Heavy Fuel Oil use in the IMO Polar Code Arctic by Russian-flagged Ships, 2015

Prepared For:
European Climate Foundation

Prepared By:
Bryan Comer, PhD

icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

October 2018

Table of Contents

Tables

Figures

Introduction

The use of heavy fuel oil (HFO) as a marine fuel poses serious environmental and economic risks, especially in ecologically sensitive areas like the Arctic. Using HFO is risky not only because of potential fuel oil spills but also because burning it produces harmful air and climate pollutants, including black carbon (BC). As ship traffic increases in the Arctic, the risk to the Arctic environment and its peoples will also increase.

The International Council on Clean Transportation (ICCT) has been investigating the use of HFO in the Arctic and the BC emissions that result from it for several years. In 2017, the ICCT published a report titled *Prevalence of Heavy Fuel Oil and Black Carbon in Arctic Shipping, 2015 to 2025*[1] which showed that while less than half of the number of ships in Arctic waters operated on HFO, HFO represented 76% of fuel onboard because larger ships (with larger fuel tanks) tend to use HFO. The Clean Arctic Alliance, a coalition of environmental non-governmental organizations, has used this and other research findings to advocate for an end to the use of HFO in the Arctic. At the request of IMO Member States, the IMO has agreed to develop a ban on the use and carriage for use of HFO in the Polar Code Arctic. A ban could be in place as early as 2021.

Ships that operate in the Arctic fly many flags – 65 different flags in 2015. However, Russian-flagged ships dominate Arctic shipping activity. Russia has the longest Arctic coastline and has invested heavily in Arctic ports and infrastructure, so it will come as no surprise that most of the ships operating in the Arctic are Russian-flagged and that these ships use and carry large amounts of fuel, including HFO. This briefing paper analyzes the use and carriage of HFO as fuel by Russian-flagged ships operating in Arctic waters in 2015. We use the IMO's definition of the Arctic (the "IMO Arctic", Figure 1), as found in IMO's Polar Code.

[1] Comer, B., Olmer, N., Mao, X., Roy, B., and Rutherford, D. (2017). *Prevalence of heavy fuel oil and black carbon in Arctic shipping, 2015 to 2025*. The International Council on Clean Transportation. Available at: http://www.theicct.org/2015-heavy-fuel-oil-use-and-black-carbon-emissions-from-ships-in-arctic-projections-2020-2025

Figure 1. The Arctic as defined in the Polar Code (the "IMO Arctic").

Methodology

To analyze the risks of using HFO as a marine fuel in Arctic waters we consider the metrics in Table 1 and summarize the results for Russian-flagged ships.

Table 1. Metrics used to analyze risks of using HFO as a fuel in Arctic shipping

Metric	Unit	Description[2]
HFO used	tonnes	Quantity of HFO a ship burned
HFO carried	tonnes	Quantity of HFO a ship had in its bunker fuel tanks
Distance-weighted HFO carried	tonne-nautical miles	The product of HFO carried and the distance the ship sailed
BC emitted	tonnes	Quantity of BC a ship emitted

Results

Summary of Arctic shipping activity by ships of all flags

In the IMO Arctic in 2015, 2,086 ships operated for 2.6 million hours, traveling 10.3 million nautical miles, with 1.1 million tonnes of fuel onboard, collectively, at any given time. These ships consumed 436 thousand tonnes of fuel and emitted 193 tonnes of BC. Of the more than 2,000 ships operating in the IMO Arctic in 2015, 889, or 42%, operated on HFO (Figure 2). HFO represented 57% of fuel use by weight, 76% of fuel carried by weight, and 56% of distance-

[2] Estimated according to the methodology in the report referenced in footnote #1.

weighted fuel carried.[3] Additionally, 131 of the 193 tonnes of BC ships emitted in the IMO Arctic in 2015 resulted from burning HFO.

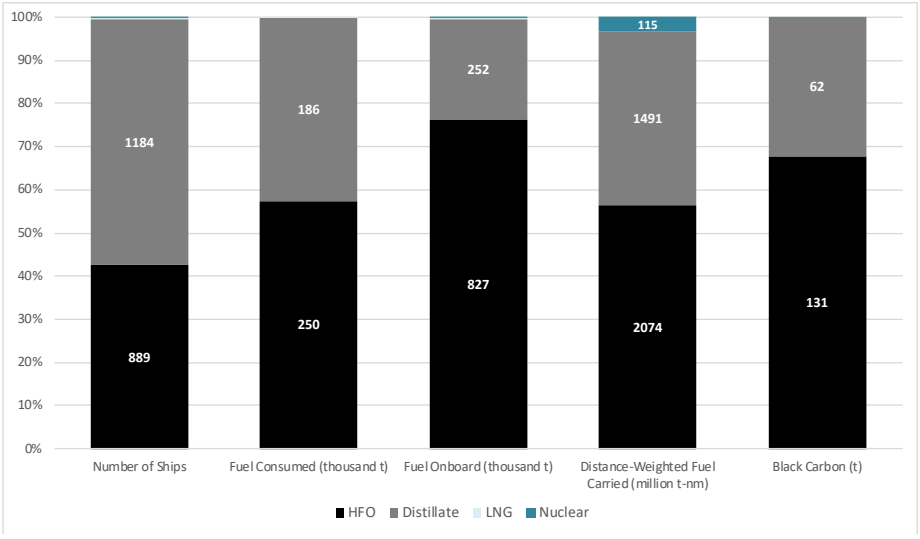


Figure 2. Fuel used, fuel carried, and black carbon emitted by all ships of all flags in the IMO Arctic, 2015

Summary of Arctic shipping activity by Russian-flagged ships

Of the 2,089 ships operating in the IMO Arctic in 2015, 722 were Russian-flagged, accounting for nearly 35% of the ships operating in the region. Of the 722 Russian-flagged ships, 332 (46%) operated on HFO, while the rest operated on distillate fuels, except Russia's four nuclear-powered icebreakers. HFO represented 67% of fuel consumed, 64% of fuel onboard ships, and 63% of distance-weighted fuel carried by Russian-flagged ships in the IMO Arctic in 2015. Furthermore, 76% of BC emitted by Russian-flagged ships was a consequence of burning HFO.

[3] As defined in Table 1, distance-weighted fuel carried is the product of the weight of HFO a ship has in its bunker fuel tanks at any given time and the distance the ship sailed in the IMO Arctic in 2015. Distance-weighted fuel carried is one metric for estimating the risk of using HFO in the Arctic as a marine fuel because the risk of an accident leading to an HFO spill can be greater for a ship with a small fuel tank that sails great distances in a given year compared to a ship with a large fuel tank that sails less frequently in the Arctic.

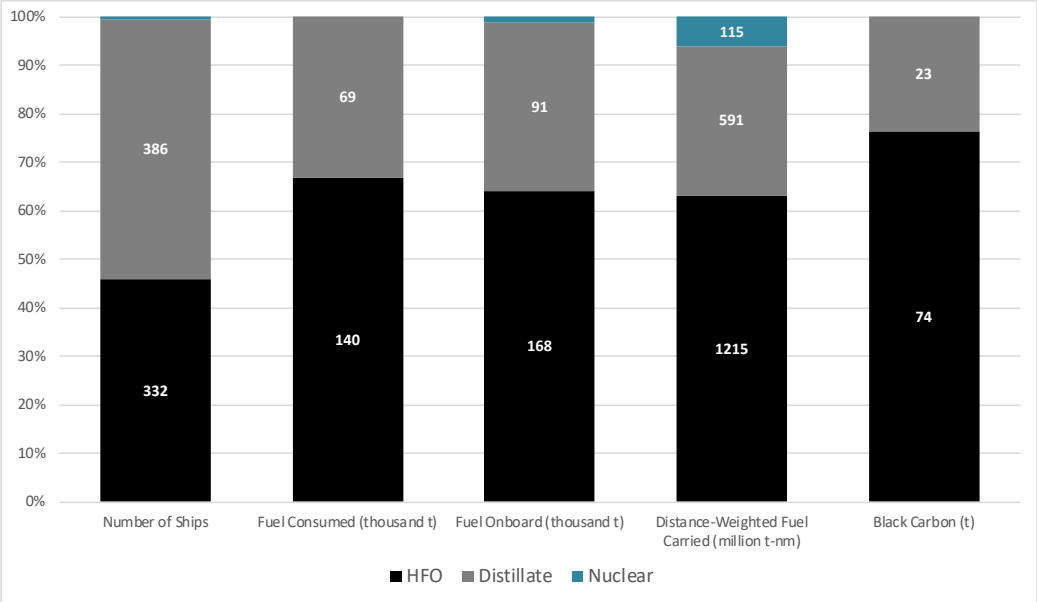


Figure 3. Fuel used, fuel carried, and black carbon emitted by Russian-flagged ships in the IMO Arctic, 2015

About one-third of Russian-flagged HFO-fueled ships are fishing vessels (Figure 4), followed by general cargo ships (24%), refrigerated bulk carriers (15%), oil tankers (8%), chemical tankers, (6%), and bulk carriers (4%).

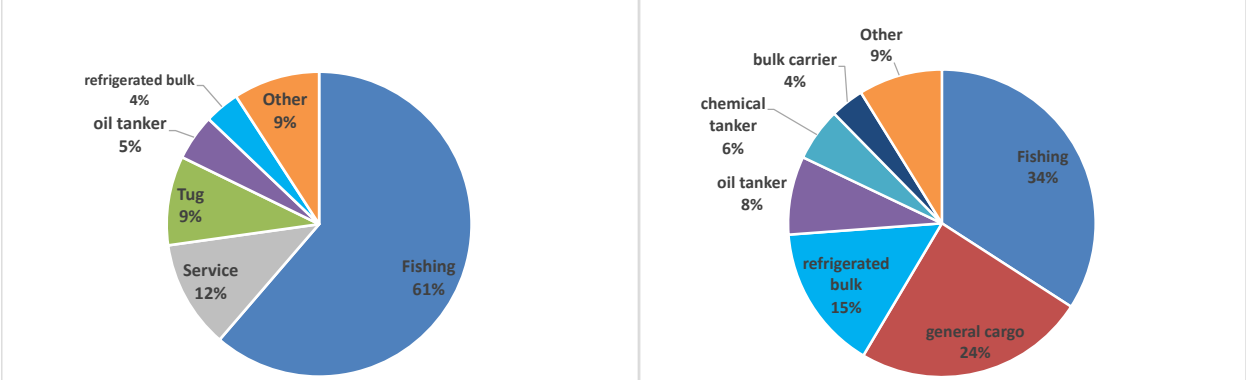


Figure 4. Proportion of Russian-flagged ships operating on distillate (left) and HFO (right) in the IMO Arctic in 2015 by ship type.

Figure 5 describes the characteristics of Russian-flagged HFO-fueled ships. HFO consumption was dominated by general cargo ships (37%) and oil tankers (27%), while HFO fuel onboard was mainly concentrated in fishing vessels (31%) and refrigerated bulk carriers (23%), followed by general cargo ships (19%). Considering distance-weighted HFO carriage, general cargo ships (35%), oil tankers (24%), and fishing vessels (15%) represented the top three. There's a similar pattern for BC emissions.

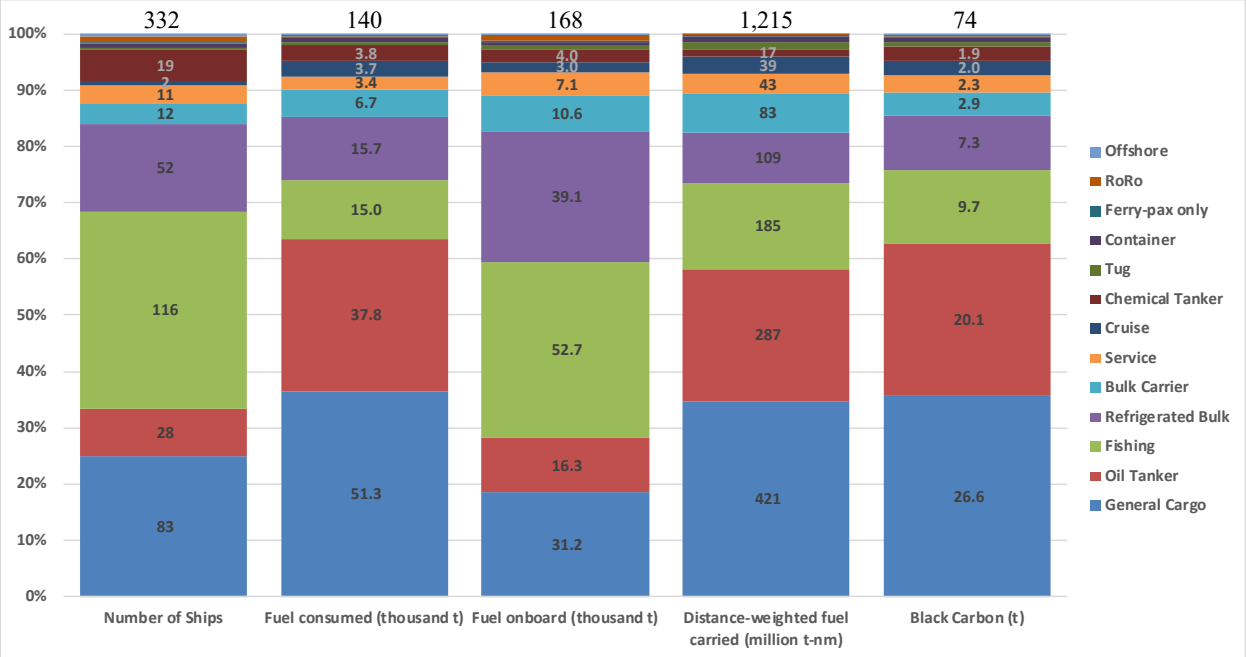


Figure 5. Russian-flagged ships' HFO use and carriage and black carbon emissions in the IMO Arctic, 2015, ordered by distance-weighted fuel carried.

There are 142 different owners of Russian-flagged HFO-fueled ships, two-thirds of which (95 of 142) own only one vessel. Among these owners, three stand out: Norilsk Nickel, Murmansk Shipping Company, and SOVCOMFLOT. The six ships (5 general cargo; 1 oil tanker) owned by Russian nickel and palladium mining and smelting company Norilsk Nickel consumed the most HFO, emitted the most BC, and had the greatest distance-weighted HFO carriage of any company's fleet. Murmansk Shipping Company (20 ships: 12 bulk carriers, 4 oil tankers, 3 general cargo, 1 cruise), which specializes in Arctic shipping, had the most HFO onboard of any company with Russian-flagged ships. The state-owned oil and gas shipping company SOVCOMFLOT (5 oil tankers) ranks second in HFO consumption, BC emissions, HFO onboard, and distance-weighted HFO carriage.

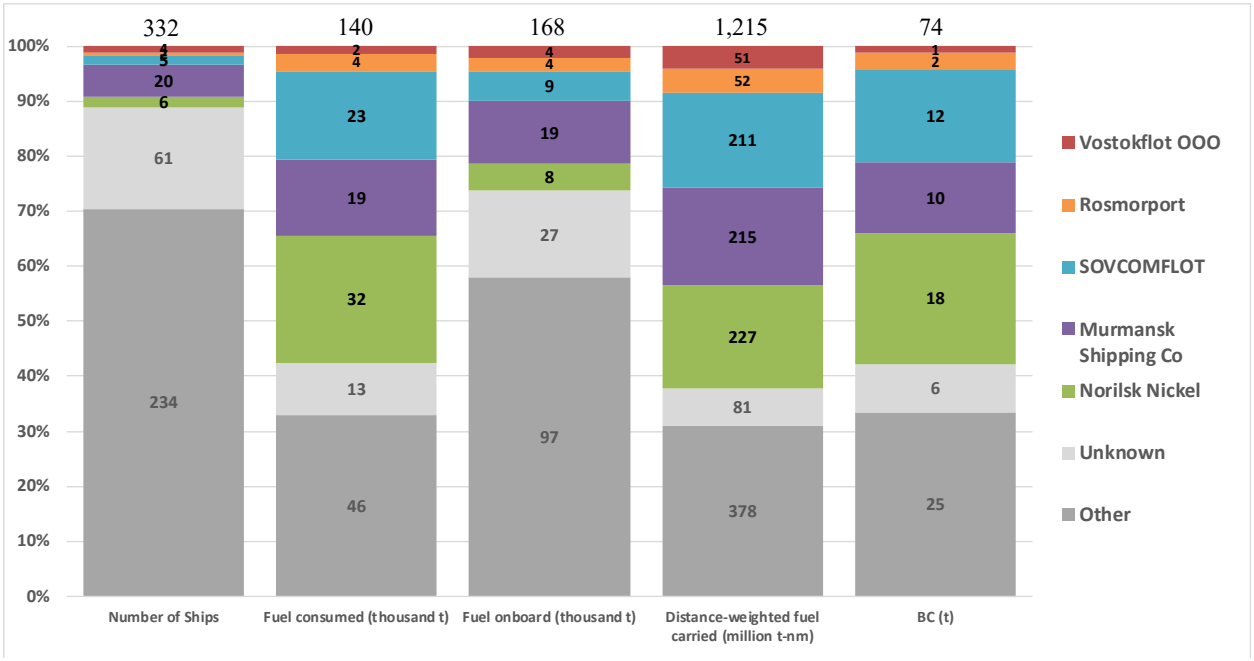


Figure 6. Russian-flagged ships' HFO use and carriage and black carbon emissions by owner in the IMO Arctic, 2015

The ship that used the most HFO, emitted the most BC, and accounted for the greatest distance-weighted HFO carried of any ship of any flag in the IMO Arctic in 2015 was SOVCOMFLOT's *Kapitan Gotsky* oil tanker (Figure 7). The *Kapitan Gotsky* is designed to operate in difficult ice conditions, usually without icebreaker assistance. This ship shuttles crude oil several hundred kilometers across the Barents Sea from Varandey to Kola Bay (near Murmansk) as part of Russia's Varandey oil project. The *Kapitan Gotsky* operated for nearly 4,000 hours (equivalent to 166 days) in the IMO Arctic in 2015, consuming over 7,000 tonnes of HFO, emitting 4 tonnes of BC, and representing 66.2 million t-nm of distance-weighted HFO carriage.

Figure 7. The "Kapitan Gotsky" oil tanker navigating in ice in the Pechora Sea in 2011; this ship used the most HFO, emitted the most BC, and accounted for the greatest distance-weighted HFO carried of any ship of any flag in the IMO Arctic in 2015 (Image Source: https://bit.ly/2M8k6nJ)

Among general cargo ships of all flags, Norilsk Nickel's *Zapolyarnyy* (Figure 8) ranks first in terms of distance-weighted HFO carried (48.7 million t-nm) and is second only to Norilsk Nickel's *Nadezhda* for HFO use and BC emissions. The *Nadezhda* (Figure 9) used 6,000 tonnes of HFO and emitted 3.3 tonnes of BC in the IMO Arctic in 2015. Both ships operated in the Russian Arctic, servicing Norilsk Nickel's mining and smelting operations. These ships are designed to operate in heavy ice conditions (Ice Class 1A Super), usually without icebreaker assistance.

Figure 8. Norilsk Nickel's "Zapolyarnyy" general cargo ship outside of Hamburg (left) and operating in ice conditions (right); among general cargo ships of all flags, the Zapolyarnyy accounted for the greatest distance-weighted HFO carried in the IMO Arctic in 2015 (Images courtesy of MarineTraffic.com)

Figure 9. Norilsk Nickel's "Nadezhda" general cargo ship operating in ice in the Yenisei River near Dudinka, Russia, March, 2018; this ship used the most HFO and emitted the most BC of any general cargo ship of any flag in the IMO Arctic in 2015 (Image courtesy of MarineTraffic.com)

The top 10 ships of any flag in terms of distance-weighted HFO carriage in the IMO Arctic in 2015 were all Russian flagged, and most were either SOVCOMFLOT oil tankers or Norilsk Nickel general cargo ships, with Vostokflot's *Poltava* refrigerated bulk carrier, Murmansk Shipping Company's *Yuriy Arshenevskiy* general cargo ship, and Rosmorport's *Kapitan Dranitsyn* icebreaker "cruise" ship (it's more of a research vessel) rounding out the 7th, 9th and 10th spots, respectively (Table 2).

Table 2. Ten ships with the greatest distance-weighted HFO carried (t-nm) in the IMO Arctic, 2015

Ship Name	Flag	Ship Type	Owner	HFO used (thousand t)	BC emitted (t)	HFO onboard (thousand t)	Distance-weighted fuel carried (million t-nm)
Kapitan Gotsky	Russia	Oil Tanker	SOVCOMFLOT	7.0	3.9	2.2	66.2
Timofey Guzhenko	Russia	Oil Tanker	SOVCOMFLOT	6.2	3.4	2.2	63.5
Vasily Dinkov	Russia	Oil Tanker	SOVCOMFLOT	6.4	3.5	2.2	62.3
Zapolyarnyy	Russia	Gen. Cargo	Norilsk Nickel	5.4	3.0	1.6	48.7
Nadezhda	Russia	Gen. Cargo	Norilsk Nickel	6.0	3.3	1.6	48.1
Talnakh	Russia	Gen. Cargo	Norilsk Nickel	6.0	3.3	1.6	45.8
Poltava	Russia	Refrigerated Bulk	Vostokflot	1.0	0.4	0.7	44.4
Monchegorsk	Russia	Gen. Cargo	Norilsk Nickel	4.5	2.5	1.6	40.8
Yuriy Arshenevskiy	Russia	Gen. Cargo	Murmansk Shipping Co.	2.2	1.2	2.1	38.6
Kapitan Dranitsyn	Russia	Cruise (mainly research)	Rosmorport	3.5	1.9	2.7	36.8

Comparison to other flag states

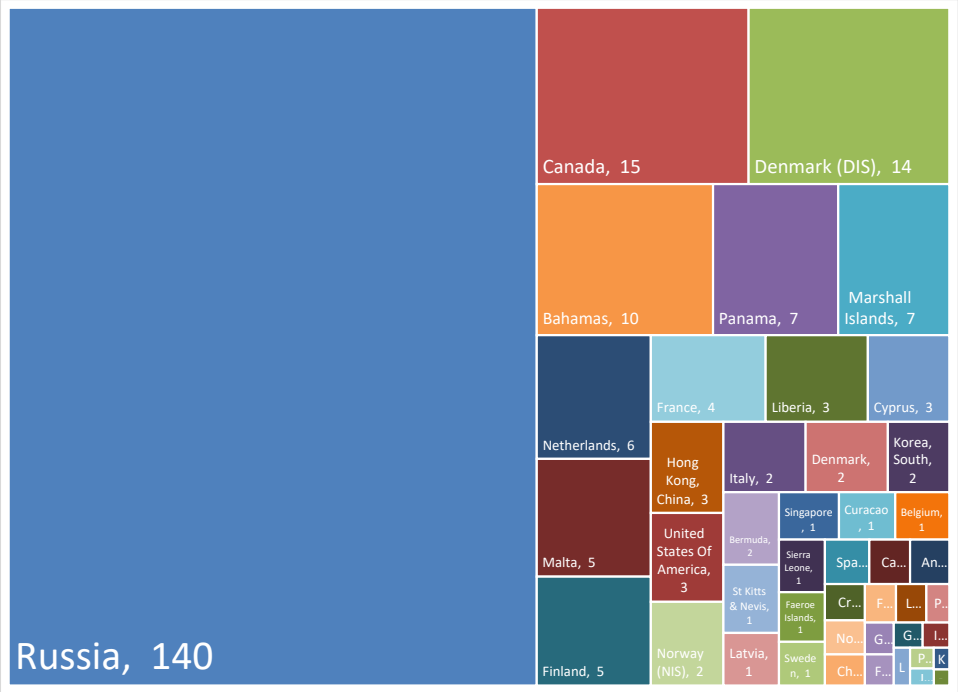
This section compares HFO use, BC emissions, HFO onboard, and distance-weighted HFO carriage by Russian-flagged ships to those of other flag states. Some of the country names in this section's figures may be too small to read or truncated; in which case, the reader is directed to the appendix, which provides summary statistics by flag state for the number of HFO-fueled ships, operating hours, distance traveled, HFO used, HFO carried onboard, distance-weighted HFO carried, and BC emissions for the IMO Arctic in 2015.

HFO use and BC emissions

Total HFO fuel consumption in the IMO Arctic in 2015 equaled 250 thousand tonnes and total BC emissions from HFO-fueled ships were 131 tonnes. Russian-flagged ships consumed the most HFO of any flag state by far in the IMO Arctic in 2015 (Figure 10), distantly followed by Canada and Denmark (DIS).[4] Russian-flagged ships consumed over 140 thousand tonnes of HFO in the IMO Arctic in 2015, emitting approximately 74 tonnes of BC, 9-times more BC than Canada, whose HFO-fueled fleet emitted approximately 8 tonnes of BC (Figure 11). As such,

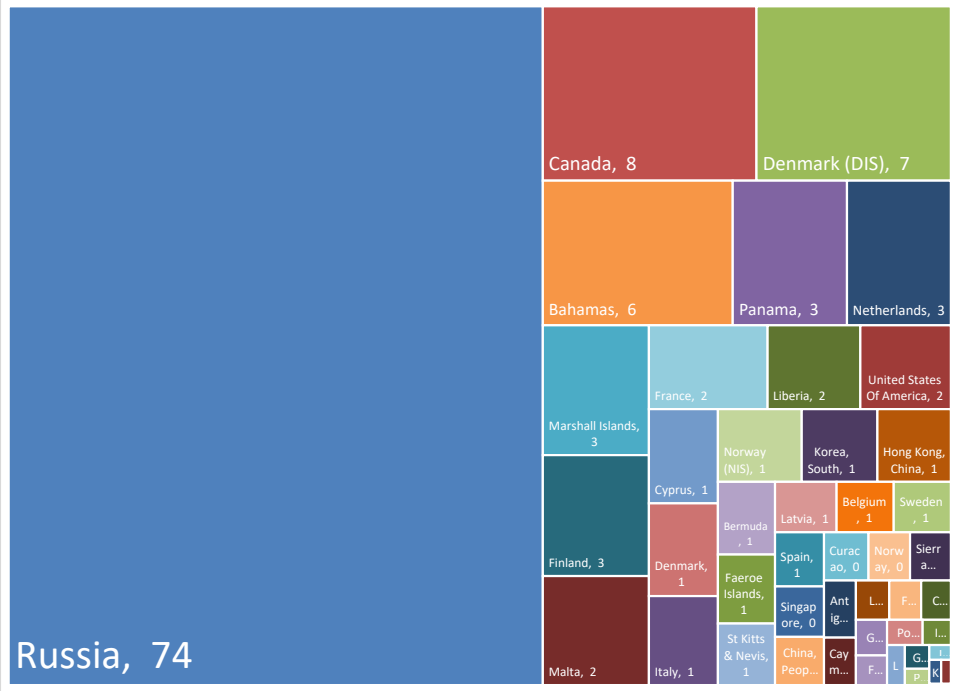
[4] DIS is the Danish International Register of Shipping, which includes merchant ships (excluding fishing vessels) above 20 gross tonnes and includes Danish ships as well as foreign ships, in some cases (e.g., when a foreign company is controlled by a Danish shipping company). More information can be found here: https://www.dma.dk/SynRegistrering/SkibsregistreringAfgifter/DIS/Sider/default.aspx

HFO-fueled Russian-flagged ships accounted for 56% of HFO consumption and 56% of BC emissions from HFO-fueled ships in the IMO Arctic in 2015. This is unsurprising given that Russian-flagged ships represented 332 of 889, or 36%, of HFO-fueled ships operating in the IMO Arctic in 2015.



Note: see appendix for a complete summary of results by flag state

Figure 10. HFO use (thousand t) by flag state in the IMO Arctic, 2015

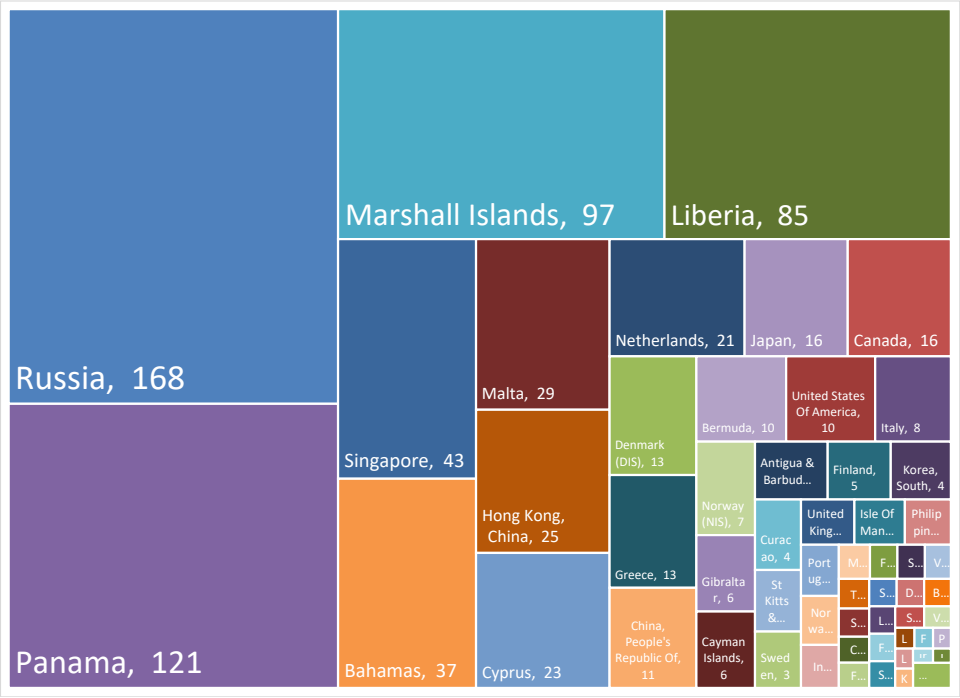


Note: see appendix for a complete summary of results by flag state

Figure 11. Black carbon emissions (t) by HFO-fueled ships by flag state in the IMO Arctic, 2015

HFO onboard

Total HFO fuel onboard ships at any given time in the IMO Arctic in 2015 equaled 827 thousand tonnes. Ships registered to Russia carried the most HFO onboard as fuel. Russian-flagged ships carried over 168 thousand tonnes of HFO as fuel, equivalent to 20% of HFO onboard in the IMO Arctic in 2015. However, prominent flag states with large cargo ships (with large fuel tanks) in their registries, including Panama, Marshall Islands, Liberia, and Singapore round out the top 5 (Figure 12). Only three Arctic states – Russia, Canada, and Denmark (DIS) – are included in the top 15 flag states in terms of HFO fuel carriage. In fact, non-Arctic flagged ships represent 74% of HFO carriage as fuel.

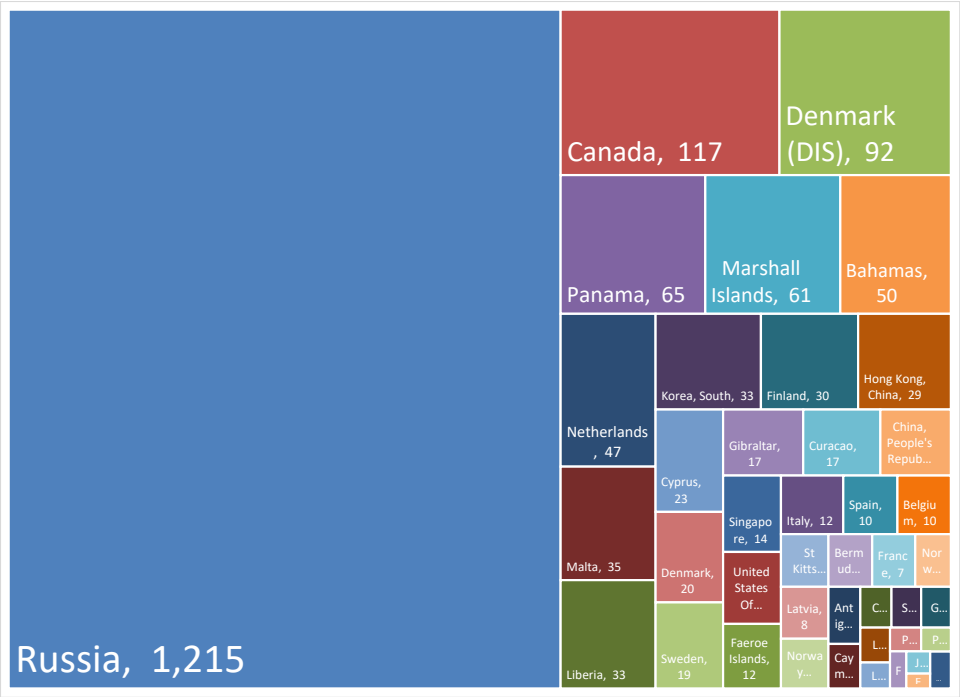


Note: see appendix for a complete summary of results by flag state

Figure 12. HFO fuel onboard (thousand t) by flag state in the IMO Arctic, 2015

Distance-weighted HFO carried

Total distance-weighted HFO carried equaled 2,074 million t-nm in the IMO Arctic in 2015. Russian-flagged ships dominated, representing 1,215 million t-nm (Figure 13), that's 10-times more than the next closest flag state, Canada, and 59% of total distance-weighted HFO carriage in the IMO Arctic in 2015. This makes sense, given that Russia has 332 HFO-fueled ships compared to Canada's 26. Notice that ships flagged to Arctic countries make up the top three in terms of distance-weighted HFO carriage, followed by prominent flag states that tend to register larger commercial ships (Panama, Marshall Islands, Bahamas, etc.). Ships registered to non-Arctic countries represented 27% of distance-weighted HFO fuel carriage in the IMO Arctic in 2015.



Note: see appendix for a complete summary of results by flag state

Figure 13. Distance-weighted HFO fuel carriage (million t-nm) by flag state in the IMO Arctic, 2015

Conclusions

Russia had 722 ships flying its flag in the IMO Arctic in 2015, 322 of which, or 46%, were HFO-fueled while the rest operated on distillate fuels, except for 4 nuclear-powered icebreakers. Russia had the largest Arctic fleet, consumed the most HFO, emitted the most BC, carried the most HFO onboard its ships, and accounted for the greatest distance-weighted HFO carried of any flag state. In 2015, 36% of the 889 HFO-fueled ships operating in the IMO Arctic were Russian-flagged. These HFO-fueled Russian-flagged ships accounted for 56% of HFO use, 56% of BC emissions from HFO-fueled ships, 20% of HFO carriage as fuel, and 59% of distance-weighted HFO fuel carriage in the IMO Arctic in 2015.

The Russian-flagged fleet relies heavily on HFO to power its ships. HFO represented 67% of fuel consumed, 64% of fuel onboard ships, and 63% of distance-weighted fuel carried for Russian-flagged ships in the IMO Arctic in 2015.

HFO-fueled ships owned by Russian companies Norilsk Nickel, SOVCOMFLOT, and Murmansk Shipping Company, all of which specialize in Arctic shipping, especially in transporting materials from mining and oil and gas operations, used the most HFO, emitted the most BC, and accounted for the greatest distance-weighted HFO fuel carried compared to other owners. These companies are important Arctic shipping stakeholders and would be among the most impacted by a ban on using and carrying HFO for fuel by ships in the Arctic. On the other hand, these companies are also in a position to be leaders in demonstrating how Arctic shipping operations could be HFO-free.

If Russia were to phase out the use of HFO in all or a portion of its fleet, it would have a dramatic impact on reducing the risks of HFO from ships in the IMO Arctic. However, large ships registered to non-Arctic countries use and carry a considerable amount of HFO in the IMO Arctic. More of these ships will come as sea ice diminishes and as companies test new routes to connect Asia, Europe, and North America. Therefore, a ban on using and carrying HFO for fuel by ships that applies to the entire IMO Arctic region, regardless of flag, would offer the best protection against the risks of HFO.

Appendix

Summary Statistics for HFO-fueled Ships Operating in the IMO Arctic in 2015 by Flag State

Table A-1: Summary statistics for HFO-fueled ships operating in the IMO Arctic in 2015, by flag state (across 3 pp.)

Flag State	Number of HFO-fueled Ships	Operating Hours	Distance Traveled (nm)	HFO Consumed (t)	HFO Carried (t)	Distance-Weighted HFO Carried (million t-nm)*	Black Carbon from HFO-fueled ships (t)
Russia	332	518,551	2,147,068	140,300	168,388	1,215	74
Canada	26	40,479	186,319	14,612	15,645	117	8
Denmark (Dis)	12	30,455	201,142	13,893	13,320	92	7
Panama	72	12,102	50,398	7,415	121,063	65	3
Marshall Islands	65	10,527	53,657	6,544	96,902	61	3
Bahamas	36	14,233	107,558	10,385	37,314	50	6
Netherlands	27	8,234	59,985	5,549	20,594	47	3
Malta	25	7,286	47,248	5,274	29,340	35	2
Liberia	44	6,194	38,730	3,462	85,179	33	2
Korea, South	10	17,761	81,324	1,708	4,494	33	1
Finland	6	6,277	25,946	4,866	4,737	30	3
Hong Kong, China	19	4,356	22,702	2,598	24,662	29	1
Cyprus	23	7,351	37,770	2,764	23,340	23	1
Denmark	4	28,206	74,866	2,253	968	20	1
Sweden	3	1,818	10,620	794	3,420	19	1
Gibraltar	5	2,128	12,295	354	5,828	17	<1
Curacao	2	908	7,866	1,042	4,226	17	<1
China, People's Republic Of	8	4,505	20,831	486	11,277	15	<1
Singapore	18	3,075	12,323	1,102	42,630	14	<1

Flag State	Number of HFO-fueled Ships	Operating Hours	Distance Traveled (nm)	HFO Consumed (t)	HFO Carried (t)	Distance-Weighted HFO Carried (million t-nm)*	Black Carbon from HFO-fueled ships (t)
United States of America	14	8,698	24,617	2,529	9,907	13	2
Faeroe Islands	6	9,986	44,293	897	1,231	12	1
Italy	7	2,230	13,563	2,266	8,365	12	1
Spain	3	11,423	44,018	769	900	10	1
Belgium	1	1,992	10,665	1,004	960	10	1
St Kitts & Nevis	7	7,531	29,441	1,477	3,693	8	1
Latvia	4	15,752	67,193	1,139	477	8	1
Norway (Nis)	7	5,322	19,665	2,376	7,043	8	1
Bermuda	4	459	5,042	1,558	9,910	7	1
France	3	2,872	24,082	3,896	907	7	2
Norway	10	8,707	25,774	535	2,382	6	<1
Antigua & Barbuda	9	1,088	9,817	689	5,418	6	<1
Cayman Islands	4	1,702	2,437	702	5,779	5	<1
Croatia	1	530	4,030	573	1,018	4	<1
Sierra Leone	5	5,294	17,994	955	1,217	4	<1
Greece	6	574	2,841	279	12,702	4	<1
Luxembourg	1	2,179	10,956	465	311	3	<1
Lithuania	1	1,914	4,806	252	519	2	<1
Portugal (Mar)	3	643	2,798	357	2,481	2	<1
Philippines	5	379	1,477	196	2,705	2	<1
France (Fis)	1	2,043	1,944	345	1,007	2	<1
Japan	15	143	1,509	158	15,657	2	<1
Faeroes (Fas)	4	8,345	15,693	466	494	1	<1
Kiribati	1	651	1,635	135	455	1	<1
United Kingdom	4	316	1,386	81	3,104	1	<1

Flag State	Number of HFO-fueled Ships	Operating Hours	Distance Traveled (nm)	HFO Consumed (t)	HFO Carried (t)	Distance-Weighted HFO Carried (million t-nm)*	Black Carbon from HFO-fueled ships (t)
Seychelles	1	2	518	3	1,118	1	<1
Iceland	2	5,489	2,031	259	327	<1	<1
Libya	1	7	82	8	920	<1	<1
Cook Islands	1	3	1,385	<1	35	<1	<1
Isle of Man	2	2	28	3	2,940	<1	<1
Turkey	2	2	32	1	1,149	<1	<1
Vanuatu	1	1	11	1	1,159	<1	<1
India	2	2	12	<1	2,082	<1	<1
Vietnam	2	2	17	1	747	<1	<1
Poland	1	1	10	<1	485	<1	<1
Irish Republic	1	1	9	<1	365	<1	<1
Moldova	1	1	30	<1	94	<1	<1
Malaysia	1	1	1	<1	1,385	<1	<1
Nigeria	1	2	5	<1	140	<1	<1
Azerbaijan	1	1	3	<1	52	<1	<1
Switzerland	1	1	<1	<1	970	<1	<1
Chinese Taipei	1	1	1	<1	151	<1	<1
Togo	1	1	<1	<1	305	<1	<1
Kazakhstan	1	1	<1	<1	6	<1	<1
St Vincent & The Grenadines	1	1	<1	<1	815	<1	<1
Belize	1	1	<1	<1	131	<1	<1
Total	**889**	**830,742**	**3,590,496**	**249,777**	**827,347**	**2,074**	**131**

*Table ordered by distance-weighted fuel carried