GERMAN
ARCTIC OFFICE

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

FACT SHEET

CURRENT KNOWLEDGE ON THE THEME:

Shipping in the Arctic

The consequences of climate change are more clearly felt in the Arctic than in any other region of the world. The particularly strong rise in temperatures in the high latitudes causes a rapid decline in sea ice (Fig. 1) and threatens the existence of highly sensitive ecosystems (see AWI Fact Sheet „Climate Change in the Arctic"). But the dwindling ice is also making regions and sea routes more accessible, which for a long time were reserved for adventurers, research expeditions and indigenous peoples: The Arctic sea routes, connecting the Pacific and Atlantic north of the continents. In addition to shorter distances between world markets, intra-Arctic traffic, combined with resource depletion, is also playing an increasingly important role in this region.

What are the impacts of climate change on Arctic sea ice?

The phenomenon of „polar amplification" has led to a particularly high temperature rise in the Arctic since the beginning of industrialization - two to three times as high as the global average. This has resulted, among other things, in an ever-earlier onset of ice melting in spring and a later freezing of the ice cover in autumn. Between 1979 and 2013, the melting period in the Arctic extended by five days per decade[1]. In addition, the proportion of ice that has survived a melting season - the so-called perennial ice - is decreasing. During the absolute sea ice minimum in September 2012, this proportion was below 50% for the first time since satellite measurements began in 1979 (see AWI Fact Sheet „Sea ice").

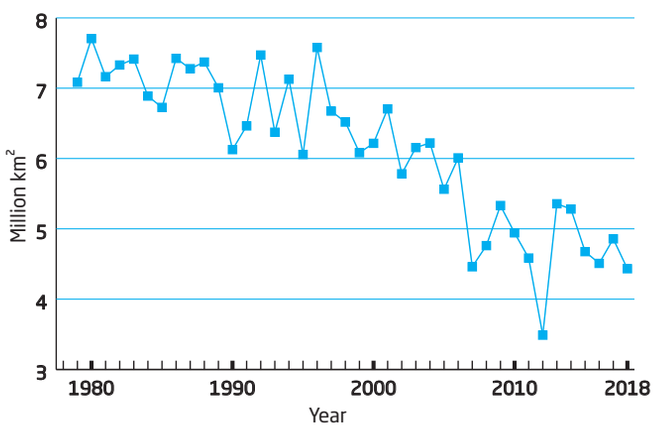

Figure 1: September means of sea ice expansion in the Arctic 1979 to 2018. From September 1979 to 2018, sea ice decreased by 37%. This means a decrease in sea ice extent in September months of 13% per decade[2]. Adapted from Grosfeld et al. (2019)[A].

- The average thickness of sea ice has decreased within the last 30 years from over three metres to less than two metres[3].
- Between 1979 and 2018 about 70% of the ice volume has already melted during the summer minimum[4].
- Approx. three square metres of sea ice melt per tonne of anthropogenic CO_2[5].

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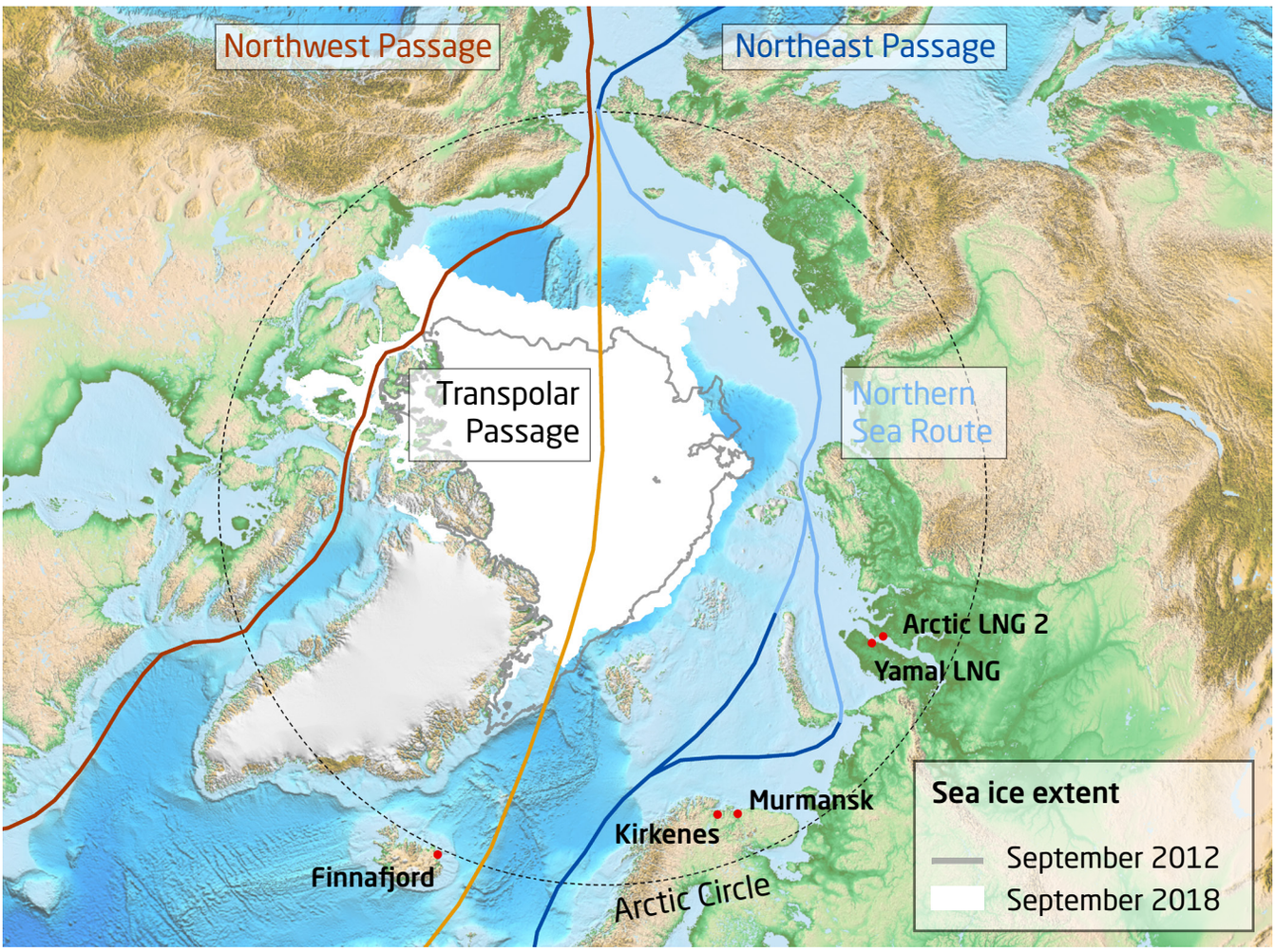

Figure 2: There are three routes for crossing the Arctic Ocean. The Northeast Passage along the Russian and Norwegian coasts is currently the most promising route[6] due to the more favourable ice conditions and better navigability compared to the Northwest Passage and Transpolar Passage. Based on data from Grosfeld et al. (2019)[A] and ARMAP (2019)[B].

What significance do environmental changes have for shipping in the Arctic?

At present, navigation along the Northeast Passage in open water is possible in four to five months between July/August and November[7]. Forecasts always show that the time window for crossing the Northeast Passage could be four to six and a half months longer by the end of the 21st century due to the earlier onset of ice melting in spring and the subsequent freezing in autumn[8]. Three trans-Arctic routes are particularly the focus of the investigations (Fig. 2):

Northwest Passage (NWP)

The Northwest Passage runs mainly through Canada's internal waters, some of which are also covered by thick ice in summer[9]:

» 36,000 islands in the region affect navigability

» The route is mainly used for inner-Arctic traffic and by private (sailing) yachts[9]

Transpolar Route

The route crosses the Central Arctic Ocean:

» The ships would for the most part be sailing in international waters and could thus avoid national regulations and user charges

» Probably unprofitable for several decades to come due to ice conditions and risks[10]

Northeast Passage (NEP)

The sea route runs along the Russian and Norwegian coasts and through their exclusive economic zones (EEZ):

» The Northern Sea Route (NSR) is part of the Northeast Passage, under Russian administration and open to non-Russian vessels since 1991[11]

What is the difference between trans-Arctic and intra-Arctic transport

When considering shipping traffic in Arctic waters, the distinction between starting point and destination of the itineraries is of great importance. A distinction is made between inner-Arctic and trans-Arctic traffic. In addition, the type of transported goods is decisive for the flexibility in voyage planning, which plays an important role for shipping in partly ice-covered waters (see right-hand infobox).

Example Northern Sea Route: Between 2008 and 2013 shipping activities along the NSR increased rapidly and declined again in the following years (Fig. 3a). One reason for the sharp decline after the maximum in 2013 could be a drop in fuel prices, as a result of which journeys along the Southeast Route in southern Asia (Fig. 4) became more profitable again[12].
A closer look at ship activity along the NSR reveals, however, an increase in trans-Arctic transits in which both the port of departure and the port of destination are outside Russia in the years 2015 to 2018. However, these data are only available from 2015 onwards (Fig. 3b).

Inner-Arctic[13]

- Start or end point of a journey or entire journey in the Arctic
- Transporting resources extracted in the Arctic, e.g. oil or liquid natural gas (LNG)
- Supply of Arctic settlements
- Tourism (especially cruises)

Trans-Artic

- Start and end points outside Arctic waters
- Use as transport route

Liner shipping

- Transport of cargoes from various suppliers in containers
- Tied to regular schedules and integrated into various supply chains - comparable to a bus[14]
- Timetables are often set months in advance
- Could be profitable in these waters from 2040 with a longer ice-free Arctic in summer[9]

Bulk shipping

- Bulk goods transport in tanks (e.g. grain, petroleum), as well as large-scale equipment
- Driving on demand - comparable to the contract model of a taxi
- Flexibly adaptable to seasonal fluctuations and Arctic uncertainties
- In particular, the transport of resources from the Arctic to non-Arctic regions is expected to increase[15]

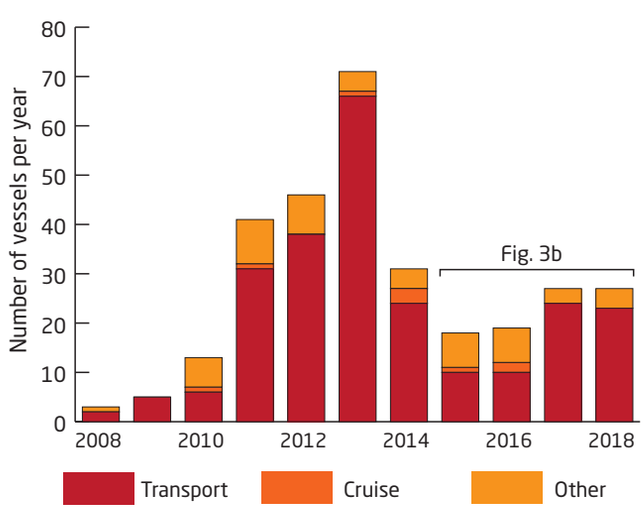

Figure 3a: Number of all ship activities along the NSR. These include intra-Arctic and trans-Arctic voyages. Intra-Arctic traffic also includes voyages within Russia. Bulk and liner shipping are combined in the ‚Transport' category. Based on data from Guy & Lassette[C] and CHNL[D].

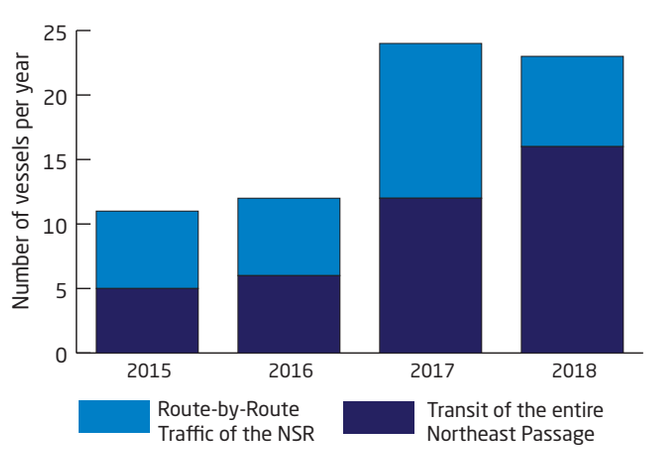

Figure 3b: Inner-Arctic and trans-Arctic transport. Travelling within Russia is part of intra-Arctic transport. The number of transits of transport vessels with start and end points outside Russia (dark blue) has risen continuously in recent years. Based on data from CHNL[D].

What are the advantages of Arctic sea routes?

The increased use of trans-Arctic sea routes as abbreviations of global trade routes is based on the sometimes significantly shorter distances and travel times compared to traditional routes. For example, a trip on the Northeast Passage offers a 30 to 40% shortening of the route between Northwest Europe and East Asia compared to the route through the Suez Canal (SCR)[9].

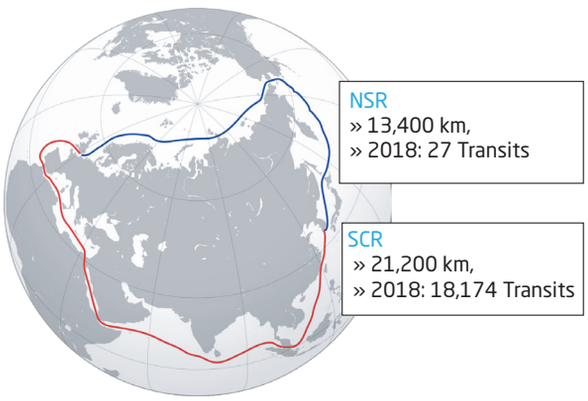

Figure 4: Sea routes between Rotterdam and Yokohama via the Northeast Passage and the route through the Suez Canal (SCR). The figure indicates the route length and the number of NSR and SCR passages. Adapted from Knopp-Schwyn & Turkish Flame[E], data based on CHNL[D], Lasserre[F] and Suez Canal Administration[G].

Further advantages:

» Time saving (journey from Rotterdam to Yokohama):
SCR (at 20 knots): 24.5 days
NSR (at approx. 17 knots): 18.3 days pure travel time, without waiting times and stops[13]
» Significant fuel savings compared to traditional routes[11]
» No risks from piracy, as may be the case on sections of the Suez Canal route.

What limitations are there?

Although the shorter sea routes in the summer months already offer significant time and fuel savings, the number of completed transits along the NSR is very low compared to the SCR (Fig. 4). Many factors still speak against an intensive use of the Arctic route:

» Fee required for use of NSR and mandatory accompaniment by Russian icebreakers
» Maximum width of ships 30 m (fairway of icebreakers), on the SCR up to 60 m ship width possible[9]
» Maximum draught of 12 m due to shoals[9]
» Lower cargo capacity of ice-compatible ships
» High insurance premiums in Arctic waters (20 to 100% above standard prices)[14]
» Lower speeds: 20 knots in open water (SCR and NSR), 12-15 knots in ice-covered waters (NSR)[15]
» Admission of a chargeable ice pilot
» Unpredictability of ice conditions problematic for liner shipping with fixed schedules.

Of 26 studies that have investigated trans-Arctic shipping, 13 include a possible profitability, 6 do not take a clear position and in 7 the conditions are still seen as too problematic[13].

„Ice-going tankers and container ships are not profitable in other waters because they have too little capacity due to the thicker hull".

Dr Jürgen Holfort,
Federal Maritime and Hydrographic Agency

What are the latest developments and country-specific activities?

Russia

» Rosatom nuclear group has been responsible for NSR administration since 2018[16]
» Yamal LNG terminal in Sabetta commissioned in 2017[17]
» Construction of 15 ice-compatible LNG tankers commissioned, seven of which are already transporting LNG via the NSR to East Asia[17]

Scandinavia

» Deepwater port in Arctic Kirkenes (Norway) with train connection to Oulu (Finland) is planned[18]
» Danish shipping company Maersk tests conditions for container shipping on the NSR[19]
» The German port management company Bremenports is planning the construction of a deep-water port in the Icelandic Finnafjord, which, among other things, has been designed as a trans-shipment point for shipping on the Northeast Passage[20].

Canada/USA

- Since December 2017 new national regulations for shipping in the Canadian Arctic (Arctic Shipping Safety and Pollution Prevention Regulations / ASSPPR)[21]
- U.S. Coast Guard plans to build three more Polar Security Cutters for the Arctic Fleet[22]

China

- Establishment of a „Polar Silk Road" planned as part of the Belt-and-Road Initiative[17]
- The Chinese oil and gas companies CNOOC and CNODC will receive a 20% stake in the LNG extraction in Nowateks project „Arctic LNG 2"[23] as project partners.

What are the challenges for the marine infrastructure in the Arctic?

A prerequisite for a safe and sustainable handling of the increasing shipping traffic in the Arctic is the expansion of the marine infrastructure and the establishment of sea rescue facilities.

- In total, approx. 6% of Arctic waters are mapped according to international standards[14]
- Low density of search and rescue infrastructure, particularly along the eastern NSR and the Canadian part of the Northwest Passage[6]
- Port capacities are not yet designed for an increase in navigation
- Satellite coverage and communication capabilities are only rudimentary in both the Russian and Canadian Arctic[9].

How is cruise tourism developing in the Arctic?

An increase in cruise tourism in the Arctic is currently limited mainly to Greenland, Iceland and Spitsbergen, but more and more companies are also operating on trans-Arctic routes:

- 2014: First non-Russian cruise ship on the Northeast Passage (MS Hanseatic, 300 passengers)
- 2017: Crystal Serenity (1700 passengers) crosses Northwest Passage for the first time[6].

What are the environmental risks?

An increase in shipping in the Arctic can lead to environmental pollution, the consequences of which are sometimes difficult to assess. A large number of marine mammals and migratory birds could also be affected by increasing shipping traffic during their migratory movements.

Photo: AWI / Stefan Hendricks

The most important environmental risks

Introduction of invasive species

» Hull growth, ballast water draining or freight discharge possible[24]
» Due to higher water temperatures as a result of climate change, the risk of invasive species from the south settling is already increased

Oil pollution

» Oil contamination of insulating layers can cause cold deaths in many marine species[6, 24]
» High long-term damage to the environment in the event of an accident, as damage repair is made more difficult by sea ice cover, extreme cold and possibly polar night

Regular discharges of wastewater and greywater

» May contain harmful bacteria, chemicals and plastics that have particularly long decay/degradation times under cold arctic conditions
» In particular, cruise ships can increase the load significantly
» No serious threat at this time, as long as government (e.g. Polar Code) must be complied with[24].

Emissions

» In addition to CO_2 emissions, soot particles (black carbon) are particularly problematic. The reflectivity (albedo) of sea ice is reduced through soot particles on the ice (mainly from heavy oil) and the ice melt is thus intensified[25]

Underwater Noise

» Noise from sonar and ship propulsion can cause physical damage and disorientation in marine mammals
» Icebreakers make more noise than other ships[6]
» Ships and marine mammals in the Arctic frequently use the same narrow passages along NSR and NWP[6]

What are the regulations?

The framework conditions and regulations for global shipping are drawn up by the UN Special Organisation „International Maritime Organisation" (IMO). With the Polar Code, the IMO has laid down the following principles for shipping in Arctic waters:

Polar Code (2017)[26]

» Contains binding rules and recommendations for ship activities in Arctic waters north of 60°N
» Ship Design: Ship Categories A, B and C: Assessment of the ice conditions in which a ship may operate in Arctic waters
» Environmental protection: „Encouragement" to refrain from using heavy fuel oil - already prohibited in Antarctica
» Training: All officers and crew members who work in navigation must be specially trained for Arctic ice conditions.

Agreements initiated by the Arctic Council

(see AWI Fact Sheet „Arctic Council")

» Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (2013)
» Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (2011)

Bottom line

As a result of the progressive decline in sea ice, the Arctic is moving more into the focus of trading nations and shipping companies that see potential for seasonal use as a sea route between world markets. The increasing resource extraction in the region also leads to an increase in intra-Arctic shipping and resource transport to non-Arctic ports. The harsh environmental conditions of the Arctic, a low rescue infrastructure and shoals along the routes are only a few examples of factors that make regular use of Arctic sea routes difficult. In addition, higher insurance premiums, icebreaker accompaniment and the requirements of the Polar Code add costs that need to be weighed when considering profitability compared to traditional sea routes. Finally, the risks to the fragile Arctic environment associated with an increase in shipping also play an important role.

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