National Peculiarities

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Development of Transit Potential of the Northern Sea Route

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ABSTRACT. *The Article defines the sectoral structure of the Northern Sea transport corridor, the set of the transport tasks provided by them - the international transit, import and export operations, and considers internal transportation. It is shown that in relation to the water area of the sector of the Northern Sea Route, both international and internal transportation (big cabotage and intersectoral transportation) can be referred to as transit. Transit transportation across the Northern Sea Route between countries in 2010-2018 has been analyzed. The Article also defines transit dynamics and commodity structure. Dynamics of transit transportation of main types of freights are considered: bulk freights (oil products, gas condensate), bulk cargoes (iron ore, coal). The dynamics of Russia's internal transit transportation across the Northern Sea Route have been analyzed. The article also analyzes the dynamics of transportation of frozen fish, the possible transit of which may prompt the creation of a year-round container line between the ports of Petropavlovsk-Kamchatsky, Murmansk, Arkhangelsk, and St. Petersburg. The author summarizes the results of the development of transit transportations in 2010-2018 and identifies the factors defining the demand for transit shipments of various cargoes. The Article also provides an assessment of the development prospects of transit freight traffic by international shipping companies (Maersk). The conclusion is that supporting national investment projects should be a priority when improving navigation along the Northern Sea Route – transportation of mineral resources and supporting mining companies. At the same time, creating a steady transportation system for Arctic mineral resources calls for the development of icebreaking, navigation, and hydrometeorological support. This will reduce risks associated with Arctic navigation and increase the appeal of the Arctic sea transport system as a whole. The Article identifies the following necessary conditions for the development of navigation in the Northern Sea Route: expanding the domestic Arctic linear icebreaker fleet; cen-*

tral planning of sea freight transportation and coordination of actions of participants, which could increase the appeal of the Northern Sea Route, including its role for transit.

KEYWORDS: *Northern Sea transport corridor, Northern Sea Route, international transit, internal transit, container transportation, navigation restrictions, cargo base, ice breakers, prospects*

The development of Arctic shipping, particularly in the waters of the Northern Sea Route, currently aims at national strategic and systemic projects, dealing with the exploitation of natural resources of the Arctic Zone of the Russian Federation.

The development of mineral resources is the first motivation for the development of Arctic shipping not only in Russia but also in other Arctic countries, such as Canada, Denmark, the USA, and Norway.

One of the directions of the Northern Sea Route's development is connected with the establishment of a competitive international trading artery to ensure cargo flow between the markets of the North Pacific and the North Atlantic.

The transit potential of the Northern Sea Route, especially in the context of global warming, is highly appraised in Arctic strategies of Arctic and non-Arctic countries alike [Arctic Strategic Outlook 2019; China's Arctic Policy 2019].

Many authors see China as having a special role in the development of Arctic transit cargo traffic. [*Kryukov* 2018; *Kheifetz* 2018].

The future of transit along the Northern Sea Route has attracted mixed criticisms. Some authors value highly the prospects for such development, explaining that this will provide for a shorter route between the ports of Southeast Asia and Europe [*Todorov* 2017; *Bolsunovskaya*, *Boyarko* 2014; *Pavlov, Selin* 2016; *Polovinkin, Fomichev* 2012]. It is also often emphasized that "Russia has more to gain from such expansion. This applies to the freight of Russian vessels, fees for the passage of foreign ships, icebreaker fees, etc. "[*Kheifets* 2018]. However, it must be noted that charges for passage along the Northern Sea Route are against the basic principles of the UN Convention on the Law of the Sea.

Some authors are skeptical about the possibility of significant growth of such transit [*Komkov*, *Selin*, *Tsukerman*, *Goryachevskaya* 2016; *Kuvatov*, *Kozmovsky*, *Shatalova* 2014; *Lukin* 2015].

According to "Atomflot" experts, the main reason for the weak development of transit shipping is the lack of a large cargo base, and "given the limited number of icebreakers, future transit will only be possible against large guaranteed consignments and a clear schedule of routes" [*Ruksha, Belkin, Smirnov, Arutyunyan* 2015].

The subsidiary role of the Northern Sea Route in the system of international transit is most clearly defined in the following way [*Selin, Kozmenko* 2015, p. 110]: "Thus, at present the Northern Sea Route as an international transit artery remains on stand-by of the international transport system, falling short of an operating link."

The current state of development of the Northern Sea Route infrastructure shows that transit voyages, both domestic and international, will be irregular and provide limited cargo flow (according to the Ministry of Transport of Russia, in 2024 international and internal transit will not exceed 1 million tons).

The article aims to analyze the peculiarities of transit shipping development in the Arctic in recent years and to identify the primary tasks to grasp its transit potential fully.

Transit transportation along the Northern Sea Route in the total freight traffic of the Northern Sea transport corridor

The analysis of the transit traffic in the waters of the Northern Sea transport corridor requires understanding of its role in the general structure of the Northern Sea transport corridor, which accommodates the entire bulk of cargo shipments in the Arctic areas of Russia.

The Northern Sea transport corridor (NSTC) is a historically established national transport link of the Russian Federation, which includes ports and shipping routes along the Arctic seas and rivers flowing into the Barents, White and Pechora seas to the west, the Northern Sea Route (*Kara, Laptev, East Siberian, and Chukchi seas*) in the central part, and the Bering Sea to the east.

The Northern Sea transport corridor (NSTC) may be divided into three sectors [*Grigoryev* (1) 2017]:

1) the Pomorsky sector includes the Barents, Pechora and White Seas;
2) the Northern Sea Route covers the water area of the Northern Sea Route as defined by Federal Law no 525-FZ of December 27, 2018, and includes the waters of the Kara Sea, the Laptev Sea, the East Siberian, and Chukchi Seas;
3) the Kamchatka sector includes the Bering Sea and the North Pacific Ocean.

To the west, NSTC is limited by the maritime demarcation line between the Russian Federation and the Kingdom of Norway in the Barents Sea, according to Federal Law no 57-FZ of April 5, 2011 "On ratification of the Treaty between the Russian Federation and the Kingdom of Norway on the delimitation of maritime spaces and cooperation in the Barents Sea and the Arctic Ocean."

The eastern boundary of NSTC is the maritime delimitation line between the USSR and the United States, as delineated by the Agreement on the Maritime Boundary, signed in 1990. At the signing ceremony, the Parties agreed on its provisional application from June 15, 1990, in accordance with the 1969 Vienna Convention on the Law of Treaties (Article 25, "Provisional application"). The Agreement was ratified by the US Congress on September 18, 1990, but has yet to be ratified by the Russian Parliament.

The internal borders of the NSTC sectors are defined by the Federal Law of 28.07.2012 no 132-FZ "On amending certain legislative acts of the Russian Federation concerning state regulation of commercial navigation along the Northern Sea Route." The law lays down the boundaries of the Northern Sea Route as follows: "The Northern Sea Route is a water space adjacent to the northern coast of the Russian Federation, covering inland sea waters, the territorial sea, contiguous zone and exclusive economic zone of the Russian Federation and bound to the east by the maritime delimitation line with the United States of America and the parallel of Cape Dezhnev in the Bering Strait, to the west – by the meridian of the Cape Zhelaniya to the Novaya Zemlya archipelago, and by the eastern shoreline of the Novaya Zemlya archipelago and the western borders of the Matochkin, Kara, and Yugorski Straits. "

The northern border of NSTC is the outward line of the exclusive economic zone of the Russian Federation in the Arctic Ocean.

The southern border of NSTC is defined by the location of seaports on the northern rivers flowing into the outlying seas of the Arctic Ocean, the inner

White Sea. It is also conditionally accepted in the Pacific Ocean at the latitude of Petropavlovsk-Kamchatsky, located on the border of the Bering and Okhotsk seas, with the Register of Sea Ports of the Russian Sea Fleet defining the Petropavlovsk-Kamchatsky seaport as follows: "Russia, Kamchatka Krai, the Pacific Ocean, Okhotsk, and Bering Sea, Avacha and Petropavlovsk bays" (annex to the order of the Federal Agency for Maritime and River Transport, Russia, ("Rosmorrechflot") of May 30, 2011, no AD181-r).

The central sector of NSTC is the Northern Sea Route, linking the western and eastern sectors. It is characterized by the most difficult navigating conditions associated with the formation of ice cover for over six months per year, and the period of navigation not exceeding three months per year in certain ports (Khatanga, Tiksi, Anadyr, etc.)

Such irregular climate begs the question if Article 234 "Ice-covered areas" of the United Nations Convention on the Law of the Sea (UNCLOS, concluded in Montego Bay on 10.12.1982, as of 23.07.1994) applies to the Northern Sea Route: " Coastal States have the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone, where particularly severe climatic conditions and the presence of ice covering such areas for most of the year create obstructions or exceptional hazards to navigation, and pollution of the marine environment could cause major harm to or irreversible disturbance of the ecological balance." In fact, the observed level of ice cover permits allows for the application of Article 234 to the areas of the Pechora Sea, the north-east of the Barents Sea, and the north of the Pacific Ocean.

Transport problems of the Northern Sea transport corridor

The NSTC maritime transport system will solve the following tasks [*Grigoryev* (1) 2017]:

1. International transit:
   a. Asia-Europe (east to west);
   b. European countries - APR countries (west to east);
   c. North American countries - APR countries (west to east);
2. Import-export operations:
   a. Pacific Direction;
   b. Atlantic direction;
3. Domestic:
   a. large coastal shipping (long-range cabotage);
   b. small coastal shipping (petite cabotage):
      i. Cross-sectoral transport;
      ii: Intra-sectoral transport.

International transit (that is, without entering the ports of the Russian Federation along the way) ensures transfer of goods between the ports of the northern Pacific and the northern Atlantic, linking the markets of the Asia-Pacific region (Asia and the Pacific coast of North America) and Europe. In addition to the traditional east-west (Asia/North America – Europe) and west-east (Europe – Asia), the NSTC has started to service transportation from the east coast of North America to Asia from west to east (for instance, in 2018 through NSTC, two runs conducted by bulk carriers loaded with iron-ore concentrate from Arctic Canada to Japan and Taiwan).

Import and export operations largely deal with the transfer of oil, gas and mining products, as well as supplying equipment and materials for extractive industries. The ports of the Pomorsky sector (Murmansk, Kandalaksha, Arkhangelsk) provide the main transshipment of car-

go in the Arctic basin, going to or arriving from the European and Asian parts of the country. Recently, the NSTC also serviced several international shipments to Kazakhstan, such as a shipment of a large cargo from South Korea for the Pavlodar Oil Refinery. The main share of cargo flow goes to the west, but since 2018, the transportation of liquefied natural gas (LNG) of the "Yamal LNG" project to the APR market has begun (including four shipments by Yamalmax LNG carriers.)

Domestic transportation includes both large and small coastal shipping (cabotage). Long-range cabotage ensures the freight traffic between ports of different seas with passage through territorial waters of foreign states (for example, from the Kamchatka sector of NSTC to the Russian ports in the Baltic Sea). Small cabotage ensures the cargo traffic between the ports of adjacent waters of the Arctic and Pacific oceans (cross-sectoral transport), or between the ports of the Arctic and Pacific Oceans within the borders of the Pomorsky sector, the Northern Sea Route sector and the Kamchatka sector (intra-sectoral transport).

The freight traffic of NSTC provides for multimodal transportation by rail, road, air, river, and sea transport. The key role is given to the sea and river ports, both within (Murmansk, Arkhangelsk, Varanday, Sabetta, Dixon, Dudinka, Tiksi, Pevek), and outside NSTC: that is, including St. Petersburg, Vladivostok, etc. [*Grigoryev* (1) 2017]

Transit transport along the Northern Sea Route

Transshipment is the transportation of cargo and passengers from one place to another through intermediate territories. Since the Northern Sea Route is the central part of NSTC, all of the following will be considered "transshipments": the transport between foreign ports (international transit) and the internal long-range cabo-

Fig. 1. Transit routes in the waters of the Northern Sea Route

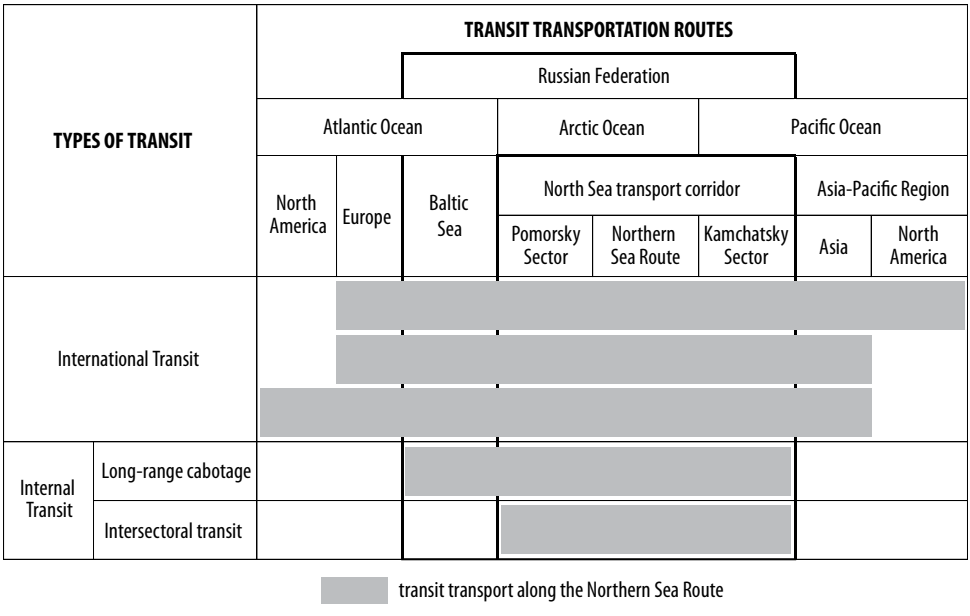

Table 1 Transit transportation along the Northern Sea Route between the countries in 2010-2018

Country of origin	Destination Country																	Total, thousands of tons
		Europe										Asia						
	Russia	Finland	Netherlands	Germany	France	Sweden	UK	Denmark	Poland	Germany and the Netherlands	Norway	China	South Korea	Japan	Thailand	Malaysia	Singapore	
Russia	465											1 018	728	36	182	61	44	**2 535**
Canada		300		72								72		72				**517**
Norway												104	76	217				**396**
Netherlands												64						**64**
Finland												63						**63**
Finland and Denmark												31						**31**
Germany														30				**30**
Sweden													17					**17**
Germany and Norway														13				**13**
UK	5																	**5**
Estonia												4						**4**
Iceland														3				**3**
South Korea		199	387	33	69													**688**
China	1		94	13		35	14	18	3	3	0							**182**
Japan						32												**32**
Vietnam							15		0									**15**
Total	**471**	**500**	**481**	**118**	**69**	**68**	**28**	**18**	**3**	**3**	**0**	**1 356**	**821**	**370**	**182**	**61**	**44**	**4 594**

tage (between the Pacific and Baltic ports) and cross-sectoral between the ports of the Kamchatka and Pomor sectors of NSTC (Fig. 1). This is precisely how the Administration of the Northern Sea Route of the Ministry of Transport of Russia views such transportation.

International transit includes three routes (transportation between the countries of the Asia-Pacific region and Europe in the eastern and western directions, as well as transportation between North America and Asia from west to east). Intra-Russian transit transport includes shipment of goods between the ports of the NSTC Kamchatka sector to the ports of the Baltic Sea (long-range cabotage) and transportation between the ports of the Pomorsky and Kamchatka sectors of NSTC (petite cabotage).

A large share of freight traffic is international transit, with the share of intra-Russian transit during the period under review amounting to 10%. The most substantial volume of cargo was transported from Russia to China (22%) and South Korea (16%) (Table 1).

Let us consider the contribution of various cargo flows to the development of transit traffic along the Northern Sea Route. The key data source for this analysis is the statistics provided by the Federal State Budgetary Institution "Northern Sea Route Administration," established in March 2013. The analysis of transit traffic covered the period 2010-2018, and for the internal Russian transit, it covered 2011-2018.

The increase in transit traffic that had begun in 2010 reached its peak by 2012, with the transportation of 1267 thousand tons of freight. That year, transit accounted for 34% of the total cargo traffic along the Northern Sea Route (Table 2). In general, freight was chiefly transported from west to east. Here and further on, freight volumes are indicated in thousands of tons.

During the period under review, four and a half million tons of transit cargo were transported, with 83% of all shipments accounting for four types of freight: bulk oil products and gas condensate, bulk ore and coal (Table 2).

Table 2. Transit dynamics along the Northern Sea Route, thousands of tons

Destination of transportation	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
East-West		65	343	445	89	21	170	39	215
West-East	113	758	924	732	185	19	44	156	276
Total	113	823	1 267	1 176	274	40	215	194	491
Share of transit in the whole cargo flow	5%	27%	34%	30%	7%	1%	3%	2%	2%
Share of East-West transportation	0%	8%	27%	38%	32%	52%	79%	20%	44%
Share of West-East transportation	100%	92%	73%	62%	68%	48%	21%	80%	56%

Table 3. The commodity pattern of the Northern Sea Route transits in 2010-2018

Cargo	Weight, thousands of tons	Share in transportation
Oil products	1 345	29%
Gas condensates	1 277	28%
Iron ore	763	17%
Coal	405	9%
Liquefied Natural Gas (LNG)	209	5%
Paper and cellulose pulp	123	3%
Equipment	120	3%
Break-bulk cargo	71	2%
Non-ferrous metals	59	1%
Frozen goods	54	1%
Oil	44	1%
Containers	33	1%
Steel	30	1%
Fluorspar	25	1%
Ships on deck	19	0,4%
Timber	15	0,3%
Total	**4 594**	**100%**

Dynamics of transit traffic of main types of cargo

BULK LOADS

Oil Products

Transit transportation of oil products was carried out both in the western and eastern directions in 2011-2013, 2018, and in the eastern direction only in 2014, and 2016-2017. In 2015, oil products were not moved (Table 3). In total, 1345 thousand tons of oil products were shipped.

Transportation of oil products reached the maximum value in 2013 when 650 thousand tons were transported in both directions. At the same time, some of the cross-freight was carried out by the same tankers, which allowed to avoid passage in ballast; in the western direction, the supply of aviation kerosene prevailed.

A significant price differential drove the transportation of oil products in the markets of Europe and the Asia-Pacific region. As the prices stabilized, the shipments lost sense for the economy.

Gas condensate

Transit transportation of gas condensate in the eastern direction began in 2010 and lasted for four years (Table 4). In total, 1277 tons of gas condensate were transported.

The Company "NOVATEK" supplied gas condensate to the port of Vitino in the White Sea by rail before exporting it through Murmansk. The first run from Murmansk in 2010 was carried out by the Aframax Arc5 ice-class oil tanker "SKF Baltica" with a deadweight of 117 thousand tons, owned by the company "Sovcomflot," under the flag of Liberia. The tanker carried out the transit in 22 days, passing through the traditional way along the Northern Sea Route through the Sannikov Strait to the Chinese port of Ningbo. When fully loaded, the tanker has a draft of 15.4 m, with the Sannikov Strait depth restrictions at 12.5 meters. Therefore, the tanker was significantly underloaded. With a total deadweight of 117 thousand tons, they loaded 70 thousand tons of gas condensate, which allowed to reduce the draft to a safe margin. Along the Northern Sea Route from the Novaya Zemlya Archipelago to the Dezhnev Cape, the tanker was accompanied by two nuclear icebreakers - "Russia" and "50 Let Pobedy" ("*50 Years of Victory*").

In 2011, Sovcomflot conducted the second pilot run carrying gas condensate from Murmansk to Thailand, with a larger-size Suezmax tanker "Vladimir Tikhonov" (ice class Arc 4) under the flag of Liberia. The icebreaker was also provided with two nuclear icebreakers – "50 Let Pobedy" and "Yamal." The run was intended to identify a deep-water route north of the Novosibirsk Islands, bypassing the Sannikov Strait. The ship was likewise significantly underloaded: with the tanker's deadweight of 163 thousand tons, when fully loaded, the draft is 16.5 meters. They loaded 121 thousand tons of LNG, which allowed to reduce the draft of the vessel to ensure the safety of navigation in the poorly studied water.

In 2011-2013, gas condensate was transported by foreign cargo ships with a deadweight of about 75 thousand tons, belonging mainly to Arctic ice-class Arc 4, both with and without icebreaker support. The cargo volumes ranged from 57 to 61

Table 4. Dynamics of transit transportation of oil products, thousands of tons

Destination of transportation	Years							
	2011	2012	2013	2014	2015	2016	2017	2018
East-West	65	238	313					94
West-East	21	64	337	185		8	15	5
Total	86	302	650	185		8	15	99

Table 5. Dynamics of gas condensate transit, thousands of tons

Years								
2010	2011	2012	2013	2014	2015	2016	2017	2018
70	601	487	120					

thousand tons. Shipments were made to China, South Korea, Thailand, and Malaysia.

The transportation gradually decreased in volumes and ceased in 2013 due to the exhaustion of the cargo base. In 2013, NOVATEK put into operation the "Complex for fractionating and transshipment of stable gas condensate" in Ust-Luga in the Baltic Sea, which allowed both to export stable gas condensate and to process it (to naphtha, kerosene, diesel fraction and fuel oil) and to ship processed products for export by sea.

BULK CARGOES

Iron ore

Transit transportation of iron ore (iron ore concentrate) in the eastern direction was carried out in 2010-2013 and resumed in 2018 (Table 5). In total, 763 thousand tons of iron ore were transported during the reviewed period.

The first shipment of iron ore concentrate along the Northern Sea Route was organized by two companies - Tschudi Shipping Company and Prominvest SA in 2010. The MV Nordic Barents bulker, belonging to the Arctic ice-class Arc 4 and owned by the Danish shipping company Nordic Bulk carriers, with a deadweight of 43 thousand tons, transported 41 thousand tons of iron ore concentrate from Kirkenes to China [*Grigoryev* 2016].

2011 marked the beginning of EuroChem iron ore concentrate shipments from the Kovdorsky Mining and Processing Plant through the port of Murmansk to China by the bulk carriers of the Murmansk Shipping Company "Mikhail Kutuzov," "Dmitry Pozharsky," and also Sanco Line's "Sanco Odyssey" to the Chinese ports of Jingang and Beilun.

In 2012, the shipments were carried out by "Nordic Odyssey" and "Nordic Orion," carriers of the Arctic ice-class Arc 4, belonging to "Nordic Bulk carriers." Each bulk ship carried out two runs to China; three were made to the port of Huanghua.

In 2013, the same two bulk vessels of "Nordic Bulk carriers" operated one route to China (the ports of Lanshan and Qingdao), and one shipment was made by the bulker "NS Yakutia" of the Arctic Ice Class Ice3. After that, the transportation of iron ore ceased.

Transporting iron ore concentrate is also attractive due to the price difference between European and Asian markets. The reason for the termination of the transit traffic is the decrease in the price of iron ore concentrate in China, which made shipments ineffective. In addition, market participants note the low quality of iron ore concentrate associated with high sulfur content.

In 2018, the bulkers "Nordic Olympic" and "Nordic Oshima" of the company "Nordic Bulk carriers" made two runs from Arctic Canada (Milne Inlet) with a cargo of iron ore concentrate to Tobata (Japan) and Kaohsiung (Taiwan). Notably, instead of taking a short route through the North-West bypassing Greenland, the ships went along NSTC. The Canadian

Table 6. Iron ore transit dynamics, thousands of tons

Destination of transportation	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
West-East (Europe – Asia)	43	110	262	203					
West-East (North America – Asia)									144

bulkers opted for the North-East passage (NSTC) instead of the North-West due to the route's safety and stability.

Coal

International transit of coal since the beginning of general transit traffic along the Northern Sea Route since 2011 was conducted in 2012, 2013, 2014, 2016, 2017, and 2018. Transportation was single. In 2012-2016. Cargo lots averaged 74.5 thousand tons, in 2018 - 16.2 thousand tons The maximum traffic was reached in 2016 - 155 thousand tons (table in total, 405 thousand tons of coal were transported during the period under review.

All shipments were carried out from east to west. In 2012, 2013, 2014, and 2016, they transported coal from Vancouver (Canada). In 2012 and 2013, to Hamburg (Germany), then to Finland (in 2014 in Pori, in 2016 in Raah). In 2018, the transportation was carried out from Japan (the port of Sakaide) to Sweden (the port of Oxelosund) (Table 7).

The transportation was carried out by the experienced Nordic Bulk carriers (Nordic Odyssey and Nordic Oshima), as well as Oldendorff carriers GmbH & CO Kg (Gretke Oldendorff and "Georg Oldendorff," ice-class Ice2 with 80 thousand tons deadweight) and ESL Shipping Oy ("Haaga" and "Viikki," Ice class Arc 4, deadweight of 24–26 thousand tons) (Table 8).

All deliveries were carried out in a single run (that is, the bulkers only navigated the Northern Sea Route once, with the exception of the Baltic Odyssey voyages in 2012) Initially, the ship delivered the EuroChem iron-ore concentrate (IOC) from Murmansk to China, after which it returned to the ballast. The next loaded route was also made from Murmansk to the Chinese port of Huanghua, but after that, the ship returned through NSTC carrying Canadian coal. This is a good example of competent logistical solutions to ensure the loading of ships during return voyages along NSTC.

Table 7. Coal transit traffic dynamics, thousands of tons

Years						
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
72	74	72		155		32

Table 8. Coal transit routes

Судно	Navigation along the Northern Sea Route							
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Nordic Odyssey		Vancouver – Hamburg						
Nordic Oshima				Vancouver – Pori				
Gretke Oldendorf						Vancouver – Raahe		
Georg Oldendorf								
Haaga								Sakaide – Oxelosund
Viikki								

Dynamics of intra-Russian transit traffic along the Northern Sea Route

The volumes of transit traffic between the Russian ports along the Northern Sea Route are very limited (Table 8). Moreover, in the last four years, Russian freight traffic has been practically absent.

The volume of Russian transit was due to the transportation of oil products, mainly from west to east, which depended on different prices for bunkering fuel in the western and eastern ports of Russia.

In 2014, the transportation of oil products amounted to 185 thousand tons, 70% of which were covered by a single project – the shipment by the bunkering company "Tranzit DV" of the bunker fuel oil from the Baltic Sea – from Vysotsk (88 thousand tons) and Ust-Luga (44 thousand tons) to Slavyanka (Vladivostok region). This was efficient due to a significant price difference in the western and eastern parts of Russia. As prices leveled in 2015, these shipments likewise lost their economic viability.

Recent development plans for transit freight, including the creation of a year-round container line, have been connected to shipments of frozen fish along the Northern Sea Route from east to west. The administration of Kamchatka Krai, Murmansk, Arkhangelsk, and, more recently, Leningrad Oblasts, have been interested in creating a transarctic bridge for the supply of frozen fish from the far East to the central part of Russia, bypassing the railway.

Let us consider the traffic dynamics. The largest amount of fish was transported in 2011 (over 24 thousand tons by three shipments from Petropavlovsk-Kamchatsky and one from Vladivostok with an average size of 6 thousand tons) but not to the nearest western port of Murmansk. They were transported to St. Petersburg, as the subsequent delivery to Moscow costs half the price from St. Petersburg than from Murmansk. In 2012, a batch of 8 thousand tons was shipped via the same route; in 2013 and 2014, shipments of fish were not carried out. In 2015, three counter-shipments were carried out,

Table 9. Dynamics of transit traffic between Russian port, thousands of tons

Destination of transportation	Cargo	2011	2012	2013	2014	2015	2016	2017	2018
West-East	Break-bulk cargo	1					4		
	Oil products	21	64	36	185		8	15	5
	Ships on deck			3					
	Total	23	64	39	185		13	15	5
East-West	Frozen goods	25	8			5	2	5	3
	Oil products		38	20					
	Ships on deck				16				
	Total		47	20	16	5	2	5	3
Total		47	111	59	202	5	14	20	8

albeit in small batches. First, the vessel of Winter Bay of Dalriada Ltd delivered frozen fish and meat from Norway to Osaka, and then, on their way back, fish from Nakhodka to St. Petersburg (less than 2 thousand tons both ways). The vessel "Harmony" of the CJSC "Yuzhmorrybflot" delivered the cargo of fish from Nakhodka to Murmansk but had to make a return journey in ballast. The shipped batch did not exceed 3 thousand tons. In 2016, 1.8 thousand tons of fish were transported from Petropavlovsk-Kamchatsky to St. Petersburg by the ship "Winter Bay" of the ice-class Ice1. In 2017, "Winter Bay" delivered 1.8 thousand tons of fish from Petropavlovsk-Kamchatsky to St. Petersburg; vessel "Garmonia," belonging to CJSC "Yuzhmorrybflot," delivered 3 thousand tons of frozen fish from the village of Ossora (Kamchatka peninsula) to Arkhangelsk. In 2018, the vessel "Progress" of the ice-class Arc 4 CJSC "Yuzhmorrybflot" delivered 2.8 thousand tons of frozen fish from Anadyr to Arkhangelsk. In 2018, as part of a test voyage of "Venta Maersk" from the far East, 17,000 tons of fish in containers were delivered to St. Petersburg, which, due to the peculiarities of the cargo flow statistics in the Northern Sea Route water area, was reflected as "container transportation." The details are shown below.

To summarize the results of transit traffic in 2010-2018, the following conclusions can be made [*Grigoryev* (1) 2017 (with additions)].

- The most attractive project of seasonal transportation of gas condensate to the Asia-Pacific region died due to the diversion of the cargo to the port of Ust-Lug.
- Iron ore concentrate transportation ceased due to the leveling of prices on raw materials on European and Asian markets;transportation of oil products terminated due to the same reason.
- Transit of coal began due to the availability of vessels for cargo pickups on their return voyages. The same supported petroleum transit. Otherwise (passing in ballast), the cost of the voyage would essentially double, leaving economical transit out of the question.
- Transit transport can only be attractive in the context of a price difference between the Atlantic and Asian markets, which would justify the possible costs of Arctic transport.
- Transit in frozen fish from the east to the west of Russia could not be established.
- Even though virtually absent now, the transit traffic helped identify a possible way for heavily loaded vessels along the Northern Sea Route north of the Novosibirsk Islands. It also confirmed the possibility of shipments by vessels of sufficient ice classes without ice-breaking escort, under favorable conditions.
- The passage of large-tonnage vessels in ballast may have been made more complicated, due to the 2014 transition to calculating ice-breakers fees based on the vessel's gross capacity, and not on the actual cargo.

Prospects of transit traffic growth in the total cargo flow along the Northern Sea Route

The "Plan of the Infrastructure Development of the Northern Sea Route," submitted to the government by the State Corporation "Rosatom," provides for the organization of year-round navigation along the Northern Sea Route in the period 2025-2030. Such navigation will mostly be connected to exporting PJSC NOVATEK's liquefied natural gas to the Asia-Pacific region, from the Yamal and Gidan peninsulas. Therefore, a competitive international and national transport corridor on the basis of the Northern Sea Route will be

formed in 2030-2035, after the completion of the nuclear icebreakers' fleet, the conclusion of hydrographic works on high-latitude routes, and the preparation of emergency and rescue teams.

Thus, Russian strategic planning documents estimate that year-round transit will be active by 2030. Before that, transit traffic will be seasonal.

Notably, the Analytical center under the Government of the Russian Federation gives a rather modest forecast of international transit cargo flow along the Northern Sea Route (April 2019). According to the pessimistic scenario, in 2030, it will amount to 0.2 million tons, while the optimistic one puts it at 1.8 million tons.

Despite numerous declarations of domestic intentions to develop container transit cargo flow, there are no concrete achievements. The development of the container line "from Petropavlovsk-Kamchatsky to St. Petersburg" resulted in a single voyage of "Severmorput" in 2019, which shipped 5 thousand tons of frozen fish and one and a half thousand tons of other container cargoes to the Baltic.

At the same time, in the 2019 summer-autumn navigation, a new domestic driver for the development of transit cargo flow appeared: the supply of crude oil by Aframax sized vessels, belonging to Sovcomflot, from Murmansk and Primorsk to the ports of China. Only time will tell how sustainable this project will be.

Prospect estimates of transit cargo flow development by foreign shipping companies

As stated above, the year 2030 is considered as the deadline to solve the problems, currently limiting the transit potential of the Northern Sea Route. These include insufficient ice-breaker security, hydrographic and rescue services, bunkering, the Lack of ports-shelters, and repair bases [*Hansenet et al.* 2016, etc.].

In this regard, it is essential to assess the current conditions of transit shipping in the Northern Sea Route by the leading shipping companies, the largest of which is the Maersk container shipping company.

In August-September 2018, the company conducted a test voyage of the container carrier Venta Maersk with a deadweight of 40 thousand tons, belonging to Arctic ice-class Arc4 of "Maersk Line," one of the leading container carriers, along the route: Busan (South Korea) - Bremerhaven (Germany) - St. Petersburg (Russia). According to the post-sea report, the ship left Busan on August 28, entered the Northern Sea Route area on September 6, and from September 9-11, was escorted by the nuclear icebreaker "50 years of Victory". On September 14, the ship left the Northern Sea Route, arriving in Bremerhaven on September 22, and in St. Petersburg - on September 28. Thus, the total transit took 35 days, including eight days along the Northern Sea Route.

According to the company, the total weight of the cargo was 32.7 thousand tons (1199 containers, with 660 containers unloaded in St. Petersburg, including 650 refrigerated containers with fish (17 thousand tons); 539 containers were unloaded in Bremerhaven, 12 out of which were refrigerated.

The run was intended to determine the conditions of commercial navigation along the Northern Sea Route. As a result of the passage, the company made the following recommendations:

- The entire Northern Sea Route should be covered by official electronic navigation maps, designed based on modern hydrographic research available through standard cartographic channels.
- A simplified version of the Northern Sea Route Administration's website should be created, accounting for

the weak Internet signal. It is desirable that the website provides daily updates on the locations of all vessels and include information on their ice class, main engine power, and draft.
- Information is Required on the maximum permissible precipitation in the waters of the main Straits and on the recommended route, the actual water level in the main straits and ports.
- Contact information is required for communication with the icebreaker and more data is needed about the icebreaker's technical features.

According to the company, "the financial indicators of the experimental passage of "Venta Maersk" (income and costs) do not justify launching a regular service along the Northern Sea Route at the moment. Only a significant increase in the volume and profitability of cargo base, which would cover additional investments in improvement of the ship's technical characteristics for full compliance with the requirements of the Polar Code, can make such transfers possible. "

In our opinion and despite the company's conclusion that they "do not currently consider the Northern Sea Route as a commercially reasonable alternative to other routes," the recommendations are crucial for the development of navigation in NSTC, including more than just transit along the Northern Sea Route.

Conclusion

Ensuring the transportation of mineral resources and supporting mining enterprises isthe priority of the development of navigation in the Northern Sea Route.

Establishing a sustainable system for the transport of Arctic mineral resources further requires developing icebreakers, navigational, and hydrometeorological support. This will reduce the risks of Arctic shipping and increase the attractiveness of the marine Arctic transport as a whole [*Grigoryev* (3) 2017].

Importantly, "the expansion of the international contingent of sailors capable of supporting year-round Arctic navigation, advancing international cooperation within the framework of projects on the export of mineral resources increases the safety of Arctic navigation and also predetermines the use of personnel and skills of shipping companies to develop of other transport operations, especially in connection with international transit along the Northern Sea transport corridor, the central part of which is the Northern Sea Route "[*Grigoryev* (2) 2017].

Creation of a transportation system of liquefied natural gas from the Kara to the Bering Sea along the Northern Sea Route in the course of enhanced or year-round navigation will allow regular trade and industrial, almost linear, navigation. This will allow creating a system of support of transit vessels in the composition of regular caravans.

The critical conditions for the development of navigation along the Northern Sea Route are:

- the fleet expansion of Arctic linear nuclear and diesel (like Icebreaker9 and Icebreaker8) icebreakers;

central planning of maritime cargo transportation and coordination of the activities of the participants. This could improve the appeal of the Northern Sea Route, including for transit transport.

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