ARCTIC NAVIGATION ROUTES: PAST, PRESENT AND FUTURE – STRATEGIC, GEOPOLITICAL AND NAVAL IMPLICATIONS OF THE NORTHWEST PASSAGE AND THE NORTHERN SEA ROUTE –

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The retreat of Arctic sea ice has transformed the Northwest Passage (NWP) and the Northern Sea Route (NSR) from historical curiosities into emerging maritime corridors. Although still limited by environmental, infrastructural and legal uncertainties, these routes are gaining increasing geopolitical and military significance. The paper reviews recent statistics on transits, major Arctic ports and military bases, as well as state strategies, placing Arctic shipping routes in the broader context of global security and trade.

The results show that, although Arctic shipping remains marginal compared to the Suez or Panama Canals, its symbolic and strategic value is growing rapidly. Naval operations, sovereignty disputes and competition between major powers are likely to intensify in the region, requiring cooperative governance mechanisms to prevent militarisation and environmental degradation.

Keywords: Northern Sea Route; military infrastructure; deterrence and submarine operations; autonomous underwater vehicles; Arctic naval operations;

INTRODUCTION

The Arctic has long been perceived as a frozen frontier, accessible only through sporadic explorations and temporary expeditions (AMAP, 2017). AMAP's (Arctic Monitoring & Assessment Programme) geographical coverage extends from the polar Arctic to the sub-Arctic areas of Canada, the Kingdom of Denmark (Greenland and the Faroe Islands), Finland, Iceland, Norway, the Russian Federation, Sweden and the United States, including associated marine areas. AMAP has established a circumpolar region as the focus for its assessment activities, which includes both high Arctic and subarctic areas. In the marine environment, the *"AMAP area"* includes the northern seas extending to 51°10'N (James Bay, Canada). Within this region, 10 *"key areas"* have been identified for coordinated pollution monitoring studies. Historically, The Northwest Passage/NWP is known as the desire of people to have a navigable route through the ice between the Canadian Arctic Archipelago and the continent, originating in the 16th century under the name of the Anian Strait – a fictitious sea route between the Pacific and Atlantic oceans sought by Spanish explorers. In practice, the NWP consists of multiple straits and channels crossing the Arctic Archipelago, connecting the North Atlantic, via Davis Strait, with the Beaufort and Chukchi Seas and, ultimately, the North Pacific (Byers, 2013) *(Figure 1).*

The NWP is often presented as a potential *"revolutionary breakthrough"* for trans-Arctic transport between Asia, North America and Europe. However, its navigability remains constrained by seasonal ice variability, shallow straits and a lack of large-scale infrastructure (Scott Polar Research Institute, 2024). Despite these obstacles, climate change has significantly altered the outlook: ice retreat has made both the NWP and NSR more accessible for commercial and military navigation (IPCC, 2023) *(Figure 2).*

From a geopolitical perspective, the United States wants the Northwest Passage to have the status of an international strait, as opposed to Canada's position, which grants it the status of internal waters under Canadian sovereignty, with significant international implications for maritime transport in the Arctic (Huebert, 2019). Similarly, the Northern Sea Route along the Arctic coast of the Russian Federation is considered by Moscow to be a central element of its Arctic strategy, developed through investments in naval and port infrastructure and modern icebreakers (Conley, Rohloff, 2015; ECFR, 2025).

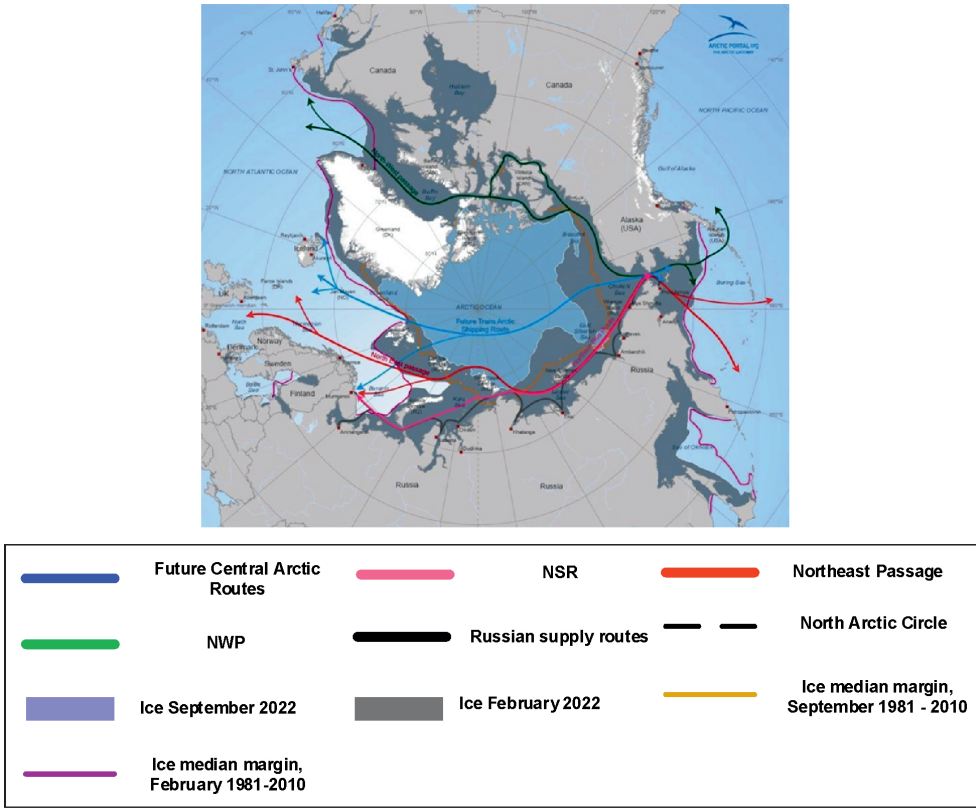

Figure 1: Arctic routes (https://arcticportal.org/maps)

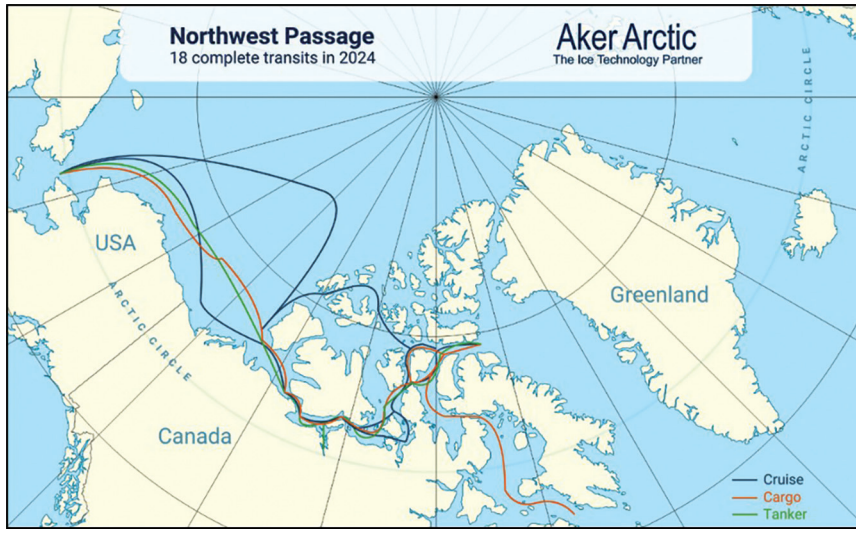

Figure 2: Complete transits through the NWP – 2024
(https://akerarctic.fi/news/international-voyages-on-the-northwest-passage-in-2024/)

Simulations of various Asia-Europe shipping routes (southern and northern) indicate a significant reduction of over 30% in the distance travelled through the Arctic (Searoutes, 2025; Nouman et al., 2025). However, due to environmental, territorial, geopolitical and military constraints, the adoption of Arctic routes remains problematic. This paper represents a first approach to the past, present and future of Arctic shipping routes, with applications to naval strategy and tactics, military and civilian port infrastructure, and a comparative analysis of their benefits and limitations.

The Northern Sea Route/NSR is considered the shortest sea route between the North-West Pacific and North-West Eurasia, from the Kara Strait, between the Kara and Barents Seas, to Cape Dezhnev, in the Bering Strait. The NSR, approximately 5,600 km long, crosses the Arctic seas: Kara, Laptev, East Siberian and Chukchi, providing access to Russian Arctic ports (Severomorsk, Sabetta, Dudinka, Khatanga, Tiksi and Pevek), as well as ports located along the main Siberian rivers.

Today, supported by Rosatom, an initiative is underway to expand this infrastructure by developing the Northern Sea Route, designed as a strategic maritime transport corridor stretching from Saint Petersburg and Kaliningrad to Vladivostok.

MATERIALS AND METHODS

This research uses a mixed approach, combining historical, empirical and strategic analyses: historical review: Arctic expeditions and naval operations during the Cold War were examined to trace the roots of Arctic geopolitics; Transit statistics: recent data from Rosatom (2025), Aker Arctic (2025) and the Scott Polar Research Institute (2024) were analysed. Policy analysis: the Arctic strategies of Russia, Canada, the United States, NATO and China were evaluated (Government of Canada, 2024; US DoD, 2024); comparative route analysis: distances between Shanghai and Rotterdam were calculated for the Suez Canal, NSR, NWP and Cape of Good Hope routes; geospatial mapping: Arctic ports and military bases were georeferenced.

This integrative approach allows for a balanced understanding of both the commercial opportunities and strategic risks associated with Arctic navigation.

RESULTS AND DISCUSSIONS

Trends in freight traffic

Statistics show that traffic through Arctic routes remains marginal compared to global *"mandatory passages"* such as the Suez Canal. In 2024, the Suez handled approximately 1.53 billion tonnes of cargo, with traffic of 13,213 ships, while only 37.8 million tonnes were transported through the NSR, with 92 transits recorded (Suez Canal Authority, 2025; Rosatom, 2025; Financial Times, 2025). The NWP recorded only 18 full voyages in 2024, mainly passengers and specialised cargo (Aker Arctic, 2025) *(Tables 1, 2, 3 and Figures 3, 4, 5).*

Table 1: Freight traffic through Arctic routes versus the Suez Canal (2013-2025), thousand tonnes

Year	Arctic routes	Suez Canal	Sources
2015	n.a.	998,532	Suez Canal Authority (2025)
2016	n.a	974,184	Suez Canal Authority (2025)
2017	n.a	1,041,573	Suez Canal Authority (2025)
2018	n.a	1,139,629	Suez Canal Authority (2025)
2019	n.a	1,207,085	Suez Canal Authority (2025)
2020	n.a.	1,169,001	Suez Canal Authority (2025)
2021	n.a	1,274,774	Suez Canal Authority (2025)
2022	n.a.	1,409,879	Suez Canal Authority (2025)
2023	n.a.	1,568,254	Suez Canal Authority (2025) Financial Times (2024)
2024	NSR: 37.8 million tonnes; 92 ship transits NWP: 18 full voyages (passengers/specialised cargo)	1,524,531	Rosatom (2025)
		–	Aker Arctic (2025)
2025	n.a	238,171 first six months	Suez Canal Authority (2025)

Year	Suez Canal	Year Suez	Suez Canal
2013	n.a.	2020	18,880
2014	n.a.	2021	20,694
2015	17,481	2022	23,851
2016	16,883	2023	26,434
2017	17,550	2024	13,213
2019	18,174	2025	6,055 /first 6 months

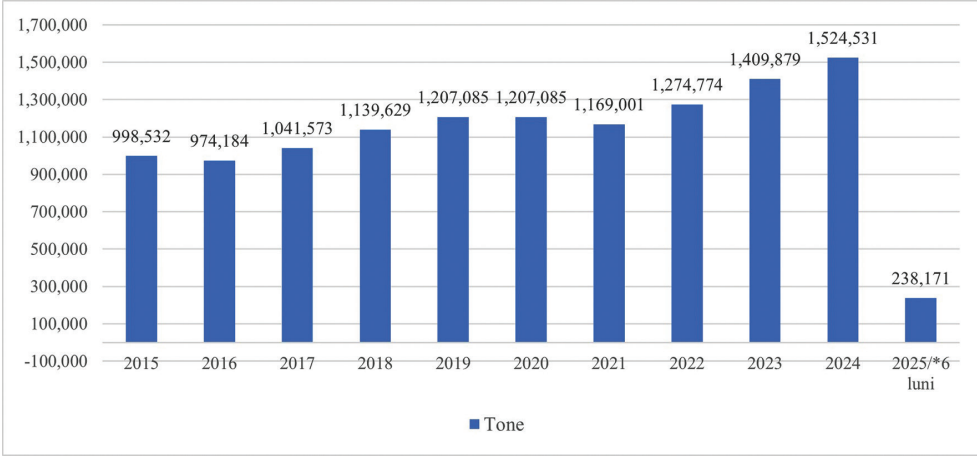

Figure 3: Freight traffic through the Suez Canal, 2015-2025

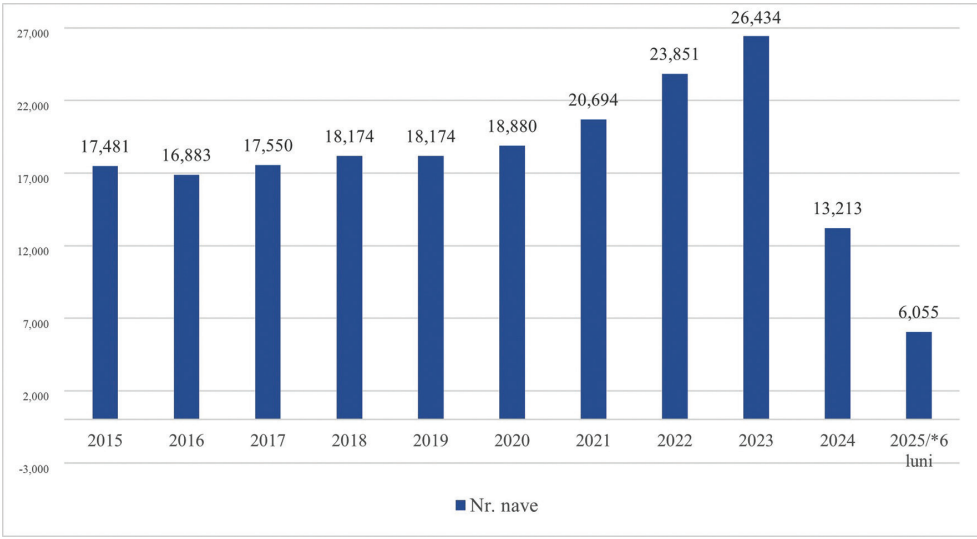

Figure 4: Ship traffic through the Suez Canal

Table 3: Single ship traffic (Arctic Polar Area), 2013-2024

Year	Single ships (Arctic Polar Area	Year	Unique vessels (Arctic Polar Area
2013	1,298	2020	1,546
2014	1,370	2021	1,740
2015	1,398	2022	1,677

2016	1,446	2023	1,782
2017	1,446	2024	1,781
2019	1,477	2025	n.a

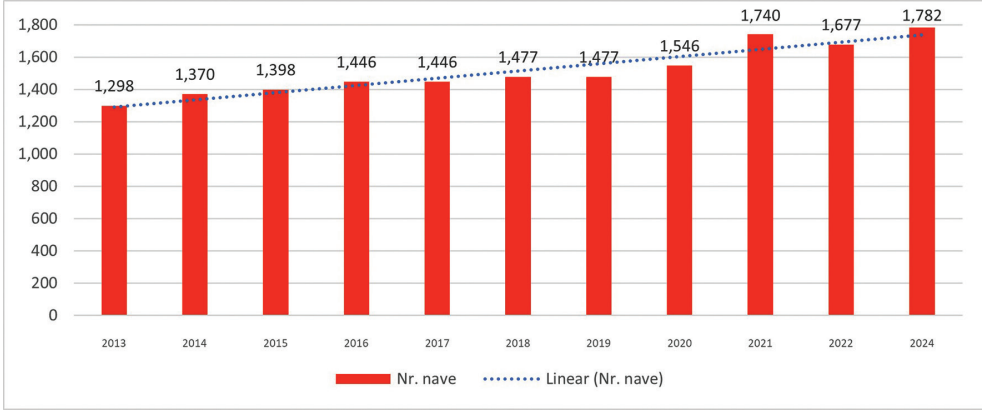

Figure 5: Single vessel traffic (Arctic Polar Area), 2013-2024

These figures confirm that Arctic shipping remains experimental and niche. However, its symbolic and strategic importance far exceeds its commercial contribution.

Distance analysis

The savings in the distance of maritime routes between Asia and Europe are substantial *(Table 4, Figures 6 and 7).* For example, transport from Shanghai to Rotterdam via the NSR saves approximately 2,050 nautical miles compared to the Suez route, while the NWP offers a similar advantage. However, ice variability and seasonality prevent these routes from functioning as reliable corridors throughout the year (IPCC, 2023).

Table 4: Distances between Shanghai and Rotterdam via different sea routes

Maritime route	Distance (nautical miles)
Suez Suez Canal	10,550
Cape of Good Hope	13,800
NWP	8,700
NSR	8,500

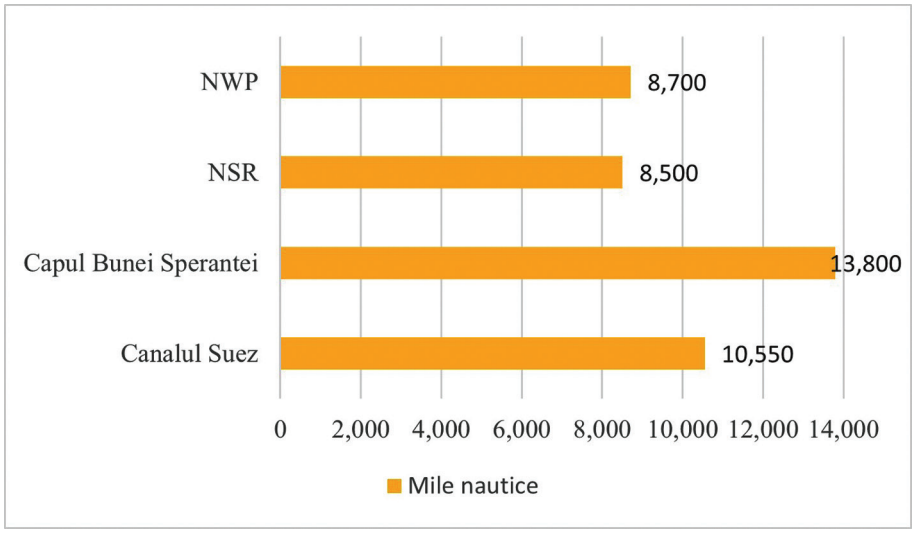

Figure 6: Distances between Shanghai and Rotterdam on different sea routes

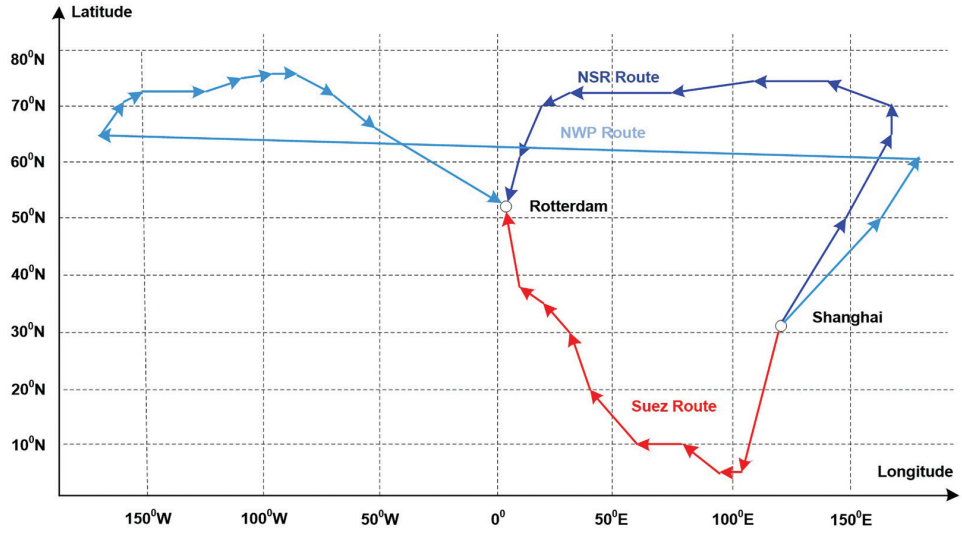

Figure 7: Global shipping routes Shanghai-Rotterdam

Analysis of Arctic port and military infrastructure

The most developed network of civil and military ports is that of the Russian Federation who owns most of the Arctic coastline (53%), where it has built important ports as naval traffic hubs and advanced military bases (Franiok, 2020).

The Russian Federation has 32 permanently monitored military bases in this region. Three of these locations, located in Franz Josef Land, Kotelny Island

and Wrangel Island, can accommodate up to 150 military personnel each (Laws, 2025).

Canada is developing its network of Arctic ports, with the port of Nanisivik currently undergoing modernisation. There are also air bases in the region, such as the American base at Thule (Greenland) and Russian bases. A specific feature of the region is the dual civilian and military use of port infrastructure, which highlights the intertwining of strategic and military interests with the economic interests of the state actors involved here. Thus, the existing infrastructure highlights the dual nature of the Arctic *(Table 5 and Figure 8)*. The Russian Federation maintains the most advanced network, centred on Murmansk and Sabetta, complemented by forward military bases such as Nagurskoye.

Table 5: Main Arctic civilian ports and military bases

Port	**Country**	**Port type**	**Geographical coordinates**		
Severnomorsk	Russian Federation	Military	69^0 04'N	33^0 25'E	
Murmansk	Russian Federation	Civil	68^0 97'N	33^0 08'E	Ice-free, main hub of the NSR
Sabetta	Russian Federation	Civil	71^0 26'N	72^0 05'E	
Kirkenes	Norway	Civil	69^0 72' N	30^0 05'E	logistics
Nuuk	Greenland	Civil	64^0 18'N	51^0 72'W	Greenland's main port
Nanisivik	Canada	Military	72^0 98'N	84^0 57'W	Naval base/ planned refuelling
Nagurskoye	Russian Federation	Military	80^0 78'N	58^0 42'E	Northernmost naval/air base
Thule	Greenland (US/DK)	Military	76^0 53'N	$68'^0$ 70'W	US/Denmark Arctic military base

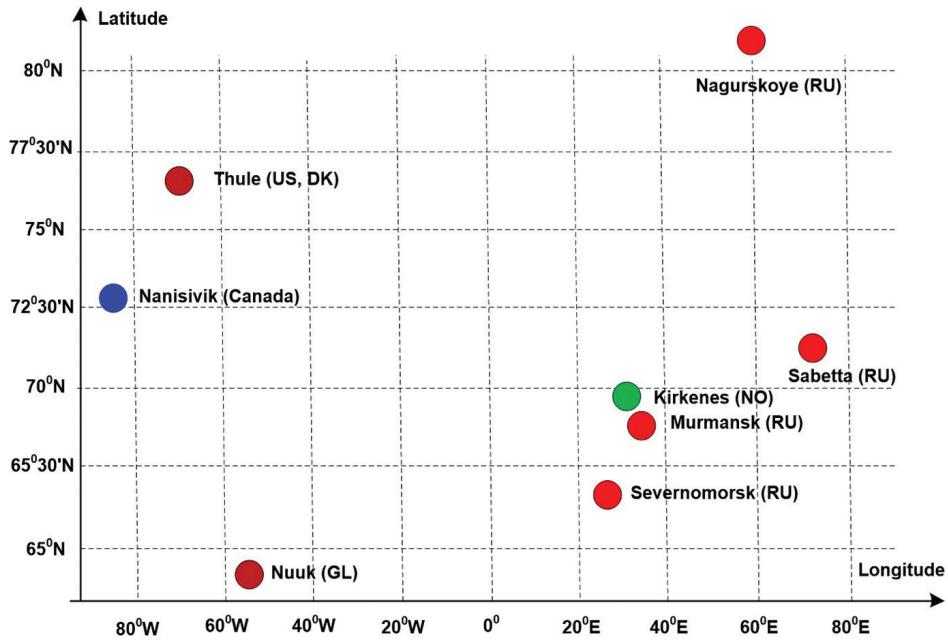

Figure 8: Main Arctic ports and military bases

Future military implications

The Arctic has become the subject of significant economic, military, and geopolitical disputes. Increased use for transportation, exploitation, and the imposition of military force has heightened its strategic importance, which appears to outweigh economic considerations, with implications for regional security. As the ice season shortens due to climate change, the Arctic has become an area of great interest for naval activities, for finding ways to increase freight traffic and, hence, for the development of dual-use (civilian and military) port infrastructure.

Of great importance to the Russian Federation is the modernization of ports and the construction of modern icebreakers to support research and the extractive industry, but also the development of maritime trade by improving military logistics and force mobility.

NATO, China, and other states perceive the Northeast Passage as an area of multi-criteria competition where the changing environment contributes to the intensification of security issues, requiring surveillance, operational research, and realistic terrestrial and maritime environmental forecasts. Thus, this route serves as a case study for the state actors involved here, but also as a new natural laboratory for oceanographic research in support of naval actions, for understanding the situation in the Arctic Ocean, and force projection in contested environments.

Russia seeks Arctic dominance through its fleet of icebreakers, LNG exports, and extensive military infrastructure (Conley, Rohloff, 2015; ECFR, 2025).

Canada emphasises the enforcement of sovereignty over the NWP, supported by Arctic patrol vessels and search and rescue (SAR) capabilities (Huebert, 2019; Government of Canada, 2024).

The United States and NATO prioritise freedom of navigation, deterrence and submarine operations under the ice (US DoD, 2024). China, although located 1,400 km south of the Arctic Circle, declared itself a *"near-Arctic state"* in 2018 and pursues scientific, economic and strategic engagement through the *"Polar Silk Road"* initiative (PRC Arctic Policy, 2018).

Naval operations face unique environmental challenges: extreme cold, unpredictable weather, magnetic anomalies, and limited satellite coverage. Adaptations include: submarine operations under ice, requiring advanced sensors and acoustic mapping; ships with ice-strengthened hulls; icebreakers; autonomous underwater vehicles (AUVs) for reconnaissance and mapping; alternative communications (low-frequency radio, underwater acoustics, experimental fibre optic systems integrated into the ice structure). Arctic naval operations have begun to increasingly integrate multidimensional warfare – at sea, underwater, in the air, and in cyberspace+using hybrid technologies and actions (cyber operations, ecological sabotage, dual-use civilian vessels).

Strategic implications of the Northern Sea Route

The possibility of using this sea route for longer periods of time has transformed it from an internal route to one of international geopolitical and military importance. The extraction of mineral resources, reduced navigation times, and strategic implications are particularly important for military oceanography and maritime security in the region. The Russian Federation has held discussions with both India and China on the route's potential, with the first meeting of the Russian-Chinese Sub-Commission for Cooperation on the Northern Sea Route taking place in November 2024. This followed a memorandum of understanding between Chinese companies and Rosatom to establish a joint venture for shipbuilding and a year-round container line between Chinese and Russian ports *(Figure 9).*

Figure 9: Russian icebreaker
(https://world-nuclear-news.org/articles/northern-sea-route-cargo-set-new-record-in-2024)

Arctic navigation and dual-use infrastructure

Russia's investments in Arctic infrastructure, including port modernization, nuclear-powered icebreakers, and satellite navigation systems, are dual-use in nature. Facilities such as Sabetta and Pevek, while primarily serving energy exports and regional logistics, (Sergunin, 2025). The development of the *"Northern Sea* Route*"*, which extends connectivity from Saint Petersburg and Kaliningrad to Vladivostok, enhances Russia's ability to integrate civil and military maritime transport networks, thereby strengthening logistical resilience and force projection capabilities in the Arctic (Staalesen, 2020).

Naval operations and strategic mobility

The NSR offers potential advantages for naval mobility, providing Russia with an *"internal maritime highway"* connecting its northern and Pacific fleets. This east-west link allows for the rapid redeployment of naval assets, bypassing chokepoints such as the Suez Canal or the Strait of Malacca. At the same time, NATO navies and extra-regional actors such as China view this development with caution, as increased Russian naval access to Arctic waters may alter the regional balance of power (Rahbek-Clemmensen, 2017).

For China, the NSR complements its *"Polar Silk Road"* strategy, providing alternative sea routes for energy imports and trade security, indirectly strengthening its global maritime presence (Lanteigne, 2019).

Military oceanography and knowledge of the Arctic environment

Marine meteorology and military oceanography will lead to the operationalization of the Northeast Passage. Safe navigation in Arctic waters requires accurate knowledge of sea ice conditions, ocean current patterns, and severe weather phenomena, which are essential for military oceanographic forecasts. Oceanographic buoys, satellites with ice research facilities, and autonomous underwater vehicles are used to study the Arctic marine environment (AMAP, 2021). For war ships, this data is important for safe navigation and for planning surface and submarine naval operations.

Security and environmental dimensions

The increase in shipping traffic along this route raises the level of complexity regarding maritime security. The Russian Federation wants sovereign control over the route in accordance with national legislation, while NATO wants the international principle of freedom of navigation to be respected.

However, shipping traffic here poses environmental risks, resulting in the adaptation of military and civilian operations to minimize the risks of accidents and pollution (Wilson Rowe, 2018).

Oceanographic research and environmental monitoring provide scientific information for the process of strengthening security and sustainability.

Strategic perspective

The broader strategic perspective shows that the Northern Sea Route functions as a trade route and as a strategic area for military oceanography to integrate into global geopolitical competition. The maritime strategy of the future can only be based on top-level oceanographic studies and forecasts, the development of remote sensing, and polar logistics.

The constantly evolving northern Arctic environment will lead to the development of new naval strategies and tactics adapted to the unique conditions of the Arctic region (Wezeman, 2016). In recent decades, climate change and the reduction of the Arctic ice cap have led to a strategic reassessment of the region by the major powers.

The Arctic is becoming an area of influence disputed by the Russian Federation, the United States, Canada, Norway and China, which are stepping up their military and economic presence in the region. Although located 1,400 km south of the Arctic Circle, China declared itself a *"near-Arctic state"* in 2018 and announced plans to become a *"polar power"* by 2030. This goal has been reaffirmed through *"practical cooperation in the Arctic"* and the development of the *"Polar Silk Road"* (Tirziu, 2025).

The new strategies include: advanced deployment of naval forces in Arctic ports such as Murmansk, Severomorsk (Russian Federation) or Dutch Harbor (USA); reactivation of Arctic naval bases, including military airfields; organisation of multinational exercises simulating war scenarios in the Arctic (Wiliams, 2020).

Military operations in the Arctic require tactics adapted to extreme environmental conditions, with particular challenges: very low temperatures; the presence of sea ice; magnetic anomalies; reduced satellite coverage and unpredictable weather. These conditions have necessitated the adaptation of naval tactics: submarine operations under ice (submarines must be able to navigate under the ice cap and break through the ice to surface). These manoeuvres involve acoustic mapping and advanced sensors; ice-navigating *hulls (Figures 10, 11 and 12)* (Pincus, 2019; Canadian Navy, 2025; Business Insider, 2025); the use of autonomous underwater vehicles (AUVs) and drones for surveillance, reconnaissance, mapping, mine clearance, search and rescue missions, and interactions with isolated communities in the far north; these can operate under the ice cap over long distances, collecting bathymetric data, environmental parameters or sonar images without requiring satellite signals or constant communication links; satellite-free communications (in polar regions, where geostationary satellites cannot be used effectively) – low-frequency radio communications, underwater acoustics or fibre optic communications integrated into the ice structure (experimental) are used for fixed monitoring and real-time data transmission.

Figure 10: Canadian Arctic and offshore patrol vessel – Harry DeWolf class
(https://www.canada.ca/en/department-national-defence/services/procurement/arctic-offshore-patrol-ships.html)

Figure 11: Russian Federation Navy ice-class patrol vessel – Ivan Papanin class
(https://www.bairdmaritime.com/security/naval/naval-ships/vessel-review-ivan-papanin-russian-navy-patrol-ship-with-icebreaking-capability)

Figure 12: Ballistic missile nuclear submarine, Borei-A class, Russian Federation Navy
(https://militarywatchmagazine.com/article/160-nukes-russian-navy-boreia-submarine)

Modern naval doctrines integrate multi-domain operations (maritime, air, cyber and space) in Arctic scenarios. Standardised capabilities and equipment for polar climates are also used in joint exercises. Elements of hybrid warfare are applied (anticipating the use of *"grey zone"* tactics), through cyber attacks on Arctic infrastructure, ecological sabotage or the use of civilian vessels as cover for military operations.

CONCLUSIONS

Arctic shipping routes are transforming from exploratory routes into geostrategic corridors, although their share in global maritime transport remains negligible.

In my opinion, future naval activities will likely include: sovereignty patrols (Canada, Russian Federation); submarine operations under ice (Russian Federation, United States); escort missions for convoys and LNG carriers (Russian Federation); NATO deterrence exercises and search and rescue (SAR) operations; intensified challenges to transit rights, particularly in the NWP.

In the near future, the Russian Federation has taken steps to modernize and expand the operational capacity of the Northern Sea Route. Rosatom, the state corporation responsible for managing Arctic navigation infrastructure, is taking steps to develop the Russian Northern Sea Route, an extended corridor connecting the ports of St. Petersburg and Kaliningrad in the west with the port of Vladivostok in the east, in order to integrate the NSR into a broader transcontinental transport system. This will be achieved by improving year-round navigability, which will strengthen Russia's position in Arctic maritime logistics and offer an alternative to traditional southern routes, in the context of increasing global shipping traffic and climate change, with major impacts on Arctic sea ice.

China, through its *"Polar Silk Road"* concept, has identified the Arctic as an extension of its *Belt and Road* Initiative, with the aim of securing shorter and more robust supply routes to Europe. Chinese shipping companies have already conducted test voyages along the NSR (with a 22-day voyage for a container ship), demonstrating Beijing's long-term interest in these new maritime trade routes. NATO and Arctic Council states are also closely monitoring developments along the NSR, concerned about the implications for regional security, freedom of navigation, and environmental protection.The gradual retreat of Arctic ice due to climate change is amplifying these dynamics, as longer navigation windows make the route more commercially viable, while also increasing environmental risks.

In this context, the NSR has evolved from a primarily domestic supply route into a corridor of global strategic relevance. Its future trajectory will be shaped by the inter y interaction between technological advances in Arctic navigation, international competition for access and influence, and the environmental constraints inherent in polar ecosystems.

The central challenge lies in balancing the growth of naval presence with cooperative governance mechanisms to ensure navigational safety, SAR coordination, and environmental protection. Without such frameworks, the Arctic risks degenerating into a contested security zone.

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