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Ice conditions affecting passage of Polish vessels convoy though the NSR in 1956. Long-term ice forecasts and passage strategies

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ABSTRACT: The goal of the study was to examine ice cover conditions that accompanied the passage of convoy of seven Polish vessels from Europe to the Far East in year 1956, which initiated an international commercial shipping transit. Several different sources of information on the state of ice cover in the Arctic were used in this study. Ice conditions (decisive for ability of a merchant vessel or icebreaker to cross the route) during the following navigational seasons in most of the NSR areas showed extremely divergent results - from the most favorable to the most difficult and vice versa.
Existing in years 1940-1957 ice cover conditions and shipbuilding technologies did not guarantee a successful transit passage in one navigation season. The Soviet Union used icebreakers that were not able to lead vessels in heavy ice conditions that occurred in 1950s. The NSR Administration used passive strategy – waiting for improvement of ice conditions - instead of forcing heavy ice. Passive strategy of navigation through the NSR included wintering and continuation of passage next year when ice conditions improved. Annual variability of ice conditions approximated by third degree polynomial line showed trends well. However, the high annual anomalies of ice conditions in relation to trend line did not allow for effective forecasts on particular sections of the NSR in next navigation season.

1 INTRODUCTION

Shipping routes along the Russian Arctic coast were recognized gradually during the movement of the local population inhabiting the coast of the Arctic Sea. They were completed when S.I. Dezhnev discovered possibility of voyages from Europe to the Far East in the year 1648 (Starkov 2001). In the years 1691-1692 was developed first map of the Arctic Ocean crossing from west to east. The first known case of the passage of the Northern Sea Route (NSR) concerns the vessel "Vega" headed by Nils Nordenskjöld from west to east (Northern Sea Route: history of development, http://www.ikz.ru/si-berianway/engl/sevmorput.html, accessed 28.02. 2014). The vessel commenced its voyage in 1878, wintered in the Arctic and reached its destination in 1879. In 1932, the Soviet icebreaker "Sibiryakow" went the NSR for the first time over the course of a single navigation season (Starkov 2001). Most of vessel' voyages on the NSR, however, involved local traffic, between external ports and ports on the NSR (Armstrong 1952). Under a special agreement between Germany and the Soviet Union in 1940 an auxiliary cruiser "Komet" passed the NSR from West to east with assistance of icebreakers. The transit voyage was completed successfully in one navigation season. It was first commercial transit passage through the NSR by a vessel other than the Soviet flag. During the Second World War military transports took place mostly from the United States to the port of Tiksi and the Gulf of Providienya; the least

to the port of Arkhangelsk. Another attempt to use of the NSR as an international transit route was the voyage of convoy of seven Polish vessels from Poland to China in 1956. The destination was not reached that time. Due to unfavorable ice conditions, it was not possible to continue voyage in one navigation season. The deputy minister of the Soviet merchant fleet tried to persuade the convoy leadership to winter and continue passage in next navigation season. However, the convoy turned and successfully returned to Poland.

2 PURPOSE OF THE WORK AND RESEARCH HYPOTHESES

The aim of the study is to examine the conditions of the ice cover that accompanied the passage of the convoy of seven Polish vessels from Europe to the Far East, which initiated an international commercial shipping transit. Next is to determine whether the knowledge of the conditions of ice dating from 1940-1956 at that time could be expected that NSR would become the route of intensive transit traffic between European ports and ports of the Far East.

The following partial research hypotheses are intended:

- It was it possible to reach the destination by a convoy of L3 ice class merchant vessels under the assistance of Soviet icebreakers in 1956.
- Was it possible to predict (forecast) failure of the implemented voyage.
- Could the purpose of the voyage be achieved at the existing that time knowledge of shipbuilding?
- Whether inducing the convoy leadership to winter and continue the voyage in the next navigation season had substantively justified grounds.

3 NARRATIVE DESCRIPTION OF EVENTS ACCOMPANYING POLISH VESSELS' VOYAGE ON THE NSR

In 1956, the Polish Ocean Lines undertook a convoy of seven Polish vessels built for China by the NSR (Falba 2011, Adamczyk et al. 2012, Gogol and Huras 2014). These were vessels named: "Łódź", "Radom", "Kalisz", "Reda", "Rumia", "Sopot" and "Wejherowo". The first three were steamers that had a load capacity of about 5.500 DWT each and four more were motorships of about 900 DWT. The steamers were built in Gdansk's Shipyard and the steamers in Gdynia Shipyard. In July 1956 vessels were loaded in Gdańsk and Gdynia. On 19 July, the convoy reached Murmansk. On July 24, 1956, the convoy left Murmansk and on the high seas joined the Soviet icebreaker "Sibiryakov". The icebreaker sailed in front of the convoy breaking ice. Behind it sailed rest of the vessels in the track. Without special disturbances, the convoy reached the Yenisei River. On July 30, the convoy anchored at southern shore of the Rastorguyev (Kolchak) Island. Vessels waited one month for suitable ice conditions to go through the Vilkitsky Strait. Three steamers supplemented the fuel supply within three days at the nearby port of Dikson. On 31 August, the convoy continued its voyage. Without problems the convoy passed through the Vilkitsky Strait. The following soviet icebreakers paved the way among the ice" „Captain Voronin", „Captain Belousov" and „Yermak". The ice was getting thicker. Near the island of Ayon and polar base Pevek convoy was stuck in ice. Statements of mariners showed that winds of hurricane force encountered. Based on simulation of ice conditions (ESIMO, http://www.aari.ru/-resources/0011_12/manual_op/infoice/szatie/vsb_ea-st/info.html, acessed 03.03.2014). It can be assumed that compacting of ice in the passage area reached value of more than 1.5 degrees. Hydro-meteorological conditions, such as ice concentration, ice thickness, compacting and ice drift, did not allow to continue voyage. With the help of icebreakers "Captain Belousov" and "Molotov" Polish vessels reached anchorage at the road of Pevek. Reconnaissance from the air and from the water shown inability to continue the voyage in near future. In place of the deputy minister arrived in the Soviet merchant fleet and tried to convince the Polish command of the convoy to wintering and continue voyage in next year navigational season. Considering wintering of vessels until the next navigational season, the convoy commander decided to return without reaching a destination (China). The return voyage was not difficult, despite fact that in the Vilkitsky Strait area vessels often got stuck in ice. The convoy was assisted by icebreaker "Yermak" . Even before reaching the Murmansk convoy was solved on 30 September 1956. Polish vessels returned to Poland individually in the first days of October. The inspection of the vessels' hulls showed only minor damage. Subsequently, all seven vessels took over Soviet crews in Kaliningrad. Then they were brought to China around Cape of Good Hope.

4 ANALYSIS OF ICE CONDITIONS ON THE CONVOY ROUTE ON THE NSR

In order to investigate the relationship between ice cover condition and schedule of conducted convoy of Polish vessels, the relative areas of the Arctic seas and their regions were analyzed for average of 10 days (decades) between 1935 and 2011 (ESIMO, Ice extent surface of the Arctic seas and their regions, http://www.-aari.ru/odata/_d0005.php?mod=0, accessed 04.11. 2014). The results are shown in graphs on Figure 1. Time points with linking lines (in black) were drawn on graph to illustrate change in relative ice coverage. It is noticeable in the northeastern part of the Kara Sea and in the eastern part of the East Siberian Sea much higher ice coverage than in other seas. From the graph, it can be concluded that the NSR Administration planned to continue voyage after ice cover of the northeastern part of the Kara Sea will be reduced from about 88% to about 52%. Merchant vessels without special adaptation of propulsion system to ice conditions were unable to overcome ice conditions in eastern part of the East Siberian Sea covered with ice at 86%. Doubts arise regarding help of icebreakers in connection with the quote, "Finally, the convoy was stuck in ice near Ayon Island, near the Pevek polar base. Help for icebreakers was needed " and a quote "After a few hours came two icebreakers" suggesting that the convoy had not been

assisted on a regular basis by icebreakers. It should be inferred that the icebreakers came when the convoy was already stuck in ice. Icebreakers "Molotov" and "Captain Voronin" provided support for move vessels out of ice. It cannot be ruled out that the lack of continuous support of icebreakers caused decision not to continue voyage and to return to Europe the same route. After the return of the convoy of Polish merchant vessels, ice conditions of the northeastern part of the Kara Sea was covered at about 52%, the eastern part of the East Siberian Sea at 37%, the eastern part of the Laptev Sea at 28%, the western part of the Laptev Sea at 45% and the northeastern part of the Kara Sea was 56%. Analysis indicates that 60-90% ice concentration in the northeastern part of the Kara Sea has prevented the passage of the convoy. The convoy continued its voyage, when was opportunity to bypass ice floes fields of concentration of 50% and higher. On the other hand, convoy of vessels was using icebreakers to pass ice fields with ice concentration of 20%. Ice conditions which prevent continuation of voyage was concentration of ice float of 90% occurring in the eastern part of East Siberian Sea.

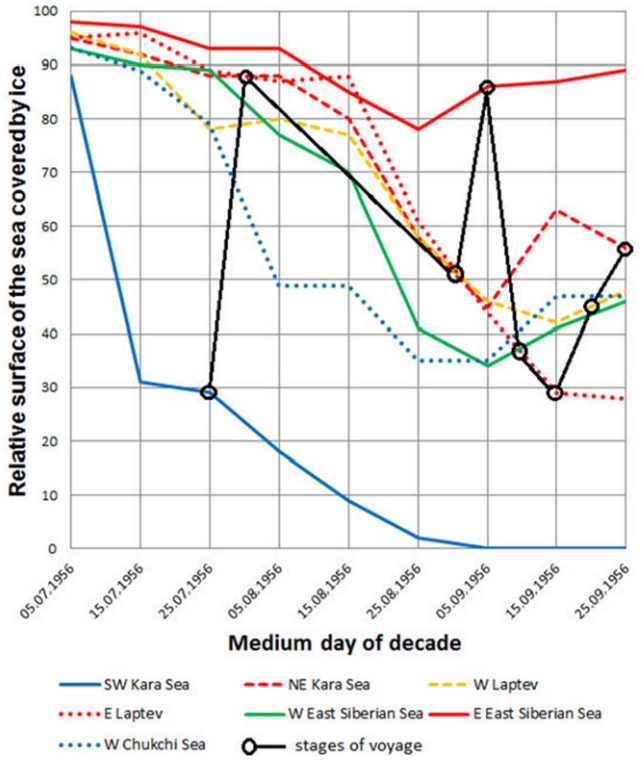

Figure 1. Relative sea ice surface on the NSR during the 1956' navigational season during voyage of Polish vessels convoy; Black circles and lines – time points on the route and linking line (made by the author based and Falba 2011 and ESIMO, , Ice extent surface of the Arctic seas and their regions, http://www.aari.ru/odata/ _d0001.php?mod=1 &lang=1&sea=0, accessed 03.03.2014)

In order to reconstruct the state of ice cover accompanying passage of the convoy of Polish vessels, the positions and route lines of the convoy were mapped onto ice maps of the Arctic for periods of 5-15 days available for the years 1950-1998 at grid resolution of 15' longitude and 15' latitude (ESIMO, Total ice concentration, http://www.aari.ru/ odata/_d0001.php? mod=1&lang=1&sea=0, accessed 04.11.2014). The next stages of voyage were presented on subsequent ice maps at intervals of 10 days. (Figure 2).

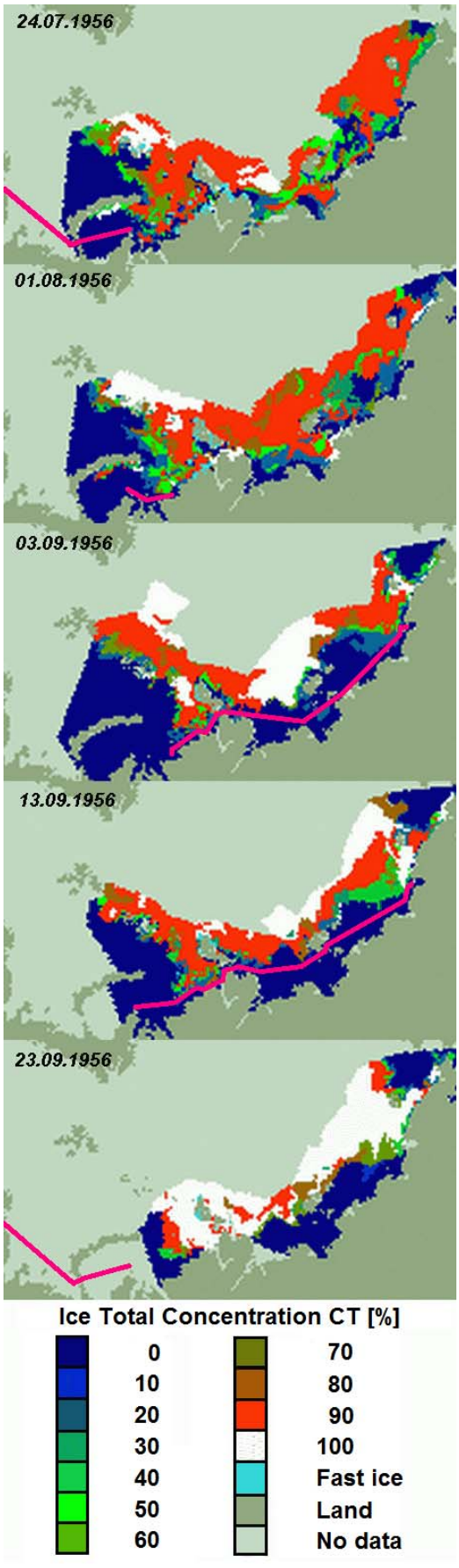

Figure 2. Ice conditions occurring on the Polish vessels convoy route in 1956. Made by author based on ESIMO, Total ice concentration, http://www.aari.ru/odata/ _d0001.php?mod=1&lang=1&sea=0 (accessed 03.03.2014) and Falba (2011); pink line – route of convoy.

5 LONG-TERM FORECASTING OF ICE CONDITIONS FOR TRANSIT PASSAGE VOYAGES

The transit of the German ship "Komet" in 1940 ended successfully. In order to clarify whether, based on known ice conditions from 15 years preceding planned trip, it was possible to predict failure of transit of seven Polish vessels in 1956 the lightest ice conditions occurring in seas covering the NSR between 1940 and 1955 was made. To this end, maps of ice navigation conditions were reviewed for averaged periods of 30 days. They are available for years 1940 – 2005 (ESIMO, Severity of ice conditions, http://www.aari.ru/odata/_d0012.php?mod=1, accessed 03.03.2014). Annual changes in ice conditions during the navigation season were very high. Sometimes they changed from the lightest to the heaviest. The greatest annual volatility was characterized by western part of the Laptev Sea, the southwestern part of the Kara sea, the eastern part of the Laptev Sea and eastern part of the East Siberian Sea. (Figures 1 and 2). In order to detect long-term trends, annual changes were approximated by polynomial line of the third degree. The approximation results shown different trends in western part of the NSR (Figure 3) and in eastern part of the NSR (Figure 4). The hardest conditions of ice navigation in western part of the NSR occurred in recent years preceding the failed voyage in the Laptev Sea in 1950 and shown a constant tendency to improve ice conditions (Figure 1). In the northern part of the Kara Sea, there were favorable conditions for navigation through the whole period of time. The lightest conditions of ice navigation in the eastern part of NSR occurred in the last years preceding the unsuccessful voyage in the Eastern Siberian Sea and the southern part of the Chukchi Sea at the Wrangel Island between 1950 and 1951, and then there was a tendency of rapid deterioration of severity of ice conditions up to 3.0-3.5 on a scale from 1 (good) to 5 (bad) in the year preceding planned trip. From the above graphs one should therefore expect a very difficult and challenging conditions at the Wrangel Island during navigation season 1956' in which planned to pass a convoy of Polish vessels by the NSR. It should be noted that successful transit of German ship "Komet" in 1940 was generally accompanied by extremely light ice navigation conditions (CIA 1959). Only in western part of the Laptev Sea and in eastern part of East Siberian Sea occurred an average ice conditions that time.

Cyclical periodicity was observed on all graphs of long-term changes of ice conditions for third-degree polynomial lines (Figures 3 and 4). The western part of all the NSR seas was characterized by a cyclical of 7.5 years and an eastern part of all the NSR seas of 10.7 years. The study included only one cycle change.

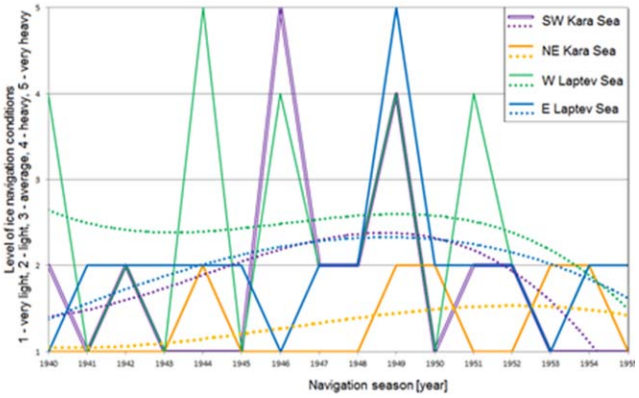

Figure 3. The lightest ice conditions on western seas of the NSR. Made by author based on Severity of ice conditions, Made by author based on ESIMO, Severity of ice conditions http://www.aari.ru/odata/_d0012.php?mod=1, accessed 03.03. 2014.

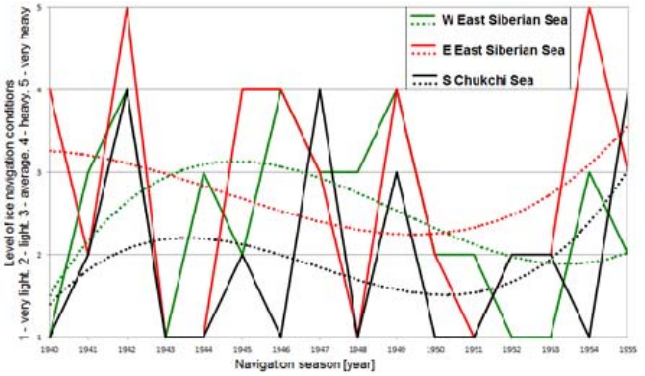

Figure 4. The lightest ice conditions on eastern seas of the NSR. Made by author based on ESIMO, Severity of ice conditions, http://www.aari.ru/odata/_d0012.php?mod=1, accessed 03.03. 2014.

6 TECHNICAL LIMITATIONS OF ICEBREAKERS NECESSARY TO CONDUCT CONVOY THROUGH ICE

Environmental conditions of each section of voyage and technical parameters of icebreakers being in use were presented in Table 1. It was assumed that icebreakers met the needs of expected conditions on the NSR. So the 6,200 horsepower icebreaker "Sibiryakov" and the 10,000 horsepower icebreakers "Yermak" and "Molotov" were able to pave the way with an ice concentration of 20%. Icebreakers drive power 12,000 HP not beat the ice cover with a concentration of over 50% or over ice with a thickness of 2.5 m or ice compactness over than 1.5 degree. In order to check whether the icebreakers assisting convoy of Polish vessels were able to overcome the 2.5 meter ice cover and the 50% concentration, technical speed of icebreakers being in use that time was presented on Figure 5 (Arikaynen 1990). Maximum thickness of ice included in the graph does not exceed 1.8 meters. This is much less than the identified ice conditions (>2.5 meters). It should be assumed that icebreakers used in that time were not able to overcome such heavy ice conditions.

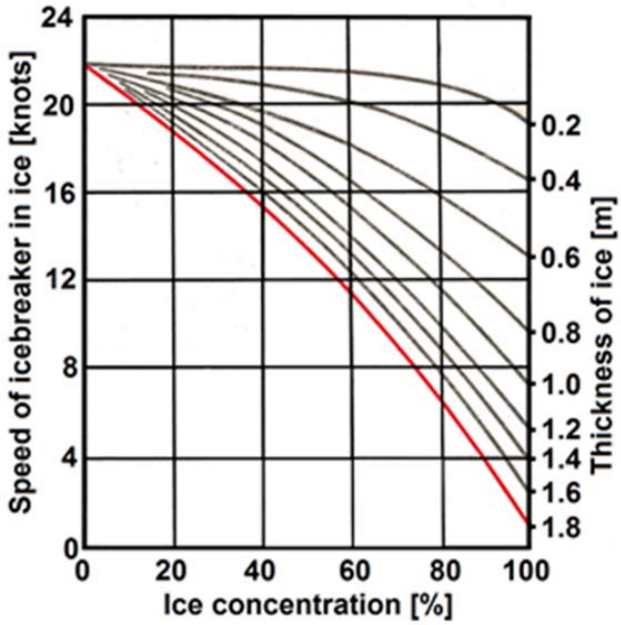

Figure 5. Technical ice speed of icebreakers depending on concentration and thickness of ice. Made by author according to Arikaynen (1990).

Only few data sources were in vicinity of vessel's route. Most of them were out of sight. However the characteristic shapes of the edge of all sources were analysed. Searched correlations.

Table 1. Parameters of icebreakers supporting the convoy of Polish vessels against ice conditions (Falba 2011; Icebreaker Captain Belousov, http://www.polarpost.ru/forum/viewtopic.php?f=4&t=795, acessed 03.03.2014; Icebreaker Captain Voronin, http://www.polarpost.ru/forum/viewtopic.php?f=4&t= 3635, accessed 03.03.2014; Icebreaker Sibiryakov, http://www.polarpost.ru/forum/download/file.php?id=3561&mode=view, accessed 03.03.2014; Icebreaker Yermak, http://tsushima.su/RU/shipsru/shipsrussiaru/shipsrussiabronru/shipsrussiabronsudaru/ledokol-ermak, accessed 03.03.2014; Icebreaker Molotov, http://www.polarpost.ru/forum/view topic.php?f=4&t=628, accessed 03.03.2017).

Icebreaker	Segment of route	Propulsion power [KM], Displacement [T], maximal speed [knots]	Ice conditions
Sibiryakow	Murmansk -Rastorguyev Island	6200, 4850, 18.0/13.5	Ice concentration up to 20%
Captain Belousov, Captain Voronin - Yermak	Rastorguyev Island - Ayon Island	12000/10500, 5360, 16.5 10000/9000, 10000, 15/12	Ice concentration 50%. Very thick ice (>2.5m). Compactness
Molotow	Ayon Island	10000, 11000, 15.5	of ice over 1.5° – 2.0°.

7 RATEGIES FOR TRANSIT VOYAGES OF VESSELS ON THE NSR

Analysis of ice conditions occurring in regions of the Russian Arctic seas over time and time schedule of vessel's convoy movement shown that the NSR Administration has adopted wait strategy for improving ice conditions rather than forcing severe ice conditions. It would have to be clarified whether inducing the convoy leadership to winter and continue voyage in the next navigational season 1957' was justified substantively. The ice conditions (their lightest values) in the seas covering NSR between 1955 and 1957 were analyzed. For this purposes used maps of ice navigation conditions for average periods of 30 days available for the years 1940-2005 (ESIMO, Severity of ice conditions http://www.aari.ru/odata/_d0012.php?mod=1, accessed 03.03.2014). Ice conditions in eastern part of the East Siberian Sea were very conducive to navigation in 1957. In southwestern part of the Chukchi Sea ice sailing conditions have improved very from difficult in 1956 to moderate in 1957. This indicates that the convoy of vessels was likely to reach the destination of transit. This situation could also be predicted on the basis of extrapolation of multiannual changes for the eastern part of the East Siberian Sea and the southwestern part of the Chukchi Sea. However, were L3 ice class vessels capable for wintering at Ayon Island - is in dispute.

Table 2. The lightest and the lightest ice conditions on the NSR in 1955-1957. Severity of ice conditions: 1 – very light, 2 - light, 3 - average, 4 - heavy, 5 – very heavy. Made by author based on ESIMO, Severity of ice conditions, http://www.aari.ru/odata/_d0012.php?mod=1, accessed 03.03. 2014.

NSR region	Ice conditions severity in navigation season		
	1955	1956	1957
Kara Sea (SW)	1	2	2
Kara Sea (N)	1	4	1
Laptev Sea (W)	1	3	5
Laptev Sea (E)	1	3	5
East Siberian Sea (W)	2	2	1
East Siberian Sea (E)	3	1	1
Chukchi Sea (S)	4	5	3
Average severity	1,9	2,9	2,6

One may wonder whether successful strategy would be to return this convoy to wintering outside of the NSR (in Europe) and re-crossing the entire NSR in 1957. Advantage of this strategy was that the vessels wintered in ice safe place of refuge. Table 2 shown that this strategy would not work. Average ice navigation conditions in 1957 were only a little better than in 1956. By contrast, in the eastern and western parts of the Laptev Sea in 1957, very difficult conditions of ice conditions occurred. Such conditions could not have been predicted on basis of extrapolation of multi-annual ice conditions on the Laptev Sea. However, this should be taken into account due to very high anomalies of ice navigation conditions on this sea from the lightest to the heaviest one, which were far away from the long-term trend line.

8 CONCLUSIONS

Several different sources of information on the state of ice cover in the Arctic were used in this study. These were maps of ice conditions for an average of 30 days

between 1940 and 2005, maps of the Arctic ice cover for periods of 5-15 days between 1950 and 1998 at 15 'latitude and 15' longitude grid resolution and the maps of seas of the Russian Arctic and their regions for an average of 10 days periods between 1935 and 2011. All used data and maps were from http://www.aari.ru/projects/ECIMO. The information was presented in different ways, but all of them gave consistent results.

It can be concluded that the Soviet Union had icebreakers that did not have capacity for effective assistance of vessels convoys in such unfavorable shipping conditions as ice concentration above 50% or ice thickness higher than 1.8 meters or when ice compactness was higher than 1.5°-2.0°. It was observed that the NSR Administration coordinating convoys had adopted tactics of waiting for an improvement ice conditions rather than forcing under severe ice conditions.

Extrapolation of annual variation in the second degree polynomial showed trends of change, but due to high annual anomalies of ice conditions, it was not eligible for forecasting ice conditions on particular sections of the NSR in the next navigation season. Therefore, it did not recognize possibility of crossing the NSR in one navigation season. In this situation, in particular due to the uncertainty of using the route from Europe to the Far East by the Suez Canal, the wintering tactic and continuation of vessels' transit voyage in the following year appeared to be justified by merit.

Long-term variability of ice conditions found on the basis of polynomial curves of the third degree was characterized by a period of 7.5 years for the western parts of the individual seas and a period of 10.7 years for the eastern parts of the individual seas. However, this cyclicality was determined on the basis of only one cycle of change. This did not allow for reliable conclusions about extrapolation of changes in subsequent years. So it was not useful for decision makers planning a convoy of Polish vessels. The usefulness of future navigational planning would be to examine many cycles of ice conditions in navigational seasons in all NSR sections.

REFERENCES

Adamczyk K., Drzemczewski J., Huras B., 2012. Polish Ocean Lines, Fleet Album 1951-2011 [in Polish] Polskie Linie Oceaniczne, Album floty 1951-2011, 2nd Edition, PORTA MARE Pomorska Oficyna Wydawniczo-Reklamowa:440 p.

Arikaynen A.I. (1990) Navigation in the Arctic ice. [in Russian] (Судоходство во *льдах* Арктики). Moscow, Transport:247 p.

Armstrong T., 1952, soft cover edition 2011, The Northern Sea Route, Soviet exploitation of the North East Passage, Cambridge:166 p.

Central Intelligence Agency, 1959. Significant activities on the Northern Sea Route 1954-1958, Top secret, Dissemination authorised 1999. CIA:45.

Falba T., 2011, Two days to happiness [in Polish] Dwie doby do szczęścia, accessed 03.03.2014, http://www.portalmorski.pl/inne/morze-tajemnic/31611-dwiedoby?tmpl=component&pri:5 p.

Gogol K., Huras B., 2014. Polish Steamship Company, Fleet Album 1951-2014 [in Polish] Polska Żegluga Morska, Album floty 1951-2014, PORTA MARE Pomorska Oficyna Wydawniczo-Reklamowa:536 p.

Starkov V.F., 2001, Essays on the history of Arctic exploration, The Russia and North Eastern Passage, Part 2. [in Russian] Очерки истории освоения Арктики Arktiki, Том 2, Россия и Северо-восточный проход, Naucnyy Mir:114