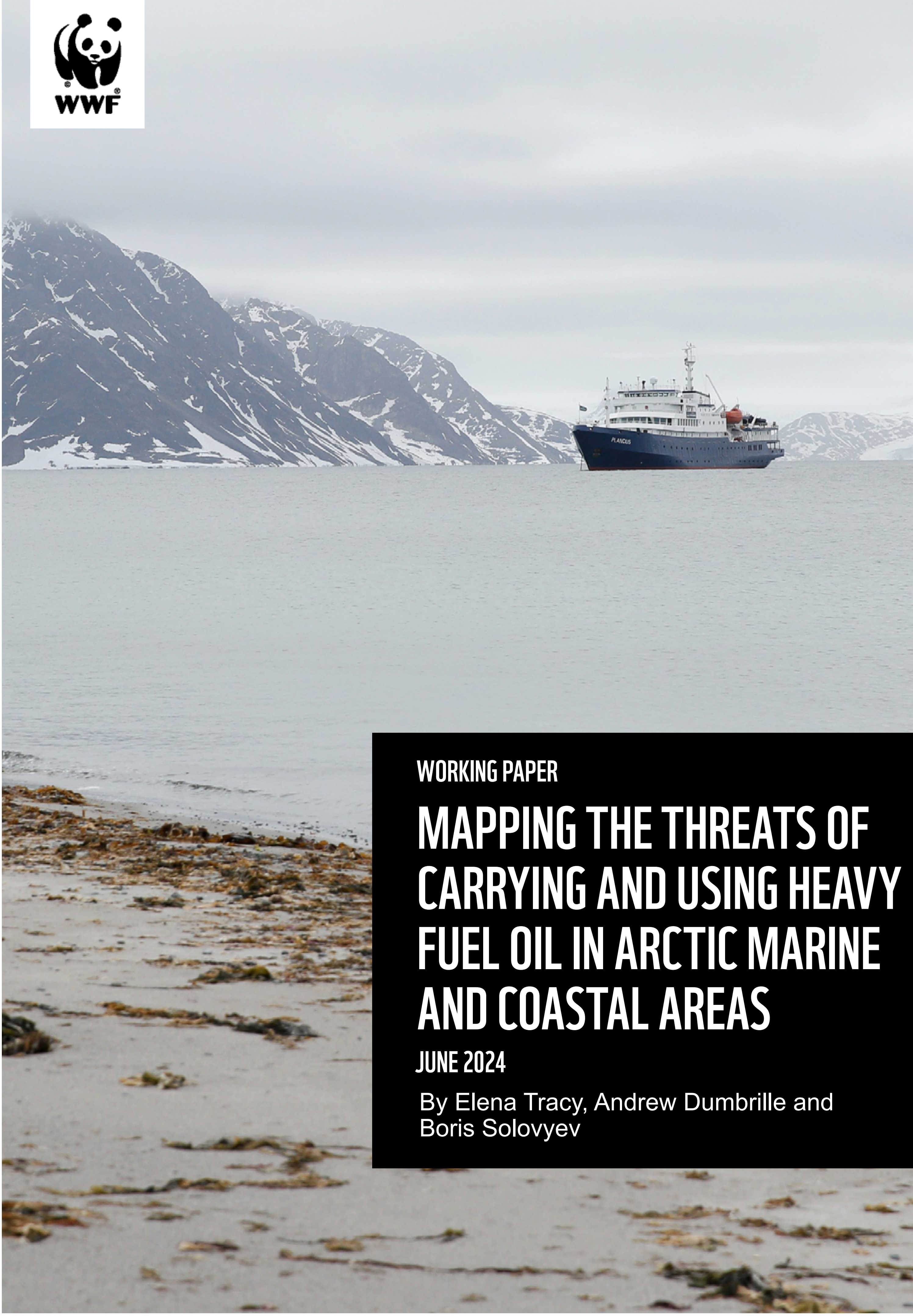

WORKING PAPER

MAPPING THE THREATS OF CARRYING AND USING HEAVY FUEL OIL IN ARCTIC MARINE AND COASTAL AREAS

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Contents

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Abbreviations

ASTD	Arctic Shipping Traffic Database
CF	conservation feature
HFO	heavy fuel oil
IMO	International Maritime Organization
LNG	Liquified Natural Gas
NSR	Northern Sea Route
OPRC	Oil Pollution Preparedness, Response and Cooperation
PAME	Arctic Council Protection of the Arctic Marine Environment Working Group
ULSFO	ultra low–sulphur fuel oil
VLSFO	very low–sulphur fuel oil

1. Introduction

Scope

The use and carriage of heavy fuel oil (HFO) poses one of the highest risks from shipping to Arctic marine ecosystems and coastal communities. The combustion of HFO emits black carbon, a potent, short-lived climate pollutant with multiple negative impacts for ecosystems and human health, while oil spills from ships present high risks to Arctic marine environments. This paper will focus on the latter, providing an overview of how an HFO spill would threaten Arctic marine ecosystems and coastal communities.

Shipping traffic in the Arctic is trending upward. From 2013 to 2023, the distance sailed increased by 111%, and the number of unique ships in the area increased by 37% (PAME 2024). These increases have been driven by the exploration and development of oil, gas and hard minerals in the Arctic, a growing tourism industry, and fisheries expanding north as sea ice retreats. Notably, the expansion of oil production in the Arctic region (i.e., the development and construction of new oil and gas fields in the coastal Arctic areas of Russia, the US and Norway) will bring more oil and LNG tankers to Arctic and near-Arctic waters (Carr et al., 2024; Vakhrusheva 2024).

This paper discusses the risks to marine biodiversity posed by the continued use of HFO by the shipping sector in the Arctic. The analysis is based on the spatial juxtaposition of two dataset layers. The first layer contains the most recent information (2023) from the Arctic Council's Protection of the Arctic Marine Environment Working Group (PAME) about vessels in Arctic waters that use and carry HFO. The second layer is composed of spatial data highlighting the risks from HFO-fuelled shipping for Arctic marine biodiversity. This layer is generated by Geranium,[2] a conservation prioritization and planning tool developed by the WWF Global Arctic Programme; it is based on an extensive database of 705 conservation features (CFs) that systematically represent marine biodiversity and its distribution across the Arctic, from benthos to marine mammals (James et al. 2024). Additional consideration is given to coastal and Indigenous communities located in proximity to vessel traffic using and carrying HFO.

Context

When spilled into marine environments in large quantities, different types of oil—such as diesel, gasoline, heating oil and kerosene—will have a range of negative ecological impacts. HFO, including bunker oil, fuel oil, bitumen and others, could cause the most severe consequences.[3] Broadly speaking, HFO belongs to the class of residual fuels that are leftover

[2] A description of Geranium can be found at https://www.arcticwwf.org/our-priorities/nature/arcnet/arcnet-purpose-built-tools-for-arctic-marine-conservation-planning/

[3] The International Maritime Organization defines HFOs as "oils, other than crude oils, having a density at 15℃ higher than 900 kg/m3 or a kinematic viscosity at 50℃ higher than 180 mm2/s". MARPOL, Annex 1, reg 43, para 1, 2.

components of crude oil after they have been separated from the distilled product. The name “heavy” reflects a key characteristic of these oils: high viscosity (resembling that of tar) when cold (PAME 2020). These high-viscosity fuels are primarily used in large vessels and must be heated to be injected into engine cylinders. Burning them produces sulphur dioxide, nitrogen oxides and particulate matter in addition to black carbon and other pollutants.

This definition encompasses all HFOs, including most very low–sulphur fuel oils (VLSFOs) and some ultra low–sulphur fuel oils (ULSFOs). VLSFOs were designed by refineries to meet the global marine fuel sulphur cap requirement of 0.5% (effective in 2020), while ULSFOs were designed to meet the 0.1% sulphur limit in Emission Control Areas (ECAs). Research is ongoing on the various blends of VLSFOs and ULSFOs and their characteristics in cold-water environments (PAME 2024a). Preliminary analysis by PAME, backed by the International Standards Association and the International Bunker Industry Association, has so far pointed to a large proportion of VLSFOs falling within the International Maritime Organization’s (IMO) definition of HFO, while a smaller proportion of ULSFOs, 36%, fit the definition (PAME 2024b). However, in cold water, both VLSFOs and ULSFOs have been shown to have a high pour point, the temperature below which the fuel stops flowing. This has led Norway to submit a proposal to the IMO to include pour point in the definition of HFO in order to ensure that high pour point fuels, which would be extremely difficult to clean up, would also be banned in the Arctic.

On July 1, 2024, the IMO’s ban on HFO use and carriage as fuels in Arctic waters (known as the HFO ban) will come into effect under the *Marine Pollution Convention* (MARPOL). It is a significant step towards a cleaner Arctic. However, the regulation has many loopholes that will be in effect until July 2029. Consequently, it only encompasses 16% of the HFO burned and 30% of the HFO carried as fuel in the Arctic, while ignoring cargoes of HFO (Comer et al 2020); therefore, it does not adequately protect Arctic ecosystems from harmful HFO spills. Loopholes can be used by ships that comply with specific fuel tank design requirements (i.e., protected fuel tanks). The loopholes also allow Arctic coastal nations to issue waivers extending until July 2029 for ships flying their national flag while operating in waters that are subject to that nation’s sovereignty or jurisdiction. Both the fuel tank exemption and waiver provisions were adopted despite evidence that the regulation, as drafted, would provide little protection for Arctic waters for most of this decade and that this timescale for implementation was inconsistent with international approaches to the protection of the marine environment.

Another international regulation dedicated to mitigating the impact of oil pollution, the *International Convention on Oil Pollution Preparedness, Response and Cooperation* (OPRC), entered into force in 1995 and was also coordinated by the IMO. The OPRC requires parties to establish a national system for responding to oil pollution incidents and commits parties to cooperating internationally in response to pollution incidents. In addition, the convention requires ships to carry an oil pollution emergency plan and report pollution incidents to coastal authorities. The convention is enabled by the *UN Law of the Sea*, which allows coastal states the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered waters.

Furthermore, the IMO has developed a set of voluntary and mandatory policy instruments specific to the conditions of navigation in ice-covered marine environments in the Arctic and Antarctic under the scope of the *International Code for Ships Operating in Polar Waters* (known as the Polar Code); these continue to evolve. The Code includes two types of tools: mandatory measures covering safety and pollution prevention and recommendatory provisions on the protection of marine environments.

In addition, the Arctic Council, a regional forum responsible for establishing cooperation in the Arctic across several policy domains (including the protection of the environment), has stated that preventing oil spills should be a top priority. To this end, Arctic Council member states signed the *Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic* (Arctic Council 2013). The agreement entered into force in 2016 and has been ratified by all eight Arctic nations. It requires parties to maintain national systems for oil spill response, notify other parties of oil pollution incidents, engage in oil spill monitoring activities, assist each other in responding to oil pollution incidents, and conduct joint exercises and training.

As sea ice decreases in the Arctic due to climate change, vessels are more frequently travelling through areas where they have never been before, and for which only limited hydrographic information is available. This increases the probability of major oil accidents in Arctic seas. In addition, ships operating in the Arctic are regularly exposed to poor weather conditions and extreme temperatures that reduce the effectiveness of ship machinery and impose additional pressures on hull and propulsion systems (IMO 2024).

Aside from introducing the HFO ban, two key approaches have been pursued by international and national regulatory authorities to minimize the risk of oil spills: designing ships to handle harsh Arctic conditions and ensuring they avoid areas where accidents are more likely to happen.

To address these and other risks associated with operating in polar waters and to prevent accidents, the Polar Code requires any vessel travelling in hazardous ice conditions to obtain a Polar Ship Certificate. The Code separates ships into three categories. Category A applies to vessels operating in at least medium first-year ice; Category B covers vessels operating in thin first-year ice; and Category C covers vessels sailing in open waters where ice is less severe. Vessels in the first two categories need to be strengthened in accordance with ice conditions, and must have reinforced hulls that can deal with significant ice accumulation. Category C vessels, which represent the greatest number of ships working in the Arctic (WWF 2022), do not require strengthening. Strengthening vessels and implementing ship safety standards appropriate for polar waters (where navigation conditions are hazardous) can be expected to reduce the risk of oil spills. However, even if ship designs and safety measures improve, the risk will never be zero. A fully implemented HFO ban with no loopholes would give an additional, much-needed layer of protection against the hazardous potential impacts of oil spills.

2. Why Oil Spills Are So Harmful to Arctic Marine and Coastal Ecosystems

While a spill of any type of oil can have devastating ecological impacts, HFO spills are particularly damaging because of the persistence of these oils in the environment. In cold conditions, HFO may become denser than the surrounding water, sinking and coating the ground. HFO can also emulsify on the ocean surface, expanding in size and causing harm to surface-frequenting wildlife. In summer months, these oils can float to shorelines and contaminate coastal areas, leading to extensive and thorough clean-up efforts to remediate shore environments, including rivers and lakes.

This persistent and potentially extensive damage can affect food security for Indigenous Peoples and coastal communities. Many communities in the Arctic depend on ocean resources for a large proportion of their daily diet, and disruptions and threats to those resources impact livelihoods and well-being for people in the region. These were among the reasons for the Inuit Circumpolar Council's support for the HFO ban at the IMO. Alongside the ban, Inuit have been calling for cost mitigation measures to be put in place to ensure communities are not burdened by increased costs associated with the move away from HFO.

The Arctic is characterized by extreme seasonal variability that influences both human activity and the behaviours of the animals that live in and migrate to and from the region. Generally, most of the central Arctic Ocean is ice-covered, dark and frigid throughout the winter months. There are some areas, such as the Aleutian Island chain, the northern coast of Norway, southern Iceland, and the Murmansk region in northern Russia, where due to ocean currents and other factors, ice does not form even during the winter. However, these areas still experience darkness, extreme cold and variable conditions. Arctic summers bring 24-hour daylight and temperatures that can be uncomfortably warm. Shipping traffic reflects this seasonal variability.

In these extreme environments, oil can accumulate on the surface of open water as well as on water surface mixed with ice, on top of ice, or submerged beneath ice (EPPR 2017). Due to these and other factors, oil spills persist. In addition, water currents can carry the oil above and below the ice across vast distances.

The impacts of oil spills on species and ecosystems varies depending on the location and season. Impacts can be acute, indirect and chronic, and there is limited knowledge about the sensitivities and recovery potentials of populations of Arctic species (Nevalainen et al. 2017). According to studies conducted by University of Helsinki researchers (Helle et al. 2020), polar bear (*Ursus maritimus*) and ringed seal (*Pusa hispida*) populations are most vulnerable to the acute effects of oil spills in the spring (with a probability of death within two weeks)—a time when they are giving birth and spilled oil can spread widely because ice cover is not continuous.

Walrus populations (*Odobenus rosmarus*) living in proximity to shipping corridors where traffic is dense—the US and Russian side of the Chukchi Sea (the Pacific walrus), Arctic Canada, West Greenland (Atlantic walrus), and the Russian side of the Barents Sea—are more vulnerable to oil spills in the summer. Moreover, because mussels (walrus' preferred prey) accumulate oil-derived toxins, walrus are sensitive to the chronic and long-term impacts of contamination (Chapman & Riddle 2005). Seabirds are also more sensitive to HFO than to lighter oils (Nevalainen, Helle & Vanhatalo 2018). Because HFO is likely to sink and coat the ground, it is particularly damaging to benthic fauna; lighter oils, on the other hand, may pose a greater threat to fish populations because these can spread across larger distances (Helle et al. 2020). Yet because of their persistence, HFO have a more damaging cumulative impact.

The lack of marine infrastructure in most of the Arctic (except along the coasts of Iceland, northern Norway and northwest Russia) can delay and complicate clean-up operations. In addition, cold temperatures have negative effects on personnel and equipment (EPPR 2017). Thus, the unique conditions of the Arctic region both increase the probability of accidents and decrease the chances for timely and effective clean-up and rescue operations, together constituting a significant response gap (WWF 2007).

Past Significant Incidents

Exxon Valdez

On March 24, 1989, the *Exxon Valdez* tanker carrying crude oil from Alaska's North Slope went aground in the pristine waters of Prince William Sound, spilling 41.5 million litres (more than 14,000 tonnes) of oil into the marine environment and contaminating 11,000 square miles of ocean and 1,300 miles of coastline. It was estimated that the spill killed 250,000 sea birds, 4,000 sea otters, 22 orcas and 300 harbour seals while also destroying billions of salmon and herring eggs. It harmed commercial fishing activities, the traditional livelihoods of coastal communities, and the recreational and tourism industries. Sixteen years on, orca populations that had suffered mortalities after the spill had still not rebounded, pointing to long-term, population-level impacts (Matkin et al. 2008). Twenty years after the incident, oil could still be found in the boulder beaches, intertidal zones and seabed. It may continue to pollute the areas for decades to come because subsurface oil remains dormant for long periods (WWF 2009).

Selendang Ayu

On November 28, 2004, the Malaysian-registered *Selendang Ayu*, en route from Seattle to Xiamen, China, broke apart off the rugged coast of the Aleutian Islands of Alaska, resulting in the deaths of six crew members, causing the crash of a US Coast Guard helicopter, and spilling 1.7 million litres of HFO and 55,564 litres of marine diesel and other contaminants into the environment, killing seabirds and marine mammals (AMSA 2009, 88). Oil contaminated 138 kilometres of beaches and rocky shores, affecting commercial fishing grounds as well as subsistence and traditional use areas (NOAA 2024).

Norilsk Nickel

Although not an accident at sea, the spill from Russia’s Norilsk Nickel mining facilities in the Taymyr Peninsula is the largest oil spill to take place in the Arctic if measured by volume. The spill occurred on May 29, 2020, near the Arctic mining city of Norilsk, when a huge diesel storage tank collapsed and spilled 17,500 tonnes of diesel into local rivers that flow into the Kara Sea of the Arctic Ocean. In combination with decades of water pollution from the mining facilities, the spill caused severe degradation of the Pyasino lake and river. The damage is still felt by local and Indigenous communities that rely on subsistence fishing and hunting. It will take years to restore these ecosystems, even if appropriate restoration measures are taken (WWF 2020).

3.Data and Methodology

The shipping traffic data included in this analysis are from the Arctic Shipping Traffic Database (ASTD) and cover the years 2021 and 2022 as well as the first nine months of 2023. They include the following types of vessels carrying or using residual marine fuels: tankers, bulk carriers, various cargo and container ships, tug/barge combinations, research vessels, and government and commercial icebreakers. Fishing and tourist vessels are excluded from this analysis. The shipping traffic maps prepared for this paper represent the "amount" of shipping for each geographical unit at a scale where each pixel represents an area 30 × 30 km in size.[4]

Maps featuring distributions of Overall Conservation Concern are based on an extensive database of 705 conservation features (CFs) contained in the WWF Global Arctic Programme ArcNet database (ArcNet 2024). The database includes the habitats of species and biological communities, systemically representing the distribution of marine biodiversity across the Arctic, from benthos to marine mammals (James et al. 2024). It also provides the results of conservation concern assessments conducted by taxonomic experts, who assessed the level of concern associated with various types of industrial activities for each CF. The results of the assessment for each CF are weighted, overlapped and shown on the map.[5]

Shipping Traffic at the Pan-Arctic Level, 2021-2023 (Figures 1, 2, 3 and 4)

The Arctic Marine Shipping Assessment (ASMA) conducted by PAME identified four types of Arctic shipping based on destination and purpose that often influence the types of vessels used and what they carry: 1) destination transport, whereby a ship sails to the Arctic, performs an activity, and sails south; 2) intra-Arctic transport, whereby a voyage stays within the general Arctic region, linking two or more Arctic states; 3) trans-Arctic voyages, which occur across the Arctic Ocean, from the Pacific to the Atlantic oceans or vice versa; and 4) coastal (cabotage) Arctic shipping, which happens between ports and communities within an Arctic state (PAME 2009). The latter make up a significant portion of ship traffic in the Canadian Arctic, eastern Russia and Greenland, providing a lifeline to many communities with limited or no road access.

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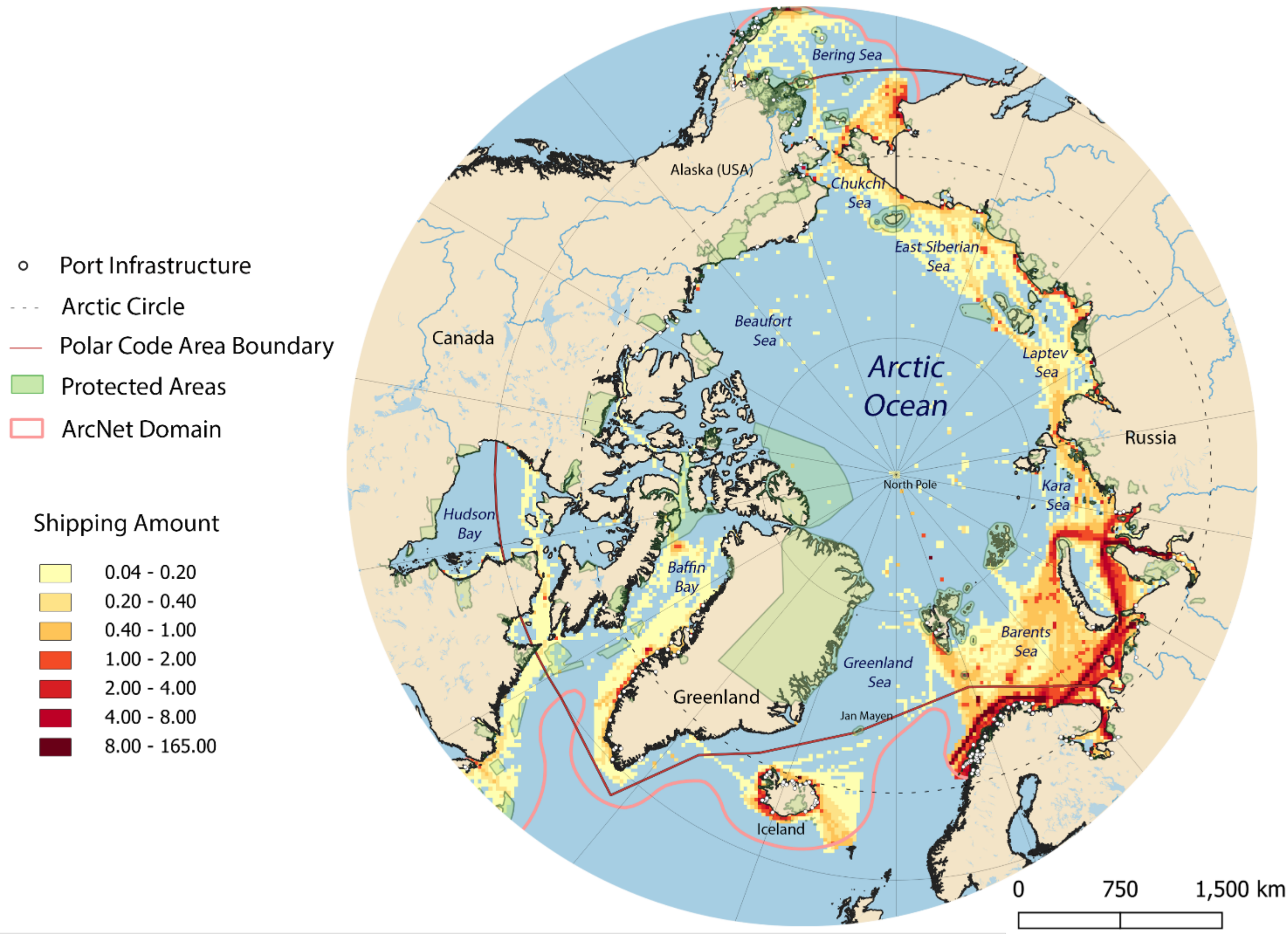
[4] The data were obtained as raw and included information on ship locations from automatic identification systems (AIS) and ship characteristics, including fuel type. It was cleared, after which mean monthly values for overall time spent by ships of each type were calculated for each geographical unit delineated at 30 × 30 km. At the next step, these data were further processed for use with the Geranium online prioritization and planning tool. This processing included the standardization and normalization of data and merging the data according to Geranium industrial activities classification and scale. The maps presented in the report are produced by Geranium and represent the "amount" of shipping (a unitless measure showing the relative importance of a given location for the specified type of shipping [Geranium categories "Cargo vessels - Heavy Fuel Oil" and "Tanker shipping"]).

[5] For more details on Geranium methodology, please refer to "Geranium prioritisation: overview and methodology" (ArcNet 2024).

Figure 1: Shipping Traffic of Carrying and Using HFO from 2021 to 2023

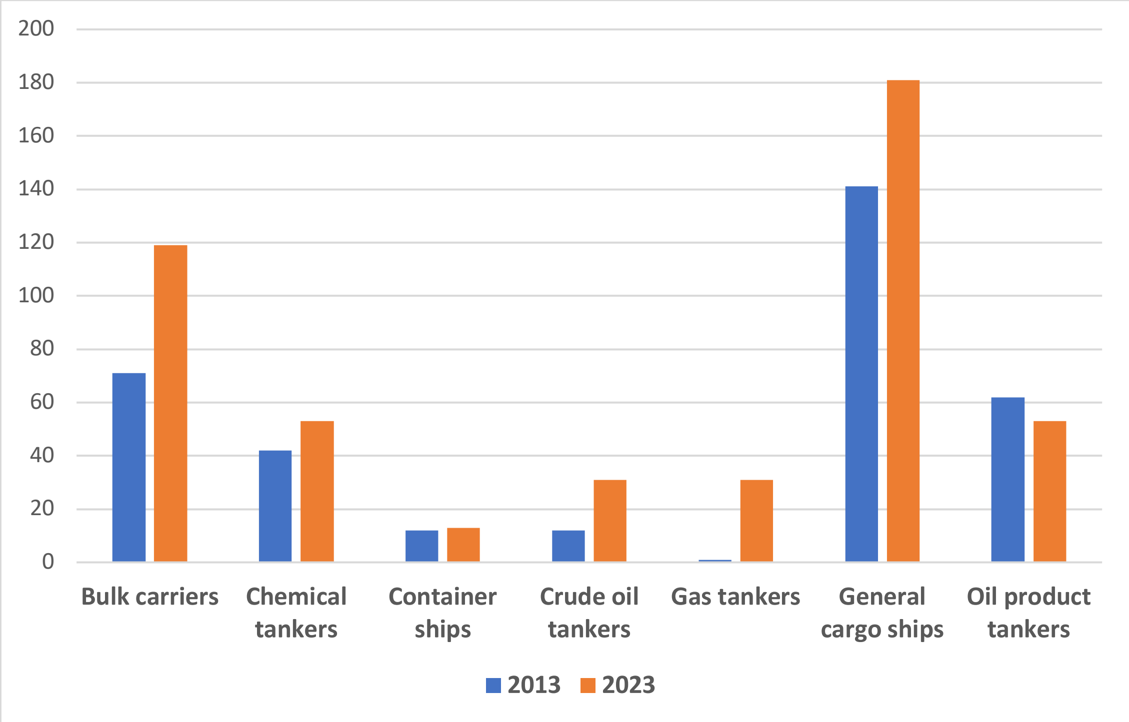


The highest density of vessels carrying or using HFO from 2021 to 2023 occurred around Iceland, in the Barents Sea, and along the Northern Sea Route (NSR) heading into the Bering Strait. Shipping volumes are indicated in these maps by the intensity of colour, with yellow denoting less intense traffic and dark red or brown denoting the highest intensity.

The coastal areas of Norway and Iceland, as well as the waters of the northwest Russian Arctic, are mostly ice-free; deep-water port facilities enable all four types of shipping. Several marine route distances are notable in the Russian coastal area: from Murmansk to the Bering Strait is 3,074 nautical miles, and the NSR from Kara Gate to the Bering Strait is 2,551 nautical miles.

The growing mineral extraction sector in the Arctic drove growth in the number of tankers and bulk carriers operating in these waters from 2013 to 2023, including LNG tankers (whose number went from 0 to 31), chemical tankers, crude oil tankers and bulk carriers (Figure 2). Notably, fuel consumption by vessels operating in the Arctic also increased over the last 10 years, with the most striking increases observed in the category of LNG tankers (Figure 3). These tankers are the biggest contributor to residual fuel consumption by vessels operating in polar waters and the biggest source of sulphur dioxide (SO_2) emissions from ships (Figure 4).

Figure 2: Number of Vessels in Polar Code Waters by Type in 2013 and 2023



Another type of vessel using residual fuels that has increased substantially in number over the last 10 years is bulk carriers, including those carrying large quantities of raw minerals. The number of these vessels went from 71 in 2013 to 119 in 2023 (Figure 2).

The shipping traffic map (Figure 1) is not seasonal as it shows cumulative shipping traffic over a two-year period. As such, it mainly represents the pattern of summer traffic, given that there is a surge in vessel activity then, when community resupply takes place; most bulk commodities are shipped out and supplies brought in for commercial operations during this period. Wildlife in the Arctic also follow this pattern: most species migrate earlier in the spring, before ice break-up, and gather in large numbers in the summer to feed and reproduce.

Figure 3: Fuel Consumption by Vessel Type in Polar Code Waters in 2013 and 2023

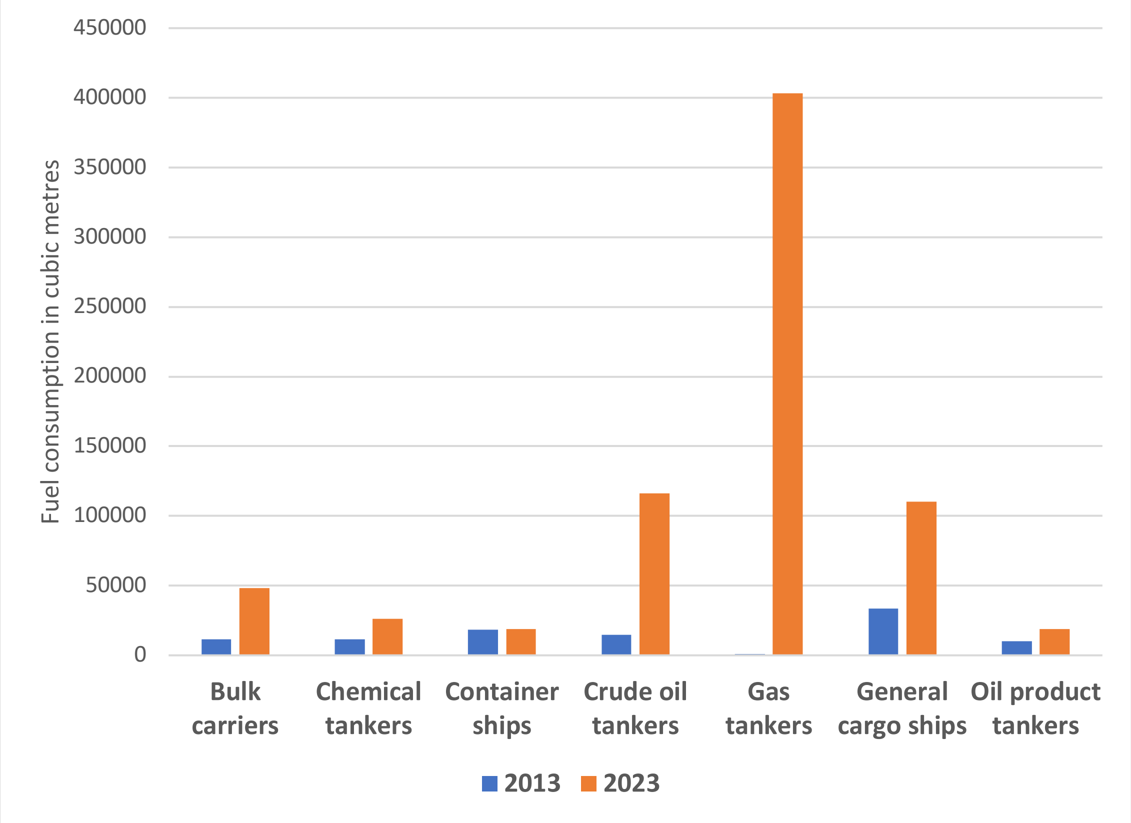
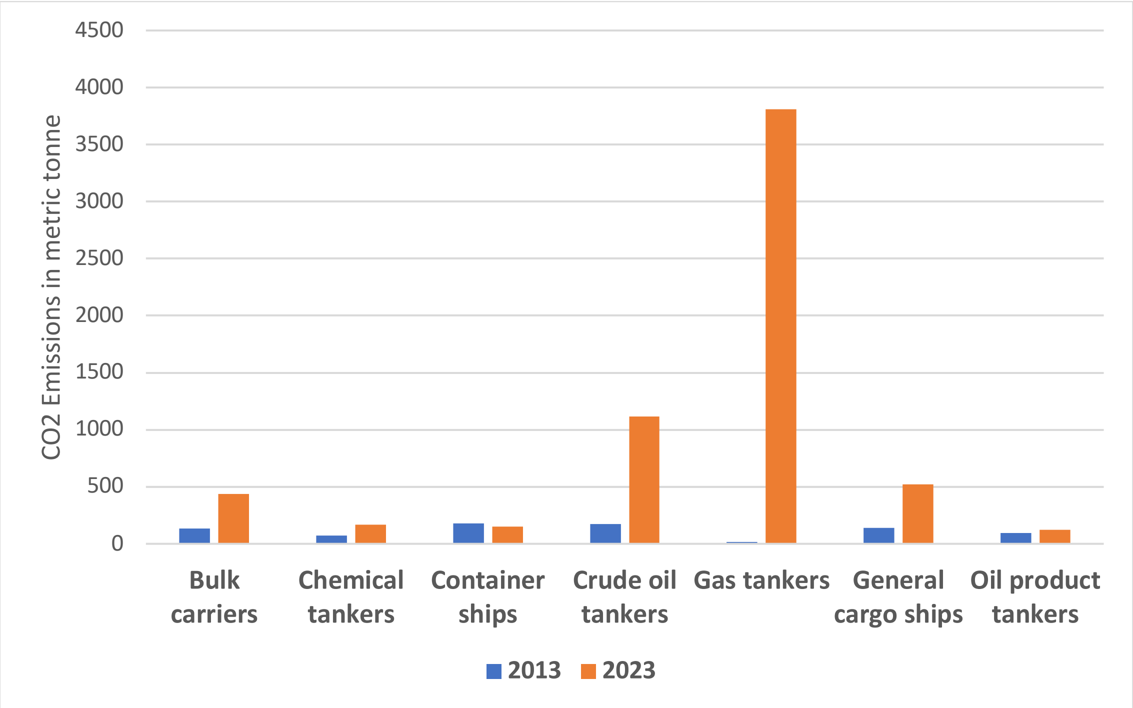


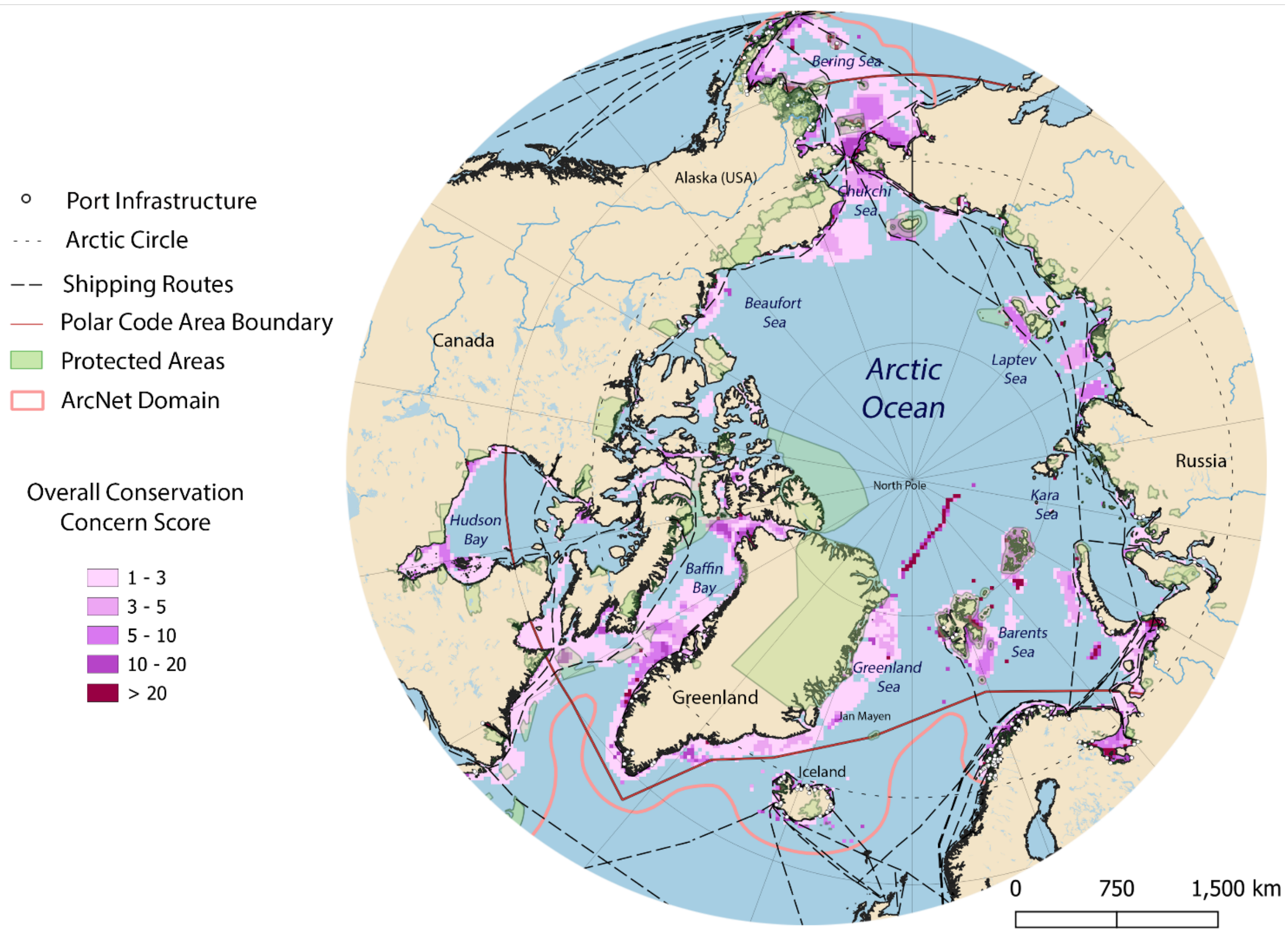
Figure 4: SO_2 Emissions from Vessels in Polar Code Waters in 2013 and 2023



Conservation Concern Score Distribution (Figure 5)

The Overall Conservation Concern score, shown in shades of purple on the map (Figure 5), is highest in the areas where several CFs that are particularly sensitive to the threats of oil spills overlap. These CFs include areas of elevated benthic biomass, key and well-defined seasonal habitats of seabirds and marine mammals (especially benthic feeders), and some coastal habitats, such as kelp forests and salt marshes.

Figure 5: Areas of Elevated Conservation Concern in Arctic Marine and Coastal Areas



The map indicates the following areas of highest conservation concern due to the potential impact of HFO use and carriage in shipping, based on the biological characteristics of the biodiversity in these regions:

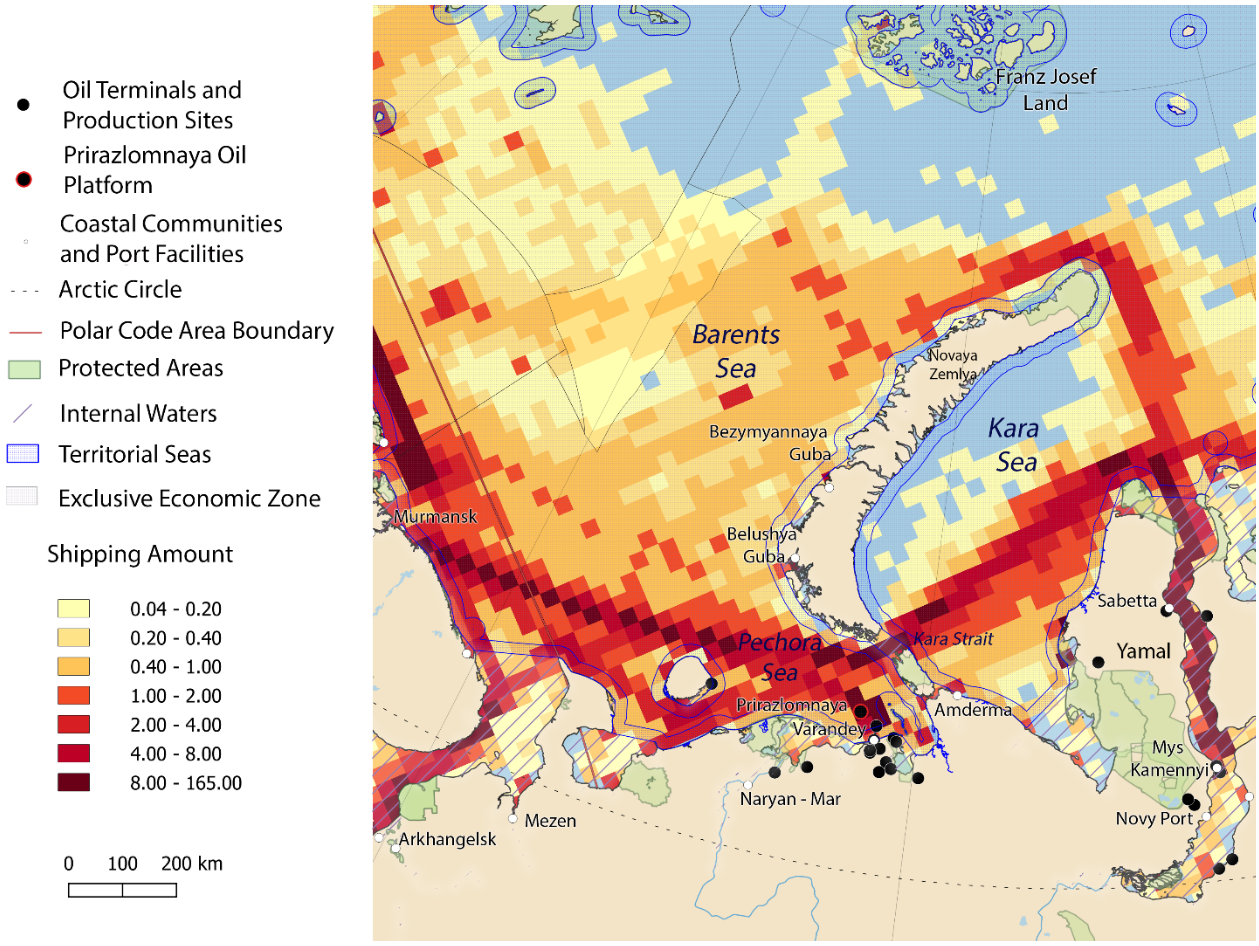
- The Bering Strait area, with adjacent parts of the Bering and Chukchi seas, including Bristol Bay;
- The White Sea and southeastern part of the Barents Sea (Pechora Sea) and the Kara Strait;
- Banks in the eastern Barents Sea;
- Significant parts of the Laptev Sea;

- The coastal waters of the Spitsbergen and Franz Josef Land archipelagos;
- Gakkel Ridge in the central Arctic Ocean;
- Baffin Bay, especially its northern and southern parts, the Davis Strait, and the adjacent waters of the Hudson Strait;
- Coastal waters of Iceland and northern Norway;
- Coastal waters of the Beaufort Sea;
- Coastal waters of the Hudson Bay.

This report evaluates three particular areas: the Kara Strait and Pechora Sea area, the Bering Strait area, and the Davis Strait, Baffin Bay and Hudson Strait area. Because these areas are both migration corridors and marine mammals and bottlenecks for shipping traffic, they are characterized by elevated pressures on mammal biodiversity. In addition, in the coming years, shipping traffic in these areas is expected to increase.

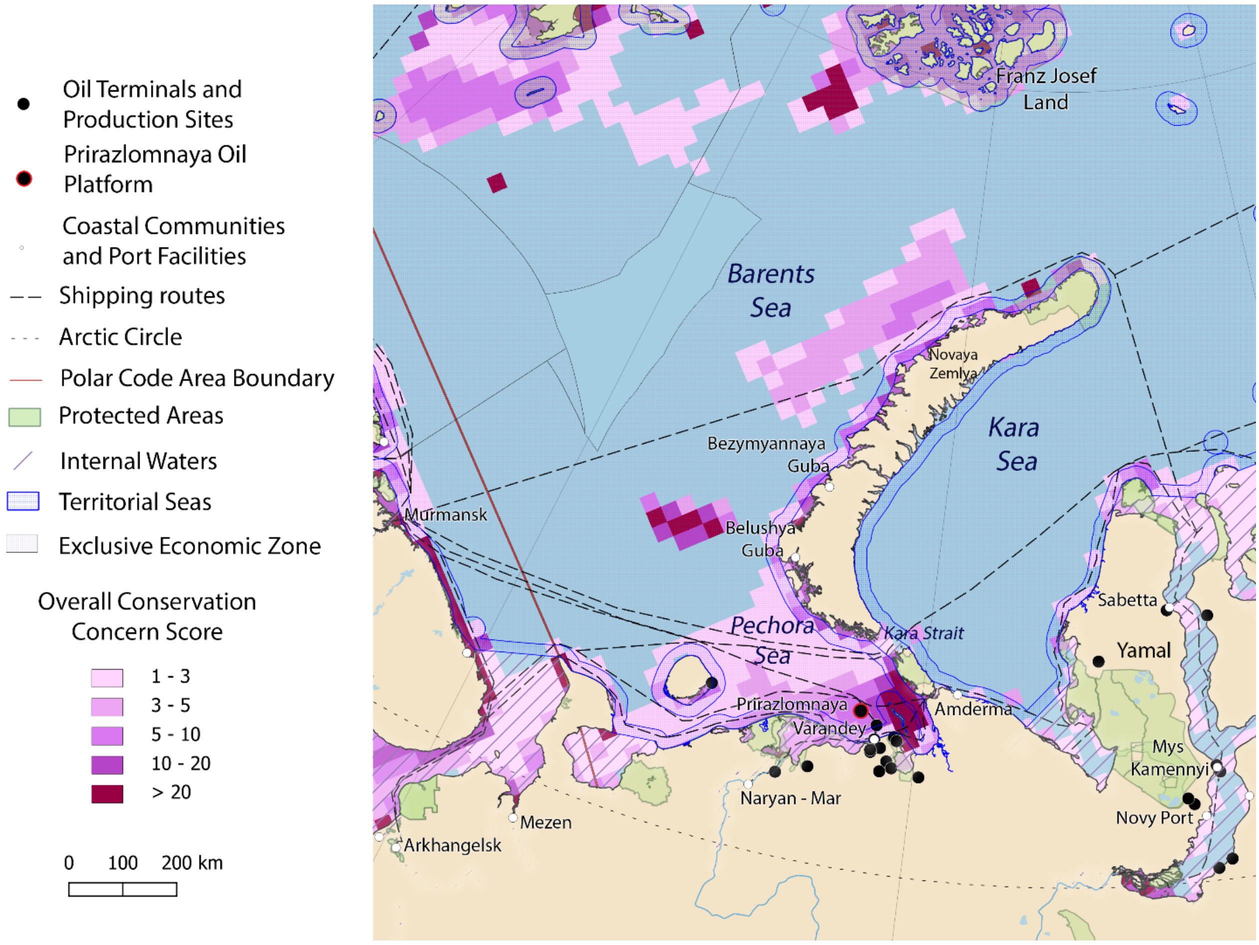
The Kara Strait and Pechora Sea Area (Figures 6 and 7)

Figure 6: The Kara Strait and Pechora Sea Area: Shipping Traffic, 2021-2023



The Kara Strait, located between the Barents and Kara seas, is the main shipping gate along the NSR. In 2023 alone, there were 1,075 occurrences of vessels using residual fuels passing through the Kara Strait—a high-intensity level of traffic compared to that seen in other Arctic marine areas (Figure 6). Traffic here is driven primarily by the development and production of hydrocarbon fields in the Yamal Peninsula (i.e., Yamal LNG). Oil production on the nearby Prirazlomnaya offshore platform and Varandey oil terminal also contribute to vessel traffic in the area. As of 2023, the traffic was mostly westbound, towards European ports, with Europe accounting for 80% of Russian liquefied gas sales by sea.

Figure 7: The Kara Strait and Pechora Sea Area: The Level of Conservation Concern

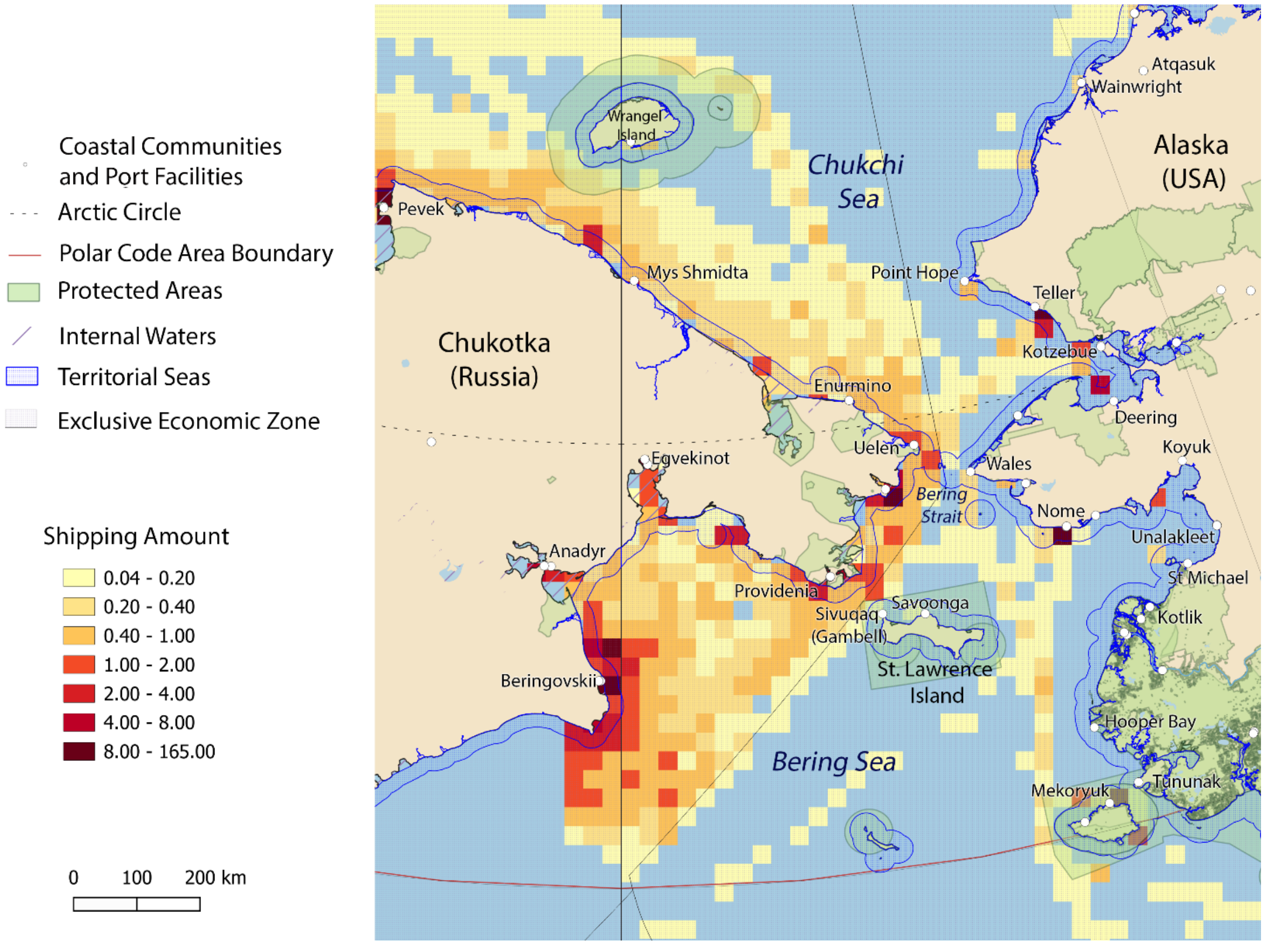


The Kara Strait is an important bottleneck for migrating beluga whales (*Delphinapterus leucas*). Habitats and biotopes for which the use of HFO and transport of oil and oil products pose the highest level of concern include a benthic biomass hotspot in the Pechora Sea; patches of kelp forests; migration stopovers for king eider (*Somateria spectabilis*); breeding and migration grounds for the Steller eider (*Polysticta stelleri*) and common eider (*Somateria* *mollissima*); summer grounds and haul-out sites for walrus (*Odobenus rosmarus rosmarus*); and whelping grounds for bearded and ringed seals (*Erignathus barbatus and Pusa hispida).*

The level of Overall Conservation Concern for the region is high throughout the whole year, with the greatest periods of risk from May to June and August to September.

The Bering Strait Area (Figures 8 and 9)

Figure 8: Bering Strait: Shipping Traffic, 2021 to 2023



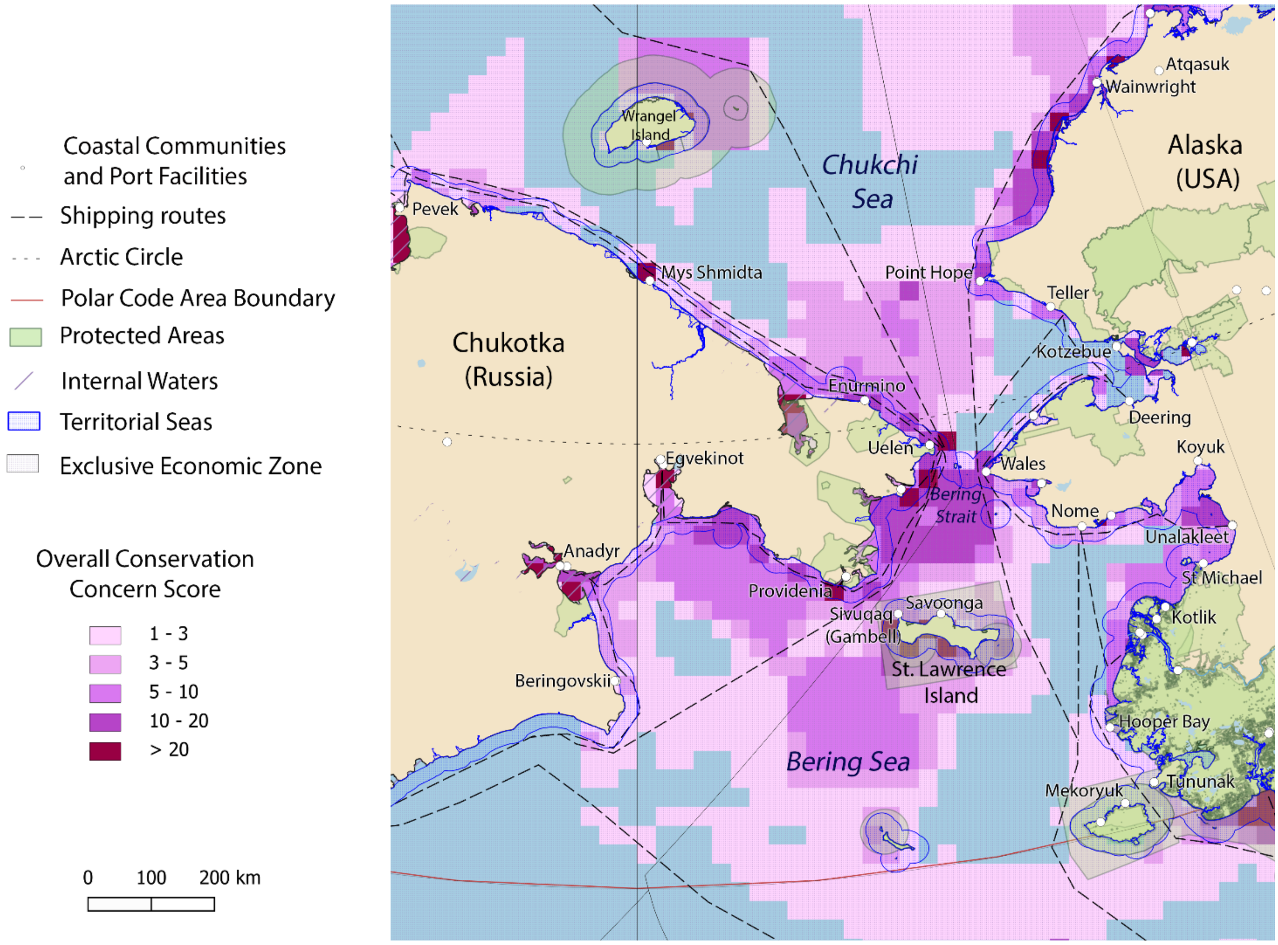
The narrow and shallow Bering Strait (85 kilometres in width and 30 to 50 metres in depth) is the only link between the Arctic and the Pacific oceans. The importance of Russia's NSR will grow because of Western sanctions that aim to halt Russian oil and gas exports to Europe. This pressure will inevitably reorient Russian Arctic oil and gas exports to Asia via the NSR and Bering Strait.

At the same time, the US is increasing fossil fuel production and maritime infrastructure in Alaska. It is building its first Arctic deep-water port in Nome, which will attract more traffic to the Bering Strait area.

In terms of marine wildlife, the Bering Strait is an important bottleneck for a number of marine mammal species that migrate through the strait to the Chukchi Sea in spring and return to the Bering Sea in autumn. Species using the strait include the bowhead whale (*Balaena mysticetus*), beluga whale (*Delphinapterus leucas*), grey whale (*Eschrichtius robustus*), walrus (*Odobenus rosmarus divergens*), bearded seal (*Erignathus barbatus*) and others.

Habitats and biotopes for which the use of HFO and transport of oil and oil products poses the highest level of concern include kelp forests; benthic biomass hotspots of the Chirikov Basin and southeastern Chukchi Sea; spectacled eider (*Somateria fischeri*) moulting grounds; salt marshes; Steller sea lion (*Eumetopias jubatus*) critical habitats; cold-water coral communities; king eider (*Somateria spectabilis*) and Steller eider (*Polysticta stelleri*) moulting and/or migration stopovers; Steller eider (*Polysticta stelleri*) moulting and/or migration grounds; and many others. The level of Overall Conservation Concern for the region is high throughout the year.

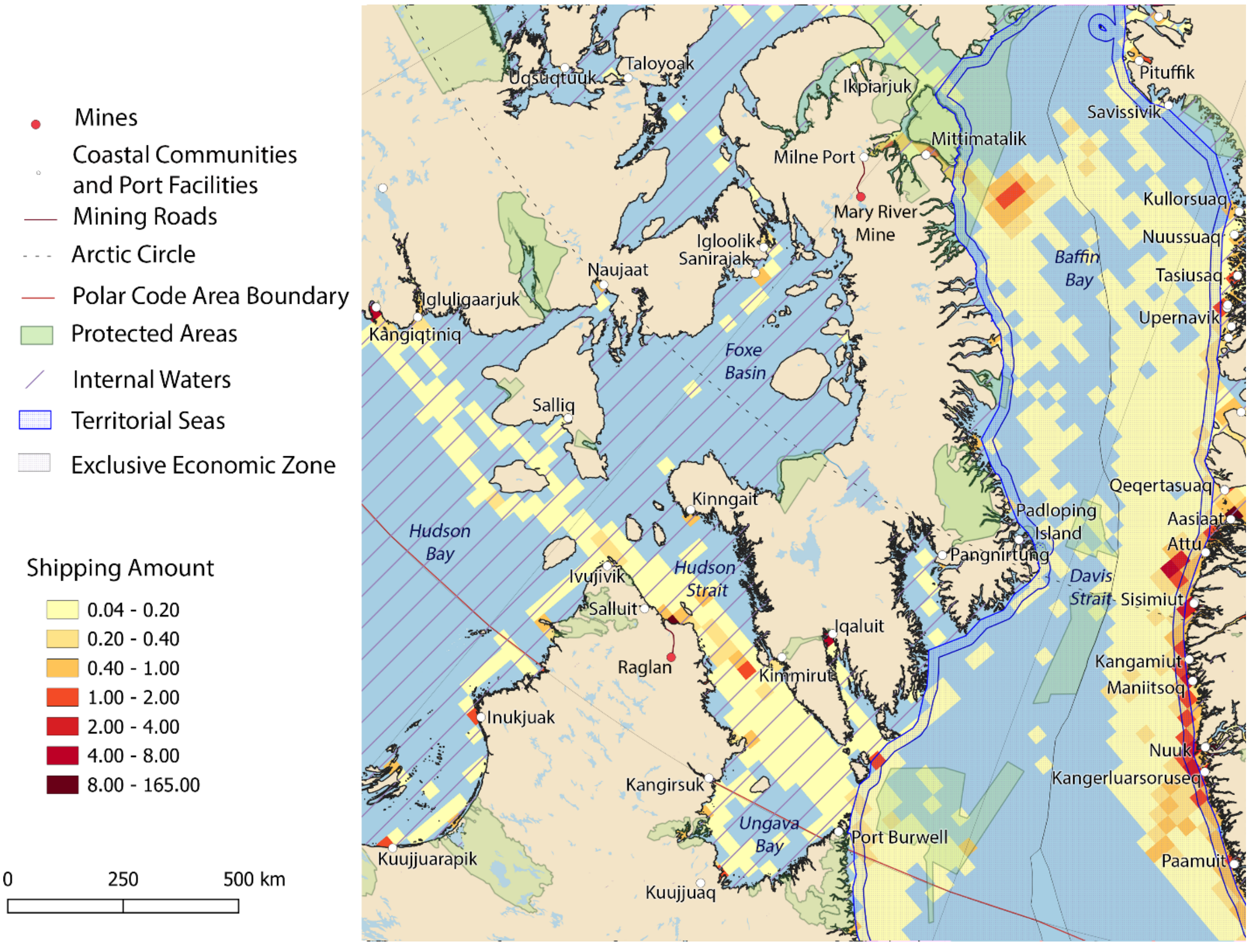
Figure 9: Bering Strait: Level of Conservation Concern



The Davis Strait, Baffin Bay and Hudson Strait Area (Figures 10, 11 and 12)

The Northwest Passage is the name given to the various marine routes between the Atlantic and Pacific oceans along the northern coast of North America that spans the Canadian Arctic Archipelago, also known as Inuit Nunangat (Inuit homeland). In the east, ships must proceed through the Labrador Sea, Davis Strait and Baffin Bay. The exception is the route that requires a transit through Hudson Strait. Davis Strait, between Canada and Greenland, links Baffin Bay with the Labrador Sea and North Atlantic Ocean. At its narrowest point, Davis Strait is about 300 kilometres wide; at its widest, it is more than 950 kilometres.

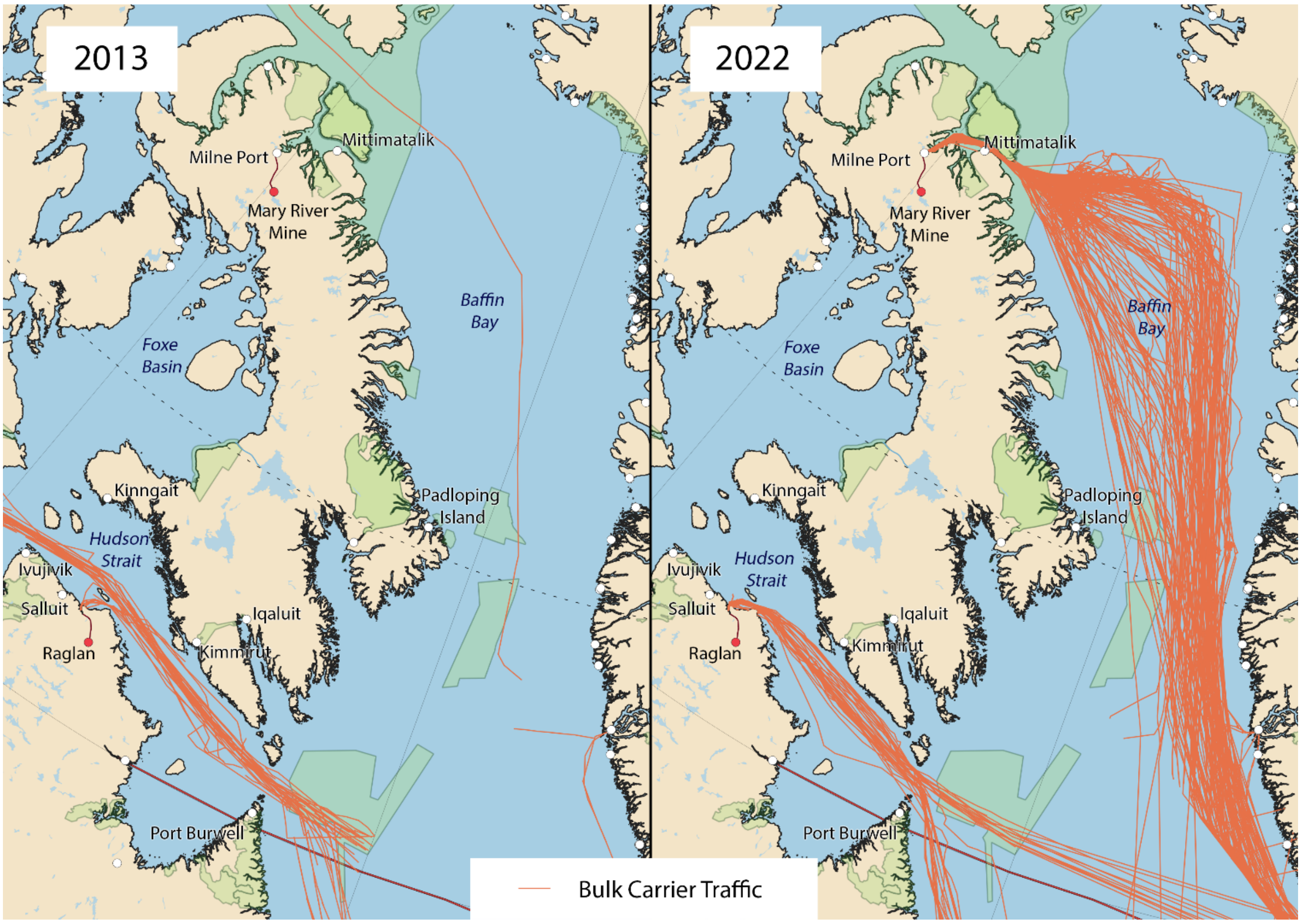
Figure 10: Davis Strait, Baffin Bay and Hudson Strait: Shipping Traffic, 2021 to 2023



The growth in bulk carrier traffic observed in this area over the last decade has been driven primarily by the development of the Mary River iron ore mining project, which commenced on Baffin Island in the Canadian Arctic Archipelago in 2014. The ore is taken from Milne Inlet (a port that receives ore transported from the Mary River mine) to be carried by bulk carriers through Davis Strait. The development of the project was accompanied by a significant increase in bulk carrier traffic in the area, particularly in Baffin Bay (Figure 11). In 2023, more than six million tonnes of iron ore were shipped by bulk carriers. Meanwhile, the level of underwater noise in the area, caused by the increased shipping traffic, went up by 600%; as bulk carriers are particularly noisy compared to other types of vessels (Jones 2021). In November 2022, the phase two expansion proposal for the mine was rejected by the Canadian federal government because of concerns from Indigenous Peoples about the potential impacts of underwater noise and other disturbances to narwhal in the region.

Pond Inlet (or *Mittimatalik*, which means “the place where the landing place is” in Inuktitut) is a mostly Inuit community in the Qikiqtaaluk Region of Nunavut, Canada, located on the northeastern tip of Baffin Island on the south shore of Eclipse Sound (*Tasiujaq*). The Hunters and Trappers of Mittimatalik have consistently voiced concerns about shipping and tourism in the region, specifically calling for vessel slowdowns, area-based restrictions, a ban on HFO, and a limit to mining activities that affect wildlife and community members’ ability to harvest.

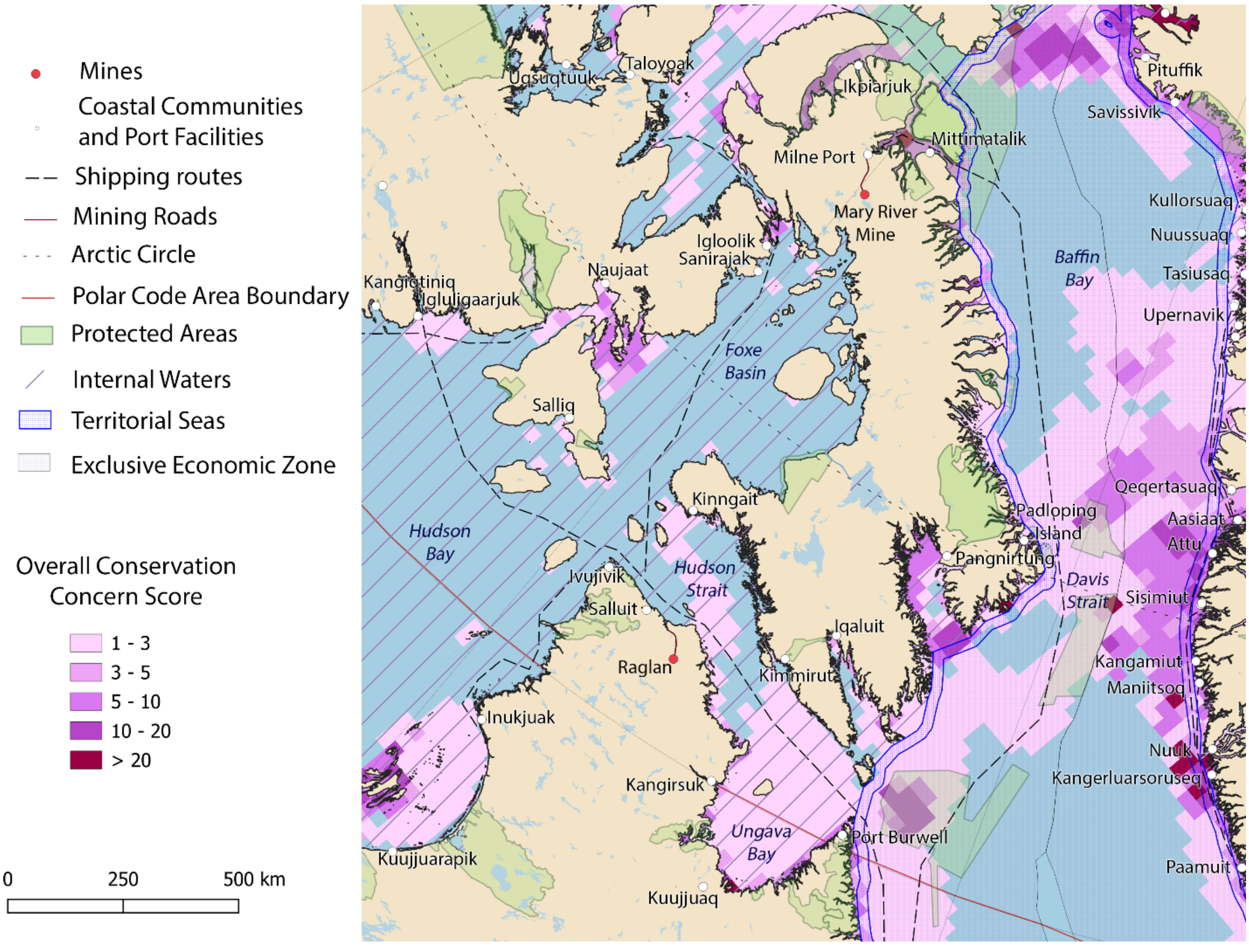
Figure 11: Changes in Bulk Carrier Traffic, 2013 and 2023



This area is important for migrations of bowhead whales (*Balaena mysticetus),* narwhal *(Monodon monoceros)* and beluga whales (*Delphinapterus leucas).* Other habitats and biotopes for which the carriage and use of HFO are of highest concern include the biological communities of estuaries; kelp forests; and whelping grounds for ringed seal (*Pusa hispida*) and bearded seal (*Erignatus barbatus*). The area also contains seasonal habitats for the

Baffin population of bowhead whales (*Balaena mysticetus*). The Overall Conservation Concern level is particularly high from July to November.

Figure 12: Davis Strait, Baffin Bay and Hudson Strait: Level of Conservation Concern



4.Discussion

As demonstrated by the shipping traffic data, the bulk transport of mineral commodities makes up a significant portion of total Arctic vessel traffic and is responsible for the largest share of HFO used in the region. There are large mines in the Arctic producing commodities such as nickel, zinc and other ores, while oil and gas is produced in fields off the coast of Norway and in Russian and US Arctic coastal areas.[6] Russia is by far the largest producer of hydrocarbons in the Arctic (WWF 2023), most of which are transported by sea. The Yamal Peninsula harbours the largest oil and gas sites that are either producing (Yamal LNG) or in development (Arctic LNG-1 and Arctic LNG-2). Currently, most oil and gas products from Yamal are delivered westward, passing through the Kara Strait and the Barents Sea via Murmansk and towards European ports. This route sees the busiest traffic in the Arctic. Because the route is largely ice-free, the traffic is year-round.

Nonetheless, in the near future, oil tanker traffic in the Russian Arctic will be mostly eastward, via the NSR, due in part to the imminent cessation of Russian hydrocarbon exports to Europe, but also because of the development of new fossil fuel fields as part of an upcoming megaproject, Vostok Oil, in the Taymyr Peninsula east of the Yamal.[7] By 2030, Russia's Rosneft intends to increase oil production from Vostok Oil to 100 million tonnes per year. This oil will be shipped on tankers using the NSR eastward along Russia's Arctic coast, then through the Bering Strait towards Asian markets.

In 2023, Russia's State Atomic Agency Corporation (Rosatom), which is responsible for shipping governance in the NSR, announced that improved navigation conditions in the NSR made it safe, overall, for oil tankers without ice-strengthening to sail in summer and fall (Kommersant 2023). The traffic generated by tankers without ice-strengthening in ecologically sensitive marine areas characterized by hazardous weather and ice conditions will create additional pressures on Arctic marine ecosystems and significantly increase the risks of oil spills.

Another class of vessels that are serving the expansion of the extractive sector in the Arctic are bulk carriers. These carriers are particularly hazardous for marine-sensitive ecosystems because they generate air, water and underwater noise pollution and introduce the risk of oil spills from reliance on residual fuels for propulsion. The largest zinc mine in the world (Red Dog in Alaska) and the largest nickel mine (Norilsk Nickel in Siberia) are entirely dependent on marine transport systems—seasonally, in the case of Red Dog, and year-round for Norilsk Nickel. In Arctic mining areas that are ice-locked throughout the winter, such as Mary River on Baffin Island in the Canadian Arctic, bulk cargoes are stored during winter and spring and shipped out in the brief ice-free summer and autumn seasons. Many of the bulk carriers

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[6] Oil and gas produced in Alaska's North Slope are transported via pipeline to Valdez in Prince William Sound.

[7] Russia anticipates significant increases in the oil and gas production associated with the Vostok Oil megaproject, which will include 13 fields and has the potential to become Russia's biggest fossil fuel project (WWF 2023).

operating throughout the Arctic in the summer are not ice-strengthened or Polar Class vessels.

The current and future development of these fossil fuel and mining locations will require vastly expanded Arctic marine operations and will drive increases in tanker and bulk carrier traffic from Arctic production sites to world markets.

5. Conclusion

To sum up, HFO is the world’s dirtiest and most hazardous marine fuel. If accidentally spilled, its characteristics will allow it to persist in the environment for many years, threatening sensitive coastal areas and food security for Indigenous Peoples and local communities. These threats are compounded by several characteristics of Arctic marine ecosystems that make them particularly vulnerable to the effects of HFO spills.

As shown in the case studies discussed in this paper, there is high spatial overlap between shipping traffic carrying or using HFO and important seasonal or permanent destinations for Arctic marine biodiversity. These include breeding aggregations of seabirds, whales and walrus, winter habitats for whales, migration corridors for marine mammals, and hotspots for benthic biomass and kelp forests. Furthermore, the risks and impacts of HFO spills are exacerbated by the tendency of many Arctic marine species, such as seabirds and marine mammals, to form aggregations during breeding, migrating, feeding, resting and moulting. This means a large proportion of a population could be exposed to an HFO spill at any given time. The long life spans and slow reproductive rates of many Arctic species also hinder their populations’ capacity to recover following a spill event. Finally, the Arctic ecosystem’s relatively short food web means that the impacts of an oil spill on one or several species could have cascading effects on the form and function of the ecosystem as a whole (Nevalainen et al. 2017 and references therein).

These are important reasons for the ban, and it is heartening to see it coming into force on July 1, 2024. In addition, switching away from HFO will bring other benefits. Cleaner alternatives, such as distillate marine fuel, have been shown to reduce black carbon by 50% to 80%.

However, loopholes in the ban will allow vessels transiting sensitive and significant Arctic waters to continue to use and carry HFO until 2029.

Due to the significant threats that unfortunately remain, Arctic states and marine industries should commit to closing these loopholes and should refrain from granting waivers to domestic vessels that would exempt them from the ban or allow them to take advantage of design and fuel tank exemptions. This would ensure full compliance with the HFO ban on July 1, 2024.

If full compliance cannot be achieved, then states and shipping operators should implement a suite of measures to reduce the risk as much as possible. These measures should include:

- Implementing area-based conservation measures that are based on both scientific data (in consultation with Indigenous and local communities) and Indigenous Knowledge to keep ships away from sensitive marine areas and harvest sites. These measures could include route restrictions, speed reductions, areas to avoid, and pilotage regimes to ensure safe, low-impact operations.

- Supporting efforts to establish Emission Control Areas (ECAs) throughout the Arctic—and mandates at the IMO for cleaner fuels, such as distillate marine fuels—to reduce spill impacts and obtain co-benefits, such as reducing black carbon emissions.
- Mandating oil spill response gap assessments and conducting such assessments regularly and at different scales to reflect ongoing changes in Arctic shipping traffic.
- Developing detailed plans for shipping management (including marine spatial tools) in the focus areas outlined in this paper, especially the bottleneck areas where intense shipping traffic overlaps with marine mammal migration corridors.
- Mandating oil and gas tankers, bulk carriers and cargo vessels operating in Arctic waters to meet the ice-strengthening requirements of the Polar Code.

Given that a full understanding of the scale of the risks and impacts of oil spills still does not exist, and that any required clean-up operations would be slow to deploy and very difficult to carry out, regulations on Arctic shipping should be firm and precautionary—that is, they should aim to prevent spills in the first place rather than to mitigate their impacts.

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