2014. The program essentially formalized and integrated activities from other industrial programs already being implemented in the AZRF.

In March 2015, the State Commission for Arctic Development was established by presidential order. The main objective for establishing the Commission was to solve strategic problems defined by the report, "Fundamentals of State Policy of the Russian Federation in the Arctic until 2020 and Beyond," and to dramatically improve the efficiency of AZRF public management.

One of the first issues considered at the meeting of the State Commission was to prepare a new version of the State Program. The goal was for the existing, formal documents to be shaped into a practical framework to guide AZRF development.

The new version of the RF State Program, "Socio-Economic Development of the AZRF until 2020," which was prepared by the Ministry of Economic Development and Trade in 2015, provides for the creation and development of a system of "support zones" in the Russian Arctic.

It is expected that the development of "support zones" and their transport component will become the main driver of the AZRF development. The following eight "support zones" are planned as a result of an analysis of the existing transport and coastal infrastructure in the Arctic:

1. Kola support zone
2. Arkhangelsk support zone
3. Nenets support zone
4. Vorkuta support zone
5. Yamal-Nenets support zone
6. Norilsk support zone
7. Northern Yakutia support zone
8. Chukotka support zone

"Anchor" investors and other enterprises interacting in the form of scientific research and/or technological cooperation are identified in each of the zones. The plan includes the provision of state support in the form of subsidies, tax benefits, investment loans, and the creation of a customs-free zone. The establishment of support zones is planned for completion by 2025.

This approach coordinates with the system of priority projects implemented in the AZRF under the State Program.

The Ministry of Economic Development and Trade has identified a list of 145 projects that have been implemented or are planned in the AZRF, some of which may potentially become "anchor" projects for the development of AZRF entities, and which could eventually provide a multiplier effect for the development of less critical projects and adjacent non-Arctic areas. They include:

1. Creation of the Northern Latitudinal Railway
2. Integrated development of the Murmansk Transport Hub
3. Construction of the seaport facilities in the vicinity of Sabetta
4. Implementation of "Yamal-LNG" project
5. Construction of the "Belkomur" railway
6. Construction of a deep-water seaport of Arkhangelsk
7. Construction of a deep-water seaport of Indiga
8. Construction of the Sosnogorsk-Indiga railway
9. Ensuring of the "Prirazlomnaya" OIFP functioning

According to this scenario, the implementation of activities provided by the State Program will result in an increase of cargo traffic along the NSR by a factor of more than ten. The largest projects are given in Table III.2.

As a result of implementing these projects, export cargo traffic will increase to 30 million tons by 2030, including 13.5 million tons heading eastward and 16.5 million tons heading westward. At the same time,

Table III.2 Largest Cargo Projects in AZRF

Project	Design capacity /year	Period
Yamal-LNG (Novatek)	16.5 million tons, LNG	2014-2040
Novoportovskoe field (Gazprom Neft)	8.5 million tons, oil	2014-2035
Norilsk Nickel	1.3 million tons, non-ferrous metals	1975-2040
Payakha field (Independent Oil Company)	7.3 million tons, oil	2019-2030
Arctic LNG-2 (Novatek)	16.5 million tons, LNG	2022-2045
Licensed Site "River Malaya Lemberova" (Arctic Mining Company)	7 million tons, coal	2016-2035
Pechora-LNG (Rosneft)	2.5 million tons, LNG	2022-2035
Prirazlomnaya OIFP (Gazprom Neft)	5 million tons.	2014-2035

imports using container cargo along the NSR are projected to increase to 16.2 million tons (including rail traffic). Coastal traffic is estimated at 4.9 million tons, including the supply of goods to northern Russia in support of Arctic regions at 3.2 million tons. Thus, the total Russian cargo traffic is forecast to be 51.1 million tons by 2030.

DEVELOPMENT OF ICEBREAKER AND CARGO FLEET, INFRASTRUCTURE, AND NSR PORTS

The following Arctic fleet and NSR infrastructure projects are expected to be completed under the integrated project of the NSR development approved by RF Prime Minister Dmitry Medvedev in 2015.

Nuclear icebreaker fleet. Currently, Rosatomflot has two "Arktika" type icebreakers with the capacity of 54 MW and draft of 11 meters (nuclear icebreakers *Yamal* and 50 *Let Pobedy*), and two "Taimyr" type icebreakers with the capacity of 35 MW and draft of 8.5 meters (nuclear icebreakers *Taimyr* and *Vaigach*). The two latter vessels will be decommissioned by 2020. They will be replaced by three dual-draft project LK60 (22220) icebreakers with the capacity of 60 MW and draft of 10.5/8.5 meters. The prototype icebreaker of this type was built by the Baltic Shipyard in July 2016.

Rosatomflot is also going to build a lead icebreaker with the capacity of 100-110 MW capable of piloting vessels in up to four-meter thick ice.

Diesel-electric icebreakers. Four diesel-electric icebreakers (*Admiral Makarov, Krasin, Kapitan Khlebnikov*, and *Kapitan Dranitsyn*) are now operating in NSR waters.

Two liner diesel-electric icebreakers, *Vladivostok* and *Murmansk*, with s capacity of 16 MW, were built for FSUE Rosmorport in 2015 under the Federal Target Program "Development of Transport System of Russia (2010-2020)" covering icebreaker assistance in NSR waters. Construction is under way on diesel-electric icebreakers *Novorossiysk* and *Viktor Chernomyrdin* with a capacity of 16 and 25 MW, respectively.

Development of cargo and auxiliary fleet. Currently, large Arctic projects such as the Varandey terminal (Lukoil), Prirazlomnoe field, and Novoportovskoe field (Gazprom Neft) have been launched. In 2017, the

Yamal-LNG plant will start production in a place where a number of high ice class vessels are already operating. In addition:

- The Prirazlomnoe field transport system includes three multitask icebreakers and two shuttle tankers.
- Safe operation of the Varandey terminal and tanker loading in ice conditions is supported by the ice class auxiliary tug *Toboy* and the icebreaker *Varandey*, built for Lukoil. Oil is exported using three Sovcomflot tankers with the deadweight of 70,000 tons, all built specially to work in this terminal.
- Three Arctic class tankers and two Arctic Class 8 icebreakers are being built.
- The Yamal-LNG project logistics provide for the construction of 16 LNG carriers of Arc7 class, two tankers to transport gas condensate, and several port icebreakers.

The stated demand of Russian oil/gas and shipping companies for vessels and offshore platforms to explore and develop offshore fields, shipment and transport of raw materials and products between now and 2022 includes more than 500 units, with an estimated cost of 2-2.5 trillion rubles. It is obvious that the deadline for implementing some offshore projects will be postponed due to a lower forecast of world hydrocarbon prices. This shortfall requires a search for innovative technological solutions to provide new levels of economic efficiency both in oil/gas and shipbuilding technologies.

Development of port infrastructure. The implementation of an ambitious program of the development of Arctic ports is scheduled for the period between now and 2020-2025:

- Construction of a deep-water seaport at Arkhangelsk. The project provides for the construction of four special transshipment terminals with a total capacity of 28 million tons.
- Integrated development of the Murmansk Transport Hub.
- Construction of seaport facilities in the vicinity of Sabetta (Yamal Peninsula), including the creation of a ship channel in the Gulf of Ob.
- Construction of the Arctic oil transfer terminal of the Novoportovskoe field with a capacity of 8.5 million tons a year in the

vicinity of Cape Kamenny, Yamalo-Nenets Autonomous Okrug.
- Reconstruction of federal property facilities in the seaport of Pevek.
- Construction of transshipment terminals in Nenets Autonomous District (seaport of Indiga) with the prospective cargo turnover of 30 million tons a year.
- Construction of LNG storage and shipping facility at the Salmanovskoe field.
- Construction of the oil terminal Tanalau to transport oil from the Payakha field with the capacity of 7.5 million tons a year.
- Construction of the coal terminal Chayka in the vicinity of the seaport of Dikson.
- Construction of a coal terminal in the vicinity of the seaport of Beringovsky with the capacity of 10 million tons a year.
- Reconstruction of the Petropavlovsk-Kamchatsky seaport infrastructure facilities.

The integrated NSR development project also includes practical measures to develop navigational, hydrographic, hydrometeorological and rescue support for the functioning of the NSR and development of communications and navigation systems and facilities.

TRANSIT TRAFFIC PROBLEMS ALONG THE NSR

Recently, problems involving use of the NSR for transit traffic circumventing the Suez Canal have emerged. Considerable adjustments are necessary to revise previous optimistic forecasts for Arctic transit development.

Low oil prices, a global economic downturn, and the relative excess of commercial fleets led to declining rates for freight transport and reduced profitability for maritime transport. As a consequence, the opportunity to invest additional funds in new high-Arctic class vessels has become problematic, since potential reductions in transport route distances that the NSR provides cannot justify the expense of constructing an Arctic fleet. At present, there is a limited number of existing Arc 5 and Arc 7 vessels in the world.

Thus, existing specialized Arctic-class vessels will be mainly used for bulk cargo transit in the foreseeable future. No large-scale construction of

new bulk carriers is expected.

As for transit container traffic, a part of container cargo traffic from northeast Asia to northern Europe can be transferred to the NSR. The NSR, however, cannot yet be considered an alternative to the Suez Canal Route.

That is why a container line between Murmansk and Petropavlovsk-Kamchatsky will be created, to transport mainly Russian cargo from the central part of Russia to Magadan and to the ports of Sakhalin and Chukotka as well as to import cargo from Asia bound for central Russia.

After the Murmansk-Petropavlovsk-Kamchatsky line is launched and functioning well, international transit services may become feasible on the NSR, with cargo transshipment from container carriers to Arctic carriers, and vice versa, at container line terminal ports.

Creating this container line project for transit along the NSR requires constructing Arctic-class container ships with the capacity of 1500-5000 TEU.

A cautiously optimistic forecast for the transit of general and container cargo by 2030 estimates suggests a range of between 15-19 million tons.

NSR MANAGEMENT ISSUES

One of the important problems cargo companies operating on the NSR will face in the near future is a lack of capacity for the nuclear icebreaker fleet to provide support for all anticipated cargo traffic.

The main customers will be:

- Federal and regional customers, including the supply of goods to northern Russia.
- Resource companies.
- Coastal commercial traffic, including container traffic.
- Transit traffic.
- Operators of drilling and auxiliary fleets in implementing offshore projects.

These sectors are already competing for common resources and attempting to address sector-specific concerns. This competition will only increase in the future.

There is an obvious need to optimize NSR operations, including the

activities of icebreaker fleets, which will require changing the management structure in the following ways:

1. Expansion of the NSR's Administration functions for the organization of maritime traffic, ensuring navigational safety and information support for the NSR, including:

   - Developing vessel navigation routes on the NSR as well as procedures for identifying the necessary icebreaker assistance and navigation.
   - Monitoring and controlling icebreaker and vessel traffic on the NSR.
   - Organizing navigational, cartographic and hydrometeorological support of maritime traffic.

2. Creation of a single logistics operator in the AZRF to organize cargo traffic on the NSR, based on public-private partnerships. The integrated logistics operator should:

   - Coordinate the execution of transport logistics and service operations to provide services for interested customers.
   - Perform centralized interaction with NSR infrastructure operators, including coordination of icebreaker assistance and navigation.
   - Perform centralized current and strategic planning for the revenue load of NSR infrastructure.
   - Perform coordination of the use of the NSR transport-logistic infrastructure to support fishery, technology, scientific, and research operations and also to support search and rescue operations in the AZRF.
   - Participate in creating tariff policies, including icebreaker dues and expenditures for delivery, as well as loading and unloading fees, including the use of undeveloped beaches for the entire Arctic zone.
   - Ensure a strong and fair competitive environment among transport operators.

The strengthening of the NSR Administration's supervisory responsibilities, together with the creation of a single coordinator acting in the name of all traffic participants, will help regulate shipping at a time

when there is an inadequate icebreaker fleet, and also help reduce expenses related to "dead freight." The creation of a single logistics operator will also allow better planning for shipping companies' activities by providing a more reliable prediction of infrastructure condition and availability, volumes of work, and deadlines for payment.

CONCLUSION

Joint efforts of the Russian Federation and business interests in developing the AZRF have launched qualitative changes in the operations of the NSR, which is considered an historical national transport route of the Russian Federation in the Arctic. The river and land components of cargo transport infrastructure that connect with loading and unloading points have not been considered here. Since the marine component is the central element of the NSR, I have emphasized its role.

Declining hydrocarbon prices have reduced the relevance of developing offshore oil and gas fields in the short term. However, transportation of raw materials produced at low cost on land and in the AZRF estuarine areas will provide multiple opportunities to increase traffic along the NSR in the near term. Efforts unprecedented during the modern history of Russia are underway to restore and improve the NSR infrastructure to increase support for shipping in anticipation of additional requirements expected with increased traffic.

Making qualitative changes in the State Program "Socio-Economic Development of the AZRF until 2020" and applying the concept of support zones has made it possible to implement large-scale measures of state support to develop the Russian Arctic, primarily within the framework of public-private partnerships.

Efforts to upgrade the icebreaker fleet will increase the capacity for providing year-round icebreaker assistance.

The strengthening of the NSR Administration's regulatory functions and the creation of a single non-governmental transport-logistic operator should become important elements of future transport policies and infrastructure organization.

We hope these measures will enable full-scale participation of our foreign partners in their future use of the NSR.

Trends in Arctic Ship-Based Tourism

Peter B. Ortner

The potential growth of the ship-based tourism sector in the Arctic differs from that of the commercial shipping and fishing sectors. While all sectors can reasonably be expected to grow as maritime access to the Arctic increases due to decreased sea ice coverage as well as reduced and thinning multi-year ice, there are current and long-term constraints on the growth of ship-based Arctic tourism. This perspective develops this thesis. First, I will distinguish between two models for ship-based tourism: conventional and expeditionary. Second, I will characterize the present status and highlight some recent trends in the industry. Third, I will discuss some of the inherent operational challenges to tourist ship operations and the near-term limitations to industry growth. Finally, I will make some highly speculative longer-term inferences and briefly discuss some collaborative opportunities and approaches already being taken that address gaps in the environmental information required for responsible risk management with respect to ship-based Arctic tourism.

First, a caveat: I am not a participant in the ship-based tourism industry, a policy expert, or an Arctic expert (although I have worked in Alaskan waters). My work has focused primarily in lower-latitude systems as a seagoing research oceanographer. That said, both my research group and our closest collaborators have for many years been using cruise ships, ferries and container ships as ship-of-opportunity research platforms in the context of what has become the OceanScope program.

My long-term industry partner in our OceanScope efforts (Royal Caribbean Cruise Lines) generously contacted both CLIA (Cruise Lines International Association) and AECO (Association of Arctic Expeditionary Cruise Operators) on my behalf. Representatives of both industry groups graciously provided relevant information[1, 2] and discussed the short-term prospects for growth that affect various sectors of the ship-based tourism industry (including vessel construction plans). They were also willing to share their issues of concern and personal assessments of the factors that currently limit growth in their respective sectors of the ship-based tourism industry. That said, my conclusions about longer-term industry prospects are entirely my own and reflect both my expertise in climate change science

and my personal experience with the industry.

In discussing ship-based Arctic tourism, it is important to distinguish between conventional and expeditionary vessels at the outset. Conventional cruise ships are larger than expeditionary ships (often very much larger), carrying from 500 to more than 5,000 passengers. Most expeditionary vessels carry only a few hundred (or fewer) passengers. The capital investment required is approximately proportional to the vessel size; a large conventional cruise ship can cost well above $1 billion. The business model of the largest carriers is to recoup their initial investment in as little as five years of operation. Moreover, conventional cruise ships are rarely if ever ice-strengthened, while many expeditionary vessels were specially built (or modified) to work in high latitudes and around sea ice. This means that the "season" open to larger cruise ships is considerably shorter than the one open to smaller special purpose expeditionary vessels, and the areas in which they can safely operate (and navigate) are more restricted as well. Nearly all expeditionary vessels carry sufficient landing craft to take all (or most) of their passengers near or onto undeveloped shorelines, or to make ice excursions assuming favorable weather conditions. Cruise ships have a much-reduced capacity in this regard. Cruise ships are highly dependent on local infrastructure. The port facilities required to simply load and discharge passengers are proportional to ship size, in addition to the requirements for shore-side support regarding supplies, wastes and fuel. By contrast, expeditionary vessels are considerably less demanding of port infrastructure. These are generalizations, and recent examples (and some historical ones as well) blur the distinctions I have made. Nonetheless this difference is to a large extent informing business perspectives on the financial opportunity represented by ship-based Arctic tourism and therefore ship traffic patterns with respect to Northwest Passage, Trans-Polar Route, and Northern Sea Route options and opportunities.[3]

AECO provided summary data (valid through last year) on passenger distribution and recent growth for overall ship-based tourism as well as AECO member (purely expeditionary) cruises. While the overall number of tourist passengers accommodated was somewhat higher in the most recent years of the past decade, this growth was predominantly around Svalbard and to some degree represented a shift from Greenland. Other regions experienced relatively low client numbers (excepting perhaps Alaska but not within the high Arctic). If one considers only the AECO expeditionary vessels (about 20% of the total tourist traffic), little overall growth has

occurred in recent years. Whatever overall growth has occurred of late represents an increase in average vessel size rather than an increase in vessel traffic.

That said, at least three forays into the Northwest Passage are planned or recently completed, which will markedly increase the 2016 Canadian totals. This includes two larger (CLIA) conventional cruise ships.[4] The largest is the Crystal lines *Serenity* (a smaller "luxury" cruise ship that still accommodates more than 1,000 passengers). She sailed in August 2016 from Anchorage, Alaska to New York City, making an historic commercial cruise line navigation of the southern route through the Northwest Passage. While a much smaller cruise ship made this passage more than two decades ago, the passage of this larger vessel is significant. Since 1903, there have been only four tankers, one recent bulk carrier and no large cargo ships that have made the full passage (USCG, personal communication). To limit risk, *Serenity* was accompanied by an icebreaker (ICE level 05), the *RRS Ernest Shackleton* chartered from the British Antarctic Survey equipped with two helicopters (not standard equipment) and supplementary zodiac landing craft. Moreover, to prepare for the voyage, relevant officials from the United States, Canada, and Crystal Lines conducted a tabletop disaster response exercise in April 2016. Last, Crystal stated that prior to the voyage, *Serenity* herself would be equipped with state-of-the-art forward-looking sonar, ice detection radar, ice searchlights and thermal imaging, as well as an ice navigation system displaying near real-time satellite and model data. In part because of these risk-related additional costs, individual passenger costs for the 32-day cruise were more than $120,000 per passenger for the most desirable cabins. Crystal provided additional opportunities for small boat natural history discovery excursions as well. While this cruise was promoted as being of "expeditionary" character, in truth it was something of a hybrid venture that included multiple port stops in Alaska, Canada, Greenland, and New England, as well as visits to Canadian Inuit communities (whose total populations are less than the sum of passengers and crew arriving aboard *Serenity*). A repeat *Serenity* cruise is already being promoted for 2017, as is one by the smaller Regent Lines *Seven Seas Navigator* (more than 500 passengers and 150 crew) from Seward, Alaska to Montreal, Canada. Last, the "expeditionary cruise ship" Hapag-Lloyd's *MS Bremen* made a partial transit of the Northwest Passage in August 2016. Her scheduled cruise began and ended in Kangerlussuaq, Greenland and penetrated the Passage as far as Cambridge Bay. In 2006

Bremen successfully navigated the entire Passage with the then novel real-time assistance of satellite-derived sea ice data. She has made seven cruises to date in the Arctic, and in 2017 she is planning a full transit cruise from Nome, Alaska, to Kangerlussuaq, Greenland.

While decreasing ice and improving technology make cruises increasingly possible, knowledgeable observers remain concerned that much of the Northwest Passage still lacks adequate nautical charts, ports, and search-and-rescue (SAR) capability. For example, with respect to Canada, SAR aircraft are based thousands of kilometers away in British Columbia, Nova Scotia and Ontario. In U.S. waters off Alaska, sea ice conditions are typically more favorable. Nonetheless, according to the most recent U.S. assessment, "As sea ice retreats, the lack of U.S. Arctic infrastructure to support increased maritime activity grows more apparent. Limited nautical charts, aids to navigation, communication, emergency response, and rescue capabilities make operations difficult and potentially dangerous. Other elements contributing to accident risks in the Arctic include inadequate maritime infrastructure and environmental and economic uncertainties."[5]

The major conventional cruise ship operators in CLIA have yet to be convinced that the Northwest Passage has "staying power" as a cruise destination, and few members see it as a major business opportunity in the near future. The cost-benefit analysis is not sufficiently favorable. They question whether a Northwest Passage cruise offers enough to attract a great many passengers (and importantly, few if any repeat passengers critical to the conventional cruise industry business model) to justify their enormous capital investment. Moreover, risk management costs remain very high, and it is not certain that routes/schedules are sufficiently predictable.

With respect to SAR responsibility, it is coordinated to the extent that it is partitioned and assigned in accordance with the Nuuk Agreement of 2011. The issue has received explicit attention in recent reports and assessments by the relevant national and international agencies, however, and these reviews do not suggest that SAR capacity is truly adequate (see the recent Arctic Council progress report[6] on AMSA 2009 implementation). Substantial problems are anticipated should a larger passenger vessel ground, become icebound, or for some other reason become disabled or uninhabitable and require full evacuation. Operational concerns include: how quickly can assistance reach a vessel given the sparse distribution of relevant assets (such as icebreakers or aircraft); how and where can the numerous passengers be offloaded, since suitable ports are few in number;

and, what transportation is available to passengers once safely ashore? In addition, cruise passengers (and crew) invariably include citizens of numerous nationalities. This raises a host of procedural hurdles in this era of heightened security concerns.

Significantly, the regions of greatest promise for ship-based tourism do not always coincide with those with the most long-term potential for cost savings in commercial transport.[7] For example, a trans-polar passage is not thought to represent a real business opportunity for ship-based tourism. There is too little to see. Also, the shorter and more direct routes through the Northwest Passage or offshore along the Northern Sea Route are for the same reason not as attractive from a tourist perspective as the more tortuous southern routes. Tourists want to see charismatic high-latitude marine life and, where possible, have the opportunity to interact with indigenous Arctic peoples. That said, and perhaps not surprisingly, there is a more substantial overlap with some regions already being heavily fished.[8] It is somewhat of an anomaly that from 1977-2004, of the 52 successful voyages to the North Pole, 39 were tourist excursions. In 2016, the Russian icebreaker, *50 Let Pobedy*, took 130 passengers to the North Pole, where they participated in collecting sea ice and other observational environmental data. The opportunity to contribute through a "citizen science" experience was cited by passengers as one of the most attractive aspects of the cruise.[9]

Based on trade journal announcements, a number of Arctic tourism "new builds" are scheduled to come on line in the next few years: Crystal is planning a 200-passenger vessel for August 2018; Companie-Ponant is planning a 184-passenger vessel for 2018/2019; Hurtigruten is planning two 500-passenger vessels for 2018 and 2019 respectively; Lindblad is planning a 100-passenger vessel for 2019, and Scenic Cruises Lines a 228-passenger vessel for 2018. Given typical industry planning horizons and build times, these plans were all made some time ago. In fact, AECO projects that over at least the next five years, whatever growth occurs will continue to be focused on Iceland, East Greenland and Svalbard. While the west of Greenland is ice-free for much of the year the only significant wildlife attraction there is said to be whale watching, keeping the focus where it has been—on the eastern shores. In addition, there is a growing concern that recently enacted legislation in both Iceland and Greenland affecting vessels accommodating 200 or more passengers will make it more difficult to operate out of the traditional ports. This could affect both new

ship construction and ship conversion plans since the "local" ports with the most capability remain Longyearbyen in Svalbard and Reykjavik.

Over the long term, the greatest potential for ship-based tourism growth is in Russian and Canadian coastal waters, primarily because both offer charismatic wildlife viewing as well as access to indigenous peoples living in communities along their Arctic coasts. That said, at present there are major impediments to growth in both regions and it remains arguable how from a tourist perspective more "expensive" cruises will differ significantly from present more accessible (and logistically favorable) destinations.

Although Russia's efforts appear to have slowed due to decreased available funding with the fall in oil prices, the Russian Federation has been investing in maritime support infrastructure, including icebreakers, port facilities, navigation aids and navigational chart improvement. Similar Canadian investment has lagged (at least according to newspaper reports), and in both regions there remain significant regulatory and approval obstacles to expanding passenger vessel operations. With respect to Russia, few non-Russian companies have as yet been able to establish the long relationships required to sustain ongoing operations from Russian ports or within Russian waters. Canada's system of government distributes relevant regulatory authority broadly among different provinces and the central federal government as well as the moral and constitutional responsibility to protect the rights of Canada's indigenous peoples. This combination has resulted in an unusually complex regulatory situation. One AECO operator has stated that getting approval for one of their recent expeditions required them to obtain 57 different "permits" from 35 different "offices." It is thought that Canada's attention has been so focused upon oil and gas development and the enormous policy and regulatory challenges it will present, that the challenges faced by the tourism industry have yet to be addressed. At present, AECO members feel their expeditionary vessels are being discouraged rather than encouraged to enter the Canadian market. Moreover, the Coasting Trade Act, the Canadian equivalent of the U.S. Jones Act, has constrained the ability of non-Canadian operators to embark and disembark passengers at Canadian ports, which rules out some favorable routes and destinations.

The above perspectives are in the short-to medium-term (at most seven years out). Looking further into the future is even more speculative. First, let us consider the issue of navigability. The consensus view is that

the Northern Sea Route (NSR) will become accessible for a longer season more rapidly than the Northwest Passage (see for example the U.S. Navy Roadmap[10]). All else being equal, one might expect tourism along the Russian Arctic coast to develop more rapidly than in Canada (and as noted earlier, Russian investment in relevant Arctic maritime support infrastructure has been more substantial). Regulatory procedures will have to be streamlined, and regardless of vessel construction, maritime support infrastructure development will help determine the extent to which Arctic tourism shifts from the "expeditionary" to the "conventional" model (and how rapidly both expand).

Other long-term issues that cannot be ignored include the effects of tourism upon previously isolated and self-sufficient coastal communities and the rapid changes being experienced by the Arctic marine ecosystem. While in the short term, cruise ship visits result in significant local financial benefit; experience indicates that over time the unique character of the affected communities is often eroded. This is particularly true in less "developed" ports of call. Unfortunately this social transformation will be occurring at precisely the same time as the Arctic marine ecosystem, itself highly dependent upon a previously predicable seasonal ice environment, is rapidly evolving and thereby further disrupting traditional ways of life. Some of these changes are inevitable. But in my view, they raise issues of long-term industry sustainability. At what rate will the Arctic lose it special character, which makes it unique, and become less attractive as a tourist destination? Will environmental and societal transformations limit tourist industry growth? Or given a "shifting baseline," can interest be sustained through the all-too-human process of diminished expectations?

The environmental information needs required to justify and support major investments (and minimize risk) also remain a limitation to the growth of ship-based tourism. These needs are likely to remain for decades, given the state of the global economy and the consequent reduction in Arctic research funding. The slow pace of substantive progress on AMSA recommendations in regard to transport infrastructure has already been noted. Equally significant is that research priorities expressed by various relevant reports have changed only incrementally over the past decade, even though it is well recognized that change in the Arctic environment has accelerated.[11] While bathymetric data are lacking throughout the global ocean (the full surface topography of Mars is mapped more accurately than the bathymetry of a large fraction of the global ocean) (L. Mayer, personal

communication), these data are particularly lacking in the Arctic. Moreover, navigational quality bathymetry is not the only data gap affecting both safe ship normal and SAR operations. Arctic oceanic and coastal currents are as yet neither well documented nor robustly modeled, especially in areas of changing ice coverage. In addition, significant changes in circulation are inevitable as a result of global warming and ice melt. Meteorological forecasts are generally less accurate in the Arctic, due in part to the highly dynamic environment and also to a paucity of the timely data on initial conditions upon which accurate weather modeling depends. The impact of decreased sea ice upon Arctic meteorological patterns is a concern; it could lead to more frequent (and intense) Arctic cyclones. Ocean circulation and meteorological modeling deficiencies (as well as inherent issues of parameterization) in turn limit sea ice modeling on operational (versus climate) scales. What is infrequently stated, and worth emphasizing here, is that the ship tourism industry can itself contribute substantially to addressing some of these data gaps (such as incorporating more "citizen science" efforts), thereby benefiting both itself and the entire maritime sector.

AECO's partnership with international regulatory and response agencies with respect to satellite ship tracking and SAR is well recognized (consider the recent and planned SAR tabletop exercise meetings in Reykjavik). There also have been remarkable partnerships with the scientific community, including collaborative projects with the University of Tromsø, Nordlandsforskning, University of Ottawa, British Antarctic Survey, Danish Meteorology Institute, and the Norwegian Meteorology Institute. Here, I want to focus on AECO's collaboration with the Norwegian Hydrographic Services with respect to "crowdsourcing depth soundings." AECO and its Antarctic counter-part the International Association of Antarctic Tour Operators (IAATO) have not only been able to implement a virtual real-time sharing of the depth-sounding data being taken continually aboard their vessels; they have also shared the treasure trove of historical depth-sounding data from prior cruises (to the extent the raw data are preserved). These data have improved the bathymetric information available, at least for the present destinations. While the data are not individually of the same accuracy as that obtainable with the sophisticated multi-beam systems used to update official navigational charts, by averaging multiple less accurate measurements reasonable precision is achieved. This is especially significant in that the financial resources required to obtain comprehensive

high resolution bathymetric data throughout the Arctic are unlikely to be available for many decades.

A final and personal observation: OceanScope is a nascent international program articulated by a SCOR-IAPSO working group uniquely comprised not only of academic and government research scientists but also of marine industry representatives (ship builders, designers, and operators as well as marine research instrument suppliers).[12] What remains unique about OceanScope is that participating vessels (cruise ships, container vessels, and ferries) autonomously collect measurements of ocean circulation and local atmospheric conditions. Their work includes simultaneously making present- and next-generation biological and chemical measurements, transmitting the information to shore site laboratories, and freely distributing these data and analyses to the international research and operational communities such as weather services, coast guards, and ship operators. The possibility of obtaining data from repeat transects in an under-sampled environment like the high Arctic and the proven willingness of Arctic cruise and expeditionary ship operators to collect data imply that an Arctic OceanScope could substantially (and cost-efficiently) augment ongoing international efforts to fill significant maritime environmental information gaps.

Notes

1. Association of Arctic Expeditionary Cruise Operators (personal communications, websites and press releases with particular thanks to Ilja Leo Lang).
2. Cruise Lines International Association (personal communications and websites with particular thanks to Kierstin M. Del Valle and Richard Pruitt).
3. William E. Eucker, "A Geospatial Analysis of Arctic Marine Traffic" (Ph.D. Dissertation, Scott Polar Research Inst., Cambridge University, 2012).
4. http://www.businesswire.com/news/home/20160916005705/en/Mission-Accomplished-Crystal-Serenity-Completes-32-Day-Northwest.
5. U.S. Committee on the Marine Transportation System, A Ten-Year Prioritization of Infrastructure Needs in the U.S. Arctic, A Report to the President(Washington, D.C., 2016).
6. Arctic Council. Status on Implementation of the AMSA 2009 Report Recommendations, April 2015.

7. Arctic Marine Shipping Assessment 2009 Report.
8. Ibid, Eucker 2012.
9. EOS Project Update, June 2016. Citizen Scientists Train a Thousand Eyes on the North Pole.
10. U.S. Navy Task Force on Climate Change, Arctic Roadmap 2014-2030, 2014.
11. U.S. National Arctic Research Policy, 2013-2017.
12. http://scor-int.org/Publications/OceanScope_Final_report.pdf.

Cooperative Currents and Challenges of Arctic Ocean Governance

David L. VanderZwaag

INTRODUCTION

Two nautical images help capture the status of international efforts to regulate three growing concerns in the Arctic Ocean: fisheries, shipping, and marine tourism. The first is "cooperative currents." Fisheries management cooperation to date has taken the form of efforts led by the five Arctic Ocean coastal States to prevent unregulated commercial fishing in the central Arctic Ocean (CAO) (Pan and Huntington 2016; Molenaar 2016; Wegge 2015) along with initiatives on the part of regional and bilateral arrangements. The North East Atlantic Fisheries Commission (NEAFC) has imposed some regional fisheries management measures for a sector of the CAO (Davis et al. 2013). At the bilateral level, the 2010 Norway-Russian Federation Treaty on Maritime Delimitation and Cooperation in the Barents Sea and Arctic Ocean has not only resolved a long-standing ocean boundary dispute, but also continues cooperation in trans-boundary fisheries management and the work of the Joint Norwegian-Russian Fisheries Commission (Scott and VanderZwaag 2015; Glubokov et al. 2014).

International cooperation in addressing increased shipping activities in the Arctic has progressed substantially at both global and regional levels. A new Polar Code has been concluded under the auspices of the International Maritime Organization (IMO) and will enter into force on 1 January 2017 (Leary 2015). At the regional level, the Arctic Council has played a role in developing two regional agreements with relevance to shipping: the 2011 Agreement on Arctic Search and Rescue,[1] and the 2013 Agreement on Marine Pollution Preparedness and Response in the Arctic.[2] The Council's Protection of the Arctic Marine Environment (PAME) Working Group has been discussing various Arctic shipping issues, including whether further protective measures should be taken for future shipping in the CAO beyond national jurisdiction. The Arctic Council has developed best practice guidelines for Arctic marine tourism (PAME 2015a).

A "sea of challenges" is the second descriptor. Governance

arrangements for the CAO have yet to be fully worked out. Shipping law and policy challenges include a number of issues: putting the Polar Code into practice; extending the coverage of the Polar Code; considering the need for a ban or bans on the use of heavy fuel oil (HFO) in Arctic waters; further addressing the emissions of greenhouse gases and black carbon within the International Maritime Organization (IMO); considering the establishment of Emission Control Areas in the Arctic; getting a firm grip on ballast water management in polar waters; and protecting areas of heightened ecological and cultural significance. Another issue is whether the Arctic Council should undertake additional efforts to address marine tourism.

Since the focus of this session is on the Arctic Ocean proper, various "sub-Arctic" fisheries challenges, of which there are many (Hassan 2009), will not be discussed. They include the following: the management of pollock in the Bering Sea "doughnut hole" (Kaye 2001); the struggles of the North Atlantic Salmon Conservation Organization (NASCO) to manage harvesting off West Greenland of wild salmon originating from North American and European rivers (VanderZwaag and Pudden 2010); the emerging take by Greenlanders of Atlantic bluefin tuna off East Greenland without the blessing of the International Commission for the Conservation of Atlantic Tunas (MacKenzie et al. 2014); and the management of the shared North Atlantic mackerel stock, which has migrated into the Icelandic EEZ (Hannesson 2016).

COOPERATIVE CURRENTS

Because the paper by Alf Håkon Hoel provides an overview of the 5+5 cooperative process to address potential CAO fisheries, and Norwegian-Russian fisheries cooperation has been extensively discussed elsewhere (Henriksen and Ulfstein 2011; Hønneland 2012), this paper emphasizes the main global and regional efforts to respond to the prospects of increased shipping and marine tourism. The limited role of the North East Atlantic Fisheries Commission in addressing CAO fisheries is also noted.

Global

The central regulatory progression for Arctic shipping at the global level is

development of the International Code for Ships Operating in Polar Waters (the Polar Code). The IMO's Maritime Safety Committee (MSC) adopted the safety provisions of the Code in November 2014, including global standards for design, construction, equipment and operational requirements for ships navigating in Arctic waters.[3] The IMO's Marine Environment Protection Committee (MEPC) adopted the environmental provisions of the Code in May 2015.[4]

The Code's coverage is limited both geographically and by type of ship. The Polar Code covers waters north of 600 North, with the exception of some warmer waters off Iceland, Norway and northwest Russia (Brigham n.d.). The safety provisions of the Polar Code will only apply to passenger vessels and cargo ships of 500 gross tonnage or more, while most of the pollution discharge provisions will apply to all ships.[5]

The mandatory safety provisions are set out in 12 chapters of Part 1-A of the Polar Code. One of the key requirements is for ships to have a Polar Ship Certificate that classifies the capabilities of ships to navigate through sea ice. Category A ships are designed for operation in at least medium first-year ice which may include old ice incursions.[6] Category B ships are designed to operate in at least waters with thin first-year ice which may include old ice incursions.[7] Category C ships are designed to operate in open water or ice conditions less severe than for categories A and B.[8] A Polar Water Operational Manual (PWOM) must be carried on board that includes information on ice capabilities and limitations and various procedures to be followed, for example, in voyage planning, emergency response situations, and when using icebreaker assistance. Machinery and fire safety equipment must be designed to operate in low temperatures and to avoid ice accretion and snow accumulation. Requirements for navigational and communication equipment are also stipulated. Various life-saving requirements are set out in chapter 8 of the Polar Code. These include a requirement that lifeboats be partially or totally enclosed.

The training requirements for masters, chief mates and officers in charge of navigational watch are set out in chapter 12 of the Polar Code. Details of the training requirements are actually found in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention) and the STCW Code, as amended.[9] The latest amendments, setting out basic and advanced training requirements from the Polar Code for ships operating in Arctic waters, are expected to be adopted at the MSC's 97th session in November 2016 with entry into force

on 1 July 2018 (MSC 2015a).

Part I-B of the Polar Code provides additional non-mandatory guidance on safety aspects of the Code. For example, a model table of contents is provided for the Polar Water Operational Manual, and contingency plans are encouraged to address the emergency transfer of liquids if needed.

Part II-A of the Polar Code will establish strict global pollution discharge standards for Arctic shipping. Discharges into the sea of oil or oily mixtures from any ship will be prohibited, as will be discharges of noxious liquid substances. Garbage discharges will be substantially restricted. Discharges will be limited largely to food wastes. Food wastes discharges are only permitted when the ship is enroute and not less than 12 nautical miles (NM) from the nearest land, ice shelf, or land-fast ice, and garbage discharges must be as far as practicable from areas of ice concentration exceeding 1/10. Food wastes must be comminuted or ground. Wastes must not be discharged onto the ice. In addition, discharges of some cargo residues are allowed if not harmful to the marine environment.

Sewage discharge standards might be described as variable. They are strong for new Category A and B ships and new passenger ships constructed on or after January 1, 2017. Those ships will be required to have operational approved sewage treatment plants. Existing Category A and B ships that operate in areas of ice concentrations exceeding 1/10 for extended periods of time will also require approved sewage treatment plants. Existing passenger ships will still be allowed to discharge untreated sewage at a distance of more than 12 NM from the nearest land, ice-shelf, or fast ice. Such discharges shall be as far as practicable from areas of ice concentration exceeding 1/10.

Part II-B of the Code provides additional guidance on pollution prevention in polar waters. For example, ships are encouraged to apply the prohibition on heavy fuel oil use in the Antarctic when operating in Arctic waters and to use anti-fouling coatings resistant to abrasion by ice.

A second major global cooperative effort to support safe shipping in Arctic coastal waters and the CAO is the World-Wide Navigational Warning Service. As a collaborative effort of IMO and the International Hydrographic Organization, the globe has been divided into 21 regions called "NAVAREAs," whereby countries are charged with collecting information on sea states and issuing navigational warnings through the Global Distress and Safety System (GMDSS). Five NAVAREAs have been designated in the Arctic (USA 2015).

Regional

As part of its mandate, The North East Atlantic Fisheries Commission includes a segment of the Arctic Ocean beyond national jurisdiction. While NEAFC has closed various vulnerable marine ecosystems (VMEs) to bottom fishing, that closure has not extended to the CAO. Pursuant to Recommendation 19:2014, future exploratory bottom fisheries would be subject to a notification and scientific assessment process (NEAFC 2014). NEAFC has also prohibited directed fishing for deep-sea sharks, effective 1 January 2013 to 31 December 2016 (NEAFC 2013).

Five regional cooperative "eddies" in relation to shipping stand out following the publication of the Arctic Council's Arctic Marine Shipping Assessment (AMSA) in 2009 (Arctic Council 2009). In May 2011, the Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic was adopted at the Nuuk Ministerial meeting of the Arctic Council. The Agreement delineates areas of national search-and-rescue (SAR) responsibilities in the Arctic, calls for further cooperation in joint exercises and training, and provides for expedited cooperative responses to SAR incidents (Wood-Donnelly 2013).

In May 2013, the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic was concluded after negotiation by an Arctic Council task force. The Agreement commits the parties to maintain effective national pollution preparedness response systems, calls for cooperation in response operations and promotes joint exercises and training. The Agreement also applies to high seas areas. Each party pledges to undertake appropriate monitoring activities to identify pollution incidents not only in areas under its national jurisdiction but also, to the extent feasible, in areas beyond national jurisdiction. When a party receives information on an oil pollution incident in the high seas, there is a duty to notify other countries. Requests for assistance in response operations may also apply to areas beyond national jurisdiction.

Efforts to identify areas of heightened ecological and cultural significance in the Arctic as called for in the AMSA report as a precursor to implementing protective measures[10] have also progressed. Three of the Council's working groups, the Arctic Monitoring and Assessment Programme (AMAP), the Working Group on Conservation of Arctic Flora and Fauna (CAFF) and the Sustainable Development Working Group (SDWG), published a report in 2013 (AMAP/CAFF/SDWG 2013)

that identified more than 90 areas of heightened ecological significance in the Arctic, including many polynya areas and more than half of the total ice-covered area of the marine Arctic. Essentially, the entire central Arctic Ocean Large Marine Ecosystem (LME) was identified as an area of heightened ecological significance. The report noted the limited information on areas of heightened cultural importance and simply provided some examples from Norway, Canada, Greenland and the United States. In March 2014, a workshop was held in Helsinki, Finland to facilitate the description of ecologically or biologically significant marine areas (EBSAs) in the Arctic. A collaborative effort of the Convention on Biological Diversity (CBD) Secretariat and the CAFF Working Group, the workshop identified [11] areas meeting the EBSA criteria under the CBD including two EBSAs in the CAO: the multi-year ice of the CAO, and the dynamic marginal ice zone having open water periods in summer (CBD 2014).

A fourth key initiative was a study undertaken by the PAME Working Group on possible future options to protect areas of the Arctic high seas from impacts from international shipping. The report, published in 2014 (Det Norsk Veritas 2014), identified three main options that could be pursued at the IMO:

- Pursue a particularly sensitive sea area (PSSA) designation for the entire high seas area with a vessel traffic system (VTS), a ship reporting system (SRS) and a dynamic area to be avoided (ATBA).
- Pursue a PSSA designation for the entire high seas with just a VTS and SRS.
- Pursue a PSSA designation for one or more core ice areas within the CAO with ATBA.

The PAME Working Group also has focused specifically on Arctic marine tourism. Following two workshops on the topic, PAME published Arctic Marine Tourism Best Practice Guidelines in April 2015 (PAME 2015a). The title is somewhat of a misnomer, since the document does not set out specific guidelines. Instead, it urges further efforts by the Arctic Council and Arctic States. For example, the Council is encouraged to complete and regularly update a publicly available repository of circumarctic marine tourism information, and governments are encouraged to streamline their marine tourism permitting and oversight processes.

SEA OF CHALLENGES

A broad array of governance challenges loom on the horizon for controlling fishing, shipping and marine tourism activities in the Arctic Ocean. Ten leading challenges are highlighted in this perspective. Regulatory issues relating to the bio-fouling of vessels (Kraska and Rittschoff 2015), noise levels, and grey water from cruise ships are not addressed, even though they continue to be important considerations (VanderZwaag 2015).

Sorting Out Future Governance Arrangements for the CAO

Four main gyres of uncertainty hover over the future of governance arrangements for the CAO (VanderZwaag 2016). First is the outcome of the 5+5 CAO fisheries process regarding many questions yet to be settled:

- Will a legally binding agreement be forged?
- If so, what will be its membership and elements?
- How will a scientific cooperation program be operationalized?
- How will cooperation in maritime monitoring, control and surveillance be advanced?
- Should a commercialization future be promoted?
- What will be the participation rights by Arctic residents and indigenous peoples?
- What principles should govern the granting of future access to fisheries resources assuming commercial fishing is authorized?
- What level of scientific certainty would justify opening up new fisheries?
- What level of "exploratory fishing" should be allowed and how should it be regulated?

A second "swirl" of uncertainty is the role of the Arctic Council's Task Force on Arctic Marine Cooperation (TFAMC) in setting future governance coordinates relevant to the CAO. The Arctic Council Ministers established the Task Force at their Iqaluit Ministerial meeting in April 2015 and charged it with assessing "future needs for a regional seas program or other mechanism, as appropriate, for increased cooperation in Arctic marine areas."[11] Detailed terms of reference for the Task Force set by the Senior Arctic officials (Arctic Council 2015) give the Task Force broad latitude

to consider the following matters: what functions might a cooperative mechanism serve; whether a cooperative mechanism should have a defined geographic scope, such as the high seas area of the Arctic Ocean and/or other (seabed) areas beyond national jurisdiction; what the mechanism's relationship is with the Council; and what legal form any agreement should take (binding or non-binding)? The AMCTC, meeting in September 2015 and February 2016, is expected to issue a report to the 2017 Ministerial meeting. It is not yet clear what recommendations will follow and how CAO governance will be addressed.

A third area of uncertainty is what future steps within the IMO might be taken to address Arctic high seas shipping. Consideration of the question within PAME might be described as "slow and stalled." At PAME's September 2014 meeting in Whitehorse, representatives agreed on the need for four interim steps to be taken prior to further actions by the IMO:

- Develop a paper exploring whether it would be possible for the IMO to establish dynamic areas to be avoided.
- Develop a paper exploring whether it would be possible for the IMO to designate a PSSA located exclusively on the high seas.
- Develop a paper exploring other ideas for making mariners aware of the ecological significance and hazards to navigation by drifting multi-year pack ice, such as NAVAREA warnings and IMO Circulars.
- Continue to seek current ship traffic data from the high seas area of the CAO (PAME 2014a).

Only two of the tasks have been carried out. At PAME's February 2015 meeting in Akureyri, Norway submitted a paper documenting 50 unique vessels operating within the high seas area in 2014 (Norway 2015). The United States submitted a paper exploring future use of NAVAREAs and IMO Circulars to give warning pertaining to drifting ice packs (USA 2015).

At PAME's February 2015 meeting, a further brake was placed on the process. PAME invited AMAP and CAFF to denote areas within the CAO high seas particularly vulnerable to international shipping activities. However, that designation has yet to occur (PAME 2015b).

A further dimension of uncertainty pertains to the implications of a potential UN Agreement on the Conservation and Sustainable Use of Marine Biodiversity in Areas beyond National Jurisdiction. Through Resolution 69/292, the UN General Assembly has set in motion a

preparatory committee process (2016-2017) to make recommendations to the General Assembly on elements of a draft text for a new agreement on marine biodiversity in areas beyond national jurisdiction. Discussions are ongoing to address a number of issues relevant to the CAO. They include gaining access to and sharing of benefits of marine genetic resources, environmental impact assessment obligations, and area-based management tools including marine protected areas (Long 2016).

Putting the Polar Code into Practice

Five especially challenging aspects of Polar Code implementation stand out:

- ***Revising national laws to give effect to the Polar Code***

Passing legislative or regulatory amendments may be time-consuming and it remains to be seen whether countries will be able to harmonize their shipping laws by the time of the code's implementation. Canada and the Russian Federation need to decide whether some national regulatory measures, previously adopted under Article 234 of the Law of the Sea Convention granting special pollution prevention powers in ice-covered waters, should be retained even though they are not consistent with the code (McDorman 2015).

- ***Deciding on whether ice conditions exceed the ship's design limits***

This is especially critical for Category C ships where an assessment needs to be made regarding whether additional equipment or structural modification is needed before navigating in ice.[12] The methodology for such assessments is not spelled out in the Polar Code and the IMO has merely issued "interim guidance" for assessing operational capabilities and limitations of ships in ice (MSC 2016).

- ***Developing detailed Polar Water Operational Manuals for each ship***

The Polar Code calls for each ship to carry a PWOM on board with considerable flexibility allowed as to details, for example, of procedures to be followed in encounters with ice exceeding the ship's specific capabilities and procedures for contacting emergency response providers. Ensuring there is a manual tailored to each ship in time for the code's entry into force has been identified as a substantial challenge (Brigham n.d.).

- ***Ensuring adequate crewing and training***

With the Polar Code calling for new special training of masters, chief mates and officers in charge of navigational watches in polar waters, Flag States may be challenged to modify and ensure appropriate training courses. Training of crew members may be even more challenging, since the code leaves wide latitude as to what exactly this training should include: "Every crew member shall be made familiar with the procedures and equipment contained or referenced in the PWOM relevant to their assigned duties."[13]

- ***Providing adequate reception facilities for ship wastes***

With new restrictive discharge standards for oil, noxious liquid substances and garbage in the Arctic pursuant to the Polar Code, the challenge of providing adequate waste reception facilities, either within or outside the Arctic, arises. PAME has established a Correspondence Group to develop a Regional Reception Facilities Plan (RRFP) and the group has been asked to complete a final draft deliverable document by the end of 2016 (PAME 2015c).

Extending the Coverage of the Polar Code

It remains to be seen if/when the Polar Code might be extended to cover other ships operating in the Arctic, such as fishing vessels and private yachts. The Arctic Ocean Review report did recommend that Arctic States consider approaches, including at the IMO, to address safety and environmental concerns with respect to other types of vessels that may not, due to their size, routes and nature of activity, be subject to the Polar Code (Arctic Council 2013: 96).

Considering Further Heavy Fuel Oil (HFO) Bans

The question of whether HFO use should be further banned in Arctic waters (beyond bans already in place for some nature preserves and national parks off Svalbard) (AECO 2015) has been controversial and remains unsettled. A ban on the use and transport of HFO in Antarctic waters has been in place since August 1, 2011. Reasons supporting broader banning include the long persistence of HFO if spilled into the environment, and the higher risk of engine failure with HFO than other fuels. Although

the IMO's Marine Environment Protection Committee decided against an Arctic HFO ban at its meeting in May 2013, some delegations were of the opinion that such a regulation might be desirable in the future (MEPC 2013). The PAME Working Group has continued to study the uses and risks of HFO in the Arctic. Studies in 2013 found that of 1,347 vessels operating in the Arctic throughout 2012, 371 (28%) were most likely using HFO as fuel (Det Norsk Veritas 2013a) while 84% of vessels operating in the Bering Sea were identified as HFO users (Det Norsk Veritas 2013b). Two additional HFO studies, one on HFO releases from shipping in the Arctic and the other on possible hazards for engines and fuel systems, are due to be submitted to the 2nd PAME meeting in 2016. PAME invited member States and others to submit proposals for mitigating the risks of HFO use and carriage in the Arctic by June 1, 2016 (PAME 2016).

Controlling Greenhouse Gas Emissions from Ships

The control of GHG emissions through the IMO has been limited (Hackmann 2012). In July 2011, a new chapter 4 was added to Annex VI of the MARPOL Convention (IMO 2011), setting out energy efficiency regulations for ships of 400 gross tonnage and above. New ships are required to meet Energy Efficiency Design Index (EEDI) requirements while each ship, including existing ships, are required to keep on board a Ship Energy Efficiency Management Plan (SEEMP).

Consideration of further measures, such as setting a global target for GHG emission stabilization or reduction or imposing a levy on fossil fuel use, has lagged. One of the points of controversy is whether a common but differentiated principle should apply in the shipping context. In the wake of the 2015 Paris Agreement on climate and growing pressure for the shipping industry to commit to its mitigation "fair share," the Marine Environment Protection Committee (MEPC) took on the issue. At its 69th session in April 2016, the MEPC agreed to establish a working group at its 70th session to further discuss the reduction of GHG emissions from ships (MEPC 2016a).

Reducing Black Carbon Emissions

Moving forward with black carbon emission measures from ships has also been a difficult issue within the IMO. The IMO began addressing black carbon in 2011, but it wasn't until the 68th session of the MEPC in May

2015 that a definition of black carbon was approved. The IMO's Sub-Committee on Pollution Prevention and Response (PPR) is still struggling with the issue of appropriate methods for measuring black carbon emissions and has yet to consider possible control measures to reduce the impact of black carbon emissions for international shipping (PPR 2015).

Considering the establishment of Emission Control Areas (ECA) in the Arctic

MARPOL Annex VI provides for the establishment of Emission Control Areas where more stringent than normal air emission controls for SOx, NOx and particulate matter might be imposed.[14] While a number of ECAs have been established under MARPOL, including for sea areas off the Atlantic and Pacific coasts of Canada and the United States (IMO 2010), none have been established for Arctic waters. The United States has gone on record through PAME regarding its openness to further analysis regarding the establishment of one or more ECAs in the Arctic including in the high seas of the CAO (USA 2014).

Getting a Grip on Ballast Water Management in the Arctic

A further challenge is ensuring effective ballast water management in polar waters in order to prevent the spread of invasive species (Jing et al. 2012). One major hurdle has been the difficulty of bringing into force the International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004) and getting all Arctic States to become parties to the agreement. The Convention's entry into force requires the ratification/acceptance by 30 States with combined merchant fleets constituting not less than 35% of the world's gross tonnage. On 8 September 2016, Finland deposited its instrument of acceptance, and the 35% gross tonnage requirement was met. The Convention will enter into force on 8 September 2017.[15] Of the eight Arctic States, Iceland and the United States are still not parties.[16]

Practical challenges also abound. Flag states have been slow to require their vessels to install ballast water management systems (BWMS), partly due to the costs and limited shipyard capacities (VanderZwaag 2012). Even where BWMS have been installed, a recent study indicates they may seldom get used (MEPC 2015). The performance of BWMS in cold waters

still remains uncertain with no shipboard trials on efficiency conducted below 5°C (MEPC 2016b). PAME's 2013 Arctic Ocean Review report recommended that Arctic States support research into ballast water management systems that are effective in colder polar regions (PAME 2013), but that recommendation does not appear as yet to have been heeded.

Protecting Areas of Heightened Ecological and Cultural Significance

While substantial progress has been made in identifying areas of heightened ecological and cultural significance in the Arctic, moving to actual protective measures to avoid adverse impacts of shipping has been slow. No PSSAs have been established in Arctic waters. Vessel routing measures remain sparse (United States, Denmark and Norway 2013) with the leading examples being the imposition of traffic separation schemes and recommended routes off Northern Norway (IMO 2006) and five recommended areas to be avoided off the Aleutian Islands, Alaska (MSC 2015b).

Considering Further Marine Tourism Measures

Very little follow-up to the recommendations in PAME's 2015 Best Practice Guidelines appears to have occurred yet. PAME has invited Canada, the United States, and Norway to submit a paper identifying specific Arctic Marine Tourism Project follow-up activities for consideration at PAME's second meeting of 2016 in September (PAME 2016). The development of yacht-specific guidelines for Arctic operations is likely to be discussed.

CONCLUSION

One final nautical image helps to capture the international regulatory realities for fishing, shipping and marine tourism in the Arctic: "unfinished voyaging." Arctic States and the broader community still have a long way to go in implementing existing law and policy commitments and in establishing further regulatory standards and measures.

Some "rough waters" will likely be encountered ahead. In particular, the disputed Beaufort Sea boundary between Canada and the United States

remains to be resolved. Sorting out access rights to subsistence and possible future commercial fisheries in the boundary area may prove to be especially challenging (Warner, VanderZwaag and Engler 2014: 401).

Notes

1. Available at <https://oaarchive.arctic-council.org/handle/11374/531>.
2. Available at <https://oaarchive.arctic-council.org/handle/11374/529>.
3. Res. MSC. 385 (94). Corresponding amendments to the Safety of Life at Sea (SOLAS) Convention were adopted through Res. MSC. 386 (94).
4. Res. MEPC. 264 (68). Corresponding amendments to the MARPOL Convention were adopted through Res. MEPC. 265 (68) [hereinafter Polar Code].
5. Annex IV, setting sewage discharge limits, applies to ships of 400 gross tonnage or more or to ships certified to carry more than 15 persons. (MARPOL 2011 Annex IV, Reg. 2).
6. Medium first-year is defined as first-year ice of 70 cm to 120 cm in thickness. Ibid., Introduction para. 2.8.
7. Thin first-year ice is defined as first-year ice 30 cm to 70 cm thick. Ibid., para. 2.15.
8. Ibid., para. 2.3.
9. Ibid., para. 12.3.1.
10. Recommendation II(C) of AMSA (Arctic Council 2009).
11. Iqaluit Declaration 2015, para. 43.
12. Polar Code, supra note 4, Part I-A, para. 1.3.3.
13. Ibid., para. 12.3.4.
14. MARPOL Annex VI, Reg. 2(8).
15. IMO, BWM. 1/Circ. 38 (2016).
16. Ibid.

References

AECO (Association of Arctic Expedition Cruise Operators). 2015. *Heavy Fuel Oil Ban*. http://www/aeco.no/2015/02/heavy-fuel-oil=ban/.

AMAP/CAFF/SDWG. 2013. *Identification of Arctic Marine Areas of Heightened Ecological and Cultural Significance*. Arctic Marine Shipping Assessment (AMSA) IIc, Oslo: Arctic Monitoring and Assessment Programme (AMAP).

Arctic Council. 2009. *Arctic Marine Shipping Assessment 2009*.

Brigham, Lawson. n.d. "IMO Polar Code for Ships Operating in Polar Waters." *Access Policy Brief* 4: 1-4.

CBD. 2014. *Report of the Arctic Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas*. UNEP/CBD/EBSA/WS/2014/1/5.

Davis et al. 2013. "The Conservation of Greenland Shark (Somniosus microcephalus): Setting Scientific, Law, and Policy Coordinates for Avoiding a Species at Risk." *Journal of International Wildlife Law and Policy* 14(4): 300-330.

Det Norsk Veritas. 2013a. *HFO in the Arctic-Phase 2*. Oslo: Norwegian Environmental Agency.

Det Norsk Veritas. 2013b. *HFO in the Arctic-Phase 2B*. Oslo, Norwegian Environmental Agency.

Glubikov et al. 2014. "Governance of Russian Arctic Fisheries in the Barents Sea: Surveying National and Cooperative Currents." *Ocean Yearbook* 28: 328-347.

Hackmann, Bernd. 2012. "Analysis of the Governance Architecture to Regulate GHG Emissions from International Shipping." *International Environmental Agreements* 12: 85-103.

Hannesson, Rögnvaldur. 2016. "Managing Shared Migratory Stocks: The Case of the Atlantic Mackerel." In *Challenges of the Changing Arctic: Continental Shelf, Navigation, and Fisheries*, edited by Myron H. Nordquist, John Norton Moore and Ronán Long. Leiden: Brill Nijhoff, 559-570.

Hassan, Daud. 2009. "Climate Change and the Current Regimes of Arctic Fisheries Resources Management: An Evaluation." *Journal of Maritime Law and Commerce* 40: 511-536.

Henricksen, Tore and Geir Ulfstein. 2011. "Maritime Delimitation in the Arctic: The Barents Sea Treaty." *Ocean Development & International Law* 42: 1-21.

Hønneland, G. 2012. *Making Fishery Agreements Work: Post-Agreement Bargaining in the Barents Sea*. Cheltenham: Edward Elgar.

IMO. 2011. *MARPOL Consolidated Edition 2011*. London: IMO.

IMO. 2010. *Information on North American Emission Control Area (ECA) under MARPOL*. Annex VI, MEPC. 1/Circ. 723.

IMO. 2006. *New Traffic Separation Schemes and Recommended Routes off the*

Coast of Norway from Vardø to Røst. COLREG. 2/Cir. 58, Annex I.

Jing, Liang et al. 2012. "A Review of Ballast Water Management Practices and Challenges in Harsh and Arctic Environments." *Environmental Reviews* 20: 83-108.

Kaye, Stuart B. 2001. *International Fisheries Management*. The Hague: Kluwer Law International.

Kraska, James and Daniel R. Rittschof. 2015. "Towards a Global Regime of Vessel Anti-fouling." *Duke Environmental Law & Policy Forum* 26: 53-69.

Long, Ronàn. 2016. "Anatomy of a New International Instrument for Biodiversity beyond National Jurisdiction." *Environmental Liability* 6: 213-229.

Leary, David. 2015. "The IMO Mandatory International Code of Safety for Ships: Charting a Sustainable Course for Shipping in Polar Regions?" *The Yearbook of Polar Law* 7: 426-447.

MacKenzie, Bryan R. et al. 2014. "A Cascade of Warming Impacts Brings Bluefin Tuna to Greenland Waters." *Global Change Biology* 20: 2484-2491.

McDorman, Ted L. 2015. "A Note on the Potential Conflicting Treaty Rights and Obligations between the IMO's Polar Code and Article 234 of the Law of the Sea Convention." In *International Law and Politics in the Arctic Ocean: Essays in Honor of Donat Pharand*, edited by Suzanne Lalonde and Ted L. McDorman, 141-159. Leiden: Brill Nijhoff.

MEPC. 2016a. *Report of the Marine Environment Protection Committee on Its Sixty-Ninth Session*. MEPC 69/21, para. 7.7.7.

MEPC. 2016b. *Ship-mediated Bioinvasions in the Arctic: Pathways and Control Strategies*. MEPC 69/INF. 17.

MEPC. 2015. *Final Report on the Study on the Implementation of the Ballast Water Performance Standard Described in Regulation D-2 of the BWM Convention*. MEPC 69/4/4.

MEPC. 2013. *Report of the Marine Environment Protection Committee on its Sixty-Fifth Session*. MEPC 65/22.

Molenaar, Erik J. 2016. "International Regulation of Central Arctic Ocean Fisheries." *In Challenges of the Changing Arctic: Continental Shelf, Navigation, and Fisheries*, Edited by Myron H. Nordquist, John Norton Moore and Ronán Long, 429-463. Leiden: Brill Nijhoff.

MSC. 2016. *Guidance on Methodologies for Assessing Operational Capabilities and Limitations in Ice*. MSC.1/Circ. 1519.

MSC. 2015a. *Amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (SCTW), 1978, as amended, and the Seafarers' Training, Certification and Watchkeeping (SCTW)*

Code. MSC 96/3/2.

MSC. 2015b. *Routeing Measures Other Than Traffic Separation Schemes*. SN. 1/ Circ. 331.

NEAFC. 2013. Recommendation 7: 2013, Deep-sea sharks.

NEAFC. 2014. Recommendation 19: 2014, *Protection of VMEs in NEAFC Regulatory Areas as Amended by Recommendation*. 09: 2015.

Norway. 2015. *Update on the Status of Current Ship Traffic in the High Seas of the Central Arctic Ocean*. PAME I-2015.

PAME. 2016. *Working Group Meeting Report*. PAME-I 2016, February 1-3, Stockholm, Sweden.

PAME. 2015a. *Arctic Marine Tourism Project (AMTP) Best Practice Guidelines*.

PAME. 2015b. *Record of Decisions and Follow-Up Actions*. PAME I-2015, February 3-5. Akureyri, Iceland.

PAME 2015c. *Working Group Meeting Report*. PAME-II 2015, September 15-17, Tromsø, Norway.

PAME. 2014a. *Record of Decisions and Follow-Up Actions*. PAME I-2014, February 11-13, Girdwood, Alaska.

PAME. 2014b. *Record of Decisions and Follow-Up Actions*. PAME II-2014, September 16-18, Whitehorse, Yukon.

PAME. 2013. *The Arctic Ocean Review Project, Final Report (Phase II 2011-2013)*. Akureyri: PAME Secretariat.

Pan, Min and Henry P. Huntington. 2016. "A Precautionary Approach to Fisheries in the Central Arctic Ocean: Policy, Science, and China." *Marine Policy* 63: 153-157.

PPR (Sub-Committee on Pollution Prevention and Response). 2015. *Report of the Working Group on Air Pollution from Ships*. PPR 2/WP. 5.

Scott, Karen and David L VanderZwaag. 2015. "Polar Oceans and Law of the Sea." *In The Oxford Handbook of the Law of the Sea*, edited by Donald R. Rothwell, Alex L. Oude Elferink, Karen Scott and Tim Stephens, 724-751. Oxford: Oxford University Press.

USA. 2015. *Using NAVAREA Warning and IMO Circulars to Alert Mariners at Drifting Ice in the Arctic*. PAME I-2015.

USA. 2014. "USA Views on Recommendations." In *DNV Report on Specially Designated Marine Areas in the Arctic High Seas*. PAME II-2014.

USA, Denmark and Norway. *Report on IMO Established Routeing and Reporting Measures in the Arctic Region*. PAME II-2013.

VanderZwaag, David L. 2015. Climate Change and the Shifting International Law and Policy Seascape for Arctic Shipping. In *Climate Change Impacts on Ocean and Coastal Law*, edited by Randall S. Abate, 299-314. Oxford: Oxford University Press.

VanderZwaag, David L. 2012. "The IMO and Arctic Marine Environmental Protection." In *The Arctic in World Affairs: A North Pacific Dialogue on Arctic Marine Issues*, 2012 North Pacific Conference Proceedings, edited by Oran R. Young, Jong Deog Kim and Yoon Hyung Kim, 99-128. Seoul: Korea Maritime Institute; Honolulu: East West Centre.

VanderZwaag, David L. and Emily J Pudden. 2010. "The North Atlantic Salmon Conservation Organization (NASCO): Surpassing a 25 Year Voyage in Transboundary Cooperation but Still Confronting a Sea Challenges." In *Recasting Transboundary Fisheries Management Arrangements in Light of Sustainability Principles: Canadian and International Perspectives*, edited by Dawn A. Russell and David L. VanderZwaag, 307-346. Leiden: Martinus Nijhoff .

Warner, Lauren, David L. VanderZwaag and Cecilia Engler. 2014. "Canada and the Governance of Arctic Marine Fisheries: Tending a Fragmented Net." *Ocean Yearbook* 28: 386-422.

Wegg, Njord. 2015. "The Emerging Politics of the Arctic Ocean: Future Management of the Living Marine Resources." *Marine Policy* 51: 331-338.

Wood-Donnelly, Corine. 2013. "The Arctic Search and Rescue Agreement: Text, Framing and Logics." *The Yearbook of Polar Law* 5: 299-318.

U.S. Coast Guard Arctic Strategy —Dramatic Vision to Implementation

Kathleen A. Duignan

The United States Coast Guard has statutory responsibilities for maritime safety, security, and stewardship in the country's sovereign waters, including waterways in the Arctic. The Coast Guard monitors all forms of human activity at sea, promulgates regulations to prevent mishaps or mischief, and prepares to respond to maritime incidents. These are especially challenging tasks in the Arctic's extreme environmental conditions. Any increase in navigable waters associated with receding ice will place greater operational demands on the Coast Guard.

ENDURING PRESENCE

The Coast Guard has been an Arctic leader since the days when the only federal presence within the Arctic borders of the United States was in the territory of Alaska. Prior to the formation of the current Coast Guard, Captain "Hell Roaring" Mike Healy patrolled the area and operated throughout the high latitudes during Alaska's nascent affiliation with the United States. Captain Healy was effectively "the law" in Alaska during the 1880s and 1890s, enforcing federal law along Alaska's 20,000-mile coastline as captain of the Revenue Cutter Bear. During his time as captain, he acted as judge, doctor, and policeman to Alaskan natives, merchant seamen, and whaling crews. His legacy is replete with stories about arresting lawbreakers, quelling mutinies on merchant ships, interdicting alcohol and drug smugglers, rescuing sailors at sea, providing medical aid to isolated villages, preventing the slaughter of wildlife, and exploring Alaska's coastline.[1] For his service, one of the two active icebreakers in the Coast Guard fleet today bears his name—the medium endurance cutter USCGC HEALY (WAGB-20).

More recently, the Coast Guard has taken a mobile and seasonal approach to meeting our statutory responsibilities in the Arctic, vastly increasing surface and air assets in the Arctic during the summer months when ice coverage recedes and marine activity is at its peak. Operating in

the Arctic is not a new prospect for the Coast Guard, but changing factors in the region and increased focus on the Arctic today affect our operational framework.

So-called "Arctic Shield" operations are an annual series of large cutter deployments providing mobile command and control functions, accompanied by patrols of ocean-going, ice-strengthened buoy tenders, maritime patrol aircraft, and land-based helicopters. These forces are used to generate a comprehensive understanding of Arctic maritime conditions covering more than 950,000 square miles of ocean off the Alaskan coast. Arctic ports, waterways, and rivers provide tremendous economic value, and national prosperity is inextricably linked to maritime activities and infrastructure in the high latitudes. The Coast Guard works closely with industry and other stakeholders to ensure this economic engine operates safely and efficiently. As both a military service and a law enforcement agency, the Coast Guard is armed with broad authority and plays a pivotal role in preserving U.S. national security interests.

Operation Arctic Shield employed more than 1,000 Coast Guard members from June through October 2015, including cutter crews, aviation personnel, and land-based personnel. Operational activities included the following:

- Maritime domain awareness patrols and ice rescue training.
- Enforcement of safety zones.
- Training for local populations.
- Public comment meetings.
- Volunteer search and rescue training.
- The rehearsal of mass-rescue operations with villages.
- A spill response drill.

The 17th Coast Guard District continued these same operations in 2016. In addition, Arctic Shield assets supported a joint mass-casualty rescue field exercise named Arctic Chinook. This exercise involved the full spectrum of response scenarios, including launching air and surface forces, transferring survivors to remote staging areas, conducting triage activities, ensuring personnel accountability, making appropriate notifications, and optimizing available resources ashore. Arctic Chinook was intentionally scheduled for the period prior to the voyage of the *Crystal Serenity*, a cruise ship headed into the Arctic by way of the Bering Strait.

Guided by the lines of effort outlined in the U.S. National Strategy for the Arctic Region, the Coast Guard focuses in the Arctic on the three strategic objectives of the Coast Guard Arctic Strategy:

- Improving awareness.
- Modernizing governance.
- Broadening partnerships.

This strategy, first published in May 2013, is part of a 10-year vision that describes where the Coast Guard is now and where the organization is headed during the next decade. Since the time of the strategy's release, the Coast Guard has worked actively to ensure that the strategic vision this document sets for the service is being fully implemented.

To develop this strategy, the service developed a Coast Guard Implementation Plan promulgated in December 2015. The Coast Guard has been a leader in the federal government in ensuring the safe, secure, and environmentally responsible conduct of maritime activities in the Arctic. In order to transform this strategy into reality, the Coast Guard outlined 13 initiatives in its Implementation Plan:

- Enhance Arctic operations and exercises.
- Improve maritime domain awareness.
- Enhance Arctic surface and air capabilities with associated support infrastructure.
- Improve Arctic communications capabilities.
- Implement the IMO Polar Code.
- Promote Arctic waterways management.
- Support the Arctic Council and the U.S. chairmanship.
- Advance the Arctic Coast Guard Forum.
- Support a Center for Arctic Study and Policy.
- Establish an Arctic policy board.
- Create an Arctic fusion center.
- Create an Arctic maritime assistance coordination center.
- Strengthen marine environmental response in the Arctic.

The Coast Guard has made significant progress regarding several of these initiatives since the Implementation Plan was published. Many of the challenges in the Arctic have been addressed, and the Coast Guard has

taken multiple steps to broaden international, federal, state, local and tribal partnerships that will increase interoperability, identify critical resources, enhance preparedness and facilitate discussions. Two noteworthy successes include the international Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic and the international Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic developed under the auspices of the Arctic Council in 2011 and 2013, respectively.

EMERGING FRONTIER

The Arctic is a vast and dynamic operating environment. Ice, persistent sub-zero temperatures, low visibility, extended darkness, equipment gaps, remote areas, and limited experience all make operating in the Arctic a challenge for maritime operations generally, and specifically for emergency and environmental response. Ships operating in the Arctic are exposed to a number of unique risks. In addition to poor weather conditions, a relative lack of hydrographic data, unreliable communications, and insufficient navigation aids collectively pose exponential dangers for Arctic mariners. Cold temperatures, for example, can reduce the effectiveness and functionality of numerous components of the ship, ranging from deck machinery to emergency equipment. When ice is present, it imposes additional loads on the hull, propulsion and steering systems, and other appendages. Moreover, the remoteness of the polar regions makes search and rescue, environmental response, and other operations difficult and costly.

Receding sea ice is generating new demands on operational resources. In September 2012, the world observed the lowest sea ice extent in the Arctic since satellite tracking began in 1978. Near-record low levels of ice coverage and thickness were also observed in parts of 2015 and 2016 along with higher-than-average temperatures. Warmer temperatures lead to reduced ice coverage and in turn increase the number of navigable waterways. Seasonal trade routes across the Arctic are now physically possible, including the Northwest Passage and the Northern Sea Route. Using these trade routes, merchant ships can cut 1800-4000 nautical miles from a journey between Europe and Asia. One result of this increased navigability is that vessel traffic is rising. Bering Strait transits have

increased steadily from around 220 in 2008 to approximately 350 in 2014. There were more than 400 transits in both 2015 and 2016. Although these numbers are relatively small in absolute terms, they signal real growth in marine activity in a region that already requires additional Coast Guard presence. Potential new shipping routes between the Atlantic and Pacific Oceans and within the Arctic Basin are major drivers for future marine activity in the Arctic.

Oil and gas exploration and recovery, as well as mineral exploitation, are also significant factors affecting future planning efforts. The expansion of open waters along the North Slope of Alaska will likely incentivize increased oil exploration, resource development programs, and the potential for increased adventure tourism. These increases in human activity are taking place in a region that has yet to be surveyed and charted to 21st-century standards, since much of the Arctic had been covered perennially with ice. The receding ice now exposes the seabed to potential exploration and extraction of vast natural resources. The Arctic seabed is rich with oil and strategic minerals. An estimated 13% of the world's undiscovered oil and 30% of the undiscovered natural gas are in the Arctic; the bulk of these resources are located offshore. An estimated $1 trillion worth of minerals, including nickel and zinc, may be available. Offshore drilling and mining projects will undoubtedly increase in direct proportion to the rate of increase in navigable waters, allowing more access to the region.

Warmer temperatures and melting ice also are causing some fish stocks to shift northward, prompting analysts to predict significant changes in Bering Sea fisheries. About 50% of U.S. fish stocks are harvested in the Alaskan Exclusive Economic Zone (EEZ), and fishing vessels are naturally expected to follow fish stocks further north, a development that will draw them further from existing response capabilities and support infrastructure. Where they go, the Coast Guard must follow.

Likewise, the prospects for profitable tourism will find less resistance as waterways open up, as evidenced by the historic *Crystal Serenity* cruise ship expedition scheduled for mid-September. This 30-day voyage from Seward, Alaska to New York City, via the Northwest Passage, is a precedent setting and major milestone in Arctic tourism. The *Crystal Serenity* (Flag: Bahamas), sailing with a scheduled 1,725 total persons on board (1,080 passengers and 635 crew), was to be the largest cruise ship ever to attempt such a voyage. Ensuring safety for this event was a team effort.

In preparation for the *Crystal Serenity* cruise, the Coast Guard hosted

four formal planning sessions, including a voyage-specific emergency response table-top exercise to test emergency plans. Coast Guard personnel were actively engaged in planning with Crystal Cruises for more than a year, planning the route, coordinating logistics, inspecting equipment, evaluating crew training, and exercising joint response drills appropriate to the anticipated challenges and potential emergency situations en route. In the end, Crystal Cruises exceeded every requirement for transits in these regions, including having two ice pilots, hiring the HMS *Shackleton* as an escort vessel, installing ice lights, radar, and countless other passenger safeguards.[2]

When considering worst-case disaster scenarios, adventure tourism is certainly of the greatest concern to the Coast Guard because of the vulnerable population and lack of onboard response capabilities. For example, a cruise ship evacuation for *Crystal Serenity* would have quickly exhausted the resources of all villages in the region as well as any federal or state assets around the region.

As a consequence of these transportation safety challenges, human and economic activity in the northern Arctic region will likely also increase the risk of maritime accidents and general incidents throughout the region, affecting visitors and residents alike. The Coast Guard and other agencies must monitor activity and assess the risks to determine proper responses and resource allocations, including the challenges of harsh climate and vast distances. The Coast Guard's plans for continued involvement in the Arctic are based on assumptions that maritime activity will remain at current levels or increase (but will not likely decrease). At-sea presence, which is essential to protecting American interests, must continue. Planners also assume that climate change and its associated affects will continue to affect the Arctic disproportionately compared to lower latitudes, with losses of sea ice occurring at rates equal to or greater than current rates. Less ice equates to more open waterways, making the Arctic more attractive to industries, fishing enterprises, adventurers, and tourists. As a consequence, Coast Guard operations will have to be responsive to changing mission demands, while respecting the limits of available resources.

A 21st-CENTURY COAST GUARD

The Arctic will be developed further as climate changes increase

accessibility to this once remote and forbidding environment. The Coast Guard monitors Arctic shipping, fishing, and tourism, and has observed rising trajectories in all three areas. Resource development is another form of human activity likely to increase over the next decade. Such development has proven to be successful despite challenging conditions off the coast of Norway, and will undoubtedly emerge in the fertile seabed off the north coast of Alaska. The Coast Guard must be ready to protect U.S. security, economic and environmental interests wherever called upon to do so. It must recapitalize its vessels, aircraft, boats and infrastructure in preparation for these anticipated changes. With many ships in its fleet already exceeding 40 years of service, recapitalizing our heavy icebreakers is particularly crucial to national and homeland security. Only heavy polar icebreakers can ensure year-round access to both polar regions in order to guarantee our sovereign rights, ensure national security, and protect commerce and lives.

Our projected needs include three heavy and three medium icebreakers. At present, we have one medium icebreaker and one heavy icebreaker, which is approaching the end of its service life. All projections for changing environmental conditions and increased human activity in the Arctic suggest that current and planned fleet improvements must be accelerated to respond to the expected increases in demand for Coast Guard services.

Tremendous steps have been made to modernize the Coast Guard, but new assets also require properly trained and equipped people to operate and maintain them. To address the challenges ahead, the Coast Guard must maintain an appropriately sized and trained workforce to address emergent challenges and remain prepared for major contingencies. An increasingly competitive labor market and new personnel policies are also increasing the competition for America's talent. To remain attractive and competitive in this market, the Coast Guard's personnel system must be agile enough to recruit, develop, and retain a diverse and talented future workforce.

The Coast Guard must also continue to demonstrate leadership among the eight Arctic nations and beyond. As the principal architect of the Arctic Coast Guard Forum, the service has forged substantive cooperation among Arctic nations, increased awareness of foreign activity in the Arctic, and helped keep the region peaceful. The Arctic Coast Guard Forum is comprised of the agencies fulfilling the functions of coast guard missions from all the Arctic countries: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States. The Coast Guard also has helped

to shape the IMO Polar Code for vessels operating in the Arctic, and is considered a lead agency for joint operations and exercises that directly support safety of life at sea and the prevention of oil spills. Demands for the Coast Guard's services will only increase.

Notes

1. Noble, Dennis L. and Strobridge, Truman R., *Captain 'Hell Roaring' Mike Healy: From American Slave to Arctic Hero*; and http://www.uscg.mil/pacarea/cgchealy/history.asp.
2. The *Crystal Serenity* completed its voyage successfully in September 2016. Crystal Cruises and other companies are considering similar voyages in the future.

Impacts on Local Communities

Denise L. Michels

Attention to Alaska and the Arctic has increased with the U.S. Chairmanship of the Arctic Council, the historic visit of President Obama to Alaska in 2015 at the time of the GLACIER summit, and an extremely early breakup this year as the "Arctic sea ice extent continued tracking close to levels in 2012."[1] The Bering Strait region in Alaska continued to see an increase in ocean vessel traffic. In 2015 the Northern Sea Route Administration permitted 18 vessels to use the Northern Sea Route, which was a smaller number than the 31 vessels permitted in 2014.[2] The Marine Exchange of Alaska tracked 452 vessels traversing the Bering Strait in 2015, which was an increase from 255 in 2014.[3] Vessel calls at the Port of Nome increased from 498 in 2014 to 635 in 2015.

In 2012, *The World*, a privately owned residential yacht, sailed from Nome to Greenland following Roald Amundsen's journey.[4] In August-September 2016, Crystal Cruise's *Serenity* traversed the Northwest Passage, stopping in Nome before transiting the Bering Strait. This happened before the IMO's Polar Code went into effect. Coincidentally, the Northern Command held its "Arctic Chinook SAR FTX" exercise at Tin City—while the *Serenity* headed to Nome—with United States Coast Guard (USCG) and Joint Base Elmendorf Richardson assets. There was international coordination from every Arctic nation.[5]

There is an ongoing increase in expedition cruise ships in the Alaskan Arctic. The *Hanseatic* and the *Bremen* were traditionally the only cruise ships docking at the Port of Nome after completing the Northwest Passage. Now the Silver *Discoverer, Silver Explorer, Le Boreal, L'Austral, Le Soléal, and the Caledonian Sky* offer expedition cruises through the Northwest Passage and down the Aleutian chain to Asia. Ponant's *L'Austral* cost per person starts at $19,600 for a 22-night cruise from Kangerlussuaq, Greenland to Nome, Alaska via the Northwest Passage.

On the horizon, there are plans to construct more ice hulled or polar-class ships, including expedition-type ships such as the upscale 25,000-gt Crystal *Endeavor*, being built by Germany's Lloyd Werft for operation by Los Angeles-based Crystal Cruises.[6] "Norway's Kleven Vertf yard has been chosen to build two, and possibly four, 600-passenger ice-strengthened

ships for Hurtigruten's expedition voyages in the Arctic and Antarctic regions."[7]

A question emerges: With this increased activity, do we need to build up the infrastructure in the Alaskan Arctic? The Port of Nome is the only medium-draft port north of St. Paul Island, Alaska. The USCG press release of June 24, 2016 reported a Norwegian-flagged chemical tanker, the *Champion Ebony*, ran aground on Nunivak Island, Alaska, though the crew was able to refloat it. The U.S. Army Corps of Engineers (USACE) cancelled its plan to build a deep draft port in Nome, Alaska after Shell pulled out of their Arctic drilling program in 2015.

As a former elected official, I have identified a gap in U.S. Arctic Policy that needs to be addressed by the Arctic Executive Committee in the Executive Office of the President. The Arctic policies of both the United States and the state of Alaska call for infrastructure development,[8] specifically for constructing a U.S. Arctic Deep Draft Port. The U.S. Navigation and Navigable Waters Law (33 USC § 2241) defines a deep-draft harbor as "a harbor which is authorized to be constructed to a depth of more than 45 feet (other than a project which is authorized by section 2020 of this title)."

In March 2013, the USACE and the Alaska Department of Transportation and Public Facilities published the "Alaska Deep Arctic Port System Study." Under Definitions and Acronyms, it states, "The term 'deep-draft' is a term to describe ports that can accommodate large vessels such as big cargo ships. In this report, the Study Team defines "deep draft" as a depth greater than 35 feet water depth (or -35)." (page e)

Under the USACE's Tentative Selected Plan, the cost-benefit ratio (CBR) analysis only identified benefits going to -28' Mean Lower Low Water (MLLW), which does not meet U.S. Arctic Policy requirement of deeper than -45' MLLW.

Russia is expanding its ports. Other nations are utilizing their services and are dependent on Russia. The U.S. needs an Arctic deep draft port for our own presence. It is diplomatically difficult for the U.S. to place sanctions on Russia, since our allies rely on Russia's Arctic port infrastructure through the Northern Sea Route (NSR).

Nome is a Port of Call for Customs. There are no Customs Ports of Call north of Nome. The U.S. is at risk from an increase in international smuggling activities, since there are no national security assets in place in Alaskan waters. Vessels with passengers are disembarking on land and in

communities north of Nome, including kite boarders, jet skiers, hikers, motor vehicles, international swimmers and yachts.

Since there are no national security assets in the Arctic, passengers can disembark at various places north of Nome, then fly from the village where they disembark to Nome. From Nome, they can fly to Anchorage and on to the lower 48—opening a route whereby smuggling activities could infiltrate the U.S. through the Arctic.

The need for Arctic marine infrastructure is abundantly clear, and the time is now to design, fund and build a deep draft port facility to ensure the protection of life, safety, the environment, and natural resources of the United States. An Arctic deep draft port at Nome would effectively meet each of the nation's Arctic strategy priorities and provide a location of strategic importance for national defense assets to protect the sovereignty of the United States.

The President, Secretary of Defense, or Congress could instruct the USACE to construct an Arctic Deep Draft Port in Nome deeper than -36 MLLW per federal regulation's definition and U.S. Arctic policy.

The closest USCG base is in Kodiak, Alaska, more than 800 miles away from the Bering Strait region. It takes more than a day of ocean travel by a cutter, two hours of flight time in a C-130, and five hours by a HM-65 helicopter to access the Bering Strait region. Along the lower 48's western coastline, there are numerous bases and stations between Washington State and California. Alaskan officials view this area as comparable to Western Alaska's coastline from Kodiak to the Canadian border. If we don't include Nome, Alaska, there is a huge gap in adequate response time for the Northern Bering Sea and the waters of Norton and Kotzebue Sounds. Nome is a prime location to allow the USCG to respond more quickly to enforcement issues and emergencies and to monitor environmental concerns.

The USCG's Bering Straits Port Access Route Study is supported by Alaska's indigenous communities, as it would provide a "highway" for all these vessels to use and limit conflict over uses of the waterways between subsistence hunters and the commercial ocean vessel industry. The USCG's District 17 issued a Marine Safety Information Bulletin 01-16 on June 14, 2016 entitled "Voyage Planning Notice for Vessels Transiting the Bering Strait," establishing voluntary measures to follow the established route.

The Arctic Council's Task Force on Arctic Marine Cooperation is discussing ideas for enhancing cooperation in the Arctic.[9] There are two

doughnut holes (high seas areas) in the Arctic. There are international marine governing bodies, including OSPAR, which have agreements for the management of high seas areas.

There are a number of existing legal frameworks for high seas issues:

- The UN Convention on the Law of the Sea.
- The International Maritime Organization's Polar Code.
- The International Convention for the Safety of Life at Sea (SOLAS).
- The International Convention for the Prevention of Pollution from Ships (MARPOL).

Recently the U.S. created a marine protected area at the Hanna Shoal, an exceptionally productive biological hot spot, with little consultation with indigenous residents of Alaska.

Several options to be considered in protecting marine areas are ecosystem-based management arrangements, regional seas agreements, and marine protected areas (MPA).

MPA's should meet three requirements:

1) There needs to be a real reason for the protection.
2) The U.S. government (Executive Order 13175) and the Arctic Council must consult with indigenous residents of the Arctic who have Permanent Participant status. Within the Arctic Council, there is very little opportunity to engage with the delegates unless you are a Permanent Participant representative or an actual delegate.
3) Indigenous residents must have access in the areas for subsistence harvests and related activities.

The Arctic Waterways Safety Committee recommends that the U.S. delegation and the Arctic Council consider geo-fencing in the high seas of the Arctic. Marine mammals are migratory and their migratory patterns are changing in response to climate change. Any governance arrangement should be dynamic and evolve as conditions continue to change

Marine discharges that can affect traditional harvests are a critical concern for our subsistence hunters. The Arctic Waterways Safety Committee is drafting a "Safety Plan"[10] with subsistence hunting coalitions, industry, and state and federal agencies to partly address this issue. "Alaskan Inuit food security is the natural right of all Inuit to be part of

the ecosystem, to access food and to take care of, protect and respect all life, land, water and air. This right allows for all Inuit to obtain, process, store and consume sufficient amounts of healthy and nutritious preferred foods—foods physically and spiritually craved and needed from the land, air and water—which provide for families and future generations through the practice of Inuit customs and spirituality, languages, knowledge, policies, management practices and self-governance. It includes the responsibility and ability to pass on knowledge to younger generations, the taste of traditional foods rooted in place and season, knowledge of how to safely obtain and prepare traditional foods for medicinal use, clothing, housing, nutrients and, overall, how to be within one's environment. Food is a lifeline and a connection between the past and today's self and cultural identity. Inuit food security is characterized by environmental health and is made up of six interconnecting dimensions: 1) Availability, 2) Inuit Culture, 3) Decision-Making Power and Management, 4) Health, and Wellness, 5) Stability and Accessibility. This definition clarifies that without food sovereignty, food security will not exist."[11]

For the last two years, Bering Strait regional leaders have held workshops entitled "Bering Straits Voices on Arctic Shipping." Oil spills are a huge concern, since we have already witnessed the damage that spills cause to the natural resources we need to survive. Discharges from vessels are also a concern, and we need to ensure that foreign-flagged vessels comply with MARPOL Annex IV for sewage discharge. A gap that needs to be addressed is contained in the Polar Code, Chapter 11-Voyage Planning 11.3.7 "current information on relevant ships' routing system, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas," including designated protected areas (such as Hanna Shoal).

The Polar Code, Chapter 4: Prevention of Pollution by sewage from ships 4.2, states the following "Operational requirements:"

1. Comminuted or disinfected sewage in accordance with regulation 11.1.1 of MARPOL Annex IV at a distance of more than three nautical miles from any ice-shelf or fast ice and shall be as far as practicable from areas of ice concentrating exceeding 1/10;
2. Sewage not comminuted or disinfected at a distance of more than 12 nautical miles from any ice-shelf or fast ice and shall be as far as practicable from areas of ice concentration exceeding 1/10.

United States-flagged vessels comply with 33 Code of Federal Regulations (CFR) 151, which governs the management of ballast water, as well as the Clean Water Act, which prohibits discharges within three miles of shore and is enforced by the state of Alaska.

The "gap" that needs to be addressed is that the Polar Code does not mention any raw sewage discharge regulations when marine mammals are present, such as when a herd of walruses or a pod of whales are migrating. We recommend that the Polar Code be amended to address the dumping of raw sewage when marine mammals are present, and that such dumping not be allowed until ships are 12 nautical miles from a pod or haul-out location. Absent such restrictions, it would be the same as a farmer herding cattle through raw sewage before harvesting the cattle for human consumption.

It is vitally important that we protect the environment that Indigenous People rely upon for food security. Kawerak, a regional non-profit organization that supplies services to residents of the Bering Strait Region, recommends reductions in CO_2 emissions. The tribal community and State of Alaska need to continue to take a more active role in addressing climate change.

Due to changing sea ice conditions as a consequence of climate change, limited access for hunting walrus in the northern Bering Sea from May 2013-2015 resulted in poor walrus harvests. The disaster was not due to flooding, earthquakes or typhoons. The food shortage created by climate change impacts on the natural environment contributed to a dire situation, which contributed to food insecurity among many residents. We believe that climate change will worsen as predicted by the scientific community, and our villages will continue to have issues related to access to marine mammals for food security and sustenance. Many rural communities in Alaska do not have piped water or sewer systems; they live in third-world conditions. Many of the United Nation's education, scientific and cultural organizations such as UNESCO and climate change programs such as the Global Environment Facility, along with grants from global banks such as the World Bank, are directed at developing countries. Alaskan communities are not eligible for UN-sponsored climate change adaptation and mitigation programs. One request is that our congressional delegation advocates that the UN accept indigenous communities in developed nations that live in third-world conditions as eligible for UN programs.

USAID, through its Office of U.S. Foreign Disaster Assistance, responds

to international disasters, including slow-onset emergencies such as prolonged droughts that create food insecurity. Communities in the Bering Strait region have a slow-onset disaster related to prolonged climate change issues. These include the impacts of reduced sea ice since 2013, which is causing food insecurity by changing migration patterns and creating accessibility issues for traditional hunters. When foreign countries qualify for USAID disaster assistance money, the program supplies immediate provisions of up to $50,000 so affected communities can coordinate with non-governmental organizations for grants. Alaska and the U.S. should each review statutes and codes to include slow-onset emergencies that lead to food insecurity. USAID programs should consider including indigenous communities for eligibility, when they live in developed nations yet experience persistent third-world conditions. The Center for Climate and Health wrote, "Climate Change in the Bering Strait Region"[12] that speaks further about resiliency and mitigation for our communities.

The North Pacific Fishery Management Council's (NPFMC) Arctic Management plan has closed the area north of the Bering Strait to commercial fishing until further baseline data are collected and studies conducted. We need sound data to ensure sustainability of fishery resources in the U.S. federal waters of Alaska's Arctic, as conditions are changing rapidly and unpredictably. Last year Edward Itta, a former Mayor of the North Slope Borough, posted a picture of a king crab that washed up after a storm. It was the first time in his life he saw a king crab in the Barrow area. The NPFMC's rule is a sound start toward sustainability for future fisheries.

Traditional knowledge is essential to human survival in the Arctic. Kawerak, like the North Slope Borough and Northwest Arctic Borough, has created ocean current maps and maps of marine mammal habitat areas. Each organization's website has posted these documents, which are available to be downloaded.

Notes

1. www.nsidc.org/arcticseaicenews/ July 22, 2016.
2. Northern Sea Route Information Office, *Vessels transited NSR in Y2015 and List of NSR transit voyages in 2014 navigational season.*

3. Marine Exchange of Alaska, *Report of Recorded Transits, Bering Strait, 2009-2015*.
4. Si Liberman, "The World: A floating home for the well-heeled," *The Boston Globe*, February 14, 2015.
5. NORAD and USNORTHCOM, *Arctic Chinook SAR FTX*, May 2016.
6. Jim Shaw, "A Record Number of Cruise Ships on Order," *Pacific Maritime*, July 2016.
7. Ibid.
8. The U.S. Commission on Marine Transportation System and Arctic Marine Transportation Integrated Action Team, *A Ten-Year Prioritization of Infrastructure Needs in the U.S. Arctic*, April 15, 2016.
9. Task Force on Arctic Marine Cooperation (TFAMC), *Co-Chairs Intersessional Non-Paper of November 18*, 2015.
10. www.arcticwaterways.org/safety-plan.html.
11. Inuit Circumpolar Council-Alaska, *Alaskan Inuit Food Security Conceptual Framework: How to assess the Arctic from an Inuit perspective*, Technical Report, 2016.
12. Western Alaska Landscape Conservation Cooperative and Alaska Native Tribal Health Corporation, 2015.

References

http://www.maritime-executive.com/article/mass-arctic-rescue-exercise-begins

http://www.northcom.mil/Newsroom/Article/927866/preparing-for-the-worst-through-practice-exercise-arctic-chinook-2016/

http://www.npfmc.org/arctic-fishery-management/

http://iccalaska.org/wp-icc/wp-content/uploads/2016/03/Food-Security-Summary-and-Recommendations-Report.pdf

http://www.poa.usace.army.mil/Portals/34/docs/civilworks/arcticdeepdraft/ADDMainReportwithoutappendixes.pdf