CURRENT MARINE USE AND THE AMSA SHIPPING DATABASE

In order to better understand Arctic shipping today, a database of Arctic marine activity for a given year was seen as essential. Since no comprehensive database existed, AMSA undertook the collection of shipping data from all Arctic states. The result is the first comprehensive Arctic vessel activity database for a given calendar year. It contains a range of information on where and when different vessels are operating in the Arctic, what types of vessels, what activity they undertake and what cargo they may be carrying, among other information. The AMSA database is a flexible tool that can be built upon as additional information is obtained and can be used to further assess environmental impacts from vessel activity, locate areas of potential conflicting multiple use and provide a baseline for an analysis of future growth in vessel activity in the region.

Methodology

Vessel activity data for the AMSA study was collected from all Arctic states with coastal waters through the use of a specially designed questionnaire distributed to the Arctic Council's Senior Arctic Officials and PAME working group representatives in February 2006. A number of state administrations responded directly and, in some cases, other organizations were engaged to develop responses on a state's behalf. For the purposes of the study, 2004 was chosen to be the baseline year; where data was found to be insufficient for 2004, data from later years was provided and used for those areas only.

The data requested included such information as the number of vessels operating in the states' waters, the type of vessels, cargo

Vessels Reported in the Circumpolar North Region, 2004

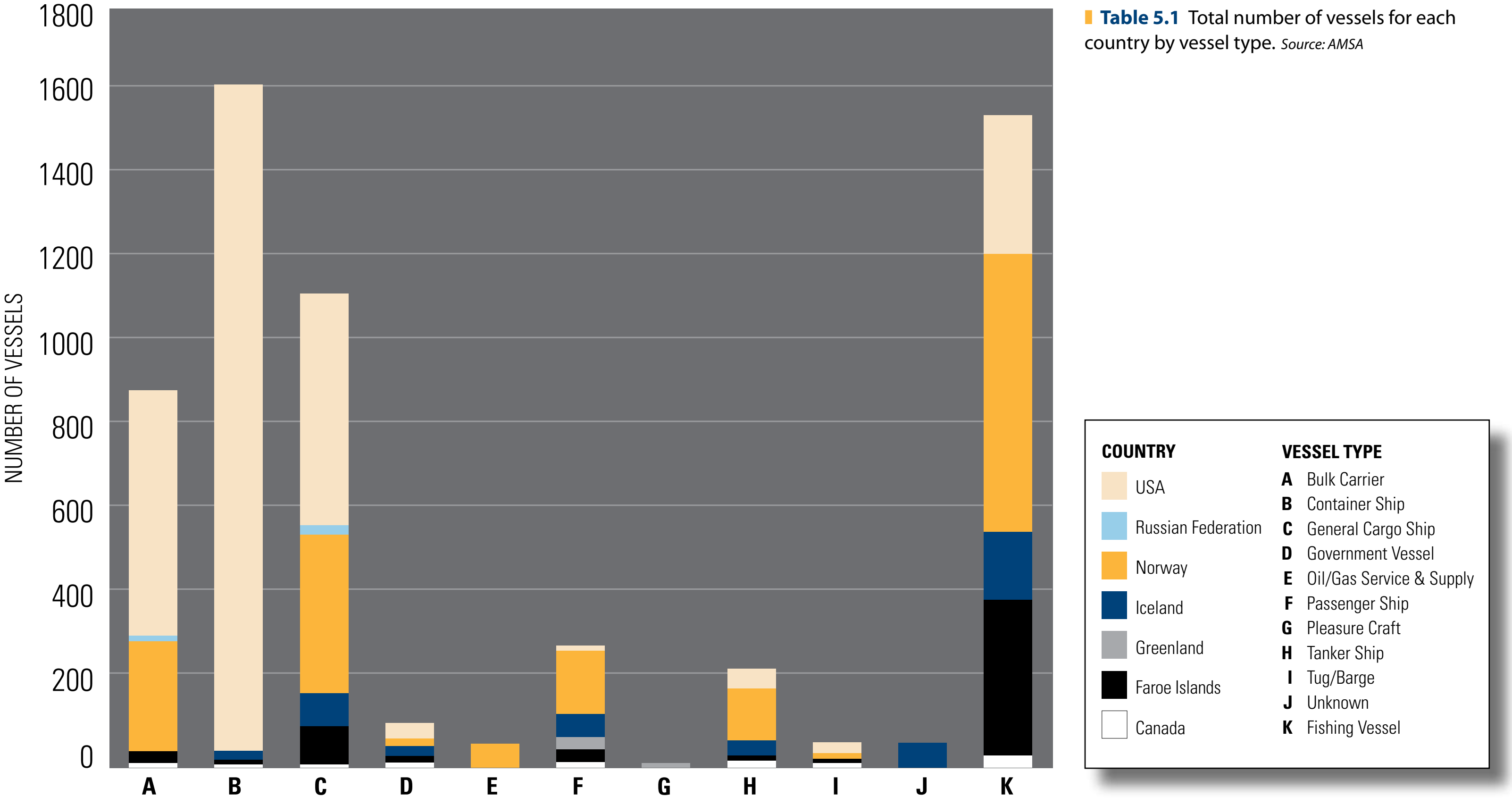


Table 5.1 Total number of vessels for each country by vessel type. *Source: AMSA*

carried, operational routes, fuel used, engine size of the vessels, date of operations, etc. Response to the questionnaire varied. Some responses were submitted with very detailed information, while some were submitted with very basic information or, at times, incomplete. In order to make the database more usable for most types of analysis, some assumptions have been made and post-processing of the data has been undertaken. For example, where route data was unavailable or contained obvious errors, such as passages across land, the information has been adjusted to follow known shipping routes. In terms of data reporting, there is some inconsistency in how states defined vessel types, as some states reported oil carriers as tankers, while others reported similar vessels as bulk carriers or tug and barge. There are also varying levels of certainty regarding the routes traveled, ranging from very complete records of course changes to records that provided only departure and arrival points.

Where limited vessel-specific information was provided, other data sources were integrated, including ferry and cargo vessel sailing schedules, to add additional parameters to the data set. To facilitate analysis of the raw data, vessels were grouped into standardized vessel categories by the country that reported it and by the season in which it operated (Table 5.2). A summary of total number of vessels per category per country is shown in Table 5.1. Seasons were defined as: Winter - December to February; Spring - March to May; Summer - June to August; Autumn - September to November. For the purposes of the AMSA, the Arctic has been defined according to the internal policies among Arctic Council member states. This has meant that some states reported vessel activity that is below 60 degrees north, the traditional definition of the Arctic.

To further enhance understanding and presentation of the data, the raw data was mapped into a Geographic Information System (GIS), which provided the tools required to manage and analyze the spatial as well as the attribute components. Incorporating the data into a GIS provided for the development of maps that create a visual presentation, allowing for further analysis of all Arctic vessel activities, such as modeling vessel CO_2 emissions and comparing current vessel traffic and mapped ecologically sensitive areas.

Table 5.2 AMSA vessel categories. *Source: AMSA*

Ship Category	General Description
Government Vessels and Icebreakers	An icebreaker is a special purpose ship or boat designed to move and navigate through ice-covered waters. For a ship to be considered an icebreaker it requires three components: a strengthened hull, an ice-clearing shape and the power to push through ice, none of which are possessed by most normal ships.
Container Ships	Container ships are cargo ships that carry all of their load in truck-size containers, in a technique called containerization.
General Cargo	Ships designed for the carriage of various types and forms of cargo and the combined carriages of general cargo and passengers with 12 or less fare paying passengers.
Bulk Carriers	Ships specifically designed for bulk carriage of ore with additional faculties for alternative, but not simultaneous, carriage of oil or loose or dry cargo. Bulk carriers are segregated into the following major categories: handysize (10,000 to 35,000 DWT), handymax (35,000 to 55,000 DWT), panamax (60,000 to 80,000 DWT), capesize (80,000 DWT and over).
Tanker Ships	Propelled ships designed and constructed for the bulk carriage of liquids or compressed gas, as in the case of natural gas.
Passenger Ships	Ships that carry passengers, whether for transport purposes only or where the voyage itself and the ship's amenities are part of the experience.
Tug / Barge	Tug: vessel designed for towing or pushing. Additional activities may include salvage, fire fighting and work duties of a general nature. Barge: non-propelled vessel for carriage of bulk or mixed cargoes on weather or protected decks. May carry liquid cargo in holds or tanks. Some barges are modified for specific purposes (for example, crane barge).
Fishing Vessels	Fishing boats can be categorized by several criteria: the type of fish they catch, the fishing method used, geographical origin and technical features such as rigging. Modern commercial fishing uses many methods: fishing by nets, such as purse seine, beach seine, lift nets, gillnets or entangling nets; trawling, including bottom trawl; hooks and lines, long-line fishing and hand-line fishing; fishing traps. Fishing boats are generally small, often little more than 30 meters (98 ft) but up to 100 meters (330 ft) for a large tuna or whaling ship and can feature holds large enough to keep a good-sized catch.
Oil and Gas Exploration Vessels	There are many specialized vessels that are designed specifically for the exploration and extraction of natural gas and oil.

Using the GIS, the fishing data was defined by fishing vessel days per year, taking the number of fishing days times the number of fishing vessels reported. This number was then assigned to the appropriate Large Marine Ecosystem (LME) based on where the fishing events took place. A bathymetry layer is also provided in GIS format and can be used to discern draft limits to navigation. Map 5.1 shows the map-based depiction of all of the vessel activity in the AMSA database, including fishing vessel activity by LME.

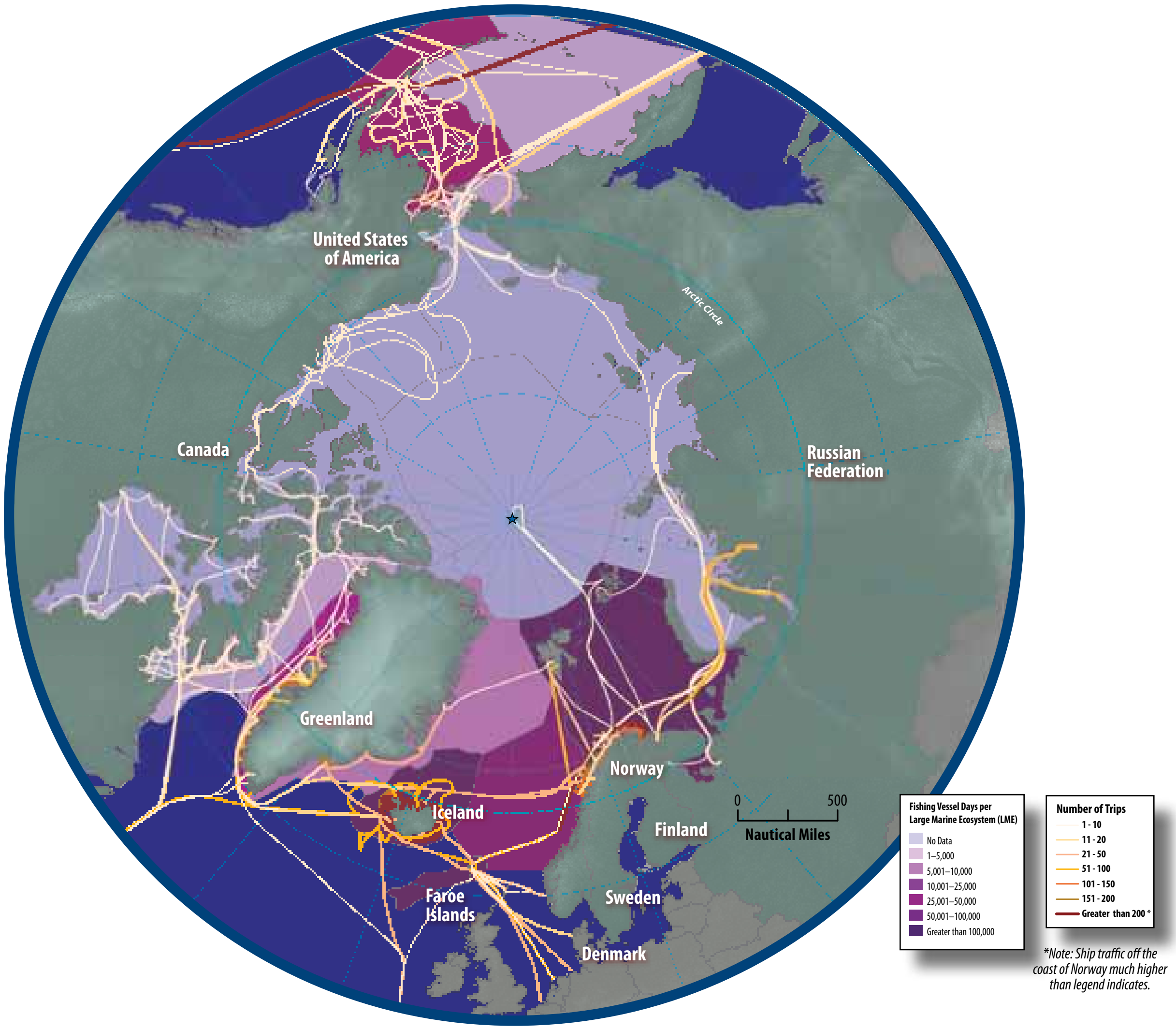
Results

In 2004, approximately 6,000 individual vessels were reported operating in the Arctic, including vessels traveling on the North Pacific's Great Circle Route between Asia and North America through the Aleutian Island chain, defined by the U.S. as within the Arctic. Great Circle Route vessels account for half of all the vessels reported. Excluding the vessels plying the Great Circle Route, the most vessels in one category were fishing boats, at slightly less than 50 percent of the total; with the next largest vessel category being bulk carriers at about 20 percent of all vessels. The AMSA database contains information on individual voyages into or through Arctic waters. This means that the number of individual vessels is not necessarily proportionate to the total number of voyages, as many vessels made multiple trips within the region. Results are also potentially an underestimation of total vessels and marine use for 2004, given probable underreporting bias and obvious data gaps in many areas and vessel types.

While 2004 provides a snapshot of current Arctic vessel traffic, clear trends emerged from the data to show what common types of vessels are operating in the Arctic, where and when most activity is typically taking place. The AMSA database identified four types of vessel activities as most significant in the Arctic in 2004: community re-supply, bulk cargo, tourism and fishing vessel activity operations.

6,000

The approximate number of vessels in the Arctic marine area during 2004, including the North Pacific Great Circle Route.



Map 5.1 Overview of all vessel activity for 2004, including fishing vessels. *Source: AMSA*

Regional Distribution of Vessel Activities

The overview map of vessel traffic shows that nearly all voyages took place on the periphery of the Arctic Ocean. Regions of high concentrations of traffic include: along the Norwegian coast and into the Barents Sea off northwest Russia; around Iceland; near the Faroe Islands and southwest Greenland; and in the Bering Sea. Different factors determine this distribution of marine activity. In the Bering Sea, in addition to the ships along the North Pacific Great Circle Route (through the Aleutian Islands), most of the ship traffic is bulk cargo ships serving the Red Dog mine in northwest Alaska, fishing and coastal community (summer) resupply. Traffic around Iceland, the Faroe Islands and southwestern Greenland is a

The AMSA database identified four types of vessel activities as most significant in the Arctic in 2004: community re-supply, bulk cargo, tourism and fishing vessel activity operations.

Icebreaker Navigation in the Central Arctic Ocean, 1977-2008

One of the historic polar achievements at the end of the 20th century and early in the 21st century has been the successful operation of icebreakers at the North Pole and across the central Arctic Ocean.

Between 1977 and 2008 access in summer has been attained by capable icebreaking ships to all regions of the Arctic basin. Seventy-seven voyages have been made to the Geographic North Pole by the icebreakers of Russia (65), Sweden (five), USA (three), Germany (two), Canada (one) and Norway (one).

Nineteen of the 77 voyages have been in support of scientific exploration and the remaining 58 have been for marine tourism, all but one of the tourism voyages conducted aboard nuclear icebreakers.

Of the 76 icebreaker voyages that have been to the pole in summer, the earliest date of arrival has been July 2, 2007 and the latest September 12, 2005, a short 10-week navigation season for highly capable icebreaking ships.

The Soviet nuclear icebreaker *Arktika*, during a celebrated voyage, was the first surface ship to attain the North Pole on August 17, 1977. *Arktika* departed from Murmansk on August 9 and sailed eastbound initially north of Novaya Zemlya and through Vilkitski Strait to the ice edge in the Laptev Sea. The ship sailed northward to the pole along longitude 125 degrees east and reached the pole on August 17. *Arktika* arrived back in Murmansk on August 23 having sailed 3,852 nautical miles in 14 days at a speed of 11.5 knots.

The only voyage to the pole not to be conducted in summer was that of the Soviet nuclear icebreaker *Sibir*, which supported scientific operations during May 8 to June 19, 1987, reaching the North Pole on May 25. *Sibir* navigated in near-maximum thickness of Arctic sea ice while removing the personnel from Soviet North Pole Drift Station 27 and establishing a new scientific drift station (number 29) in the northern Laptev Sea. This successful voyage in the central Arctic Ocean could be considered the most demanding icebreaker operation to date.

No commercial ship has ever conducted a voyage across the central Arctic Ocean. However, seven trans-Arctic voyages, all in summer, have been accomplished by icebreakers in the central Arctic Ocean through the North Pole.

A voyage across the central Arctic Ocean with tourists was conducted by the Soviet nuclear icebreaker *Sovetskiy Soyuz* in August 1991. The Arctic Ocean Section 1994 Expedition, conducted by Canada's *Louis S. St-Laurent* and the *Polar Sea* of the United States, was the first scientific transect of the Arctic Ocean accomplished by surface ship. During July and August 1994 both ships sailed from the Bering Strait to the North Pole and to an exit between Greenland and Svalbard through Fram Strait. The expedition made

extensive use of real-time satellite imagery (received aboard *Polar Sea*) for strategic navigation and scientific planning.

Two trans-Arctic voyages with tourists through the North Pole were accomplished by the Russian nuclear icebreaker *Yamal* in summer 1996. In summer 2005, Sweden's icebreaker, the *Oden*, and the American icebreaker *Healy* also made trans-Arctic passages in a second and highly successful scientific expedition by surface ships across the central Arctic Ocean.

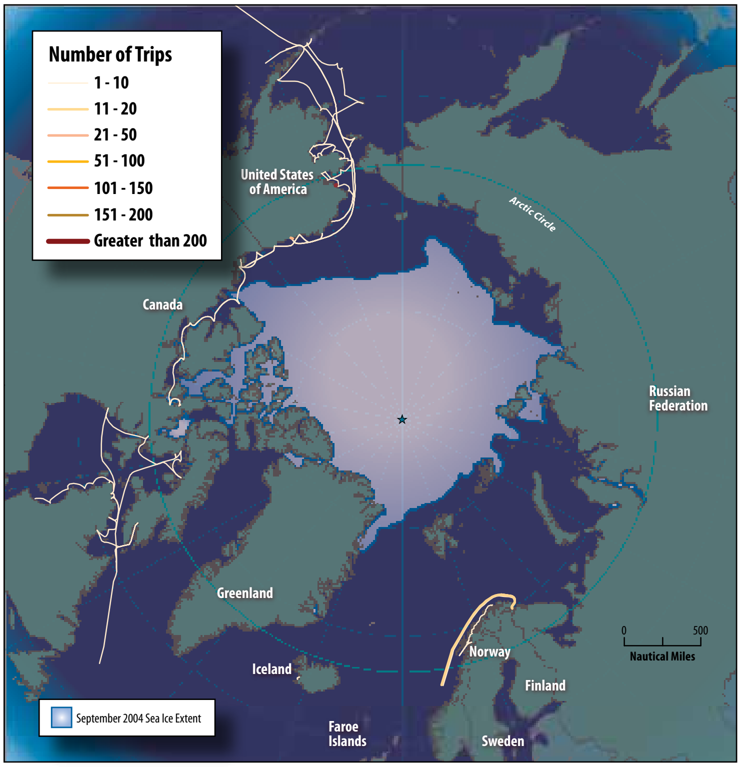
Although not a trans-Arctic voyage, the operation of a three-ship scientific expedition for Arctic seabed drilling during late summer 2004, mentioned earlier, is noteworthy. Included in the AMSA 2004 database, the expedition was composed of Russia's nuclear icebreaker *Sovetskiy Soyuz* and Sweden's *Oden*, both used extensively for ice management, and the Norwegian-flag icebreaker *Vidar Viking* outfitted for drilling. One of the key accomplishments was the return of a 400-meter sediment core from the seabed that is being used for scientific studies of past Arctic climates.

A review of these historic polar voyages indicates that marine access in summer throughout the Arctic Ocean has been achieved by the 21st century by highly capable icebreakers. The nuclear icebreakers of the Soviet Union and later the Russian Federation have clearly pioneered independent ship operations in the central Arctic Ocean, especially on voyages to the North Pole in summer. Conventionally powered icebreakers have also operated successfully on trans-Arctic voyages in summer, as well as on scientific expeditions to high-latitudes in all regions of the Arctic Ocean. Any planning for future navigation in the central Arctic Ocean would do well to understand the ship performance, environmental conditions and ice navigation capabilities of these successful operations in the ice-covered central Arctic Ocean.

mix of fishing, domestic cargo supply and cruise ships. The Barents Sea experiences the highest concentrations of marine activity in the Arctic region. Ships plying these waters include: bulk cargo carriers, oil tankers, LNG carriers, coastal ferries, fishing vessels, cruise ships and other smaller vessels. Many ships pass along the Norwegian coast and in Norwegian waters during bad weather en route to Murmansk and northwest Russia. There is tanker traffic in the region and ships servicing the Norilsk Nickel mining complex sail year-round from the port of Dudinka on the Yenisei River to Murmansk.

Marine Use: Arctic Community Re-supply

For 2004, community re-supply made up a significant portion of the ship traffic throughout the Arctic. In some areas of the region, this is also referred to as coastal Arctic shipping. In areas such as the Canadian Arctic, eastern Russia and Greenland, this activity was the basis for most ship traffic. Re-supply activities provide a lifeline to many communities that have no or very limited road access and no or limited capacity to handle heavy aircraft. Most communities serviced - mainly in Canada, the Russian Federation, Greenland, the United States, Svalbard and Bear Island - are ice-locked for parts of the year and rely heavily on marine transportation during the summer months for their dry foods, fuel, building materials and other commodities.



Map 5.2 Tug/barge traffic. *Source: AMSA*

Community re-supply and coastal Arctic shipping involve a range of ship types, including tankers, general cargo and container ships and, in some areas, tug/barge combinations. Tug/barge operations are particularly common in the western Canadian and Alaska Arctic and are used in these regions for mostly community re-supply, as well as for supplying mining and other construction projects. Tug/barge operations typically consist of a tug towing up to three barges. Depending on conditions, a tug/barge train can be a kilometer in length or more. Map 5.2 shows where the tug/barge activity took place, according to the data reported.

Summer resupply is handled by barge traffic along the Alaska Arctic, and in the Canadian Arctic a lack of deepwater ports requires lightering from larger supply ships at select Arctic communities. Lightering (shuttling goods from the anchored main ship to shore) is used to bring cargo ashore and tanker ships transfer petroleum products ashore by way of pumps and floating fuel lines, at many Arctic locations without deepwater access. There are select ports in Greenland, Svalbard and along the Northern Sea Route for normal cargo handling in small ports. Along the coasts of Norway and Iceland, and in Murmansk (northwest Russian Federation), all of which are ice-free year-round, there are deepwater port facilities to handle volumes of cargo from global shipping.

Community re-supply is expected to expand in the coming years due both to population increases in Arctic communities and increasing development in the region, stimulating demand for goods and construction materials. The 2004 AMSA data shows where this type of vessel traffic is occurring and can, therefore, serve as a good baseline tool when projecting future activity under various scenarios for population and economic growth.

Bulk transport of commodities such as oil, gas and various types of ore is a significant portion of total Arctic vessel traffic in 2004.

Marine Use: Bulk Transport of Ore, Oil and Gas

Bulk transport of commodities such as oil, gas and various types of ore is a significant portion of total Arctic vessel traffic in 2004 in volume of cargo transported. There are some very large mines in the Arctic producing commodities such as nickel, zinc and other ores, as well as oil and gas producing fields off the coast of Norway and in the Russian and U.S. Arctic. The Red Dog mine in Alaska is one of the world's largest zinc mines. The Norilsk Nickel mine near the port of Dudinka in the Russian Federation is also the world's largest producer of nickel and palladium. Nearly all bulk traffic in the Arctic is outbound, shipping extracted natural resources out of the region to the world's markets. In 2004, there were no Arctic transits of bulk goods east, west or through the central Arctic Ocean.

Most bulk transport takes place during the ice-free season or in ice-free parts of the Arctic including the Norwegian Arctic and parts of the Russian Arctic such as Murmansk. The exceptions are high-value perishable cargoes such as the concentrates from the Dudinka region and the nickel from Deception Bay in northern Quebec, Canada, which must be shipped year-round because they degrade if left too long without processing. In 2004, these two operations were the only all-season operations recorded in seasonally ice-covered parts of the Arctic, which demonstrates that given economic incentive, year-round operations may be possible in other areas where ice is a limiting factor. In other Arctic mining areas that are ice-locked throughout the winter, bulk cargoes are stored during winter and spring and are shipped out in the brief ice-free summer/autumn season. Because some of the mines, such as Red Dog, produce very large amounts of ore, the ice-free season means heavy traffic and carefully planned bulk shipments to ensure mines get all of the ore out before the fall ice forms. Large bulk carriers, Panamax and Handymax size up to 65,000 tons, visit Red Dog mine in Alaska during the short summer season. Many of the bulk carriers operating throughout the Arctic in the summer are not ice-strengthened or *Polar Class*.

Development of the rich natural resources in the Arctic is a rapidly growing industry. Since 2004, several significant new bulk shipments have begun operations, such as the year-round oil shipments out of Varandey in the Russian Arctic. In early 2008, an offshore lease sale conducted by the U.S. Minerals Management Service for the U.S. Arctic totaled nearly $US2.7 billion; offshore

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$US2.7B

The approximate amount of money received by the U.S. Minerals Management Service for an Arctic offshore lease sale in 2008.

gas appears to be the resource under consideration for development in this Arctic region. In June 2008, the Government of Canada received record breaking bids for oil and gas exploration leases in the Beaufort Sea, including a $C1.2 billion bid for the rights to explore an offshore area of 611,000 hectares. In September 2008, a test shipment of some of the purest iron ore found on the planet was delivered to Europe from the Baffinland mine in Mary River on Baffin Island. Depending on the regulatory review, the mine could begin year-round operations in the next 3-5 years. As planned resource development projects such as these become operational, bulk carrier traffic in the Arctic will continue to increase. This type of ship activity is likely where the most growth will be witnessed in the near future.

Marine Use: Fishing

Fishing vessel operations constitute a significant portion of all vessel activity in the Arctic in 2004, given that some of the world's most productive fisheries are in the Arctic region. The amount of fishing activity reported in the AMSA database almost certainly underestimates the amount of activity actually taking place, as there are regions of the Arctic for which no data was submitted, but there is known to be commercial fishing occurring. Also, much fishing activity is likely to take place on smaller vessels, which are, for the most part, not captured in the AMSA database. The reported fishing vessel activity takes place in a few key areas, including the Bering and Barents seas; on the west coast of Greenland; and around Iceland and the Faroe Islands. Very limited fishing activity occurs in the Arctic Ocean and the Canadian Arctic Archipelago, mostly small-scale food fisheries. Since fishing in the Arctic takes place up to the ice edge, not in close ice pack conditions, operations are in completely or seasonally ice-free or low ice concentration areas and opportunistic in nature. Fishing vessel activity in the database has been categorized according to the Large Marine Ecosystem in which the activity took place. LMEs are geographical entities defined as ecosystems based on a series of ecological criteria. Each comprises a fairly large sea area, typically 200,000 km^2 or larger, with distinct bathymetry, hydrography, productivity and trophically dependent populations.

Map 5.3 Fishing vessel activity. *Source: AMSA*

Fishing vessel operations constitute a significant portion of all vessel activity in the Arctic in 2004, given that some of the world's most productive fisheries are in the Arctic region.

23
The number of commercial cruise ships transiting the Northwest Passage between 1984 and 2004.

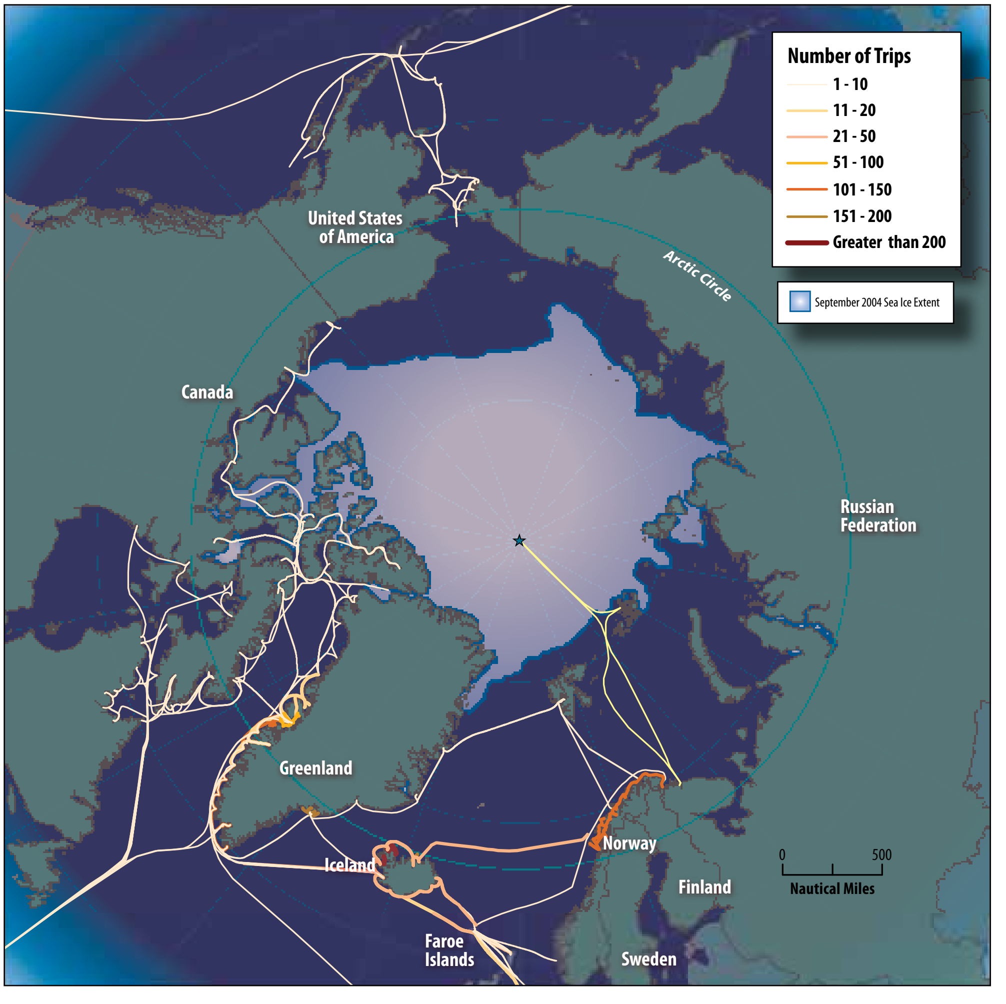
Map 5.3 shows general levels of activity in each of the LMEs within the AMSA area of study and highlights those for which data was not available. Fishing vessel data is presented in terms of days in an area rather than as routes, because fishing vessels typically meander in search of catch rather than follow a specific itinerary. Although further analysis of the impacts of fishing or its potential growth fall outside the scope of this report, it is important to appreciate that fishing activity represents a significant proportion of all current vessel activity in the Arctic region in considering cumulative effects.

Marine Use: Passenger Vessels and Tourism

Passenger vessel activity represents a significant proportion of the vessel activity reported in the Arctic for 2004. The type of activity captured in the AMSA database includes ferry services, small and large cruise vessels and any other vessels where people are transported, whether for tourism purposes or otherwise. The type of activity taking place varies depending on its location. In Norway, Greenland and Iceland, some of the passenger vessel traffic consists of ferries, carrying people into and out of coastal communities. In other areas, such as Alaska and the Canadian Arctic, ferry services are non-existent and all passenger traffic would be vessels for marine tourism only. Some services, such as the Hurtigruten around Norway and ferry service to Iceland and Greenland from mainland Europe are hybrids, serving both as ferries and cruise ships. Map 5.4 presents the overall passenger vessel traffic in the Arctic for 2004.

Nearly all passenger vessel activity in the Arctic takes place in ice-free waters, in the summer season and the vast majority of it is for marine tourism purposes. In 2004, the only passenger vessels that traveled in ice-covered waters were the Russian nuclear icebreakers that took tourists to the North Pole, voyages they have been making for tourism purposes since 1990. The heaviest passenger vessel traffic in the AMSA 2004 ship activity database is seen along the Norwegian coast, off the coast of Greenland, Iceland and Svalbard. Though there was some passenger vessel traffic in the Canadian Arctic and Alaska, those numbers were small in comparison to the higher traffic areas.

Marine-based tourism is the largest segment of the Arctic tourism industry in terms of numbers of persons, geographic range and types of recreation activities. The size and type of vessels that service this industry range from relatively small expedition style vessels that hold less than 200 people, to large luxury cruise liners that can hold 1,000 or more. In the Arctic, marine tourism is highly diversified and is driven by five main types of tourists seeking out a range of activities. These include mass market tourists primarily attracted to sightseeing within the pleasurable surroundings of comfortable transport and accommodations; the sport fishing and hunting market driven by tourists who pursue unique fish and game species within wilderness settings; the nature market driven by tourists who seek to observe wildlife species in their natural habitats, and/or experience



Map 5.4 Passenger vessel traffic. *Source: AMSA*

157 to 222

The increase in cruise ships making port calls in Greenland between 2006 and 2007.

© Ross MacDonald

Year	Arrivals	Number of cruise ships	Average number of arrivals/ship	Average passenger capacity/ship
2003	164	14	13	490
2004	195	24	8	468
2005	115	25	5	714
2006	157	28	6	546
2007	222	35	6	671
2008	375*	39*	10*	641*
*= Estimates for 2008 (full data not available at time of printing)				

Table 5.3 Cruise ship arrivals in Greenland ports and harbors, 2003 – 2008.
Source: Greenland Tourism (Grønlands Turist- og Erhvervsråd)

the beauty and solitude of natural areas; the adventure tourism market driven by tourists who seek personal achievement and exhilaration from meeting challenges and potential perils of outdoor sport activities; and the culture and heritage tourism market driven by tourists who either want to experience personal interaction with the lives and traditions of indigenous people, or personally experience historic places and artifacts.

While Arctic ship-based tours are booked well in advance, many of the itineraries are somewhat opportunistic. The precise route and the ports and communities visited depend on the ice conditions and the difficulty and risk of access. Cruise ships often intentionally travel close to the ice edge and shorelines for wildlife viewing opportunities, increasing the risk of interaction with ice and other hazards. Many Arctic cruise ships visit destinations that were once totally inaccessible to the public, such as the North Pole, Northwest Passage and the Northern Sea Route. Between 1984 and 2004, 23 commercial cruise ships accomplished transits of the Northwest Passage; seven commercial tours were planned for 2008 alone.

According to the Cruise Lines International Organization, the number of passengers served worldwide has grown from about 500,000 in 1970 to more than 12 million in 2006. Additional growth is now occurring in the number and passenger capacity of new cruise ships entering the market. The Royal Caribbean's *Freedom of the Seas* entered the fleet in June 2007 with the largest passenger capacity yet – 3,634 – twice the size of ships built a decade ago. From 2000 to the end of 2008, 88 new cruise ships were introduced. The vast majority of these vessels were not constructed or designed to operate in Arctic conditions, yet as Arctic cruise tourism continues to grow, it is very likely that many of them may make trips to the region. The cruise ship industry considers Arctic voyages to be a vital and especially lucrative part of their international tourism product. This is apparent when considering the price that tourists pay to travel to this region. As of 2008, the prices for Arctic cruises range between $US2,900 and $US55,000 per person. The cruise ship industry has indicated that it not only intends to maintain an Arctic presence, but to expand in terms of ship passenger capacity, destinations and extended seasons of operations. This will be encouraged by circumpolar nations that consider tourism important for growing and strengthening their economies.

Cruise ship traffic in the Arctic region has increased significantly in the four years that have passed since the AMSA database was developed. An independent survey indicated more than 1.2 million passengers traveled in 2004 to Arctic destinations aboard cruise ships; however, by 2007 that number had more than doubled.

A specific example of where cruise ship traffic is increasing at a rapid rate is off the coast of Greenland. As Table 5.3 shows, cruise ship visits and the number of passengers visiting Greenland has increased significantly between 2003 and 2008. For example, between 2006 and 2007, port calls into Greenland increased from 157 to 222 cruise ships. The number of port calls in 2006 combined for a total of 22,051 passengers, a number that represents nearly half of Greenland's total 2006 population of 56,901.

In 2008, approximately 375 cruise ship port calls were scheduled for Greenland ports and harbors, more than double the number of port calls seen in 2006. The areas visited by the cruise vessels in Greenland are also changing. Likely driven by increased demand in adventure tourism, Tourism Greenland has reported that in the past few years there has been a marked increased interest in trips to the

Arctic Marine Tourism: A New Challenge

As passenger and cruise vessel traffic continues to increase in the Arctic, infrastructure and passenger safety needs will become of increasing concern. The large number of tourists already cruising Arctic waters now exceeds the emergency response capabilities of local communities (See page 172). The Arctic's cold air and water temperatures require the quick and efficient rescue of capsized vessels and tourists aboard lifeboats and rafts. Even limited exposure to cold weather and seas quickly reduces human endurance and chances of survival. These hazardous environmental conditions prevail in a region that has very scarce emergency response resources and where long distances result in lengthy response times. Emergency protocols become increasingly difficult as both small and large cruise ships seek remote wilderness settings and wildlife habitats. The primary polar attractions sought by tourists are rarely close to emergency response services. This combination of hostile environmental conditions and scarce emergency infrastructure is a serious threat to human life.

When performing search and rescue in the polar regions, there is an urgent need to respond quickly, as the prevention of injury and loss of life depends on timely response, prompt evacuation and the application of medical and other emergency response services. Effective responses can only be accomplished by the design and implementation of appropriate search and rescue management policies and programs, supported by appropriate physical infrastructure and well-trained personnel.

Ship evacuation produces a host of emergency response problems in the polar world. Passengers and crew must be sheltered from inclement weather, properly clothed, nourished and hydrated. The provision of these basic necessities in the polar environment, either sea or land, is formidable. The ability to successfully communicate a distress signal of any sort in the polar world can further exacerbate these threatening circumstances. Communications in the Arctic may be a challenge. However, ships equipped with adequate communication equipment (for example, digital selective calling-high frequency, or DSC-HF, and Electronic Position Indicating Radio Beacon, or EPRIB) are able to transmit distress messages.

It is not likely that communities located in the remote, high Arctic have sufficient medical resources to respond to illnesses involving hundreds, or perhaps thousands, of cruise ship passengers and crew. And given their histories, the indigenous people living in rural Arctic communities are understandably fearful of exposure to infectious diseases.

A dangerous consequence of the growing popularity and number of cruise ships operating in and transiting through polar waters is the significant increase of marine incidents. Serious marine incidents include sinkings, groundings, pollution and other environmental violations, disabling by collision, fire and loss of propulsion. Rapid increase in the number of cruise ship voyages has led to a similar increase in the number of incidents.

Given the large number of cruise ships and other recreational boaters currently operating throughout the polar seas and the probable growth of those markets, marine operators, Arctic governments and local communities are faced with significant management challenges.

far North of Greenland, an area that has traditionally not been visited by many tourists. In 2008, 28 vessels were scheduled to travel as far north as Uummannaq, some continuing on to Qaanaaq, both destinations far north of the Arctic Circle and far from good infrastructure or emergency response capabilities. Many of the cruise vessels traveling to these destinations are likely not ice-strengthened. Though this area is classified as ice-free in the summer, this does not mean that ice is not present and, even in small amounts, ice can pose a serious hazard. The Greenland government is very conscious of the rapid growth in cruise ship traffic in their waters and Island Command Greenland, the naval service covering Greenland waters that organizes both rescue and emergency operations, has recently put an increased focus on cruise activities in Greenland waters.

Passenger vessels, in particular cruise ships, is a sector that has experienced rapid growth in certain regions in the few years that have passed since the development of the AMSA database and is one which is expected to expand further in coming years. As this sector grows and more and larger ships begin to ply Arctic waters, it will become increasingly important to understand this type of activity so that Arctic states are prepared to meet the future needs of these vessels and their passengers.

Marine Use: Icebreaker, Government and Research Vessel Operations

Icebreakers, government and research vessels represent a relatively small proportion of the total vessel traffic in the Arctic. However, they are invaluable for surveying, oceanographic research, vessel escort in ice, salvage, pollution response and search and rescue. For the AMSA database, these vessel types were grouped since they conduct similar missions and also often carry out multiple tasks on a voyage. In the AMSA 2004 database, 83 of this type of ship were reported; however, several Arctic states did not include government vessels in their submission so the total for this category is likely larger. In keeping with the scope of the Arctic Council, naval or military vessels were not included in the AMSA database.

The icebreaker fleets of Canada and the Russian Federation conduct a range of tasks in their respective regions; summer sealift icebreaking duties are an important mission for these ships. Though several icebreakers might be capable of operating in the winter, nearly all icebreaker operations reported in the AMSA are conducted in the spring, summer and autumn. During summer 2004, the AMSA database indicates that there were eight voyages that reached the

Community re-supply is expected to expand in the coming years due both to population increases in Arctic communities and increasing development in the region, stimulating demand for goods and construction material.

© Aker Arctic Technology

Year-round Arctic Marine Transport to Dudinka in Support of Natural Resource Development and Production

Since the winter of 1978-79, one of the most advanced Arctic marine transport systems in the Arctic has been the year-round operation comprised of rail traffic between the mines of the Mining and Metallurgical Company Norilsk Nickel to the port in Dudinka, on the Yenisei River and then the 231 nautical mile sailing to Murmansk, on the Kola Peninsula.

MMC Norilsk Nickel is the world's largest producer of nickel and palladium, and is among the top four platinum producers in the world, as well as among the top 10 copper producers. MMC Norilsk Nickel is also a large global enterprise with production facilities in the Russian Federation, Australia, Botswana, Finland, the United States and the Republic of South Africa.

Mining in the Norilsk area began in the 1920s. The region quickly became a critical supplier of non-ferrous metals within the Soviet Union. During the 1950s, the Northern Sea Route Administration was tasked with building a year-round Arctic marine transport system on the western end of the NSR and into the Yenisei.

The development of large, nuclear icebreakers came first with the *Lenin* in 1959 (world's first nuclear surface ship) followed by a small fleet of larger icebreakers of the *Arktika* class. These icebreakers were designed to create tracks in the ice for lower-powered cargo ships to sail in convoy astern of a lead icebreaker.

With unlimited endurance, the nuclear icebreakers could provide year-round services in the deeper waters along the major routes of the NSR. Ice-strengthened cargo ships and shallow-draft icebreakers came next. By the 1978-79 winter season there was enough icebreaking capacity to maintain year-round navigation by convoying ships from the Yenisei west across the Kara Sea and into the Barents Sea to Murmansk. A continuous flow of non-ferrous metal concentrates could be maintained to smelters on the Kola Peninsula and to other industries in the Soviet Union.

During 1982-87 a new icebreaking cargo ship, the SA-15 or *Norilsk* class, was delivered by Finland's former Valmet and Wartsila shipyards to the Soviet Union. Nineteen of these Arctic freighters (174 m length and 19,950 dwt) were built and several today remain in service on the route between Dudinka and Murmansk.

In many respects, the *Norilsk* class multi-purpose carriers revolutionized Arctic shipping in the same manner as the commercial carrier *M/V Arctic* developed for the Canadian Arctic during the same years. With high propulsion power (21,000 shp), the *Norilsk* class ships could operate under their own power as an icebreaker. These ships carried cargoes the length of the NSR in summer during the late 1980s; during the winter they were used effectively to support the Norilsk-Dudinka operation.

Their proven capability for independent navigation through ice fields without icebreaker support was a significant technological achievement, as well as a notable advance in efficient (and cost-effective) Arctic marine operations. The successful operation of these ships was a harbinger of the future for Arctic marine transport.

In April 1988, a new, shallow-draft polar icebreaker named *Taymyr* was delivered to the Soviet Union by Wartsila's Helsinki shipyard. A single nuclear reactor was installed at the Baltic shipyard in (then) Leningrad, and the ship was ready for service along the NSR and in the shallow Siberian rivers by 1989. A second ship of the class, *Yaygach*, was added to the Murmansk Shipping Company's icebreaker fleet in 1990.

The design of this class represents the apex in the development process for the Soviet polar icebreaker fleet. Coupled in its design are Finnish advances in shallow-draft ship design with nuclear propulsion developed in the Soviet Union. A draft of only 8 meters was attained with *Taymyr*, which compares favorably with the average 11-meters draft of the largest Soviet icebreakers of the period. A power plant producing 44,000 shp provided a capability of continuously breaking 1.8 meters of level ice at a 2-knot speed. These capabilities fit perfectly with the requirements for icebreaking (level river ice) on the shallow Yenisei River to the port of Dudinka; these extraordinary nuclear ships could maintain an ice track out to the Kara Sea through the winter in nearly all conditions.

Year-round shipping to Dudinka functioned throughout the 1990s and the early years of the new century despite the financial challenges facing the Russian Federation. MMC Norilsk Nickel was restructured several times and since 2001 the company has flourished, focusing on economic efficiencies, foreign marketing and potential investments. The marine transport component also received significant attention as the SA-15 *Norilsk* class ships supporting the Dudinka run began to age.

The company's marine operations department worked closely with the Finnish shipbuilder Aker Yards to develop a new freighter class that would be owned and operated by MMC Norilsk Nickel. The vision was for a fleet of five icebreaking containerships designed for year-round operations. The first of the ships, *Norilsk Nickel* (168 meter length, 14,500 dwt, 650 TEU capacity), was completed in Helsinki early in 2006. The new ship is designed as a "double-acting hull" and is fitted with an azimuthing pod for propulsion.

The Azipod concept, as it is called, allows the ship to move stern-first efficiently in the ice; the ship is designed to break 1.5 meter thick ice unassisted. In light ice or open water, *Norilsk Nickel* turns 180 degrees and moves bow first. Ice trials for the new ship were conducted in March 2006 in the Kara Sea and Yenisei River, and the vessel achieved a 3-knot speed continuously moving through 1.5 meter thick ice.

Norilsk Nickel has performed well in operating unassisted (without icebreaker escort or convoy) during its initial two years of service. With four more of the class being built in Germany, MMC Norilsk Nickel will have an operational fleet of five icebreaking carriers, all highly capable of operating independently through the winter season to serve the port of Dudinka. Safe and efficient, the *Norilsk Nickel* class ships represent a new concept of Arctic marine operations. They will enhance a regional, Arctic marine transport system in western Siberia and better link a key Russian commercial enterprise to world markets.

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North Pole, including a three-ship scientific expedition designed to drill into the Arctic seabed. The expedition was composed of the Russian Federation's nuclear icebreaker *Sovetskiy Soyuz*, Sweden's icebreaker *Oden* and the Norwegian-flag icebreaking drill ship *Viking Vidar*. During 2004-2008, there were 33 icebreaker transits to the North Pole for science and tourism. An increasing number of icebreakers and research vessels are conducting geological and geophysical research throughout the central Arctic Ocean related to establishing the limits of the extended continental shelf under UNCLOS.

Seasonality of Operations and Sea Ice Extent

The Arctic is defined by extreme seasonal variability, impacting the behavior of the animals that live in and migrate to and from the region, as well as human activity. Generally, most of the central Arctic is ice-covered, dark and very cold 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 in the Arctic in the winter. However, these areas still experience darkness, extreme cold and variable conditions. The Arctic summer is the opposite extreme, with 24 hours of light and temperatures that can be uncomfortably warm. The pattern of vessel traffic in the AMSA database shows that vessel activity in the Arctic is highly affected by seasonal variability.

The AMSA GIS database includes Arctic sea ice maps for each month in 2004, with information collected and compiled by national ice administrations working cooperatively to create an Arctic sea ice picture. When layered with 2004 seasonal vessel traffic this data demonstrates how vessel traffic patterns interacted with the minimum sea ice extent at the time.

Maps 5.5 and 5.6 show the differences in sea ice extent between winter (January) and summer (July) traffic levels. Map 5.5 shows virtually no vessel activity in the central Arctic in the winter, although some takes place on the fringes in year-round ice-free zones. As mentioned earlier, the database indicates that only year-round commercial operations in the Arctic in seasonally ice-covered areas were into Dudinka in the Russian Federation and Deception Bay in Canada. These two operations were the only commercial icebreaking activities taking place in 2004; government icebreakers and research vessels conducted all other icebreaking that year. The data indicates that this was done only in the spring, summer and fall seasons.

Map 5.6 demonstrates the surge in vessel activity in the summer season, when all of the community re-supply takes place and most bulk commodities are shipped out and supplies brought in for commercial operations. Summer is also the season when all of the passenger and cruise vessels travel to the region. Wildlife in the Arctic also follows this pattern: although most species migrate

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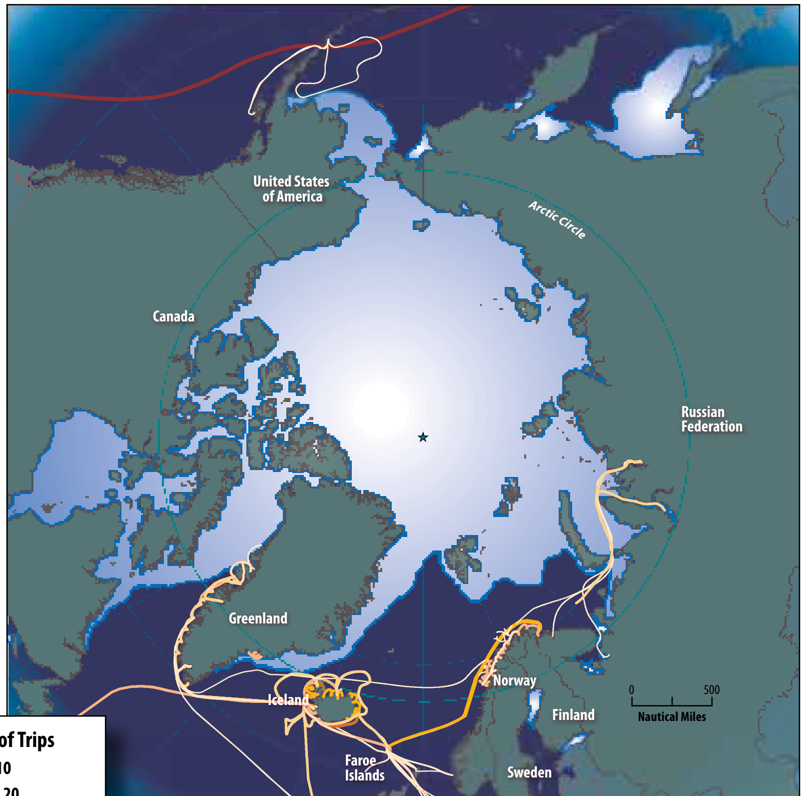
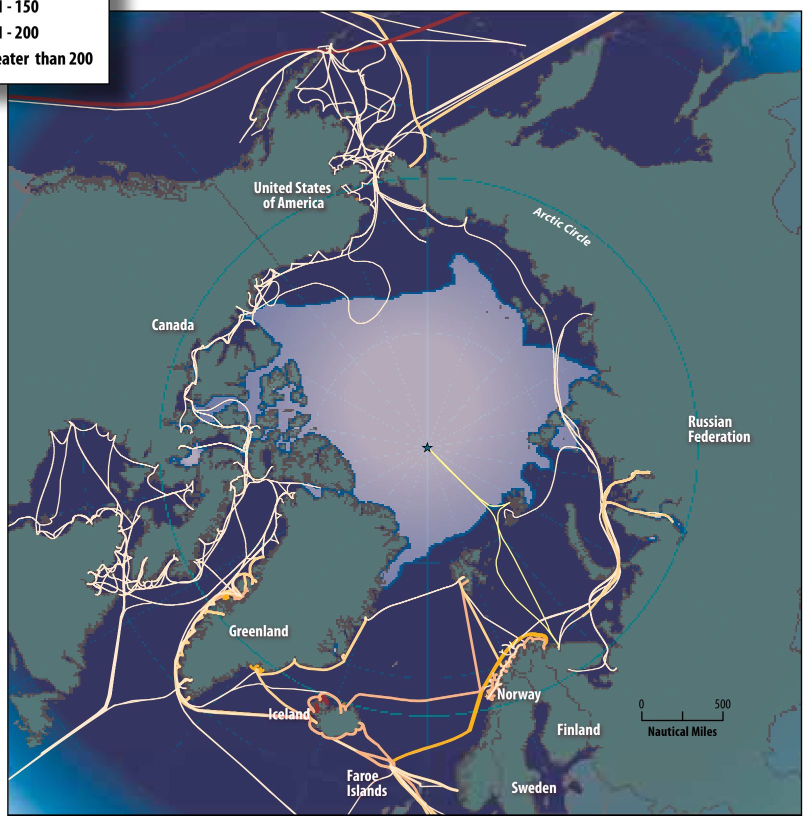
Sea Ice Extent Differences



Map 5.5 January traffic.
Source: AMSA



Map 5.6 July traffic.
Source: AMSA

earlier in the spring before ice break-up, animals gather in large aggregations in the summer to feed and reproduce. This is important to consider when examining potential environmental and ecosystem impacts that may result from current or increased vessel activity in the region.

Summer and fall are the safest and most economical seasons for marine activity; therefore, activities such as resource development, tourism or community re-supply will most likely increase in the summer months. There may be a few exceptions, where high value commodities may drive year-round operations, but that will be driven by economics, not climate. If ice conditions continue to change and sea-ice extent reduces as predicted in the near term, the summer and fall shipping seasons will most likely lengthen. Even as perennial sea ice is reduced, winter in the central Arctic will remain inhospitable to marine navigation; therefore, future Arctic vessel activity will continue to be highly seasonal in the region.

Incidents and Accidents in the Arctic

The Arctic has always been and will continue to be a challenging environment for search and rescue and emergency response (See page 168). This is due to the very large geographic area involved and the relative low density of activity and response capabilities. In order to grasp potential threats to human safety and the marine environment as a result of potential incidents, it is important to understand what incidents may have occurred and where the areas are that have had the most incidents.

As part of the AMSA database, a summary of the incidents and accidents occurring in the Arctic region between 1995-2004 was developed. No one source of data was found to be sufficient to cover the circumpolar region; therefore a compilation of a number of sources was necessary to create the summary. The main sources

Table 5.4 Incident summary tables, 1995-2004. *Source: Lloyd's Marine Intelligence Unit Sea Searcher Database, Canadian Transportation Safety Board (Marine), Canadian Hydraulics Centre - Arctic Ice Regime System Database.*

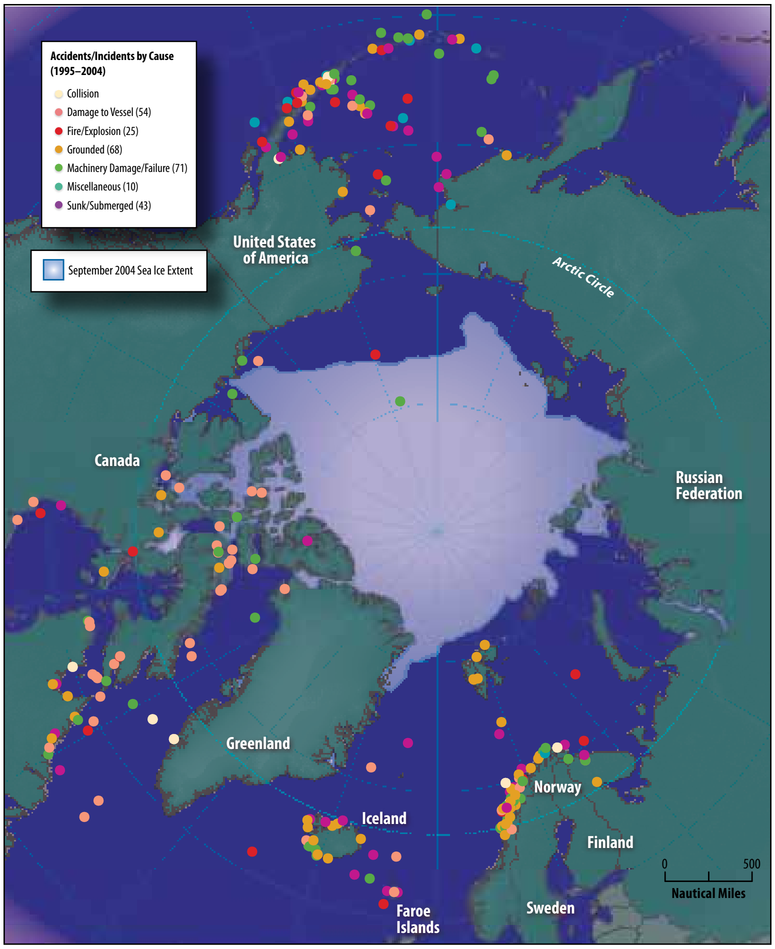
Accidents and Incidents in the Arctic, 1995-2004

Vessel Type	#
Bulk Carrier	37
Container Ship	8
Fishing Vessel	108
General Cargo Ship	72
Government Vessel	11
Oil/Gas Service & Supply	1
Passenger Ship	27
Pleasure Craft	0
Tanker Ship	12
Tug/Barge	15
Unknown	2

Primary Reason	#
Collision	22
Damage to Vessel	54
Fire/Explosion	25
Grounded	68
Machinery Damage/Failure	71
Sunk/Submerged	43
Miscellaneous	10

Month	#
JAN	16
FEB	35
MAR	30
APR	6
MAY	15
JUN	18
JUL	39
AUG	22
SEP	31
OCT	35
NOV	23
DEC	23

Year	#
1995	35
1996	53
1997	23
1998	19
1999	21
2000	19
2001	31
2002	30
2003	28
2004	34



Map 5.7 Arctic shipping accidents and incidents causes, 1995-2004. *Source: Lloyd's Marine Intelligence Unit Sea Searcher Database, Canadian Transportation Safety Board (Marine), Canadian Hydraulics Centre- Arctic Ice Regime System Database.*

of information used were the Lloyds MIU Sea Searcher database, the Canadian Hydraulics Centre Arctic Ice Regime System database and the Canadian Transportation Safety Board (Marine.) Though this combined dataset is limited, it provides a basis for a very broad analysis of what type of incidents are occurring in the Arctic region and what areas may be more prone to incidents and therefore at a greater risk of further ones in the future.

The incidents and accidents were categorized by the type of incident that occurred, where and when it occurred, whether there were fatalities as a result, whether there was a significant oil spill involved and whether the vessel involved was considered a total loss for insurance purposes. Incident types were grouped into the following categories:

- **Grounding:** where a vessel came in contact with the bottom and, therefore, required assistance or significant effort to be re-floated. In some cases, vessels could not be re-floated and were either abandoned or broken up for salvage.
- **Collision**: where two vessels make contact resulting in minor to a serious damage to the vessel.
- **Damage to Vessel**: where damage to the vessel occurred, due to a variety of reasons ranging from contact with the pier, collision with ice, extreme weather or other factors.
- **Fire/Explosion**: where a fire or explosion occurred onboard a vessel, resulting in minor to very serious damage to the vessel and other consequences, such as fatalities.
- **Sunk/Submerged**: where a vessel was submerged in water for a period of time or sunk completely due to a range of causes.
- **Machinery Damage/Failure**: where a vessel sustained damage to machinery or complete machinery failure.

It is important to note that the incidents captured as part of AMSA excluded onboard incidents that may have involved injury to passengers and crew, but where there was no damage to the vessel. For a summary of the number and type of accidents and incidents involving vessels see Table 5.4.

Using the exact geographic locations for the different incidents and accidents, the data was entered into the GIS database, along with the different characteristics identified. The result was Map 5.7, which shows all of the reported incidents and accidents reported for the circumpolar region for the period of 1995-2004.

When looking at the geographic distribution of the incidents for the defined period shown in Map 5.7 there are certain gaps and trends that emerge. There is a complete absence of incidents reported in the Russian Arctic and there are some areas where there appears to be a concentration of incidents during the years collected. These areas are along the northern coast of Norway, around the Aleutian Island chain and in the Bering Sea, along the Labrador coast and in Hudson Strait in Canada and around Iceland and the Faroe Islands. These concentrations of incidents are consistent with the traffic patterns shown in the AMSA activity database – areas that show the concentrations of incidents are also those where the largest volume of vessel activity is occurring. This trend is even more apparent when the vessel routes for 2004 are shown on the same map as the incidents.

One of the most dramatic incidents in 2004 was the loss of life and sinking of the *Selendang Ayu* off the coast of Alaska. The incident is a graphic example of the key gaps in infrastructure, emergency response and salvage services that are readily available in other parts of the world's oceans.

The *Selendang Ayu* Disaster in the Alaska Arctic

On November 28, 2004, after loading 1,000 tonnes of fuel and 60,200 tonnes of soybeans, the *Selendang Ayu* departed Seattle, Washington, with a crew of 26 along the North Pacific Great Circle Route bound for Xiamen, China. Ten days later the 225-meter Malaysian-registered bulk carrier 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 U.S. Coast Guard helicopter and spilling an estimated 66 million metric tons of soybeans, 1.7 million liters of intermediate fuel oil, 55,564 liters of marine diesel and other contaminants into the environment further causing the deaths of seabirds and marine mammals (See page 151).

A U.S. National Transportation Safety Board marine accident brief is the basis for this report. Despite passing inspection by port authorities and U.S. Coast Guard officials prior to leaving Seattle, the seven-year old Panamax class vessel encountered engine problems approximately 100 nautical miles from Dutch Harbor, the closest place of refuge, and about 46 nautical miles from the nearest point of land. After leaving port in Seattle, the ship had encountered heavy seas and between gale and strong gale force winds.

On his second transit of the Bering Sea, the vessel's master, a citizen of India and a 32-year seagoing veteran, notified the harbormaster in Dutch Harbor via the vessel's satellite phone he was having difficulties and needed assistance. The Coast Guard immediately dispatched the cutter *Alex Haley* but because of the rough seas could only reach a top speed of 10 knots. Nearly six hours later, the cutter reached the *Selendang Ayu* and attempted to slow its drift toward the coastline by attaching a tow line to the vessel until the tugboat *Sidney Foss* arrived, which was then approximately 11 nautical miles away.

In the meantime, the wind and sea conditions continued to deteriorate. Arriving on scene, the tugboat master reported seeing the *Selendang Ayu* lying beam to the sea in 7.6-meter seas, hammered by 45- to 55-knot winds. Some crew members were desperately struggling to remain on the bow as the freighter rolled 25 to 35 degrees with waves crashing over the deck amid passing snow and ice squalls. The remainder of the crew, some who had been up for some 41 hours, worked frantically to restart the engines.

On the scene, the *Sidney Foss* was able to slow the drift but unable to turn the stricken ship's bow into the wind as the vessel drifted closer to the shore. A second tug, the *James Dunlap*, arrived from Dutch Harbor with sunrise 5 ½ hours away, noted the NTSB report. "Because of the sea state and the darkness, the masters of the *Sidney Foss* and the *James Dunlap* decided to wait until daylight before attempting to swing the bow of the *Selendang Ayu* around by putting a line on the stern."

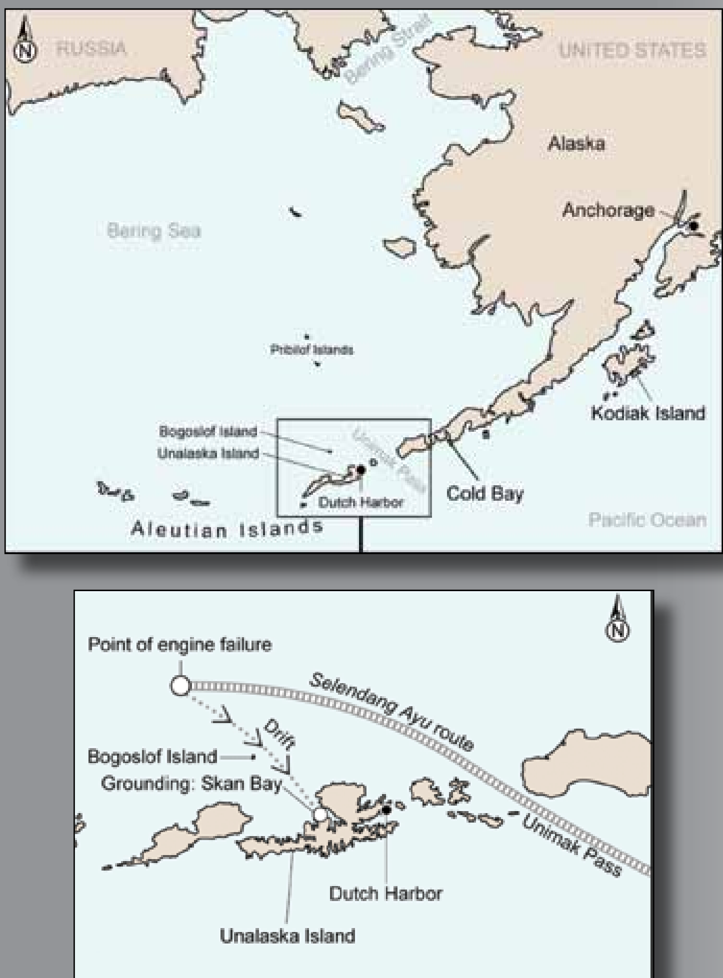
Then, some three hours before sunrise, the towline parted and the stricken vessel continued its now unabated drift toward Unalaska Island. At sunrise, with the *Selendang Ayu* picking up speed toward the coastline, the ship's master dropped anchor in hopes to slow or even stop the drift. It almost worked.

The port anchor immediately caught, slowing and almost stopping the vessel's drift. The feeling of relief was short-lived as some 15 minutes later the ship began slipping its anchor under the unrelenting pounding of the growing storm and started to drift at 2 knots toward shore. The weather continued to worsen with steep seas of 6 to 7.6 meters and periodic wind gusts of up to 65 knots, which occasionally pushed the waves to 9 to 10 meters. The Coast Guard suggested dropping the starboard anchor, "but the *Selendang Ayu* master said the starboard anchor might foul on the port anchor's chain," the report stated.

Several attempts to reestablish a towline failed and with now fading light and its proximity to shore, the Coast Guard recommended evacuating the crew. The master finally allowed a group of 18, those he considered the least essential for dealing with the emergency, to depart. Wearing lifejackets, but not the reddish-orange buoyant survival or immersion suit that protects against heat loss and ingress of water, they would be extracted in two groups. (At the time of the accident, the *International Convention for Safety of Life at Sea*, SOLAS, required a cargo vessel to carry at least three immersion suits for each lifeboat, unless the vessel had a totally enclosed lifeboat on each side. The *Selendang Ayu* carried two fully enclosed lifeboats, one port and one starboard and was equipped with three immersion suits. In an amendment effective July 1, 2006 the SOLAS regulation was changed to require one immersion suit for each person onboard a cargo ship. An exemption from this requirement for ships that voyage "constantly" in warm climates is not allowed for bulk carriers.)

Using a USCG HH-60 Jayhawk helicopter that had arrived from Cold Bay, Alaska, the first group of nine *Selendang Ayu* crew members were hoisted from the rolling deck. Then only a mile from shore, the ship's port anchor was dropped. It caught. Shortly thereafter, a second Jayhawk helicopter hoisted the second group of nine sailors from the ship. Eight crew members remained on board and continued to work frantically on the engines. As darkness began to close in, the Coast Guard radioed the master and said they wanted to remove the remainder of the crew before sunset. Then came the first of several shudders as the vessel ran aground on a small underwater shelf about 130 meters offshore. Knowing the ship's fate, the master radioed the *Alex Haley* and requested immediate extraction.

The eight remaining crew members gathered on the port bow, where the two previous evacuations had taken place. The vessel was rolling badly in the shallow water and increasing groundswell. Another HH-60 Jayhawk helicopter was dispatched from Dutch Harbor to the scene and a short time later the *Alex Haley* launched the smaller HH-65 Dolphin helicopter. Both aircraft reached the freighter around 6 pm with the larger Jayhawk helicopter performing the rescue. Fifteen minutes later all of the ship's crew, save the master and the USCG rescue swimmer, had been hoisted onboard when a huge rogue wave struck the bow of the freighter, sprayed up and engulfed the Jayhawk. The helicopter's engines stalled, spun around causing its tail and mail rotor blades to slam into the side of the crippled ship and crashed into the sea next to the *Selendang Ayu*'s forward port side. The Dolphin helicopter, which had been hovering close by, immediately went into rescue mode and quickly recovered the three-member flight crew and the one *Selendang Ayu* crew member who survived the crash. With no other sign of survivors, the helicopter headed to Dutch Harbor. While the master and the Coast Guard swimmer were awaiting rescue, the ship broke in two on the rocks. After three hours of being bombarded by crashing waves, howling winds in total darkness, the ship's master and the USCG rescue swimmer were hoisted on board the Dolphin, which had returned from its trip to Dutch Harbor. It was 10:35 pm on December 8, nearly 60 hours since the *Selendang Ayu* engines failed.



Map 5.8 Accident location in Bering Sea. Inset shows route of *Selendang Ayu* through Unimak Pass, approximate point at which engine failed, path of vessel's drift without power, and site on Unalaska Island where it grounded.
Source: National Transportation Safety Board

Summary Discussion: Current Arctic Marine Use

As noted earlier, Arctic shipping has existed since the late 1400s, mostly on the periphery of the region. As in the past, most commercial activity today is generally linked to supplying communities or exporting raw goods out of the Arctic. The number of ships operating today in the Arctic is significant in the context of both the unique aspects of the Arctic environment and the insufficient infrastructure and emergency response in many parts of the region, relative to southern waters. However, from the outlook of the global maritime industry, the level of vessel activity found to occur in the 2004 baseline year is still relatively low. To put it into perspective, the total number of vessels reported as operating in the Arctic region (not including fishing vessels and the Great Circle Route traffic) represents less than 2 percent of the world's registered fleet of oceangoing vessels over 100 gross tonnage. Although the total vessels operating in the Arctic may represent a small proportion of the world's fleet, they can still have significant impacts on the environment in which they operate. At current shipping activity levels, it will not take many more ships operating in the Arctic in future years to double or triple the 2004 numbers.

Most shipping traffic in the Arctic is in waters that are either permanently or seasonally ice-free, an important distinction. Permanently ice-free waters include those in the Aleutian island chain, the northern coast of Norway, southern Iceland and the Murmansk region in northwest Russia. In other areas of the Arctic, which are seasonally ice-covered, nearly all the vessel activity occurring in 2004 took place in waters where the ice had melted or was melting and where icebreakers are not required for access. However, an area can be determined to be ice-free and still have ice-related dangers, such as bergy bits and pan ice, which are hard to detect and can damage a vessel.

In recent years, given the changing ice conditions in the Arctic, much attention has been paid to possible trans-Arctic shipping via the central Arctic Ocean, Northwest Passage or the Northern Sea Route. In the AMSA 2004 database, it was found that vessels operated on sections of both the NSR and NWP; however, there were no full transits by commercial vessels on any of three routes. The vessels reported as operating in the Northwest Passage were either community re-supply or Canadian Coast Guard. On the Northern

Sea Route, the only vessels reported were bulk carriers and tankers for community re-supply. None sailed the full route, and the only Russian traffic through the Bering Strait were bulk carriers servicing communities on the far northeast of Russia coming from the Bering Sea. In 2004, no ships transited the entire Arctic Ocean from the Pacific to the Atlantic or vice versa.

The only vessels that went into the central Arctic Ocean in 2004 were the eight trips made to the North Pole, three of which were research vessels carrying out a core drilling expedition and five Russian nuclear icebreakers for tourism purposes. Apart from those trips, all the vessel activity in 2004 took place around its periphery and largely in coastal waters.

In the four years that have passed since the AMSA 2004 baseline year for shipping activity, there has already been an increase in vessel activity in certain sectors. As discussed earlier, cruise vessels have been traveling to the Arctic in rapidly increasing numbers. There has also been new activity in other types of vessel traffic, particularly in the Barents, Kara and Norwegian seas. An Arctic tanker shuttle system has been established to support a route from a new Russian terminal in Varandey in the Pechora Sea to Murmansk and direct to global markets. The first 70,000 dwt tanker for this service, *Vasily Dinkov*, delivered its initial cargo to eastern Canada in June 2008; two additional icebreaking tankers for this operation have been built in South Korean shipyards. Two similar icebreaking tankers, under construction in St. Petersburg, will be used to ship oil from the Prirazlomnoye oil field in the northern Pechora Sea to a floating terminal in Murmansk. Again, year-round operations are envisioned in seasonally ice-covered waters, in this case to provide a continuous supply of oil to Murmansk for subsequent export by supertanker.

Off the coast of the Norwegian Arctic, the Snohvit ("Snow White") gas complex is now operational and its first shipment of gas arrived in Spain via an LNG carrier in October 2007; another shipment of Snohvit LNG was delivered to the U.S. East Coast in February 2008. LNG carrier operations out of northern Norway to world markets are poised to increase during the next decade and Norwegian Arctic offshore production is forecast through 2035.

In early 2008, an offshore lease sale conducted by the U.S. Minerals Management Service for the U.S. Arctic totaled nearly $US2.7 billion; offshore gas appears to be the resource under consideration for development in this Arctic region. Increasing Arctic marine operations off Alaska in the Chukchi and Beaufort seas to support oil and gas exploration are envisioned for the next decade.

While the AMSA database only looks at the year 2004, it is apparent, based on anecdotal information, that Arctic marine vessel activity is in a state of transition. The current types of vessel activities seen today are in support of community re-supply, bulk natural resource shipments, fishing and tourism. It appears there will be a growth in all Arctic shipping sectors, as well as the possible emergence of new opportunities.

Research Opportunities

- Develop a consistent and accurate circumpolar database of Arctic ship activity, as well as ship accidents and incidents to date.
- Trend analysis of shipping activity, using the 2004 AMSA database as the baseline.

Findings

1] There were approximately 6,000 vessels in the Arctic in 2004: nearly half the vessels were operating on the Pacific Great Circle Route, which crosses the Aleutian Islands and the southern Bering Sea. Of the remaining vessels, about 50 percent, or 1,600, were fishing vessels. The availability of data and reporting on Arctic marine activity varied greatly between Arctic states; several states could not provide comprehensive data for 2004. As a result, the AMSA database likely underestimates the levels of activity throughout the reporting year.

2] Marine activity took place throughout the Arctic in 2004 and in recent years icebreaking ships voyaged in the central Arctic Ocean in the summer. However, operations were primarily in areas that were ice-free, either seasonally or year-round.

3] The AMSA database indicates that no commercial vessels conducted trans-Arctic voyages on the Northwest Passage, Northern Sea Route or in the central Arctic Ocean in 2004.

4] Early in the 21st century there are only a few Arctic regions with year-round shipping in seasonal sea ice. These year-round operations are driven largely by natural resource development such as in the Canadian Arctic and northwest Russia.

5] Most shipping in the Arctic today is destinational, moving goods into the Arctic for community re-supply or moving natural resources out of the Arctic to world markets. Nearly all marine tourist voyages are destinational, as well.

6] Regions of high concentration of Arctic shipping activity occur along the coasts of northwest Russia, and in ice-free water offshore Norway, Greenland, Iceland and the Bering Sea.

7] Most of the Arctic fishing took place in the Bering and Barents seas, on the west coast of Greenland and around Iceland and the Faroe Islands.

8] The Arctic states do not generally collect and share Arctic marine activity data in any systematic manner.

9] Information about vessel incidents and accidents in the Arctic is not shared among Arctic states, other than through IMO processes. Knowing such information is an important step toward understanding and assessing future risks.

10] Cruise ship traffic into and around Greenland has increased exponentially in recent years. The majority of cruise ships observed recently in Arctic waters are not purpose-built for Arctic operations. Many are built for voyaging in open water in lower latitudes and warmer climates.