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OBSERV – OBSERVATIONS OF SHIP ICE PERFORMANCE IN THE BALTIC
Winter 2012

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FOREWORD

In its report no 84, the Winter Navigation Research Board presents the outcome of the project on observations of ship ice performance in the Baltic in the winter 2012.

The performance of the Finnish winter navigation system lies on the performance of icebreaker assistance. The efficiency of the assistance depends also on the performance of the assisted ship. If the ship cannot keep up with the icebreaker or has to be cut from ice repeatedly, it slows down the assistance and causes delays for the ship and the icebreaker. The Finnish-Swedish Ice Class Rules state the requirements for a ship to gain a certain ice class. These include a requirement for the ship to have enough engine power for each ice class.

This study started from the need to determine whether these ships for which ice class had been granted according to more precise calculations or ice model tests have the ability to actually perform adequately in ice. The aim of this study was to find common denominators amongst a pool of ships. The focus was on the ships with poor ice-going capabilities. The results can be used to assess the engine power requirements of the Finnish-Swedish Ice Class rules or traffic restrictions set by the Finnish Transport Agency or the Swedish Maritime Administration. The requirements still have to be set in a way that is a balance between economical features of the navigating ships and the need of icebreakers.

The Winter Navigation Research Board warmly thanks Ms. Leena Vedenpää for this report.

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OBSERV-
Observations of Ship Ice Performance in the Baltic
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ILS OY/Leena Vedenpää

1. Background

The Finnish-Swedish Ice Class Rules (FSICR) state the requirements for a ship to gain a certain ice class. These include a requirement for the ship to have enough engine power for each ice class. The required engine power is calculated according to formulas stated in the ice class rules. The engine power of the ship must be in the minimum the engine power given by the formula. The rules also give the possibility to determine the minimum engine power by other methods than the formula. If the ship does not fulfill the formula requirement, the ice resistance can be proven by more precise calculations or ice model tests to be smaller than that indicated by the rule calculation formula. This way the ship can gain an ice class it would not have gained according to the rule formulae. Some of these ships have special design features that are not taken into account in the ice class rules formulas. These include e.g. nozzle propellers and double acting ships.

This study started from the need to determine whether these ships for which ice class had been granted according to more precise calculations or ice model tests have the ability to actually perform adequately in ice. After this initial idea, the scope spread to a wider study of ship performance on ice. It was decided to research if ships with poor ice-going performance (i.e. performing worse than what ship's ice class would indicate) sail in ice conditions in Finnish waters. This was done by studying ship notices made by icebreakers of ships with poor ice-going capabilities. Also, the icebreaker fleet was asked to keep a list of ships with poor ice-going capabilities.

The performance of the Finnish winter navigation system lies on the performance of icebreaker assistance. The efficiency of the icebreaker assistance depends also on the performance of the assisted ship. If the icebreaker has to assist a ship that cannot keep up with the icebreaker or has to be cut from ice repeatedly, it slows down the assistance. This causes delays for the ship and the icebreaker. With only limited icebreaker availability in the Baltic Sea, the inefficient assistance of another ship will result to longer waiting periods of icebreaker assistance for other ships. Thus it would be in the benefit of all parties of the winter navigation system, if the assisted ships would be adequate enough to keep up with the icebreakers. The results of this study can be used to assess the engine power requirements of the Finnish-Swedish Ice Class rules or or traffic restrictions set by the Finnish Transport Agency or the Swedish Maritime Administration. The requirements still have to be set in a way that is a balance between economical features of the navigating ships and the need of icebreakers.

The project was started in winter 2011, for which a separate report has been created. It was noted in 2011 that there wasn't enough of data for making definite decisions, so it was decided that the project would carry on during winter 2012. Winter 2012 turned out to be a "poor" winter navigation winter, with mild ice conditions. Still, there was enough of ice in the Bay of Bothnia and the Gulf of Finland for observations to be made.

The conditions especially in the Bay of Bothnia were harsh enough to count as a proper winter. Some of the ships under scrutiny visited Finnish ports sailing in ice and needing ice breaker assistance. Also, several ship notices of ships with “poor” ice-going capabilities were made. These were analyzed both separately and in addition to winter 2011 data.

It has to be noted that the ships used in this study are used only as statistical data, and individual vessels are not identified in the study. The aim of this study was rather to find common denominators amongst a pool of ships.

2. Methods

Analysis of the ships with ice class gained by more detailed calculations or ice model tests

For the analysis, statements of compliance were received from the Finnish Transport Safety Agency Trafi. These statements represented the ships for which ice class was given according to detailed calculations or ice model tests. According to the 2010 Ice class regulations, vessel has to be able to have the minimum speed of 5 knots in ice channel, the ice thickness of the channel depending on the ice class. The requirements for the other methods of determining required engine power are stated in the 2010 Ice class regulations issued by the Finnish Transport Safety Agency, chapter 3.2.5. 108 statements of compliance were received, these from years 2000-2011. Most of these were Panamax and Aframax tankers that had applied for the ice class but were not likely to visit Finnish or Swedish ports. It was not known whether these tankers visit Russian ports, since that data was not available. Thus the tankers were left out of the research. In total 24 ships that had the possibility to visit Finnish or Swedish ports were left. In addition 12 ships from the Swedish authorities were added to the list.

A list of port calls to Finnish ports was received from the Finnish Transport Agency. The list included those ports to which the ship had to go in ice during winter 2012, which was a mild winter. From this port call list, it was seen if any of the ships with a statement of compliance had visited Finland in decent ice conditions. Ice charts were studied to determine the ice conditions during these visits. Only three ships remained, which had visited Finnish ports in a decent amount of ice. Really mild ice conditions and short ice voyages were discarded, since they would not provide good information.

For these three ships AIS-data was received from the Finnish Meteorological Institute. From the AIS-data, those voyages that were done in ice were picked. From this data, the average speeds of the ships were calculated. Since the winter was mild and the voyages in ice were short, average speeds were calculated for ingoing and outgoing voyages to and from the port. There was no reason to cut these into shorter segments.

Analysis of the ships with poor ice going capabilities

For the analysis of the ships with “poor” ice-going capabilities, two sources of information were used. The first list was the ship notices from 2000-2012. The second list was the so called “icebreaker’s list”, which has been compiled from icebreaker’s observations of ship from winters 2011 and 2012. All the Finnish and Swedish icebreakers were sent a list in the beginning of the winter, where they were asked to mark down any ships that seemed to be performing poorly on ice. After winter the lists we gathered. This data gathering is cumulative, so the data analysis of this report includes all the ships from the ship notices list and the icebreaker's list from all years. All these ships were analyzed as combined data.

First, it was analyzed why these ships had gained a ship notice or were performing poorly on ice. Second, the ages and deadweights of the ships were identified and plotted. Also, the age distributions of the ships were plotted. For further analysis, only those ships which had weak engine power listed as the reason for poor ice performance were used. From these ships the installed power distribution was determined. Ice classes were determined for these ships also. A list of 2011 and 2012 port calls (received from the Finnish Transport Agency) to Finnish ports was used to determine the number of port calls these ships had. Also, the ratio of power/DWT was calculated for these ships. This ratio is often used as a rough measure of ice capabilities. The bigger the ratio, the better the ship is considered to be navigating in ice.

In previous years report the required power vs. installed power was used as an indicator figure, but since it is difficult to calculate the required ice class power for the ships when there is no detailed information available, this approach was not applied in this report. Also, there were not many new ships that came into the analysis this year, so last years analysis is still very much valid. For the possible report next year, the required ice class power analysis can be introduced again.

3. Results

3.1 Analysis of the ships for which ice class was given according to ice model tests or more detailed calculations

<u>Ship A</u>

Ship A is a 90 m long ship with a deadweight of 4000 and engine output of 1880 kW. She received her IA ice class based on an assessment of the required propulsion power, i.e. more detailed calculations.

The ship A visited Finland sailing through ice three times during winter 2012. The first visit was in the end of January, when the ice cover had only started to grow. The visit was to Tornio, and the level ice thickness was only 10-30 cm. The ship was still escorted to and from the port. It managed to sail in ice with a speed close to its open water speed. The ingoing average speed was 9,7 knots and outgoing 10 knots.

In the beginning of March ship A visited Tornio. This time the ice situation was worse, level ice thickness up to 70 cm, with some ridging. The ship was not able to proceed in ice alone and stayed to wait for icebreaker assistance. With the icebreaker assistance the ship was able to proceed well. The ingoing average speed was 9,2 knots. Outgoing, the ship was taken into towage, because for small ships it is an easy assistance method in relatively poor ice conditions. The outgoing average speed was 9,4 knots.

Ship A visited Tornio third time during the ice season in mid-March. The ice situation in the Bay of Bothnia was similar to the beginning of March, 30-70 cm of level ice. The ship was escorted by an icebreaker to and from the port. The ingoing average speed was 9 knots and outgoing 10,3 knots.

<u>Ship B</u>

Ship B is a 100 m long ship with a deadweight of 5200 and engine output of 1800 kW. The ship is equipped with a high efficiency nozzle which according to more detailed calculations gave enough of propeller thrust for ice class IA.

Ship B visited Baltic Sea ports in ice conditions three times during winter 2012. The first visit was mid-February to St. Petersburg. The ice conditions on that trip were mild, 10-30 cm of level ice. The ingoing average speed in ice for ship B was 4,9 knots. It was assumed that the ship waited for icebreaker escort for a while at the Finnish-Russian border as it stayed put there for a while. Most likely the vessel was not stuck on ice but rather just waiting for an escort, so this time was reduced from the calculations. The outgoing average speed was 6,7 knots. It is not known whether the ship received icebreaker assistance on this trip or not.

In mid-March the ship visited Oulu. The ice conditions were with thicknesses of 40 to 60 cm on the fairway. The ship was assisted to and from the port. The ingoing average speed was 7,5 knots and outgoing 9,4 knots. The third visit was in the beginning of April to Tornio. The ice conditions were similar to the previous visit to Oulu, level ice thicknesses varying from 40 cm to 60 cm. The ship was also assisted to and from the port. The ingoing average speed was calculated to be 8,6 knots and outgoing 8,5 knots.

Ship C

Ship C is a 100 m ship with a deadweight of 5600 and engine power of 1920 kW. The ship received an ice class 1B according to recalculations of the required propulsion power. Ship C visited Finland in ice conditions once in the end of January. The ice conditions were mild, with ice from 10 to 30 cm. The ship was escorted to and from the port. The ingoing speed for the ship was 7,6 knots and the outgoing speed 6,1 knots. All the speeds are presented in table 1.

Table 1. Dates, ports and speeds of the observed ships.

Ship	Date	Port	Speed
Ship A	24.1.2012	Tornio in	9,7
	26.1.2012	Tornio out	10,1
	4.3.2012	Tornio in	9,2
	6.3.2012	Tornio out	9,4
	19.3.2012	Tornio in	9
	21.3.2012	Tornio out	10,4
Ship B	13.2.2012	St. Petersburg in	4,9
	17.2.2012	St. Petersburg out	6,7
	12.3.2012	Oulu in	7,5
	17.3.2012	Oulu out	9,4
	5.4.2012	Tornio in	8,7
	7.4.2012	Tornio out	8,6
Ship C	25.1.2012	Kemi in	7,6
	26.1.2012	Kemi out	6,1

Summary of the analysis of ice-going capabilities of ships A, B and C

The author of this report had the privilege to observe, onboard an icebreaker, ship A on the second visit to Tornio. The ship managed to follow the icebreaker well, even though it was a small one. The ship also had an advantage on being small, it made corners well. On the outgoing trip the ship was towed, but this was just in case and because the ship was easy to be towed being so small. Towing a ship is a faster assistance method than cutting ship from ice.

Ship A is a small cargo ship, but seems to manage well in ice. Also its size makes it easy to assist. Most likely it is not able to go on its own in ice, but is easily assisted by an icebreaker. A ship notice was issued about the ship in the beginning of April, but this was only related to the draft of the ship that was exceeding the depth of the ship channel.

Ship B seems to have managed to sail in ice at a decent speed, although the average speeds of the St Petersburg voyage in mild ice conditions seem small. It has to be said that the author has no specific knowledge of the icebreaking practices in Russia, which could have effect on the speed of the ship. During the visits to Finnish ports the speed was above the 5 knot "limit", but close to the 8 knot speed that icebreakers find to be a slow assistance speed. The open water speed of the ship is around 12,5 knots. A ship notice was made of ship B in mid-March. The notice included too small a draft, existence of a big bulb that made it difficult to be towed and a notice of an inexperienced master. It would seem that ship B has some difficulties in sailing in ice conditions, and is not easily assisted by icebreakers.

Ship C visited Finland in relatively mild ice conditions. Still, the ship managed only an average speed of 6 to 7 knots. A ship notice was issued of the ship then, stating a weak engine power. It was added to the ship notice that the ship is not suited for winter navigation. Even though the average speed of the ship is more than 5 knots, ice breaker crews find all assistance speeds below 8 knots to be slow. The ice conditions were mild, so it can be said that the ship has had some obvious difficulties sailing in icy conditions.

3.2 Analysis of the ships with noted poor ice-going performance

From the combined ship notice/icebreaker's list the reasons for poor ice-going performance were gathered. 33 reports of poor ice performance were made during winter 2012. The winter was mild, which most likely affected the number of reports, which sunk from 77 of 2011. The data in this section is handled according to the amount of reports, even though there were several ships that had received several notices or mentions. The data was divided to cases from 2012 and to older (2000-2011). 324 cases were reported altogether in the previous years. Table 2 shows the division of the reasons for the reported poor ice-going performance. The biggest reason for the poor ice performance seemed to be weak engine power. 36% of the ships reported in 2012 (42% in 2011) had weak engine power or other engine related issues as the cause, comparing to the 55% of the older reports and 53% of all together. The second biggest reason was problems with the crew, with 21% year 2012, 24% of older and 23% altogether. Other major reasons were propeller problem, unsuitability for towing etc.

Table 2. The reasons for poor ice performance.

Reason	2012	older
– Weak engine power – Does not use 100% of the power – Cooling problems	12/ 33	178/ 324
– Inexperienced crew – The crew does not obey the orders – Language problem	7 / 33	76 / 324
– Propeller problem/failure	1 / 33	3 / 324
– Unsuitable for towing	6 / 33	23 / 324
– Unsuitable positioned anchors	2 / 33	12 / 324
– Ballast problem	2 / 33	12 / 324
– Rudder failure	0 / 33	5 / 324
– Other	3 / 33	15 / 324

Figure 1 shows the distribution of the reasons for poor ice performance in the year 2012.

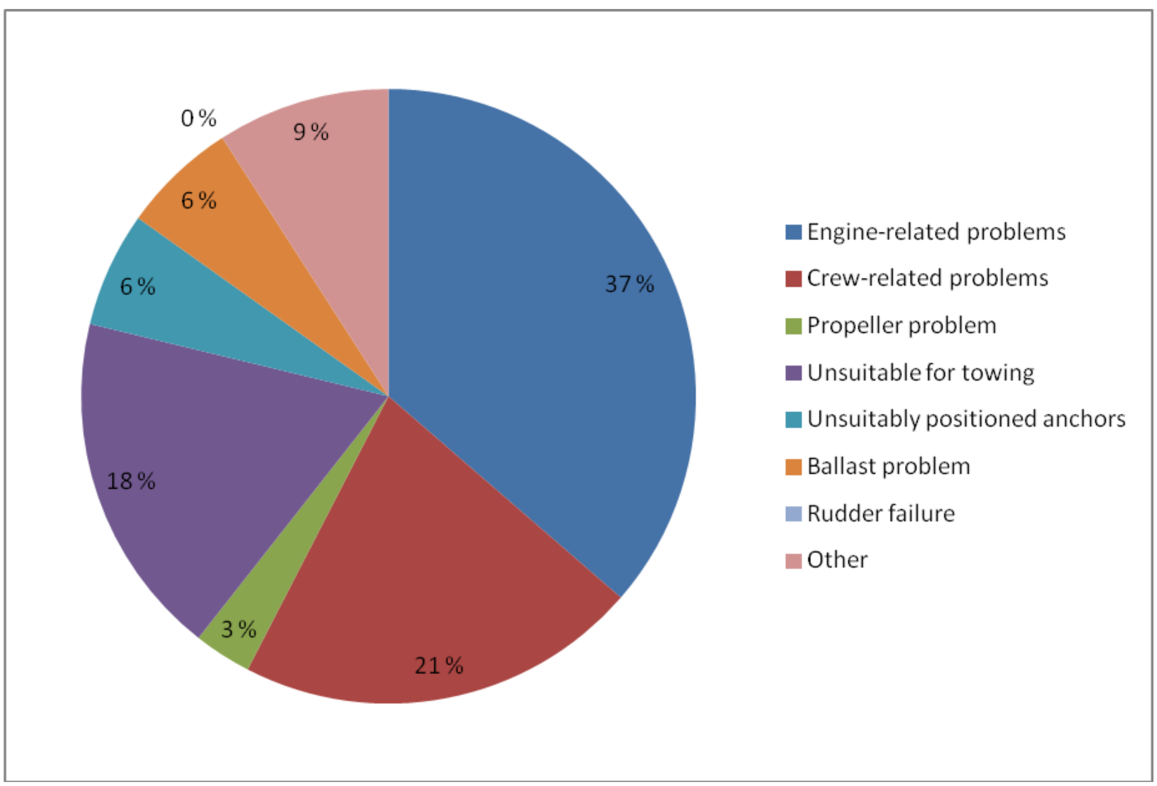

Figure 1. The reasons for poor ice performance in 2012.

Figure 2 shows the distribution of the reasons for poor ice performance in the years 2000-2011.

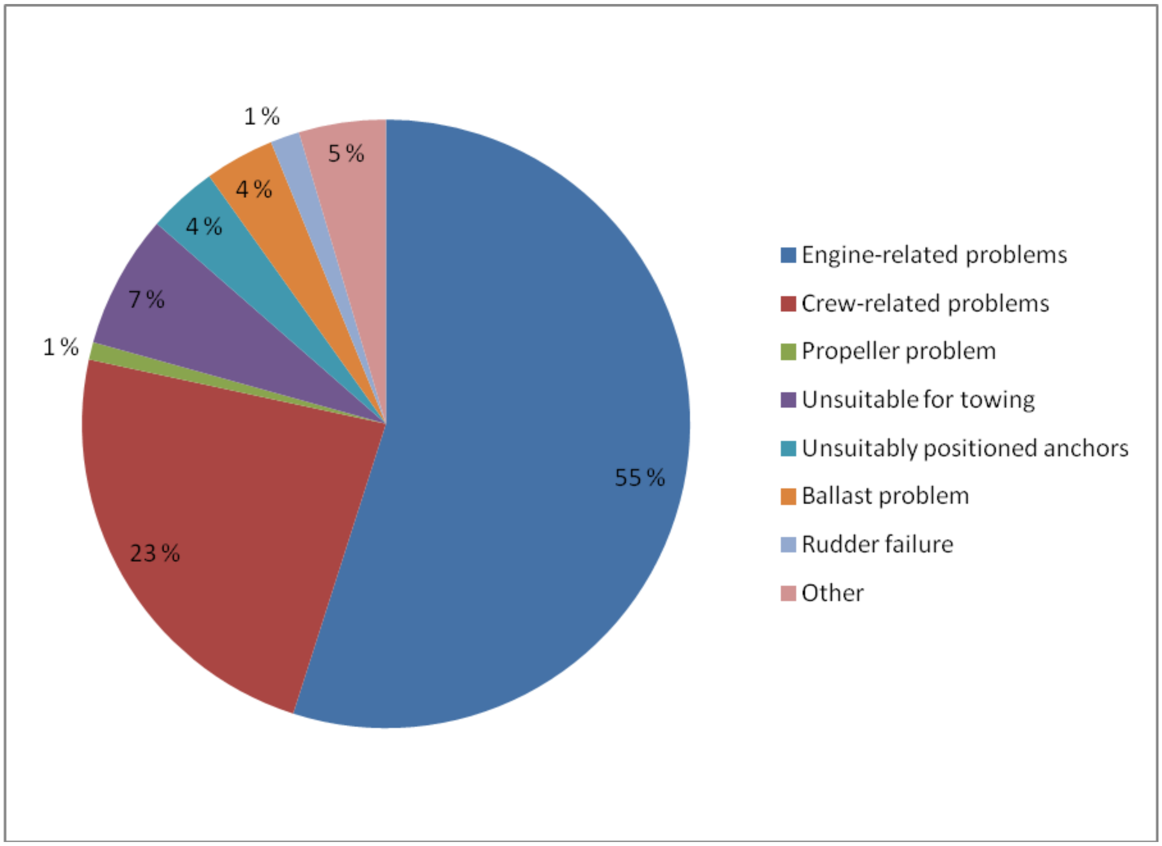

Figure 2. The reasons for poor ice performance in 2000-2011.

Figure 3 shows the distribution of age and deadweight of the ships from the combined ship notice/ icebreaker's list. It can be seen from figure 3 that most of the ships listed are relatively small in size. Most are under 5000 DWT. The younger ships seem to be larger than the older ships.

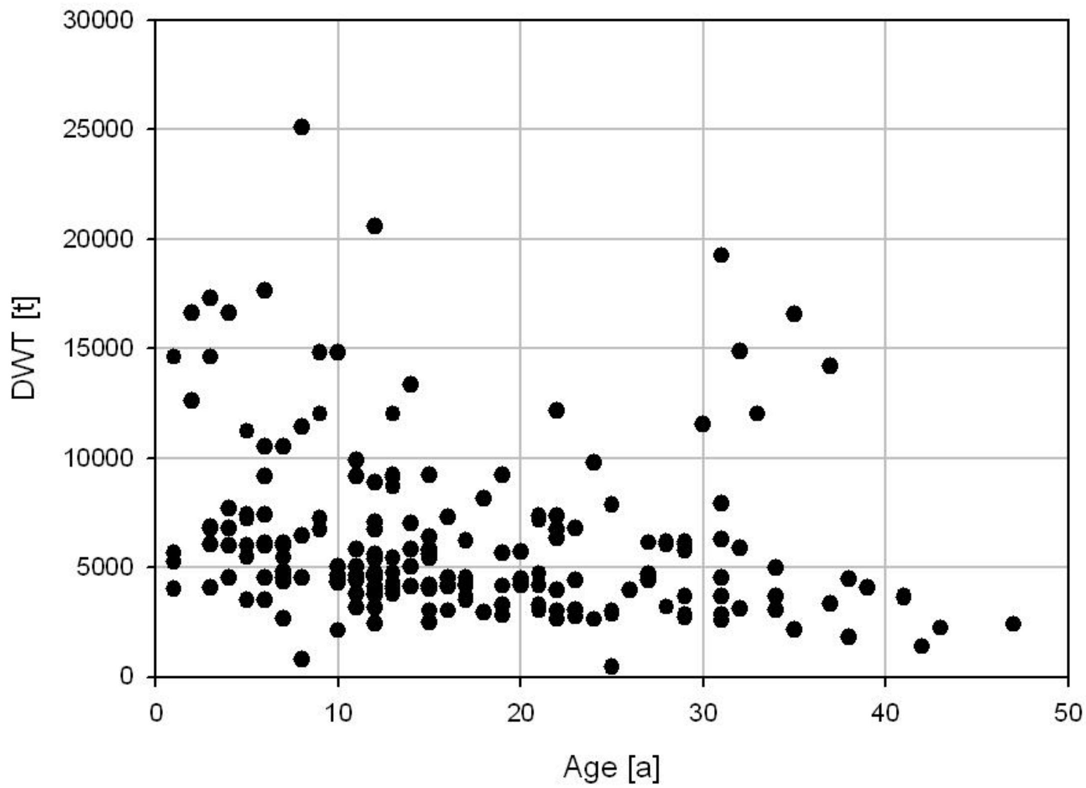

Figure 3. The age/deadweight distribution of the combined list.

The age of the ships ranged from 1 to 47 years. It has to be remembered that the ship notice list included notices all the way from 2000, which would mean that even though the age of the ships nowadays could be 47 years, it is most likely that some of the older ships are not operational anymore. Figure 4 offers the age distribution of all the ships on the combined list.

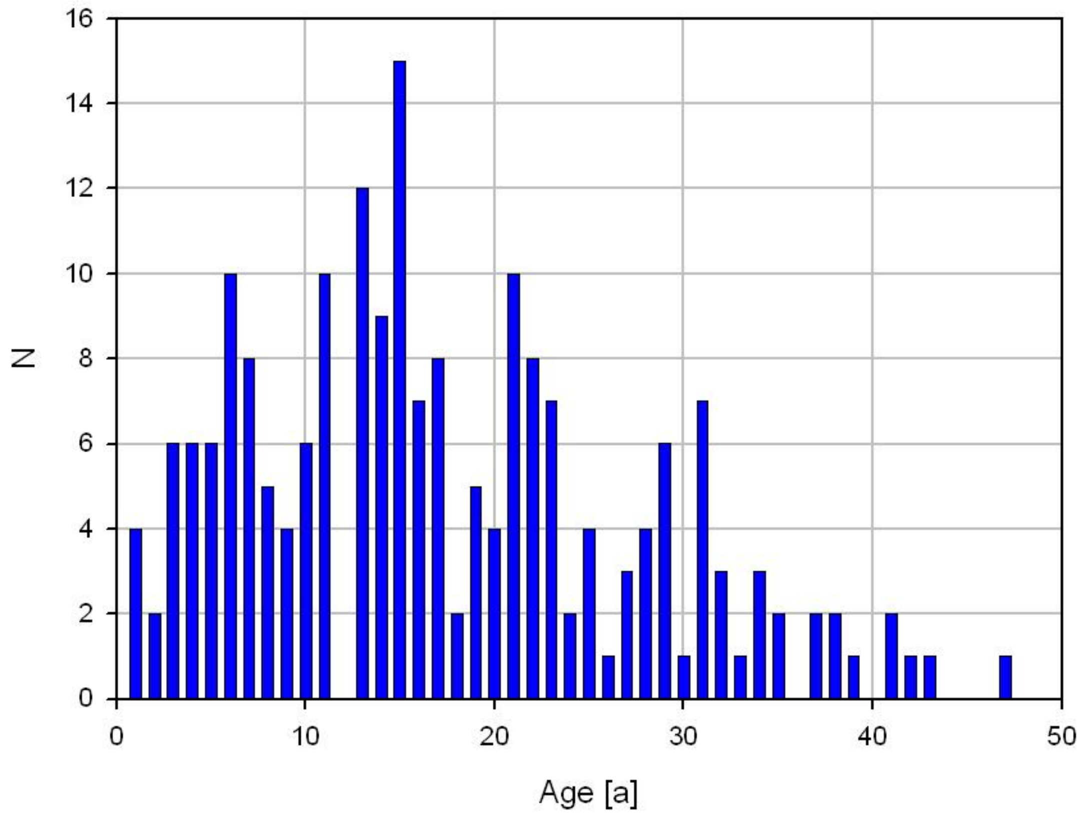

Figure 4. The age distribution of the ships from the combined list.

In order to see better the relation of age and weak engine power, in figure 5 the age distribution is shown with the bars divided to the amount of ships reported to have weak engine power and other problems related to ice-going capability.

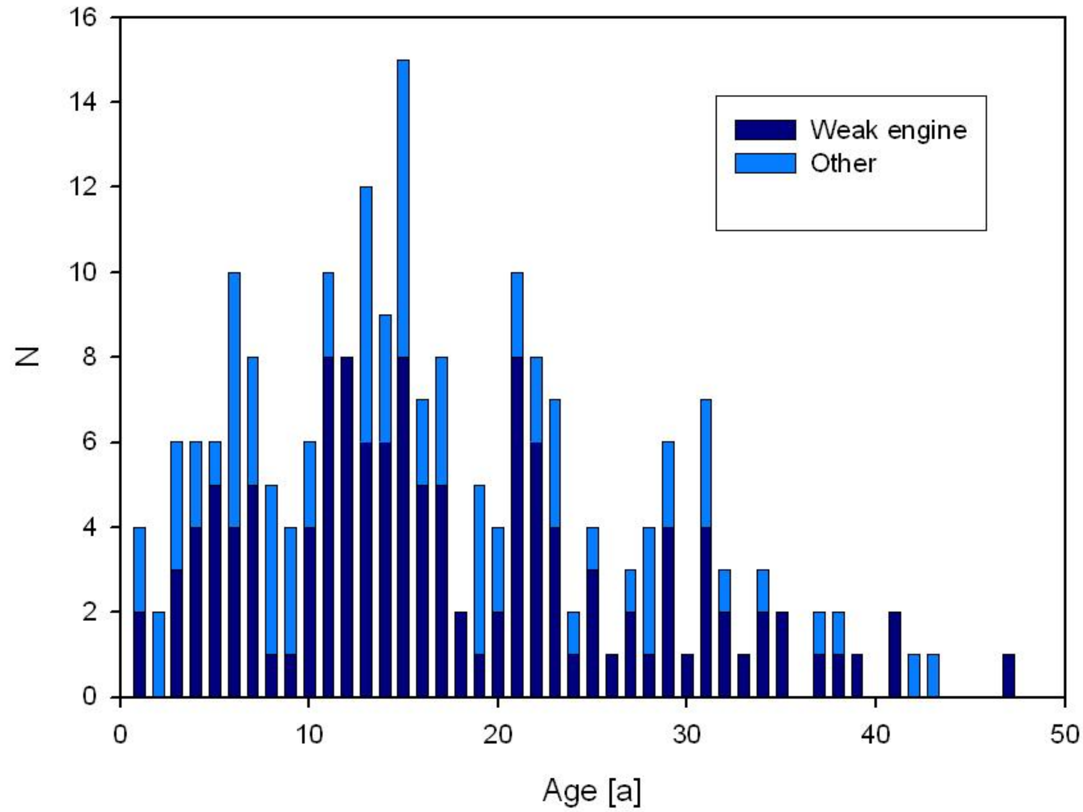

Figure 5. The age distribution of the ships with bars divided according to the reason of the poor ice performance.

For further analysis only the ships for which the reason for poor ice performance was engine related were used. For this analysis only the information of individual ships was used, even though some ships had received several mentions of weak engine power. The total amount of ships was 223 of which 127 had engine related issues as the reason for poor ice-going performance.

For 88 ships out of these 127 an ice class was identified. Most of the ships were of ice class IA (69 ships), IA super (IAS) ships were 5, IB ice class 13 ships and one IC. 89 ships of these 127 had visited Finland in the year 2011. Table 3 shows the distribution of the port calls. The amount of port calls varied from 1 to 75. Most of these ships had visited Finnish ports 1-5 times during the entire year of 2011. During winter 2012 (January-April), 74 of these ships with reported weak engine power visited Finnish ports.

Table 3. The amount of visits in Finnish ports by the ships with reported weak engine power during year 2011.

Amount of visits	Number of ships
1-5	35
6-10	15
11-15	10
16-20	10
21-25	6
26-30	5
>30	8

Of the 127 ships for only 90 ships it was possible to find an engine power, thus only 90 ships were used in the further analysis.

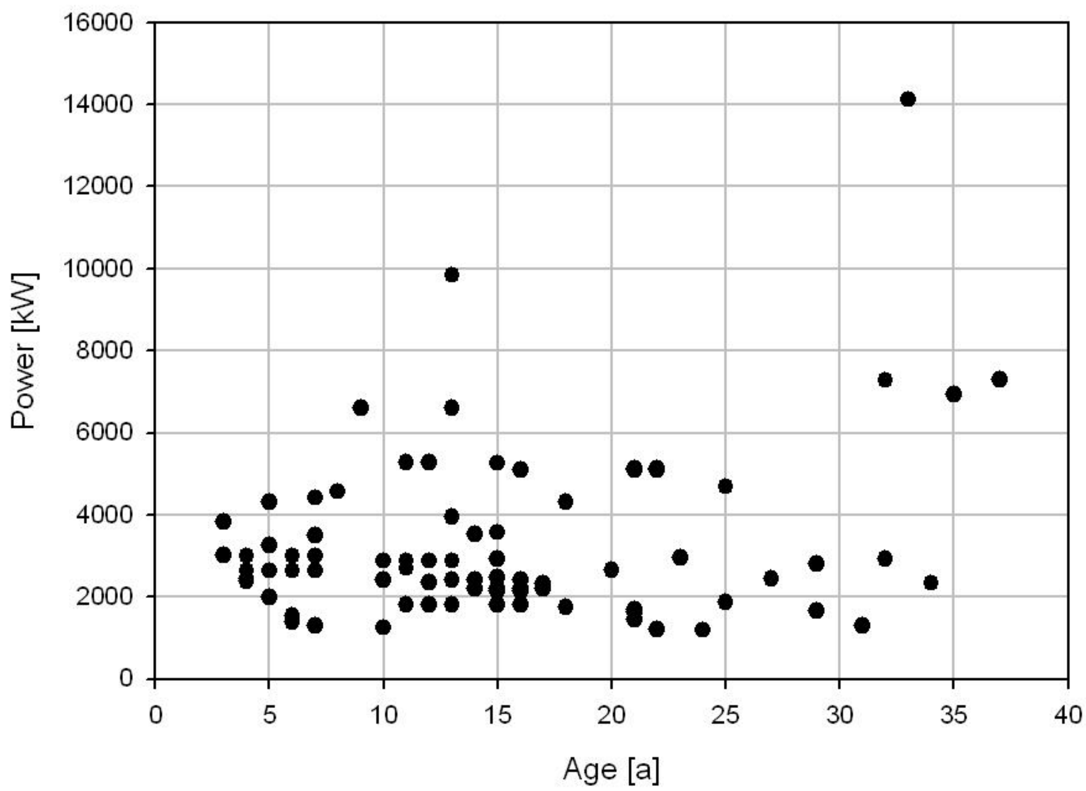

Figure 6. The age-power distribution of the ships.

For these 90 ships the power/DWT ratio was calculated. In table 4, the results are shown. The bigger the ratio, the better should be the ice going capabilities. For most of the ships from the reduced list the ratio was between 0,4 and 0,7.

Table 4. The power/DWT ratio of the ships reported with weak engine power.

The power/DWT ratio	**Amount of ships**
0-0,09	0
0,1-0,19	1
0,2-0,29	2
0,3-0,39	5
0,4-0,49	21
0,5-0,59	31
0,6-0,69	21
0,7-0,79	7
0,8-0,89	0
0,9-0,99	0
>1	2

The age of the ship does not seem to have an effect on the power/DWT ratio of the ship. The distribution is wide in all the ages of the ships as can be seen from figure 7.

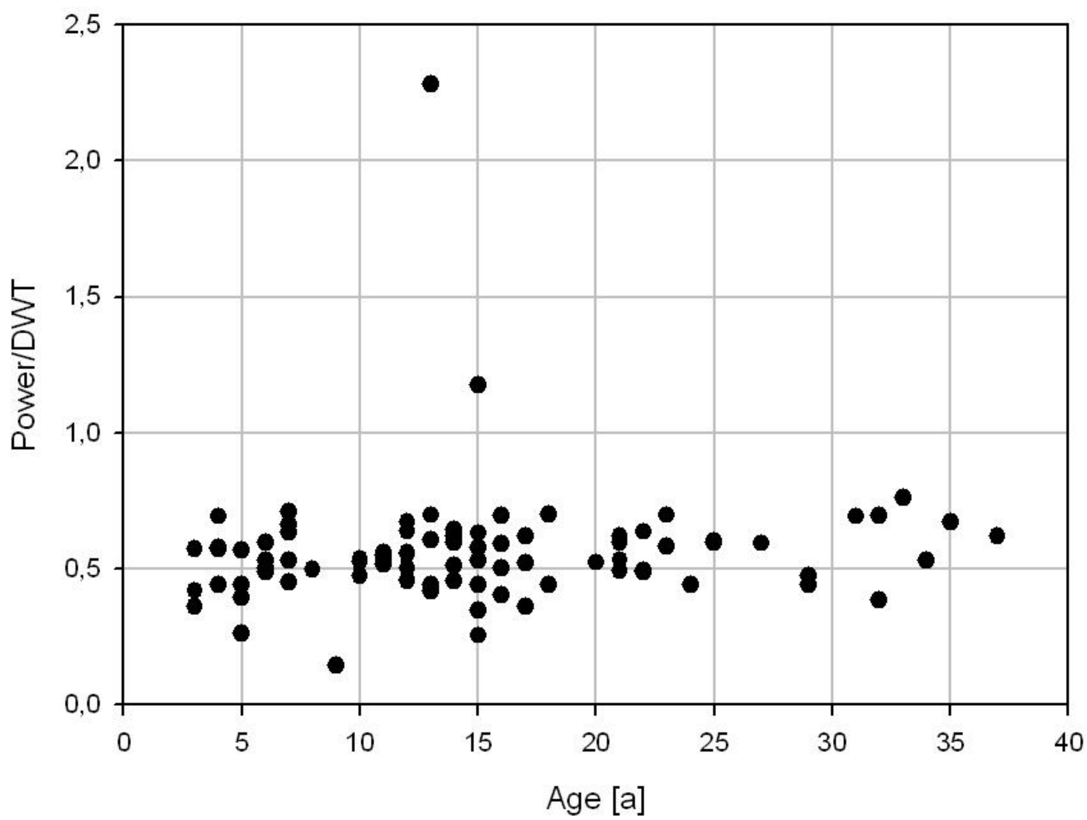

Figure 7. Age vs. Power/DWT ratio.

4. Discussion

It can be deduced, based on previous year's data and this year's data that ships that have been granted an ice class according to additional calculations don't seem to be having any more difficulties in navigating in ice than other ships. One of the ships had this year received a ship notice, but so far it is the only one. Still, more data is needed to make more precise analysis on the accuracy of ice model tests or calculations proving ship's sufficient ice class performance. It can be also noted that all of the ships studied this year and previous year had gained their ice class based on more detailed calculations, not ice model tests.

There were fewer ship notices this year made of ships with poor ice capabilities, which can be explained by the milder winter. Still, it was clear that the biggest reasons for poor ice-going capabilities were engine problems and problems with the crews. According to ship notices and icebreaker crews, the biggest problem with ship engines seems to be the fact that the nominal power of the engine is not available. This can be due to restrictions in the machinery or cooling system. Also, it is clear that even the best ice capable ships with enough of power cannot sail well in ice if the crew is not accustomed to winter navigation and icebreaker assistance.

The data shows that usually the older ships are less capable of navigating well in ice. It is also known that the older ships' machinery is not able anymore to give out the power stated in the documents. The new ice class rules (FSICR, 2002 and newer rules) most likely have had their effect on the higher power levels of the newer ships. The ships that have been stated to have poor ice-going capabilities are mostly on the smaller side of ships (then again, a large amount of ships visiting Finland are small). But small size does not automatically mean that it is a poor ice-going ship. Small ships are often easier to assist by icebreakers, which means saving time and bunker by the icebreakers. It has to be also taken into account that it would not always be economical for the ship owners if the ice class rules or traffic restrictions would demand for more power or size. General rules might not be as effective since there aren't that clear reasons behind the poor ice-going capabilities. For example, a small ship can go in a channel that a larger ship with wider breadth can't or an old ship with more installed power might not be able to give out as much power as a new ship with less installed power.

Because still there is not enough data to make straight conclusions, it can be recommended that the data gathering would continue next winter also. Data on the ships with ice class gained by ice model tests or more direct calculations should be gathered, but it would seem that the more interesting data would be of ships that have been reported to have poor ice-going performance already several times. These ships are well known amongst icebreaker crews and they have said that they don't even want to report these anymore, because nothing seems to be done about their poor ice-going performance. Also, it was shown that most of these ships that have received a ship notice during the past 12 years are still operating very frequently in the Finnish waters. Some of these ships actually have visited Finnish ports several times a year, also on ice conditions. These ships could be observed like the ones with ice class determined by model tests or more direct calculations. It could be studied, if they really are so poor as the reports indicate. This could be achieved by analyzing their AIS data and their ice-going capability further. This could offer valuable information on how the ice class rules or traffic restrictions during the wintertime could be altered (or should they?).

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