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DANGEROUS ICE CONDITIONS AND ACCIDENTS IN RUSSIAN ARCTIC

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ABSTRACT

Navigation conditions and ship accidents along Northern East Passage have not came out still enough despite the great interest to Russian Arctic and wide investigations published in CRREL, INSROPE, ISO documents and articles by T. Armstrong and W. Barr. The only rather full description of the seas had been printed in 1982 in Russian, but it did not include navigation aspect. Meanwhile for the modern operations in the northern seas both hydrocarbon production and transport it is very important to know natural environment and learn from the previous ice pilot experiences.

In frame of PetroArctic project the information about Russian Arctic Seas and activities in the area has been gathered and shaped in form of double language (Russian-English) book. The physical environment and navigation in the Kara, Laptev, East Siberian and Chukchi seas are described. The half part of the work devotes to accidents induced by heavy ice conditions since 1900. 94 accidents (with detailed information for many) are under consideration and the classification is produced. It was possible to locate the accidents and create the maps shown the accidents place for all 4 seas. The main types of accidents are shipwreck, forced drift (ice jet as a special case), forced overwintering, damage of ship. There are complicated cases also. For example, the accident with a convoy of the icebreaker Lenin (1937—1938) began as wintering, but the ice field was torn off and the ships were taken out and drifted in the high sea, thus one ship was lost and many vessels have been damaged.

The main reasons of shipwrecks and damages are hits of ice floes (often in rather calm ice conditions), ice nipping (compression) and drift.

INTRODUCTION

The Arctic has long been considered a romantic and attractive area with a certain utilitarian appeal. Researchers and travellers have noted that people visiting the Arctic receive what is known as the "Arctic virus", which causes people to repeatedly risk their lives and endure discomfort, cold temperatures and hunger to undertake more northern travels.
The Arctic has also attracted people because of its natural resources. In the Middle Ages, people hunted whales, walruses and seals for their fur, blubber, skin and meat. In the early XX century,

the production of coal and other minerals began. During the XX and XXI centuries, the extraction of hydrocarbons from the shelf became an important issue.

Travel and business in the Arctic have always been associated with some risk that should ideally be minimised. Sailors, before departing on trips, asked about the dangers they may see along the way. Norwegian fishermen, the Pomors and indigenous population of Siberia gathered and passed knowledge down through generations. Opportunities to find and obtain this information have grown, and the information itself has become more comprehensive and multifaceted as science and publishing have developed. The volume of printed material on the navigation in the Arctic now amounts to several hundred thousand tonnes. Information has also become more accessible with the development of the Internet. However, the choice of methods of collection, compilation, classification, reporting and receiving of this information has always been very important. Great attention has been paid to the problems associated with sea ice caused by the present development of the Arctic. Sea ice can significantly affect transportation, mining, and the construction and operation of platforms and handling terminals.

Dangerous ice conditions and ship accidents in the Arctic have been investigated in the frame of the project "PetroArctic", led by Norwegian University of Science and Technology (NTNU) in 2007 - 2010. The "PetroArctic" project was funded by the Research Council of Norway and was dedicated to the extraction and transport of hydrocarbons in the Arctic. Along with other tasks, the project faced the problem of documenting the experience of sailors who dealt with heavy ice conditions and either overcame them or failed to do so (resulting in shipwreck, vessel damage, or forced overwintering). The project was performed by Norwegian shipbuilder Johannes Bjarne Alme and the author. The purpose of this study was to systematize the knowledge of ice conditions and of human behaviour in extreme situations to ensure the safety of transport and other operations in the Arctic for sustainable development and proper use of natural resources. The information collected as a result of this work summarises the marine incidents and experiences of seafarers. It combines geographical, historical, technological, and psychological data. This compilation has been guided by the need to understand how people operate in the Arctic to solve complex problems while dealing with extreme conditions. Detailed descriptions of accidents can not only provide us with examples of heroic behaviour by seafarers but also provide information on the natural features of the seas, weather and ice conditions in the Arctic Ocean, and special techniques used by the ships' crews to save their ships.

My colleague on the project, Johannes Alme, studied the experiences of Norwegian sailors, and the result of his work was the book, "The experience of the polar sailors"("Ishavfolk si erfaring" in Norwegian) (Alme, 2009). His book describes the people and ships that scoured the Norwegian and North Seas in search of whales and seals. My investigation was devoted to the Eastern sector of the Arctic, with a description of the Russian Arctic seas and accidents caused by heavy ice conditions. The main point is the description of incidents starting in 1900, there the only those events are considered that were recorded in the XX and XXI centuries, and unveiled in public sources of information, such as books, scientific articles, and reports. The area under consideration, structure and main principle will be shown in this article further as well as some example and analysis. The intermediate issues had been reported on previous POAC-09 conference (Marchenko, 2009a) and on International Navigational symposium (Marchenko, 2009b).The book "Russian Arctic seas. Navigation conditions and accidents" will be as final outcome.

INVESTIGATION AREA AND THE STRUCTURE OF STUDY

Four seas, the Kara, Laptev, East Siberian and Chukchi Seas, where sea ice is consistently observed and is very dangerous for ships, were reviewed from a navigation point of view. The Barents Sea, which is strongly influenced and warmed by the North Atlantic Current, has a natural environment that is dramatically different from those of the other Arctic seas; therefore, it was not included in the consideration. Sea ice in the Barents Sea is usually located far from major transport routes and does not impede navigation. Only a few incidents involving ice are known, and they have been mainly caused by icing. One of the episodes - the deaths of three trawlers who went missing in 1931 during fishing - most likely happened because of icing. The vessels had short freeboards and high bulwarks, and the nets were usually placed along them. If the twines and nets froze, the deck water could not drain overboard. It has been suggested that flooding of the deck by waves caused the vessel to capsize (Peskov, 1936). In the eastern part of Arctic, icing is rare because of the ice cover. In the fall of 1949, a large icebreaker in the Kara Sea underwent strong icing during which a few hundred tonnes of ice accumulated in the forward part of the ship. However, the potential accident was prevented by the in-time entrance to the floating ice, that stopped cold water dropping (Aksyutin, 1979).

The main focus of the presented study is ship accidents with the sea ice. But to provide background for the heroic and sometimes tragic events that unfolded, we offer an overview of the natural conditions of the four Arctic seas. This information is necessary because a detailed natural-scientific "portrait" of the seas was last done in 1982 in the book by A. Dobrovolsky and B. Zalogin, "Seas of the USSR" (Dobrovolsky,1982). In 1995, the "Guidelines for through navigation of ships along the Northern Sea Route" (Guide, 1995) was published. It contained information on navigation performance in the seas and described the recommended sailing routes. Since this time, several studies have considered the seas and their ice conditions. These materials have been summarised and are presented as well. So two key parts of the description of the seas are a description of the sea and descriptions of accidents that occurred there. The first part describes the traditional physical-geographical characteristics of the sea (its borders and underwater topography, climate and water dynamics, hydrological features and sea ice) and presents information about the navigation conditions and the main sea routes. The most original part here is the map of ice condition. Figure 1 shows the example of such map for East Siberian Sea. This map combines the date about ice massifs (USIMO, Dobrovolsky, 1982), stamukhas (Gorbunov, 2007) and traditional line of minimal ice spreading. Map for Kara and Chukchi seas include also data on ice river (Kupetsky, 1983, 2007, Benzeman, 1989)

In the second part, accidents caused by heavy ice conditions that have occurred since 1900 are described in chronological order. Preceding the descriptions of these events, a map is provided that shows the locations of events and the drift lines using conventional signs that are in accordance with the accepted classification (Figure 2). The numbers on the map match the numbers in the table which also serve as a legend for the map. The date of the accident, the name of the vessel involved and the type of accident are listed for each event in the table (Table 1). It is easy to find a detailed description of the event by finding the number in the text that corresponds to the table. This number is highlighted in bold print and precedes the story about the event.

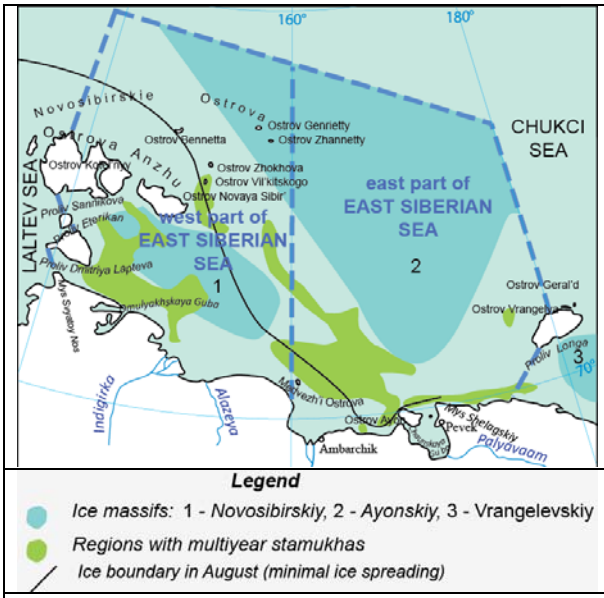

Figure 1. Sea Ice Condition in the East Siberian sea. Example of the map

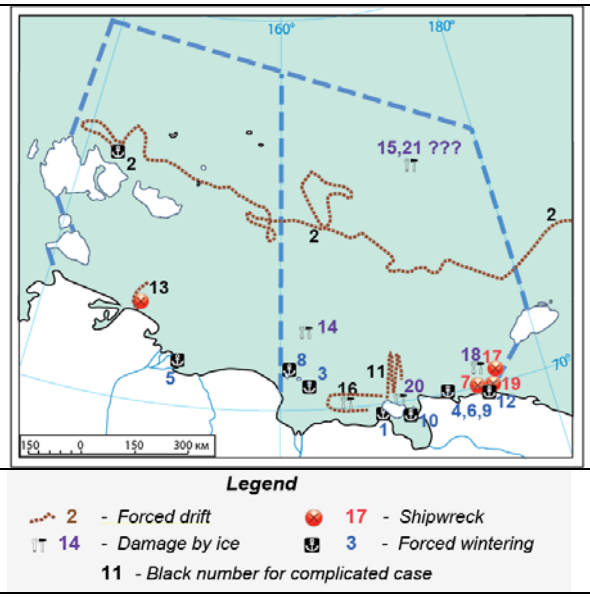

Figure 2. Accidents in the East Siberian sea. Example of the map

Table 1. Ship Accidents in the East Siberian sea since 1900

№	ACCIDENTS	№	ACCIDENTS
1	1919—1920. *Maud.* Overwintering	11	1932—33. *Uritsky.* Overwintering, Drift
2	1923—1924. *Maud.* Drift, Overwintering	12	1932—33. 1933—34. 3 vessels Overwintering
3	1924—1925. *Maud.* Overwintering	13	1933. *Revolyutsionny* and several barges. Drift, Shipwreck
4	1924—1925. *Stavropol.* Overwintering	14	1933. *Chelyuskin.* Damage
5	1927-1928. *Pioner.* Overwintering	15	1936. *Smolensk.* Damage
6	1928-1929. *Kolyma.* Overwintering	16	1938 -1939. *Ost.* Drift, Damage
7	1929. *Elisif* . Shipwreck	17	1947. *Mossovet.* Shipwreck
8	1929—1930. *Pioner.* Overwintering	18	1955. *Kamenets-Podol'sk.* Damage
9	1931—1932. *Kolyma and Leytenant Shmidt.* Overwintering	19	1965. *Vitimles.* Shipwreck
10	1932—33. 6 cargo ships (*Anadyr, Sever. Suchan, Mikoyan, Krasny Partizan, Uritsky*), *Litke* and schooner *Temp.* Overwintering	20	1965. *Admiral Lazarev.* Damage
		21	1978. *Kapitan Myshevsky.* Damage

ACCIDENT CLASSIFICATION

Quite naturally, it was necessary to classify accidents to create such maps (Figure 2). Among the accidents induced by ice, we found the following types: forced drift, forced overwintering, shipwreck and serious damage to the hull in which the crew, sometimes with the help of other crews, could still save the ship. It should be noted that the allocation of these four groups is very

conventional. For example, a forced drift or forced overwintering can be fatal. Sometimes, overwinterings were accompanied by drift. The most eloquent example of the difficulties of classification is the drift of the caravan with the icebreaker *Lenin* in the Laptev Sea. In October 1937, the icebreaker *Lenin*, along with five other vessels, after unsuccessful attempts to break through heavy ice, was set to overwintering in the strait between the Begichev Islands and the mainland.

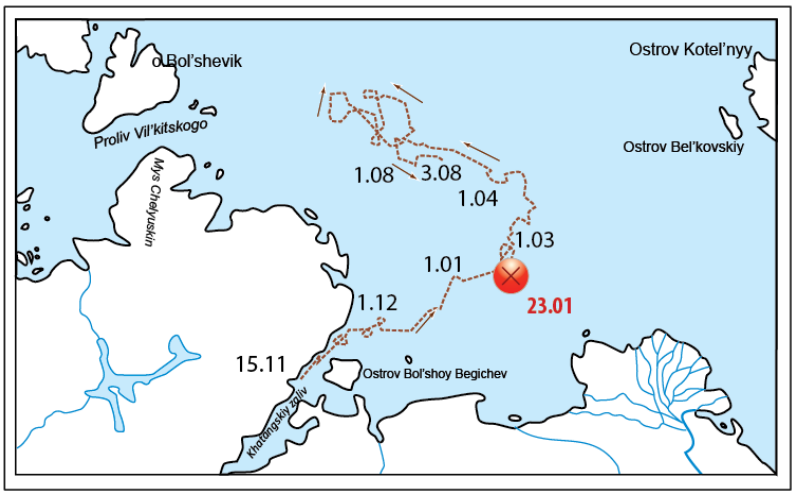

Figure 3. The line of the drift of the *Lenin's* convoy and the place where *Rabochy* sunk in 1938. Create on the base of the map (Belov,1959, p.285), see also (Barr, 1980)

However, in mid-November, the ice field in the overwintering location was broken by the south-west gale hack, and the vessels were brought into the open sea, where they drifted until the summer of 1938. One vessel, the timber carrier *Rabochy,* was crushed by ice and compression hummocking and sank on January 23, 1938 (Figure 3). The other ships were damaged. This event involved all four types of accidents. Despite there being no ambiguity, it is convenient to map and examine marine accidents by highlighting the leading factor. This convention was applied in this case. Lines of drifts are sketchy on the main map because drawing all of the twists and chaotic movements of the ice at a small scale is very difficult. If there is enough information, the drifts are presented in detail on separate large-scale maps. Such information can be very helpful, and its careful consideration has often led to geographical discoveries (for example, Vize Island in the Kara Sea). Particular attention is paid to cases of ice drift falling into the "ice jet." Such cases are shown on the maps by special characters. An "ice jet" is a drift with considerable speed (up to 1-2 nautical miles per hour) against which the icebreakers are powerless. More than once, an "ice jet" has led to the loss of ships. This phenomenon is little known in the English-language literature but is often the most dangerous.

A few words should be said about the completeness of the information in the realized investigation. Numerous books and scholarly articles, including documentaries and feature films, have been devoted to some relevant incidents, such as the tragic drift of the schooner *Svyataya Anna* or the heroic "*Chelyuskin* epic". Almost nothing was known about the other accidents, and information had to be accumulated slowly by gradually reconstructing the course of events.

Unfortunately, it was not possible to find information about the losses of 2 ships: *Kazakhstan* in 1949 and *Sevan* in 1956. These events are marked with question marks on the map. Perhaps, it was not entirely correct to provide such kind of compilation, in which there are written pages, maps, diagrams, photos for some of the events and only a shot summary for others. This decision does not satisfy the criterion of uniformity. The information that was collected was extremely heterogeneous at times. However, to unify these data would mean losing a lot of valuable information and would dilute the essence of the work.
There are 94 accidents under consideration. Most of them are drifts and overwinterings (see Table 2). 19 shipwrecks are described (see Figure 4). The majority of incidents occurred along the line of the Northern Sea Route. Most of the accidents occurred when the ships were not well equipped to deal with the severe ice encountered during navigation. Mostly, damaged vessels had been in operation for a long time in the Arctic: *Nina Sagaydak* for 12 years, and *Kolya Myagotin* for 13 years. The exception is the destruction of the timber-carrying vessel *Vitimles* (1965), which sunk in its first voyage. The authoritative commission investigating this case decided that the case in point with motor ship *Vitimles* is classified as the shipwreck caused by action of force majeure at sailing in ice (Smirnov,1993).

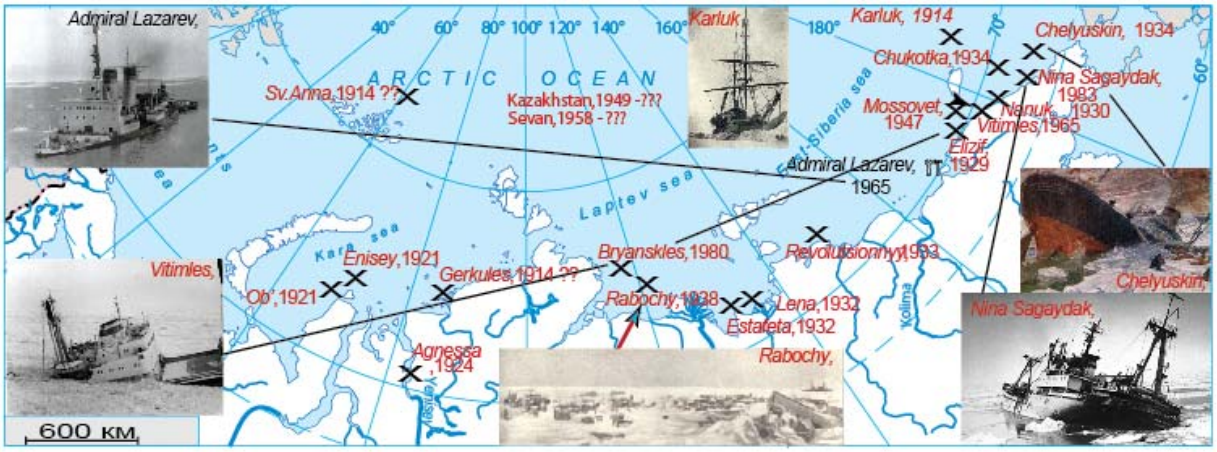

Figure 4. Shipwrecks in the Russian Arctic

On Figure 4 the places of shipwrecks are shown as black cross and the names of the ships and the year of events are written in red near by. The pictures are shown for some accidents. There is also one example of ice damage, when the crew maneged to rescue the vessel. It is the accident with icebreaker *Admiral Lazarev* (1965) and it is swown by special sign and written in black.

Table 2. The amount of ship accidents of different types in the Russian Arctic

Accident types	Kara Sea	Laptev Sea	East Siberian Sea	Chukchi Sea	Total
Shipwreck	6	2	4	7	19
Drift	12	7	3	7	29
Wintering	8	6	9	8	31
Damage	4	2	5	4	15
TOTAL	30	17	21	26	**94**

The Kara Sea had the largest number of accidents, partly due to the relatively high intensity of navigation and not because it sustained the worst ice conditions compared to other seas. The Laptev Sea and the East Siberian Sea differ by a small number (17 and 21, respectively, compared to 29 and 26 in the Kara Sea and the Chukchi Sea, respectively). This pattern can be explained by the reduced amount of navigation in these areas rather than by the sea ice conditions.

Here is the short summary for all the seas about the accidents that were caused by severe ice conditions after 1900.

The Kara Sea. 30 accidents have been investigated in the Kara Sea. There were 6 shipwrecks among these accidents. The details of 3 loss (the *Mechta* in 1900 and the *Gerkules* and *Svyataya Anna* in 1913-14) and the exact dates and places are unknown. The ships disappeared, and one can speculate on their fate only using certain findings. Before disappearing, the *Mechta* and *Svyataya Anna* were involved in ice drift. Two shipwrecks occurred, one after another, during the First Kara Barter Expedition in 1921 (*Ob* and *Yenisey*). The schooner *Agnessa* was crushed by ice during spring ice break-up in 1924 in the lower reaches of the Yenisey River.
Six times, ships were forced to stay away from their ports for the winter. 12 cases of forced vessel drift are described in the book, two of which ended in shipwreck, and five that were identified as being caused by ice jets.
The most difficult years to navigate were 1935 and 1937.

The Laptev Sea. 17 incidents have been caused by heavy ice conditions in the Laptev Sea. Among them, there were 2 shipwrecks: the timber-carrying vessel *Rabochy* in 1938, and the steamship *Bryanskles* in 1980. The timber-carrying vessel *Rabochy was* crushed by compressing ice and hummocking while drifting in the ice field. *Bryanskles* was hit by ice floes while following the icebreaker in the channel. In total, ships remained for overwintering 9 times. Six overwinterings occurred in closed bays, and 3 overwinterings took place in drifting ice accompanied by hummocking, compression and damage to the ships. One overwintering lasted for 2 years — *Yakutiya* in 1943-1945. The icebreaker *Sedov* drifted for 812 days.
The most difficult years for navigation were 1935 and 1937.
Overwinterings in 1901, 1934 and 1943 revealed the danger to vessels of overwintering in the closed bays, which retain ice for longer periods. Therefore, there is often no possibility for the ships to release independently without the help of icebreakers in the spring. On the other hand, the overwintering of a convoy of the icebreaker *Lenin* (1937—1938) in open passage resulted in a situation where the ice field was torn off and the ships were taken out and drifted in the high sea, with one ship lost.

The East Siberian Sea. Among 21 accidents in the East Siberian Sea, there are 4 shipwrecks: *Elizif* in 1929; *Revolyutsionny* and some barges in 1933; *Mossovet* in 1947; and *Vitimles* in 1965. The steamship *Revolyutsionny* and all barges of the caravan sunk in a gale when the stamukha they had moored to washed away. Vessels began to drift and were thrown out to a shallow. Almost nothing is known about the shipwreck of *Mossovet*. Information about the shipwreck of the vessel *Elizif* is inconsistent. *Vitimles* sustained heavy damage to the hull as a result of powerful hummocking and drifts of ice («the ice jet»). The ship started to leak and finally sunk.

The icebreakers *Moskva* and *Leningrad,* which were nearby, lost their speed at once in «the ice jet» and could do nothing except evacuate the crew of *Vitimles*.

The ships overwintered 10 times away from their home ports. All of these overwinterings passed rather easily, unlike the overwinterings in the Laptev Sea. The most dramatic event was the overwintering of the caravan of vessels of the Northern East Expedition in 1932-33. Some of the vessels had to spend the following year in the Arctic. Many vessels sustained damage; however, there were no human victims thanks to the carefully coordinated actions of the crews. The ship *Uritsky* was sometimes exposed to intensive compression during its drift in the winter of 1932-33, but its hull sustained the stresses. The other drift during overwintering of the Norwegian vessel *Maud* was actually planned. However, this drift did not pass on an expected trajectory as planned by the researchers, led by R. Amundsen and H. Sverdrup. Failure to drift over the North Pole showed that ice drift in the Arctic was not well understood.
Two cases are especially remarkable in that the sinking ships (icebreaker *Admiral Lazarev* and transport vessel *Kamenetsk-Podolsk)* were rescued thanks to the self-sacrificing and coordinated actions of the crews and the skill of the captains and seamen. However, these cases are also remarkable because both of them occurred when ice conditions seemed rather quiet and trouble was not predicted. This once again indicates that navigation in the Arctic seas is unpredictable and demands special attention, skill and constant use of the newest tools and experience collected over the years.

The Chukchi Sea. We examined 26 accidents in the Chukchi Sea. Among them were 9 drifts in the ice fields, 8 overwinterings and 7 shipwrecks and 2 cases of serious damages, not account the events of 1983 year, when more than 30 vessels had been hurt.
4 vessels have been crushed by ice, as a result of compression (1919. *Belvedere,* 1922. *Eagle,* 1930. *Nanu,*. 1931 *Chukotka).* 2 vessels drifted with the ice before the crushing during quite a long time – these are the famous *Karluk* (1914) and *Chelyuskin* (1933-34). *Nina Sagaydak* had been involved into “ice jet”
The overwintering occurred quite often during the initial period of Northern Sea Route mastering. There were 8 overwinterings over 20 navigation seasons between 1914-1934, or 40% of years. Navigation in 1983 in the eastern sector of the Arctic is a vivid example of how necessary it is to have powerful icebreakers for mastering the Arctic Ocean when more than 30 ships suffered and one lost.

AFTER 1990
There were quite a few events in Russian Arctic after 1990. Because ice navigation practically ceased except for the Murmansk-Dudinka route. Information about the current state of affairs in the Russian Arctic is extremely scarce. And unfortunately, this is still basically a statement of the plight. Many polar stations and observatories have been closed, Arctic hydrometeorological control was on the verge of elimination, and the navigation system for ice reconnaissance has ceased to exist. The division of emergency services, supply depots and maintenance of the fleet in the Northern Sea Route, located in the settlements of Dikson, Tiksi, and Pevek, have been completely eliminated. Leaders of shipping companies, maritime operations headquarters, heads of research institutes and experts have all discussed this change. Not happy "Reflections on the fate of the Arctic Shipping" (so called the last chapter) are presented in the book published in 2010 by the famous ice captain, G. Burkov, who is chairman of the association of polar

researchers (Burkov, 2010). The Northern Sea Route legislation is stalled. The "Rules of sailing along the Northern Sea Route", which was accepted in 1990, is still in use. A draft law on the Northern Sea Route that has been contributed to the State Duma (parliament) has not been adopted.

The problems of training captains for ice navigation are acute. The art of ice navigation requires careful preparation and clear organization of service, high discipline, and the ability to quickly orient and make decisions in a constantly changing environment. The likelihood of an ice accident depends largely on the experiences of the captain and chief officers on the vessel.

However, several events in 2010 suggested that this year would be a turning point in the development of the Russian Arctic. Three important achievements have increased hope that Russia will again sail ships along the Arctic coast. Each of these achievements happened for the first time in history. The hope comes from three unique escorts along the Northern Sea Route: the large-capacity tanker *Baltika* (capacity of 100 thousand tonnes and a width of 44 metres) in August, the cruise ferry *Georg Ots* in October and the Swedish icebreaker tug *Tor Viking* in December 2010. The nuclear icebreakers *Taymyr, Rossia,* and *50 Let Pobedy* helped the vessels at various stages of the way. It is interesting to note that radar satellite images supplied by the "Scanex" company have been used to assess the ice conditions along the routes of vessels to help choose the optimal path (Http://www.scanex.ru/ru/index.html).

In September 2010, Moscow hosted an international forum, "The Arctic - the territory of dialogue", in which issues were discussed at the highest political level. In late 2010, government statements were made about the need to recreate the Administration of the Northern Sea Route and the fact that the law of the Northern Sea Route could be adopted in 2011. Economists predict an increase in traffic to 30 million tonnes per year. It is expected that by 2020, three universal atomic icebreakers will be built. They will have a variable draft and a power of 60 megawatts. Five diesel-powered icebreakers with linear power of 25 megawatts will also be used. Scientists and engineers have also discussed a project using a nuclear-powered icebreaker, which could lead with 110-130 megawatts of capacity for effective year-round operation in any ice conditions and in any area of the Arctic. In addition, by 2020, a supply of about 60 ships is expected at the expense of extracting companies.

CONCLUSIONS AND FUTURE INVESTIGATIONS

The Northern Sea Route is reborn. Many books and articles will be written about the process. Meanwhile, the main task of presented work— to gather and organise as much information as possible about navigating in ice, along with the tragic and heroic episodes of the sailors, under the best and worst circumstances — has been completed and seems to be very relevant.
In the book "Russian Arctic Sea. Navigation condition and accidents", the reader will not find a "database" but rather a collection of information and memories. A scientific approach takes the features of the book, where reminiscences are correlated the geographic and historical data with existing ideas about the weather and ice conditions that affect the dynamics of sea ice and the trends in shipbuilding. The collection that has been created will be expanded and improved; however, it can still be used to analyse the ice conditions and the suitability of different types of vessels and human behaviour in extreme situations.

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