Northwest Alaska Transportation Plan

# Arctic Shipping: Conditions, Issues and Trends

Draft Technical Memorandum

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## Acronyms and Abbreviations

| | |
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| AMAP | Arctic Monitoring and Assessment Program |
| IAMPE | International Association of Maritime and Port Executives |
| PSC | Polar Security Cutter |
| SAR | Search and Rescue |
| USCG | U.S. Coast Guard |

# Arctic Shipping Analysis: The Arctic Defined

The Arctic extends across the northern regions of North America, Europe, and Asia and includes eight countries and the marine features in between. The Arctic is often defined as the area above the Arctic Circle. A second broader definition is often used to account for the commonalities of various environmental factors. The Arctic Monitoring and Assessment Program (AMAP) has defined the Arctic region as the region that encompasses both High Arctic and sub-Arctic areas[1] (see Figure 1). The AMAP definition accounts for physical, geographical, and ecological features such as climate, vegetation boundaries, permafrost areas, and oceanographic elements. Both definitions are provided for context in the discussion of Arctic issues.


*(Source: John Walsh, International Arctic Research Center)*

*Figure 1. AMAP Arctic Boundary*

[1] AMAPS, https://www.amap.no/about/geographical-coverage

# 1 Introduction

Retreating and thinning sea ice has the potential benefit of opening Trans-Arctic Sea Lanes that will allow more direct commercial passage of vessels between Asia and Europe. Two primary routes have been navigated in recent years: the Northwest Passage and the Northern Sea Route. The Northwest Passage, the primary concern of this memorandum, enters the Arctic through the Bering Straits between Alaska and the Russian Federation, and then heads east along Alaska, Canada, and Greenland's Arctic Coasts. The Northern Sea Route, which has experienced more shipping activity, enters from the Bering Straits and then heads west along the Russian Federation's Arctic Coast to Norway. This memorandum provides an assessment of current conditions relative to shipping in the Arctic. It discusses the developments and actions that will encourage future shipping operations in the Arctic as well as the limitations.

# 2 Northwest Passage

The Northwest Passage is considered to be various ocean routes between the Atlantic and Pacific through the Arctic Region (see Figure 2). It connects Asia and Europe along the northern coast of North America following Alaska's Arctic Coast, through the Canadian Arctic Archipelago, and enters the Atlantic Ocean beyond Greenland. There are several route options through the Canadian Archipelago which would be utilized based on existing environmental conditions and the amount of open or limited ice bond water.

*(Source: IAMPE)*

*Figure 2. Arctic Northwest Passage Routes*

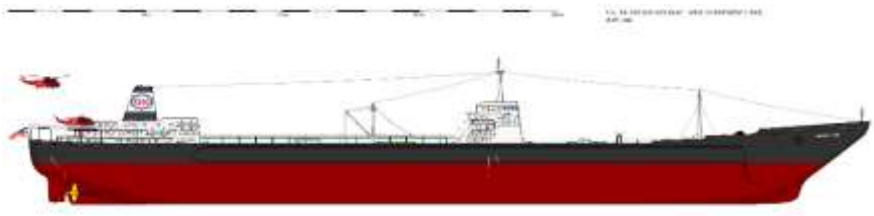
Arctic sea ice historically covered more than 2,100 nautical miles of ocean. The shorter distance between the Atlantic and Pacific oceans has long been considered a possible ocean-going route for vessels; however, the ice has been a significant physical barrier to developing the waterway as a global trade route. No commercial cargo ship has crossed the central Arctic Ocean over the North Pole, although there have been trans-Arctic voyages during summer along the Russian Federation's Northern Sea Route and the Northwest Passage. Vessel transits have normally required assistance by modern icebreakers, which led merchant ships with reinforced hulls in a convoy.[2] The amount of ice present has declined in

[2] Arctic Marine Shipping Assessment. 2009. Challenges of Trans-Arctic Navigation

recent years which has reignited interest in using the route for commercial activities. In 2007, the ice had sufficiently thinned to allow for passage without the aid of an icebreaker.[3] Depth along the route is near 50 feet along the surveyed areas, which is sufficient for the safe passage of large commercial vessels.[4]

Sovereignty along the Northwest Passage is contested. Canada considers many of the waterways as Canadian Internal Waters, and maintains that ships entering the passages must report to the Canadian Government.[5] The United States, as well as several European nations and Russia, consider the area to be in international waters, and transit by any vessel of any flag is permissible.

The tanker SS MANHATTAN was the first commercial ship to transit the Northwest Passage, in August 1969 (see Figure 3). The 115,000 deadweight tonnage ship was modified and equipped with a special icebreaker bow and structurally enhanced. Several German-based commercial ships made the passage in 2009. The 69,000-gross-ton cruise ship CRYSTAL SERENITY (see Figure 3) sailed from Vancouver, Canada, to New York in 28 days, and carried 1,500 passengers. It was the largest cruise ship to make the transit to date.



*(Source: Lazerone)*

*(Source: Crystal Cruises)*

*Figure 3. Tanker MANHATTAN (left) and Cruise Ship CRYSTAL SERENITY (right)*

# 3 Current Arctic Shipping Activities

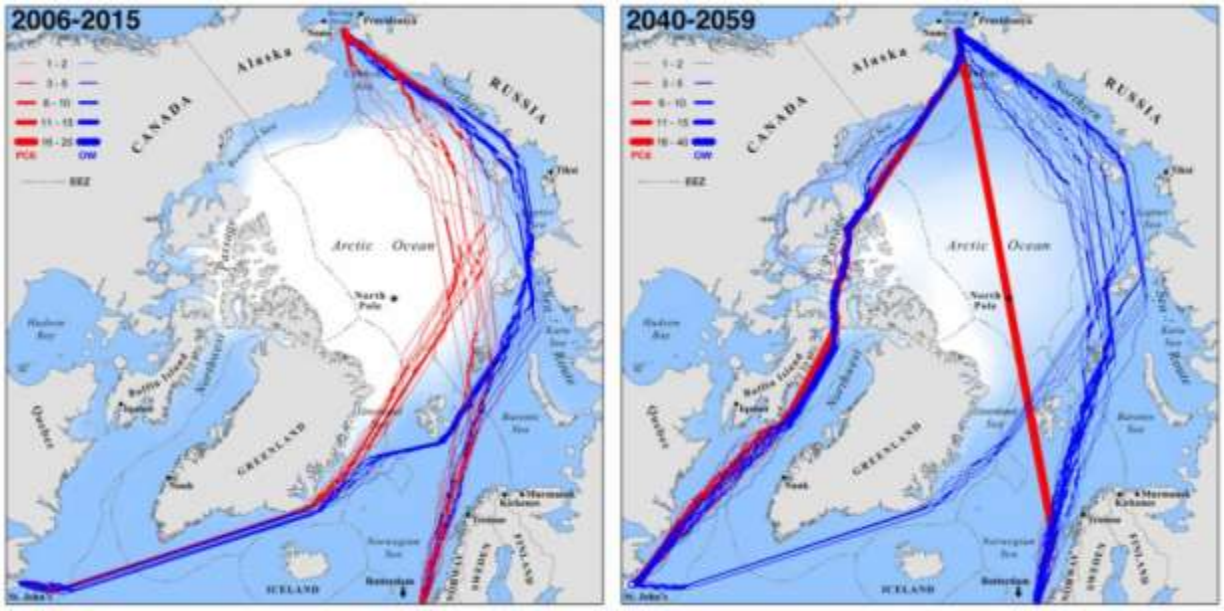
Changing Arctic ice conditions are making the opening of new potential transit routes for cargo and shipping possible. These routes are expected to open even farther if sea ice continues to retreat, as is predicted by many scientists.[6] Immediate use of this potential new passage is estimated to be costly, and higher utilization may not occur until mid-century.[7]

Routes directly over the North Pole could open for ice-breaking cargo ships by 2030 if the current climate warming trend continues. These specially built, ice-classed vessels have the ability to operate in sea ice up to 4 feet thick. It is also estimated that if the current warming trend continues, by 2045 to 2060, further reduction of Arctic sea ice could allow standard built and operated cargo ships to journey directly over the North Pole as well as to traverse the northernmost Northwest Passage routes (see Figure 4).[8] A passage between Europe and Asia over the North Pole could average between 22 and 25 days compared

[3] Britannica, Northwest Passage and the Arctic Region
[4] Arctic Voyage Planning Guide, Fisheries Canada
[5] *Ibid.*
[6] Patel, J.K., and H. Fountain. May 2017. As Arctic Ice Vanishes, New Shipping Routes Open
[7] *Ibid.*
[8] *Ibid.*

to almost twice that amount of time when made through the Panama (45 days) or Suez (55 days) Canal. There could also be transits into the region to provide supplies to communities and resource developments, as well as cruises designed for tourists.

Although there is increased interest in commercial transit from Asia to Europe via the Arctic Ocean, the primary goal of transport throughout the region is anticipated to be destination-based traffic related to natural resource development and regional trade. New economic linkages in the Arctic to global markets are influenced by commodities prices for scarce natural resources, including oil and gas, nickel, zinc, palladium, copper, platinum, and high-grade ore. Existing and expanded Arctic marine transport systems and commercial ship traffic are primarily tied to the global demand for these resources.[9]




*(Source: National Oceanic and Atmospheric Administration)*

*Figure 4. Current Ice Coverage (left) and Predicted Change in Ice Pack with Predicted New Routes (right)*

Navigation has its challenges and limitations. Icebreakers, oil and gas exploration vessels, several cruise ships, smaller Chinese cargo ships, and a Maersk Line container ship have used the Northern Sea Route off the Russian Federation's coast in the last several years.

In September 2018, the Maersk Container Ship VENTA MAERSK arrived at the Port of St. Petersburg, Russia, after successfully completing a trial passage of the Northern Sea Route (see Figure 5). The VENTA MAERSK is one of Maersk Line's new Baltic feeders. The vessel began its voyage in August 2018 from the Port of Vladivostok, Russia. The route took the VENTA MAERSK through Bering Strait on the way to Bremerhaven. The vessel arrived in St. Petersburg 37 days after the voyage began. The ship has a capacity of just over 3,500 Twenty-foot Equivalent Units and is the fourth of seven ice-classed vessels built by

[9] Arctic Knowledge Hub, Challenges of Trans-Arctic Navigation, 2018

Maersk for Baltic trade. These vessels are designed in a manner to operate effectively in cold ambient air temperatures and environmental conditions including wind chill down to -25 degrees Celsius.[10]

*(Source: IAMPE)*


*(Source: Maersk Lines)*

*Figure 5. Russian Icebreaker Escorting Cargo Ships through the Northern Sea Route (left); Container Vessel VENTA MAERSK (right)*

Silversea Luxury Cruises has developed a number of Arctic itineraries for 2019. The luxury cruise line will operate exploration-style cruises for passengers using its 6,072-gross-ton, 144-passenger vessel MS SILVER EXPLORER (see Figure 6). The line is also refurbishing the MS SILVER WIND, which is similar in size to the SILVER EXPLORER, for Arctic and Antarctic cruises. Silversea also operates a similar vessel, MS SILVER CLOUD, in those regions. Hurtigruten is planning on operating three new 350-passenger ships in the Arctic region. These include the MS ROALD AMUNDSEN, launched in 2018 (see Figure 6), the MS FRIDTJOF NANSEN, which is under construction, and an additional new ship that is planned for construction. The vessels will be ice-classed, with a length of 459 feet, beam of 79 feet, gross tonnage of 20,889 mega tons, and speed of 15 knots. The vessels are designed with hybrid propulsion, which uses both electric and conventional fuel-based systems.

*(Source: Courtesy Silversea Luxury Cruises)*

*(Source: Hurtigruten Cruises)*

*Figure 6. MS SILVER EXPLORER (left) MS ROALD AMUNDSEN (right)*

[10] Maersk Line Press Release, September 25, 2018

# 4 U.S. Coast Guard Arctic Program

The operational U.S. polar icebreaking fleet currently consists of one heavy polar icebreaker, the Polar Star, and one medium polar icebreaker, the Healy. The Polar Star entered service in 1976 and is now well beyond its originally intended 30-year service life.

The U.S. Coast Guard (USCG) is currently in the process of developing its Arctic Program under the Office of Arctic Policy. This includes the USCG Polar Security Cutter (PSC) program, previously known as the polar icebreaker program. The intent is to acquire three new heavy polar icebreakers, to be followed later by the acquisition of up to three new medium polar icebreakers.[11]

In February 2019, Congress passed a funding bill that was signed into law that included a total of $675 million for the PSC program—$655 million to fully fund the first PSC and $20 million for long-lead-time materials for a second PSC. The Department of Defense Contracting Office announced in April 2019 that VT Halter Marine, Inc., of Pascagoula, Mississippi, has been awarded the contract to build the nation's first new heavy PSC in more than 40 years.[12]

To address Canada's territorial claims Arctic governance concerns, the USCG has signed an agreement with the Canadian Government to undertake passage in the claimed territorial waters. Proposed transits by U.S. Navy vessels would most likely require a similar agreement.[13]

# 5 Vessel and Operational Requirements

Vessels intended for use in Arctic waters must be ice-classed based on international requirements. These requirements are delegated to vessel classification societies that certify that construction standards are met when vessels are designed and built. In addition to construction, standards include operational requirements related to shipboard systems designed to handle cold weather environments.

Vessels are constructed and outfitted according to internationally standardized rules for one of seven Polar Classes ranging from Polar Class 1 for year-round operation in all polar waters to Polar Class 7 for summer and autumn operations in thin, first-year ice. Standards are contained in the Unified Requirements for Polar Class Ships, which are developed and maintained by the International Association of Classification Societies. These internationally standardized rules ensure that the classification societies from other nations are consistent in their requirements for vessels operated in polar waters. The International Maritime Organization has developed requirements that are published in their Guidelines for Ships Operating in Arctic Ice-covered Waters. Fisheries Canada publishes the Arctic Voyage Planning Guide for vessels making the transit. The Swedish Maritime Administration, Finish Transport Safety Agency, USCG, Transport Canada, and several other maritime nations have various forms of navigation guides and construction standards available for vessels. The American Bureau of Shipping, Russian Maritime Registry of Shipping, and Det Norske Veritas are some of the classification societies that certify

[11] *Congressional Research Report, Coast Guard Polar Security Cutter (Polar Icebreaker) Program, February 2019*
[12] Press Release from the Office of Senator Lisa Murkowski, "Alaska Congressional Delegation Welcomes Progress on Icebreaker: Contract Awarded for New Polar Security Cutter," April 23, 2019.
[13] U.S. Coast Guard Office of Arctic Policy, March 2019.

ice-class vessels. Canada has also established the Canadian Arctic Shipping Pollution Prevention Regulations to address pollution issues in Canadian territorial waters.

# 6 Challenges

In addition to the need for ice strengthened vessels and cold weather operating systems, there are a number of identified challenges that impact safe navigation in Arctic waters, especially through the Northwest Passage. Arctic conditions can change rapidly, and navigation requires as close as possible to real-time awareness of ice conditions, including ice coverage, thickness, and drift. Satellite navigation, which is heavily used by vessels, experiences degraded coverage at high latitudes. Atmospheric phenomena (e.g., Aurora Borealis) can also degrade the general accuracy and availability of satellite positioning. Overall visibility is often poor, radio communications coverage is inconsistent, and maps and nautical charts are not accurate in all surveyed areas.[14]

Multiple global satellite navigation systems exist, including Global Positioning System (United States), Global Navigation Satellite System (Russia), Galileo (European Union), and BeiDou systems (China). Each has limitations associated with satellite signal degradation, geo-spatial positioning, and deployment.[15] Systems are undergoing upgrades in anticipation of Arctic navigation. For example, Galileo modernization includes the addition of Advanced Receiver Autonomous Integrity Monitoring, an emergency warning service, and an ionosphere prediction service, which will make it possible to quickly react to sudden signal degradation.[16]

Rapid modification of radio waves by small-scale structures in the ionosphere is an important concern in the Arctic region, primarily for service availability and continuity rather than signal integrity. Dual-frequency global satellite navigation (e.g., Global Navigation Satellite System) offers a possible solution, as it would allow users to estimate ionospheric delay, and would provide the ability to correct positions.[17] The deployment of High Earth Orbit satellites would provide expanded and more accurate coverage of navigation in the Arctic region.

Finally, search and rescue (SAR) capability is a key issue. In addition to the difficulties encountered by users of satellite navigation systems for accurate positioning, the deployment of SAR assets is a significant concern. Effective SAR capabilities involve the pre-positioning of vessels and aircraft that allow for quick response coverage in a geographic area. In 2011, the United States signed the Arctic Search and Rescue Agreement, which is a treaty that gives the United States responsibility for conducting SAR in the territory that surrounds Alaska and stretches to the North Pole. In general, the United States has the technical capacity to respond to Arctic SAR scenarios, but not without encountering challenges that may impede successful operations (see Figure 7).[18]

Challenges facing the United States in conducting SAR include:

- Overcoming Arctic weather conditions

[14] ARKKI PROJECT (Finland), Challenges in Arctic Navigation, International Conference Survey, April 2018.
[15] Marine Radionavigation and Communications, Monroe, Cornell Maritime Press.
[16] European Global Navigation System Agency Workshop Report, April 2018.
[17] *Ibid.*
[18] Search and Rescue in the Arctic, Smith, Rand Graduate Program, 2016.

- Deploying assets and geographic capabilities
- Supporting survivors
- Overcoming a lack of medical services
- Coordinating SAR responses between multiple organizations and nations

Overall, these issues will have to be addressed by the United States (agencies and the military) and by cooperating agencies in various nations within the region.


*(Source: Rand/Smith)*

*Figure 7. Geographic Challenges Associated with Effective SAR Capability for the United States*

# 7 Summary

The variability of sea ice and the uncertainties associated with transit times make predicting the use of Arctic sea routes by marine operators, certain vessel types, and trades highly speculative. It remains uncertain how long the ice-free period will last during late summer, or exactly when it will occur in any given year. It could be as brief as a few days or weeks, or nearly ice-free conditions could last considerably longer in the central Arctic Ocean. However, most of the potentially navigable spring, summer, and autumn months should remain covered with ice that may be thinner, but more mobile and navigable than in previous decades.[19]

The year-to-year variability of sea ice in coastal seas and straits is uncertain. This will impact the evaluation of risk for insurance purposes and determination of the overall reliability of Arctic marine

[19] Search and Rescue in the Arctic, Smith, Rand Graduate Program, 2016.

routes. The length of the navigation season in all Arctic regions remains uncertain, posing a significant challenge to the prediction of actual navigational routes.[20]

For example, large liquefied natural gas carriers and oil tankers may not be used for trans-Arctic trade routes. Future oil and natural gas pipelines built from sources to transship locations may compete with oil and gas carriers to bring Arctic resources to market by reducing the demand for vessels on northern routes.[21] Transport through pipelines is more cost-effective over time than by ship; however, the initial high cost of pipeline infrastructure investment and the permitting requirements are significant challenges. Ships offer more flexibility, particularly with changing market demand.

The challenges for container traffic and carriers using trans-Arctic routes are significant, including schedule reliability due to transit and voyage variables, and tight supply chain and logistic requirements. The potential impacts on the safety of ships, personnel, and cargo, as well as the actual fuel costs and time savings—given that ice navigation is required on at least a portion of various routes—are significant. The costs associated with investment in ice-class ships would also be a major issue, since their operation in non-Arctic trades would not be cost-effective if year-round Arctic operations could not be achieved.[22]

Other trade options may be more viable. Several types of dry-bulk and break-bulk carriers could conceivably use seasonal trans-Arctic routes. Bulk metal ores and concentrates, which can be stockpiled at a mine or destination port similar to Red Dog Mine's current operations, could be shipped along Arctic routes and across the central Arctic Ocean. Suitable ice-class ships would have to be built or be readily available for charter. Break-bulk carriers of forest products and pulp might use the Northern Sea Route to trade from northern Europe to Pacific and North American ports. It is reasonable to assume that experimental voyages of a commercial ice classed vessel to test the operational and technical challenges associated with trans-Arctic navigation could take place within the decade.[23] Such vessels may or may not require escorts depending on ice conditions.

Observations and measurements of Arctic sea ice indicate a decrease in coverage areas and thickness during the past 50 years. Various global climate models for ice coverage and thickness predict that areas of the coastal Arctic Ocean with partial ice coverage or open water will continue to expand. Although currently no credible scientific source indicates that there will be a complete disappearance of the Arctic sea ice, some models indicate a strong possibility that large portions of the Arctic Ocean will be ice-free for a short period of time in late summer if current trends continue.[24]

Global satellite navigation systems coverage, SAR capabilities and response, territorial challenges, and the environment make Arctic navigation challenging. While it is not anticipated that the Arctic routes will replace current primary logistical pathways and supply chain routes, the use of Arctic routes, particularly in certain bulk commodity trades, will likely continue to expand.

[20] Search and Rescue in the Arctic, Smith, Rand Graduate Program, 2016
[21] European Global Navigation System Agency Workshop Report, April 2018
[22] *Ibid.*
[23] European Global Navigation System Agency Workshop Report, April 2018
[24] Arctic Knowledge Hub, Challenges of Trans-Arctic Navigation, 2018

The critical near-term actions by Arctic nations and industries need to focus on improving safe navigation, vessel safety, SAR response, and environmental protection, and on implementing necessary governance requirements and programs to make Arctic shipping more viable.