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EEDI AND THE NEED FOR ICEBREAKER ASSISTANCE II

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FOREWORD

In this report no 118, the Winter Navigation Research Board presents the results of research project EEDI and the Need for Icebreaker Assistance II. The ice-going capability of several EEDI-compliant vessels was investigated and compared to older, non-compliant vessels. It was found that EEDI-compliant vessels are less powerful than older vessels of similar type and need assistance more often.

The Winter Navigation Research Board warmly thanks Teemu Heinonen for this report.

Helsinki

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EEDI AND THE NEED FOR ICEBREAKER ASSISTANCE, PART II

FOR

FINNISH TRANSPORT AND COMMUNICATIONS AGENCY

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Summary:

The ice-going performance of different EEDI-category vessels has been investigated in this report. The number of EEDI vessels is still relatively small but the number of vessels is increasing. Currently there are a total of 421 ice-classed vessels built/being built according to the EEDI regulations and 336 of these are currently in service.

On the winter 2018-2019 approximately 30% of the actual EEDI vessels and ~20% of the older EEDI compliant vessels have needed assistance. This is approximately the same magnitude as observed in the previous research project. The non-compliant vessels need clearly less assistance.

Comparison of vessel parameters indicated that the new ice-classed EEDI vessels are less powerful than the older pre-EEDI ice-classed vessels. For example for IA general cargo ships, which are the most common merchant vessels observed in the northern Baltic sea during the past winters, the new EEDI vessels have P/DWT ratio of 0.33 kW/ton while the older vessels have ratio of 0.48 kW/ton which means approximately 30% reduction. The need for icebreaker assistance increases as the power-deadweight ratio decreases. In addition, the new EEDI vessels have a higher L_{pp}/L ratio than the older vessels. This most likely results into very steep frame angles at the bow which is unfavorable for ice-going capability. Based on the vessel data, the small P/DWT ratio of the new vessels is linked to high Lpp/L ratio. Both factors could result that more icebreaker capacity is needed in the future. In addition, the upcoming EEXI regulations most likely decreases ice-going capability also for older vessels, which could increase the need for icebreakers in the future.

Keywords:
towing; Escort Icebreaker; Assistance; EEDI

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ABBREVIATIONS

AE .... Auxiliary engine
B .... Breadth
C_b .... Block coefficient
C_F .... Carbon factor
CO_2 .... Carbon dioxide
DWT .... Deadweight
EEDI .... Energy efficiency design index
f_j .... Correction factor for general cargo ships
f_{iCb} .... Correction factor for improved ice-going capability
f_{jRoRo} .... Ship specific correction factor for ro-ro ships
f_l .... Correction factor for the loss of deadweight
GT .... Gross tonnage
HFO .... Heavy fuel oil
IMO .... International maritime organization
LNG .... Liquified natural gas
L_{pp} .... Length between perpendiculars
ME .... Main engine
MEPC .... Marine Environment Protection Committee
P .... Power
Ro-Ro .... Roll on – roll off
SFC .... Specific fuel consumption
T .... Draught

∇ .... Displacement

1 INTRODUCTION AND OBJECTIVES

The energy efficiency design index (EEDI) and the need to reduce greenhouse gases (GHG) have a big impact on current and future ship characteristics as new ship concepts are designed to be more energy efficient than previously. The fuel consumption is minimized by reducing installed power and also by optimizing the vessels hull-form for open-water performance. Both factors typically have negative impact to the vessel's ice-going capability.

In order to have a functional winter navigation system in the northern Baltic Sea in the future with optimized icebreaker fleet, the effects of the merchant vessel fleet's ice performance characteristics should be understood. This study is a continuation to Winter Navigation Research Board project *W18-11 EEDIAssistance* and will provide more information how the new vessel designs are functioning in the Northern Baltic Sea during wintertime, and what kind of ice-going characteristics the new merchant vessel fleet has.

The objective is to compare the need for icebreaker assistance (distance, time, speed, towing) between the new EEDI-compliant vessels and older vessels for winters 2019 and 2020. This provides valuable additional information as more new EEDI-designs have entered service since the previous research.

In addition, as more new EEDI-compliant designs exist it is possible to investigate how the vessel parameters have changed over the years. Therefore, this study also includes an investigation in which the ship parameters between the different merchant vessels operating in the northern Baltic Sea are compared. From this investigation it is possible to conclude if the new ice classed EEDI-compliant vessels have different characteristics compared to the older vessels.

2 ENERGY EFFICIENCY DESIGN INDEX

The energy efficiency index is mandatory for new vessels of certain ship types and sizes (Table 2-1). The index is not described in detail in this report as the focus is in the effects of EEDI. However, a short summary of the EEDI is presented below.

The energy efficiency index basically represents the amount of CO_2-emissions related to the carried cargo:

$$EEDI = \frac{CO_2\ emission}{transport\ work} \quad = \quad \text{EEDI} = \frac{\text{Engine power x SFC x } C_F}{\text{DWT x speed}}\ (\text{g}CO_2\text{/ton-mile})$$

In practice the formula used to calculate the EEDI-index is more complicated taking into account ship specific design elements with different type of correction factors (IMO resolution MEPC.308(73):

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE} *\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME} **\right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref}}$$

The vessels which are part of the EEDI regulations must attain a smaller EEDI value than the required EEDI related to their specific vessel type and size. The required EEDI is calculated based on ship type specific reference line which represents the EEDI as a function of ship size. Reduction factors are applied to the reference EEDI depending on the order date of the vessel.

Currently, ships built in accordance with Phase 0 and Phase 1 requirements of EEDI are already sailing in the Northern Baltic Sea area. Phase 2 requirements have come into force since the beginning of 2020 and it is expected that vessels built in accordance to Phase 2 would be in service within a couple of years. In addition, it is also worth mentioning that the IMO is planning to implement energy efficiency requirements also for older vessels in the future along the EEXI-regulations. However, this is not yet certain.

Table 2-1: Ship types which are affected by the EEDI regulations, EEDI implementation phases, cut-off limits and reduction factors.

Ship Type	Size	Phase 0 1 Jan 2013 – 31 Dec 2014	Phase 1 1 Jan 2015 – 31 Dec 2019	Phase 2 1 Jan 2020 – 31 Dec 2024	Phase 3 1 Jan 2025 and onwards
Bulk carrier	20,000 DWT and above	0	10	20	30
	10,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
Gas carrier	10,000 DWT and above	0	10	20	30
	2,000 – 10,000 DWT	n/a	0-10*	0-20*	0-30*
Tanker	20,000 DWT and above	0	10	20	30
	4,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
Container ship	15,000 DWT and above	0	10	20	30
	10,000 – 15,000 DWT	n/a	0-10*	0-20*	0-30*
General Cargo ships	15,000 DWT and above	0	10	15	30
	3,000 – 15,000 DWT	n/a	0-10*	0-15*	0-30*
Refrigerated cargo carrier	5,000 DWT and above	0	10	15	30
	3,000 – 5,000 DWT	n/a	0-10*	0-15*	0-30*
Combination carrier	20,000 DWT and above	0	10	20	30
	4,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
LNG carrier***	10,000 DWT and above	n/a	10**	20	30
Ro-ro cargo ship (vehicle carrier)***	10,000 DWT and above	n/a	5**	15	30
Ro-ro cargo ship***	2,000 DWT and above	n/a	5**	20	30
	1,000 – 2,000 DWT	n/a	0-5*,**	0-20*	0-30*
Ro-ro passenger ship***	1000 DWT and above	n/a	5**	20	30
	250 – 1,000 DWT	n/a	0-5*,**	0-20*	0-30*
Cruise passenger ship*** having non-conventional propulsion	85,000 GT and above	n/a	5**	20	30
	25,000 – 85,000 GT	n/a	0-5*,**	0-20*	0-30*

Note: n/a means that no required EEDI applies.

* Reduction factor to be linearly interpolated between the two values dependent upon ship size. The lower value of the reduction factor is to be applied to the smaller ship size.

** Phase 1 commences for those ships on 1 September 2015.

*** Reduction factor applies to those ships delivered on or after 1 September 2019, as defined in paragraph 43 of regulation 2.

2.1 CALCULATING EEDI

As there is still limited number of vessels in service which have been built to comply with the EEDI regulations, the EEDI is calculated also for older vessels which are not part of the EEDI regulations based on their age. This allows to have more data to compare the performance of the EEDI compliant and non-compliant vessels.

The EEDI calculations are done based on the IMO resolution MEPC.308(73). However, following simplifications, limitations and differences as listed in the next chapters should be noted.

The EEDI calculations presented in this report are conducted exactly in same way as in the previous report/project *W18-11 EEDIAssistance.*

2.1.1 REDUCTION FACTOR

Phase 1 reduction factors are used to calculate the EEDI for old vessels as it still is the most up to date EEDI phase for vessels entering service. This means that the older vessels are compared whether they are compliant to Phase 1 regulations.

2.1.2 ICE CLASS CORRECTION FACTORS

The ice class correction factors are used as presented in MEPC.308(73) which have replaced the old correction factors given in MEPC.245(66). The new correction factors are related to the vessel's deadweight instead of its length. The ice class correction factors take the additional engine power, steel weight and lower block coefficient of an ice class ship when compared to an open-water ship into account.

2.1.3 CARGO-RELATED GEAR OF GENERAL CARGO VESSELS

It is not possible to attain information regarding the cargo-related gear (cranes, side loaders, Ro-Ro ramps) of general cargo ships and therefore it is not possible to calculate correction factor f_l, which takes the loss of deadweight into account for general cargo ships (MEPC.308(73), Annex 5, chapter 2.14). However, the error is assumed to be insignificant.

2.1.4 DISPLACEMENT

Displacement data is not available for all vessels. Displacement is needed for following corrections:

- Ice class related capacity correction for improved ice-going capability f_{iCb}. This correction is used only for tankers, bulkers and general cargo ships (MEPC.308(73), Annex 5, Chapter 2.2.11.1).

- Ship specific correction factor f_{jRoRo} for ro-ro cargo ships and ro-ro passenger ships (MEPC.308(73), Annex 5, chapter 2.2.8.3).

- Ship specific correction factor f_j for general cargo ships (MEPC.308(73), Annex 5, chapter 2.2.8.4).

The correction factors f_{iCb} and f_j for general cargo ships are assumed to be 1 if the displacement data is missing. These correction factors are close to 1 or exactly 1 in most cases and therefore the error due to missing displacement is assumed to be small.

On the other hand, for Ro-Ro vessels it is almost impossible to fulfil the EEDI requirement without the correction factor f_{jRoRo}. Therefore, the missing displacement is approximated with following formulas in order to calculate the correction factor:

- $\nabla_{roro,cargo} = 1.6926 * DWT - 24.12$

- $\nabla_{roro,passenger} = 0.38548 * GT + 5256.1$

These approximations are based on the data of ro-ro ships present in the port call data of 2017-2018 winter from the previous project *W18-11 EEDIAssistance*. The same formulas are used in order to have same assumptions in the both projects to maximize the comparability.

2.1.5 SHAFT GENERATORS OR MOTORS

The effect of shaft generators and motors or other energy efficient technologies are not taken into account in the EEDI calculations as the data of these devices is not available.

2.1.6 SPECIFIC FUEL CONSUMPTION

For the sake of simplicity, the specific fuel consumption of each vessel is estimated based on the engine type. The official reference EEDI lines have been calculated with constant 190 g/kWh consumption for main engines and 215 g/kWh for auxiliary engines and similar values are also used in this study.

Following values for specific fuel consumption are used when calculating the EEDI:

- 4-stroke diesel engine = 190 g/kWh
- 2-stroke diesel engine = 175 g/kWh
- 4-stroke dual-fuel engine running on LNG = 160 g/kWh (+ 6 g/kWh for pilot fuel)
- 2-stroke dual-fuel engine running on LNG = 147 g/kWh (+ 6 g/kWh for pilot fuel)
- Auxiliary engines = 215 g/kWh

Different values are used depending on the stroke type of the engine. The reason for this is that two-stroke engines are larger and heavier compared to 4-stroke engines. This affects to the ship parameters and therefore is taken into account in the calculations.

Following carbon content C_F values are used in the calculations:

- LNG = 2.750
- HFO = 3.114

The HFO has been used in the analysis even though the majority of the vessels use distillate fuel. HFO is used in order to have better comparability to the previous research project. The difference to the final outcome would be small as the carbon content of MDO/MGO is higher than for HFO even though the consumption would be smaller.

3 DATA USED IN THE ASSISTANCE ANALYSIS

The assistance analysis is based on two sets of data:

- Port call and assistance data of the Finnish and Swedish ports
- Vessel data from IHS Seaweb database

The vessel data and port call data are combined based on the IMO number of the vessels.

The two data sets are described in more detail in the following subchapters.

3.1 PORT CALL AND ASSISTANCE DATA

Port call data contains the port call data of the Finnish and Swedish ports including icebreaker assistance information during the periods when there have been traffic restrictions due to ice conditions. The data is available for winters 2018-2019 and 2019-20220. The data is obtained from database of the Finnish Transport Infrastructure Agency. Following information is extracted from the port call data (information both for arrival & departure):

- IMO number
- Name of the vessel
- Ice class
- Distance assisted
- Duration of the assistance
- Distance of towing
- Duration of towing
- Distance assisted by more than one icebreaker simultaneously
- Duration of being assisted by more than one icebreaker simultaneously
- Current traffic restriction
- Possible exemption

All distances listed above are based on the AIS information of the merchant vessel.

Only the ports of the northern Baltic Sea are included in this research. The ports are categorized into port groups (same groups as in *W18-11 EEDIAssistance*) based on their geographical position:

- Finland:
    - Area 1 (FIN_1): North of Raahe
    - Area 2 (FIN_2): Raahe – Vaasa
    - Area 3 (FIN_3): Vaasa – Rauma
    - Area 4 (FIN_4): Rauma – Hanko
    - Area 5 (FIN_5): Hanko – Kotka
    - Area 6 (FIN_6): East of Kotka
- Sweden:
    - Area 1 (SWE_1): North of Haraholmen
    - Area 2 (SWE_2): Haraholmen – Umeå
    - Area 3 (SWE_3): Umeå – Söderhamn
    - Area: 4 (SWE_4): Söderhamn – Stockholm

The geographical locations of the port groups are presented in Figure 3-1. A detail list of the ports in each port group is presented in Appendix 1.

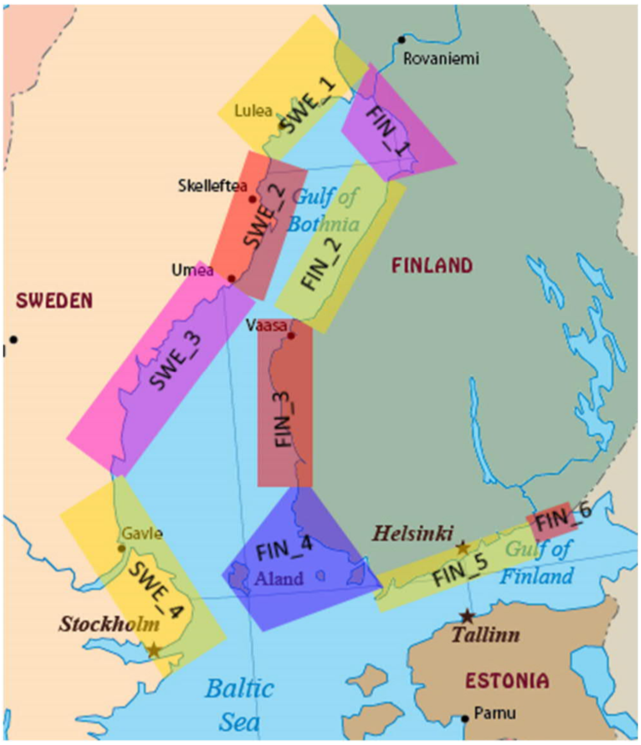


Figure 3-1: A schematic presentation of the geographical locations of the different port groups.

3.2 VESSEL DATA

Vessel data is obtained from IHS Maritime Seaweb database. Following information is gathered:

- IMO number
- Vessel name
- Order Date
- Ship type
- Main particulars: L_{oa}, L_{pp}, B, T
- Deadweight
- Gross Tonnage
- Displacement
- Cargo tank volume
- Service speed
- Main engine power
- Engine stroke type
- Fuel type

In addition, the Finnish-Swedish ice class notation is obtained for the vessels. For new EEDI vessels discussed in chapter 4, ice class is obtained from IHS Seaweb. Otherwise the ice class is obtained from the port call data.

The vessel data is used both for the vessel parameter analysis of chapter 4 as well as for the icebreaker assistance analysis. The vessel data used for assistance analysis is discussed in more detail in the next subchapter.

3.2.1 VESSEL DATA USED FOR THE ICEBREAKER ASSISTANCE ANALYSIS

The above-mentioned vessel data from IHS Seaweb is used to calculate the EEDI index and other ship parameters of all vessels listed in the port call data.

The ships are divided into following categories based on their EEDI compliance:

- **Phase 0 & 1**: new vessels which have been built according to the EEDI regulations.
- **EEDI-compliant:** old vessels which do not need to comply the EEDI regulations based on their age but fulfil the required EEDI (Phase 1).
- **Non-compliant**: old vessels which do not need to comply the EEDI regulations and have larger attained EEDI value than the required EEDI (Phase 1).
- **N/A**: ships which are not part of the EEDI regulations due to their size (cut-off limits) or type.

Only ice classes IA Super, IA, IB, IC are included in the data set and analysis. In addition, only vessels which have visited the ports listed in the previous chapter are included in the analysis and port calls which are done under an exempt are excluded from the analysis.

In Figure 3-3 to Figure 3-6 is presented summaries of the EEDI-compliancy of the different vessels and how the port calls are divided based on the EEDI-compliancy on different winters. In Figure 3-7 to Figure 3-10 is presented how different ship types are represented.

As noticed already in the previous research project *W18-11 EEDIAssistance*, majority of the port calls are conducted by general cargo ships. The size of the merchant vessels is generally small as can be seen from Figure 3-2.

Also, as noticed in the previous work, most of the port calls are done by EEDI compliant vessels. This is because most of the old general cargo vessels fulfil their EEDI requirements. The actual Phase 0 and 1 EEDI vessels are still clearly minority (on winter 2019 3.4% of all port calls by EEDI vessels and 5.3% in winter 2020) but there is some increase since the previous work. The EEDI vessels observed in northern Baltic Sea during past two winters are presented in more detail in the next subchapter.

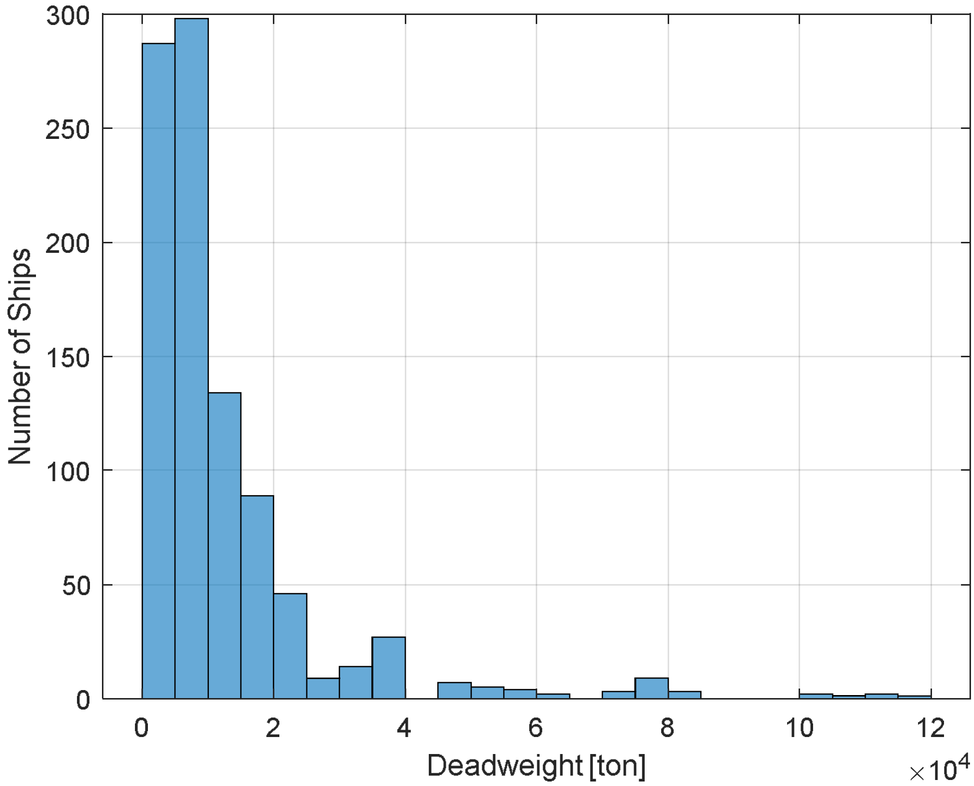


Figure 3-2: Histogram of the size of all ships during the two winters 2019-2020.

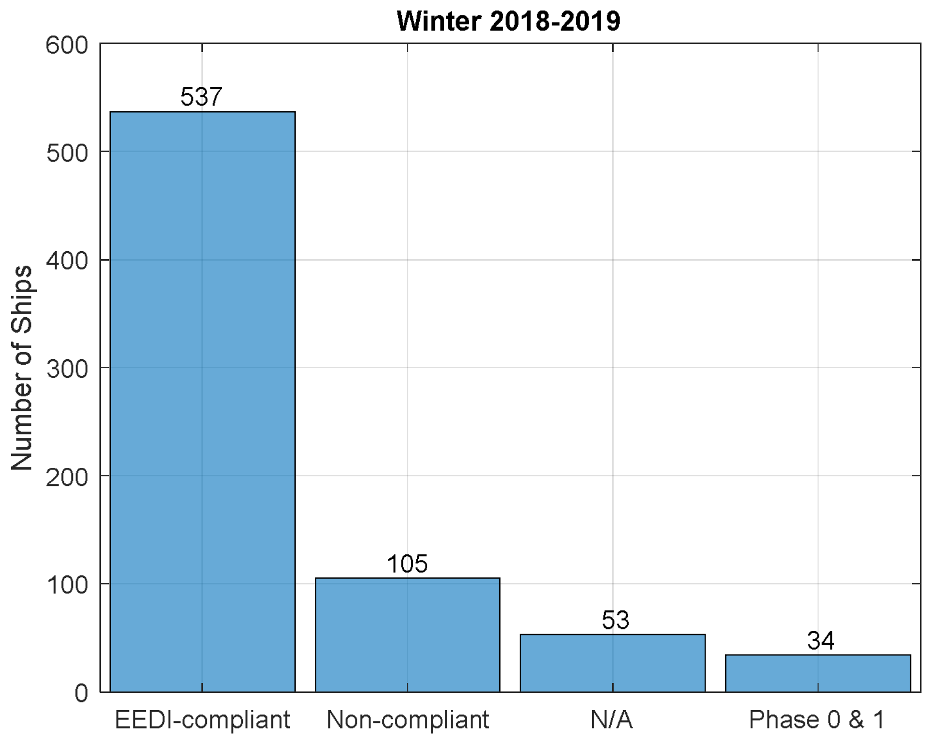


Figure 3-3: Histogram of the EEDI-compliancy of different vessels observed during winter 2018-2019.

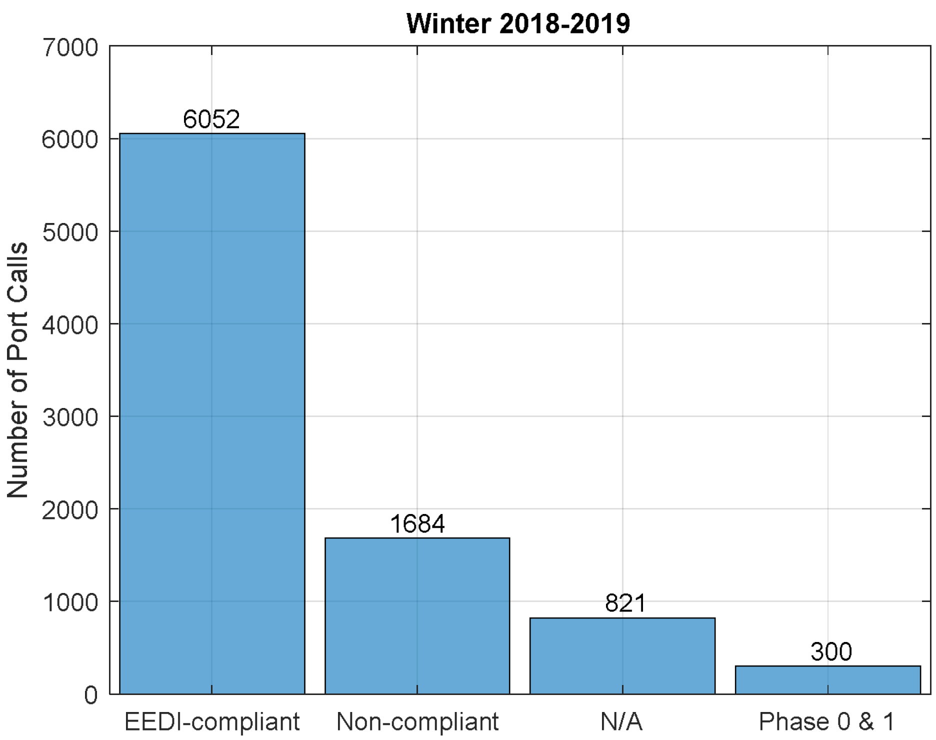


Figure 3-4: Summary on how the port calls are divided based on the EEDI-compliancy on winter 2018-2019.

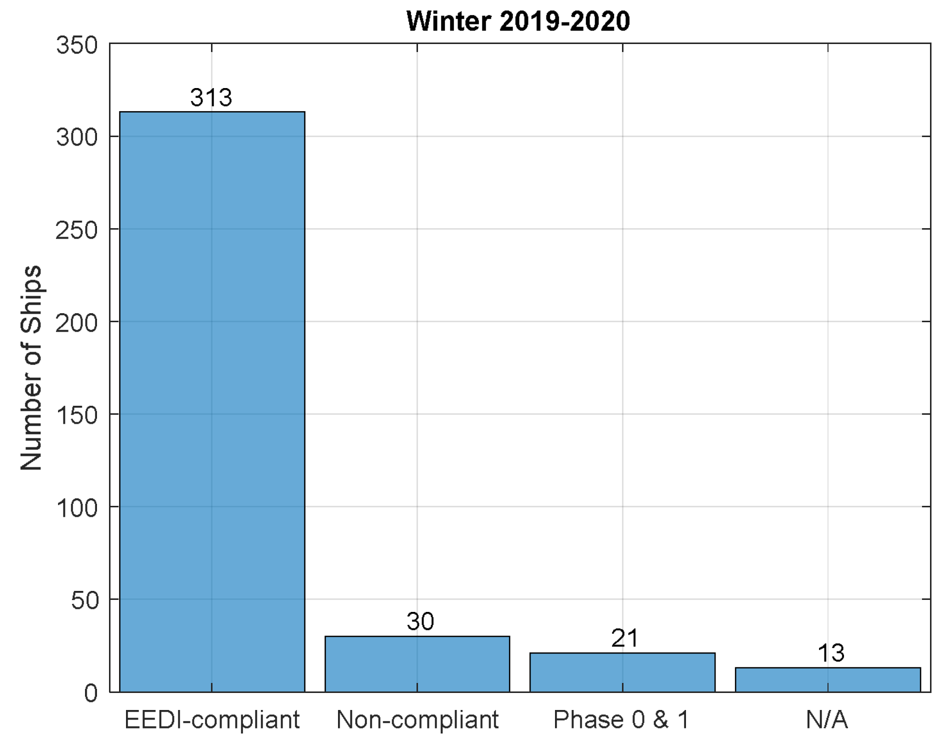


Figure 3-5: Histogram of the EEDI-compliancy of different vessels observed during winter 2019-2020.

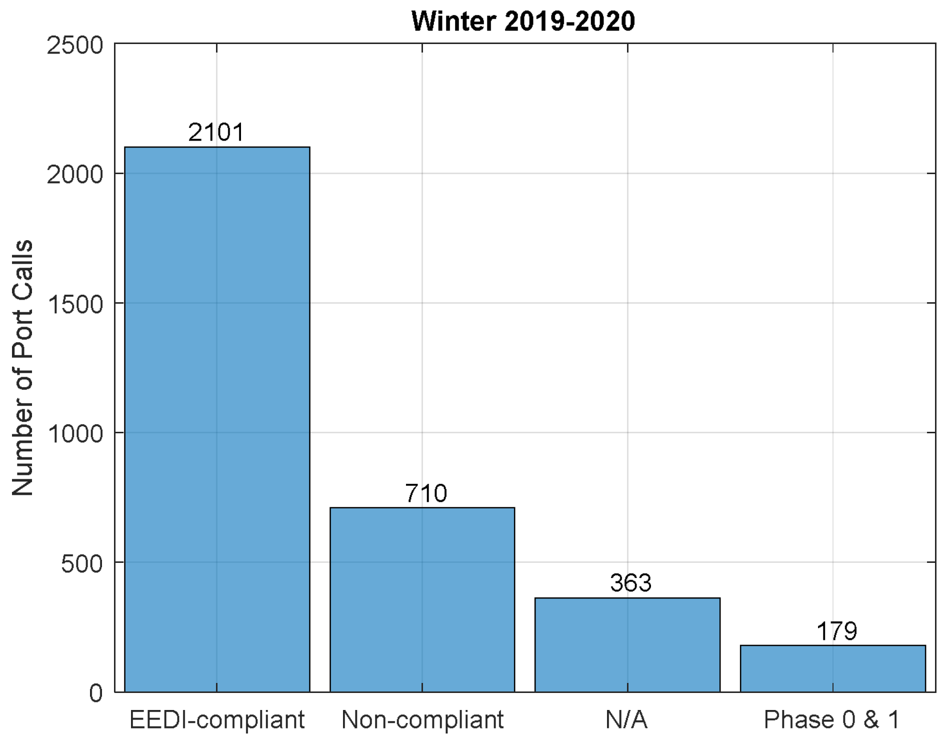


Figure 3-6: Summary on how the port calls are divided based on the EEDI-compliancy on winter 2019-2020.

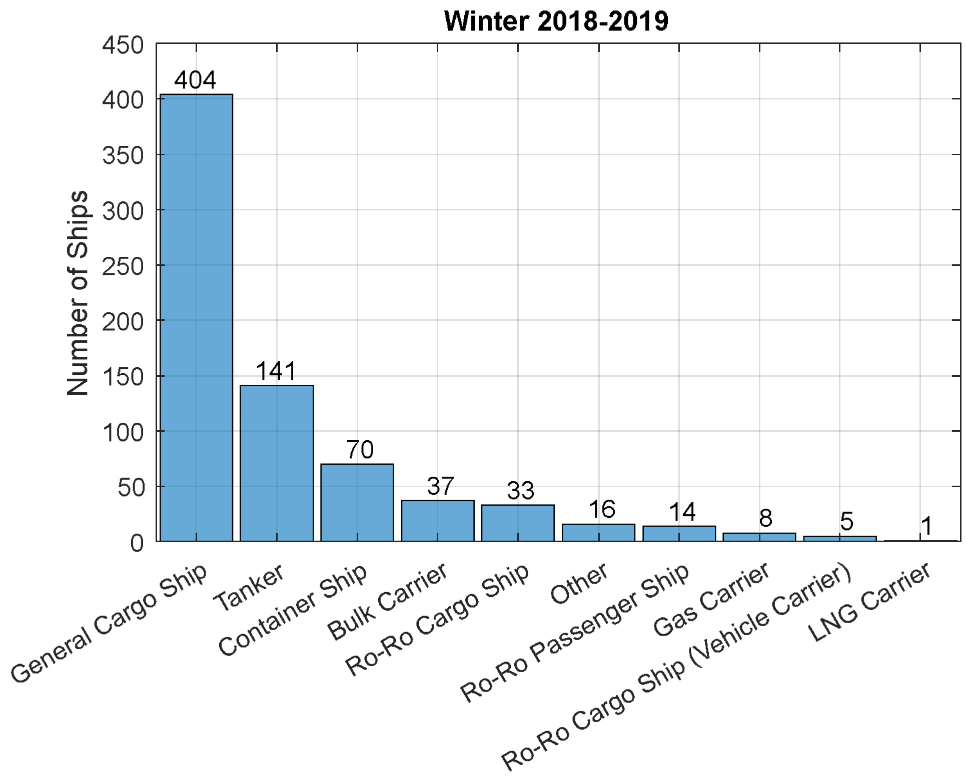


Figure 3-7: Summary of the ship type of different vessels observed during winter 2018-2019.

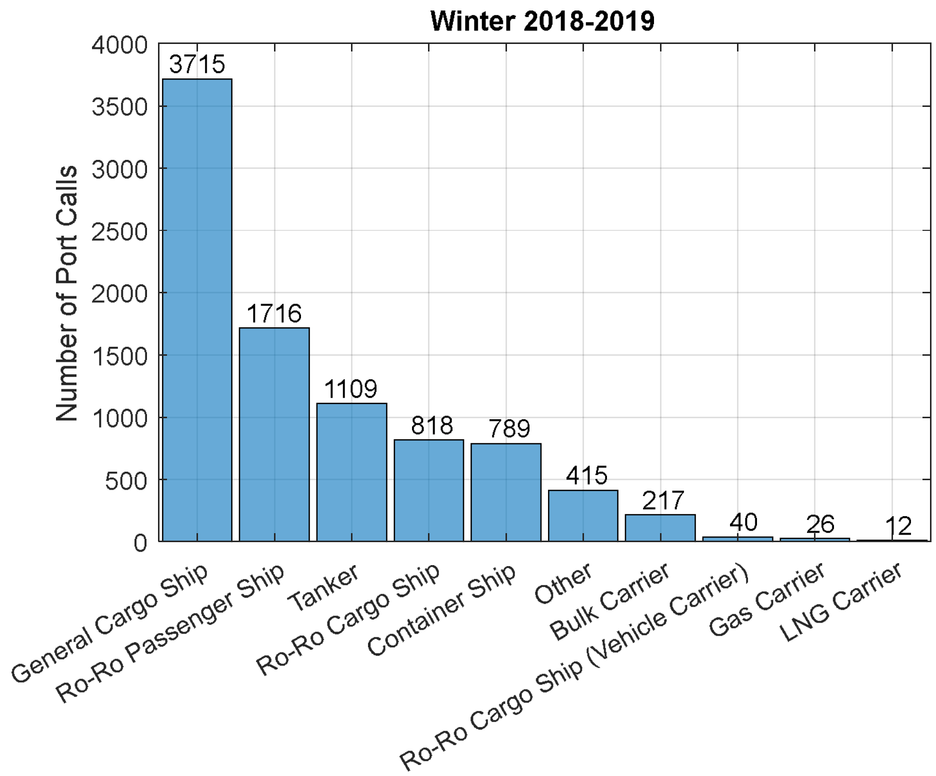


Figure 3-8: Summary on how the port calls are divided based on the ship type on winter 2018-2019.

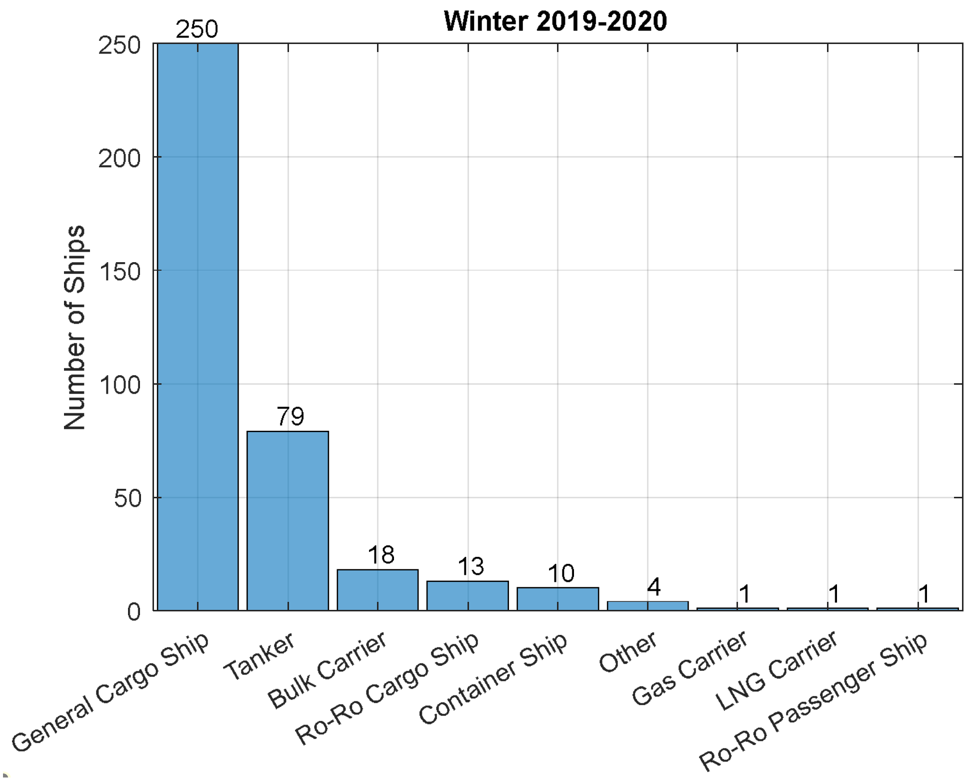


Figure 3-9: Summary of the ship type of different vessels observed during winter 2019-2020.

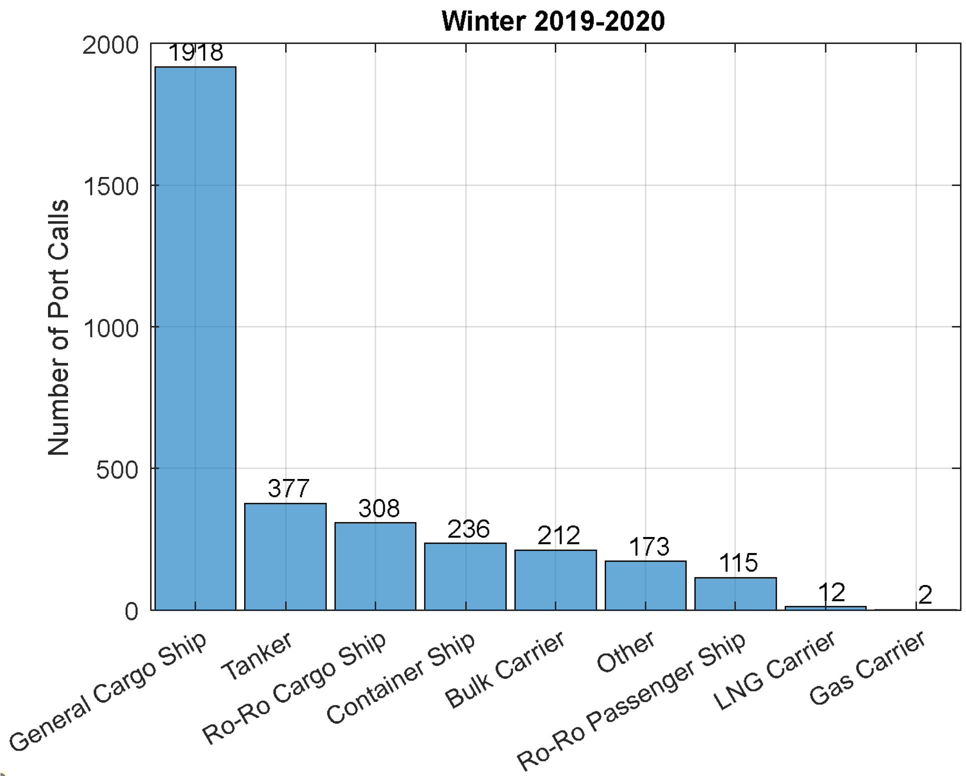


Figure 3-10: Summary on how the port calls are divided based on the ship type on winter 2019-2020.

3.3 EEDI PHASE 0 AND 1 VESSELS

The actual Phase 0 and 1 EEDI vessels are still minority but there is clearly some increase since the previous work. A summary of the different Phase 0 and Phase 1 EEDI vessels observed in northern Baltic Sea during past two winters vessels is presented in Table 3-1.

Table 3-1: Summary of the new Phase 0 & 1 vessels.

EEDI_ShipType	EEDI_Phase	VESSEL_ICECLASS	Built	LengthBP	Breadth	Draught	Deadweight	ServiceSpeed	TotalKWMainEng
Tanker	Phase 0	IA	09-2014	176.0	27.4	11.9	38 734	14	8 502
Bulk Carrier	Phase 0	IC	06-2014	175.0	30.0	10.0	35 900	14.2	6 400
Tanker	Phase 0	IA	10-2014	176.0	27.4	11.9	38 734	14.5	8 502
Tanker	Phase 0	IA	09-2014	176.0	27.4	11.9	38 734	14.5	8 502
Tanker	Phase 0	IA	01-2015	176.0	27.4	11.9	38 734	14.5	8 502
Bulk Carrier	Phase 0	IC	08-2015	177.0	32.0	10.5	38 668	14	6 100
Bulk Carrier	Phase 0	II	11-2015	194.5	32.3	13.3	63 591	14.2	8 050
Bulk Carrier	Phase 0	II	10-2017	194.5	32.3	13.3	63 607	14.4	8 050
Tanker	Phase 0	IB	02-2016	176.0	27.4	11.9	39 070	14.4	7 290
Bulk Carrier	Phase 0	II	11-2015	176.9	30.0	10.6	38 947	14	6 050
Bulk Carrier	Phase 0	IA	02-2015	220.0	32.3	14.4	76 180	14.5	12 000
Bulk Carrier	Phase 0	IA	01-2016	220.0	32.3	14.4	75 800	14.5	12 000
Gas Carrier	Phase 0	IA	06-2016	152.2	25.6	9.5	18 208	15.7	7 170
Gas Carrier	Phase 0	IA	08-2016	152.2	25.6	9.5	18 208	15.7	7 170
Tanker	Phase 0	IB	10-2017	242.0	44.0	15.0	113 039	15	11 820
Gas Carrier	Phase 0	IB	04-2017	152.2	25.6	9.5	19 002	15.5	7 410
General Cargo Ship	Phase 1	IA	09-2016	101.2	13.6	6.1	5 019	10.5	1 650
General Cargo Ship	Phase 1	IA	11-2016	101.2	13.6	6.1	5 019	10.5	1 650
General Cargo Ship	Phase 1	IA	11-2017	186.4	28.5	11.0	37 125	14.8	10 470
General Cargo Ship	Phase 1	IA	12-2017	186.4	28.5	11.0	37 130	14.8	10 470
Container Ship	Phase 1	IA	05-2018	196.0	35.2	11.0	39 938	19	17 279
Container Ship	Phase 1	IA	07-2018	196.0	35.2	11.0	39 964	19	17 279
Tanker	Phase 1	IA	05-2017	243.0	43.8	15.1	112 870	14.5	14 280
Bulk Carrier	Phase 1	IC	01-2017	196.1	32.3	13.0	59 450	14.5	7 550
General Cargo Ship	Phase 1	IA	01-2019	142.0	25.6	8.3	13 300	15	5 750
Tanker	Phase 1	IA	10-2017	116.2	19.4	7.4	9 921	13	3 480
General Cargo Ship	Phase 1	IA	01-2019	142.0	25.6	8.3	14 013	15	5 750
Tanker	Phase 1	IB	09-2017	174.0	32.2	13.3	49 990	14	9 230
General Cargo Ship	Phase 1	IA	09-2018	157.1	26.0	10.0	25 532	14	6 000
General Cargo Ship	Phase 1	IA	08-2018	157.0	26.0	10.0	23 650	14	6 000
Tanker	Phase 1	IA	08-2018	150.9	23.8	9.5	17 500	13	6 000
Tanker	Phase 1	IA	10-2018	151.0	23.8	9.5	17 500	13	6 000
Tanker	Phase 1	II	06-2018	134.0	22.0	9.1	16 258	13.5	4 830
General Cargo Ship	Phase 1	IA	04-2017	146.9	15.9	8.6	14 330	11.5	2 999
General Cargo Ship	Phase 1	IB	06-2017	84.9	15.2	5.7	4 800	10.5	1 850
Tanker	Phase 1	IA	08-2018	149.1	23.8	9.8	19 884	13	5 500
Tanker	Phase 1	IA	10-2018	149.1	23.8	9.8	19 881	13	5 500
General Cargo Ship	Phase 1	IA	02-2018	85.0	14.8	6.7	4 938	10.5	1 600
Tanker	Phase 1	IA	05-2019	112.3	15.9	7.0	7 999	13.5	2 999
General Cargo Ship	Phase 1	IA	11-2017	85.0	13.4	7.2	5 790	12	1 950
General Cargo Ship	Phase 1	IA	02-2018	100.6	13.4	6.9	6 706	12	1 950
Tanker	Phase 1	IA	08-2018	107.5	18.0	7.1	7 746	14	3 600
General Cargo Ship	Phase 1	IA	05-2018	186.4	28.5	11.0	37 077	15	10 470
Tanker	Phase 1	IA	06-2019	125.7	19.7	8.2	10 543	12.5	4 320
Tanker	Phase 1	IA	10-2019	125.8	19.6	8.2	10 501	12.5	4 320
Bulk Carrier	Phase 1	IAS	09-2019	241.8	43.0	14.5	104 553	14.5	18 620
Bulk Carrier	Phase 1	IAS	10-2019	241.7	43.0	14.5	104 555	14.5	18 620

Total of 48 different Phase 0 & 1 compliant vessels have visited the Finnish and Swedish ports during the previous two winters. This more than double the amount to the previous research project (23).

4 PARAMETERS OF NEW EEDI VESSELS AND OLDER PRE-EEDI VESSELS

This chapter presents the current fleet of EEDI compliant ice-classed merchant vessels. The parameters of these new EEDI vessels are compared to older vessels which have been built before EEDI-requirements (referred as *pre-EEDI vessels* or *Old vessels*) which have been observed operating in the northern Baltic Sea during recent winters. This allows to do the comparison between new vessels and old vessels which are at least in principle designed for the transportation task and environmental condition relevant present in northern Baltic Sea during winter periods.

All vessel information is obtained from IHS Maritime Sea-web database. It is possible that both data sets could contain cargo vessels which would not have an EEDI requirement based on their icebreaking capability (at least 2 knots speed in 1.0 m level ice thickness). However, such icebreaking cargo vessels have been tried to manually recognize and remove from the data.

4.1 EEDI COMPLIANT VESSELS

The list of existing EEDI compliant vessels is presented in this chapter. The IHS Maritime Sea-web database does not directly contain information of the vessels' EEDI number nor phase. The EEDI requirement/phase is determined based on the ship type, order date and deadweight/GT of the vessel as described in Marpol Annex VI, regulation 21 (summary in Table 2-1). As the EEDI phase is based on secondary information instead of actual EEDI information, small errors in the data are possible.

Total of 421 ice-classed EEDI-compliant vessels are available. 336 of these are in currently in service. Statistics of the vessels are presented Table 4-1, Figure 4-1 and Figure 4-2.

Table 4-1: Summary of the ice-classed EEDI-compliant vessels.

	IAS	IA	IB	IC	PC6	PC7
Bulk carrier	-	7	4	94	3	-
Gas carrier	-	2	4	2	-	-
Tanker	-	67	39	37	-	2
Container ship	3	20	-	12	-	-
General cargo ship	-	38	2	35	-	-
Refrigerated cargo carrier	-	-	6	-	-	-
Ro-ro cargo ship	7	4	-	4	-	-
Ro-ro passenger ship	1	4	4	15	-	-
Cruise passenger ship having non-conventional propulsion	-	-	-	5	-	-

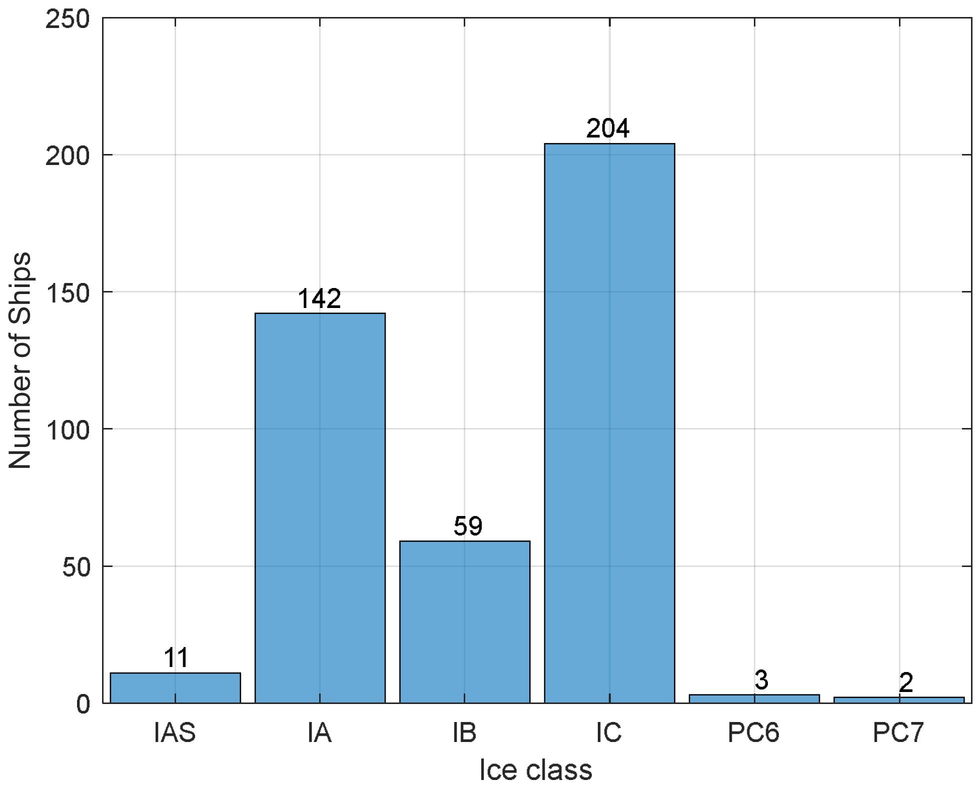


Figure 4-1: Summary of the new EEDI-compliant vessels' ice classes.

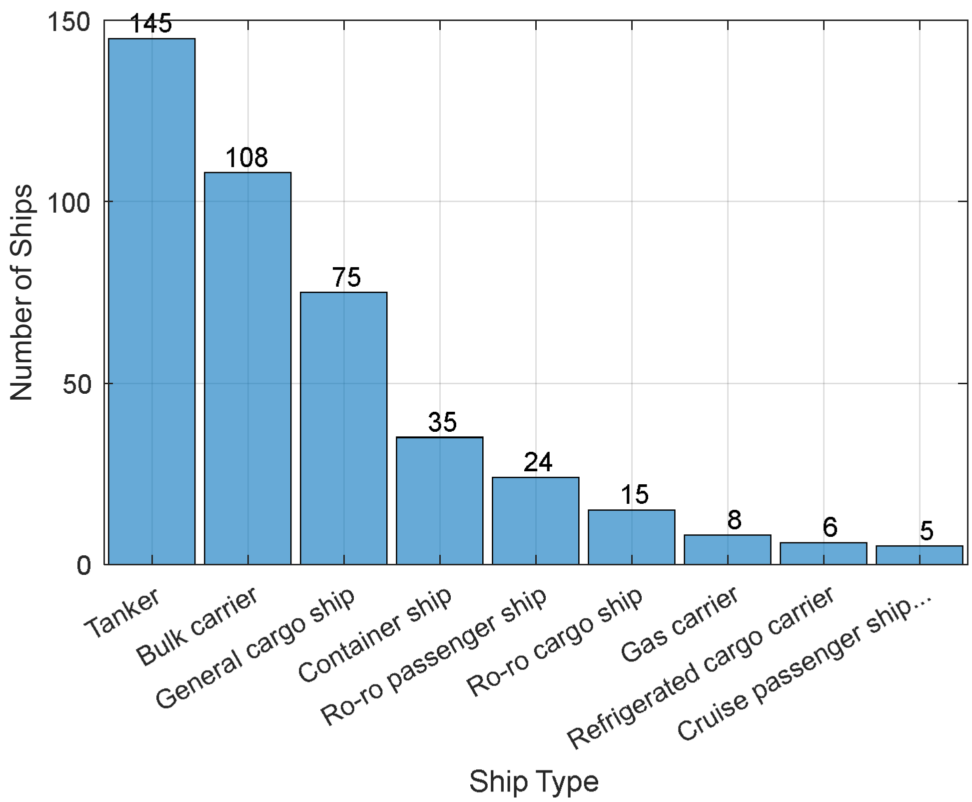


Figure 4-2: Summary of the ice classed EEDI-complaint vessels' ship types.

4.2 PRE-EEDI VESSELS

The data set of older pre-EEDI vessels contains vessels which have been observed in the port call data of the previous project *W18-11 EEDIAssistance* (winters 2016-2018) and in the port call data of this project from two previous winters 2019-2020. The data set contains only vessels which have visited ports described in chapter 3.1 during periods with traffic restrictions. Only the ship types which have EEDI requirements are included in the data set of pre-EEDI vessels. In addition, the data set has been limited by deadweight based on the cutoff limits of the EEDI regulations (Table 2-1) so that the data set contains only vessels which could have an reference EEDI value.

Table 4-2: Summary of the older ice-classed pre-EEDI vessels which have visited ports of the northern Baltic Sea during winters 2016-2018.

	IAS	IA	IB	IC
Bulk Carrier	1	9	2	33
Gas Carrier	-	7	5	4
Tanker	21	171	30	21
Container Ship	14	89	1	-
General Cargo Ship	10	499	103	36
LNG Carrier	-	1	-	-
Ro-Ro Cargo Ship (Vehicle Carrier)	-	-	-	1
Ro-Ro Cargo Ship	30	26	-	-
Ro-Ro Passenger Ship	22	9	2	-

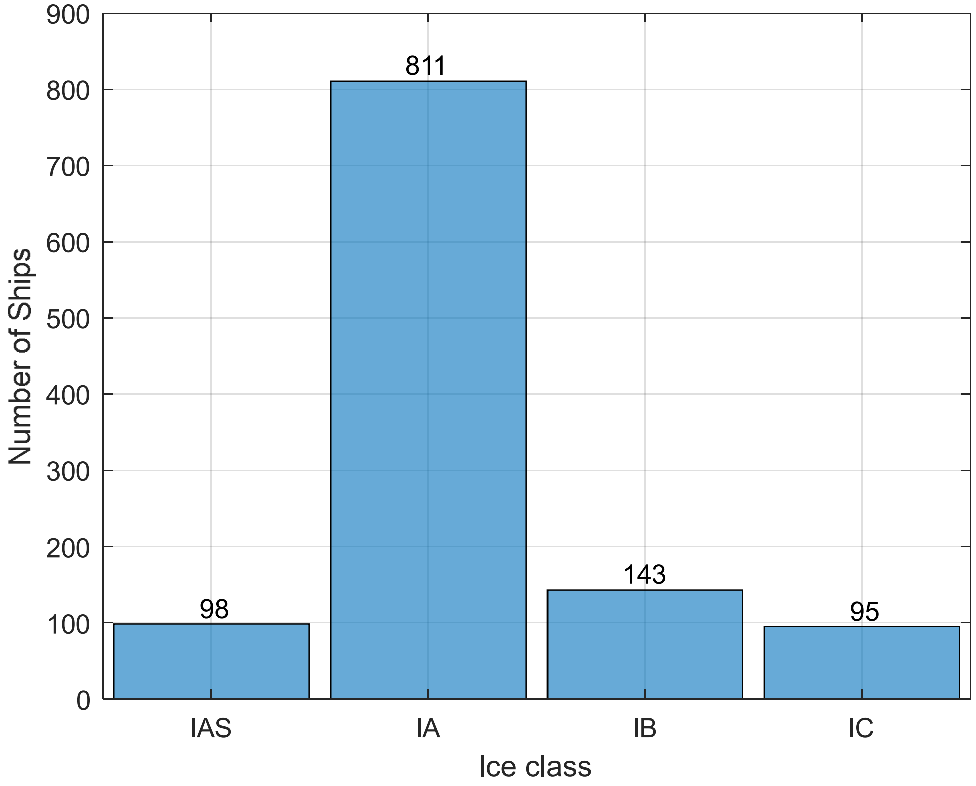


Figure 4-3: Summary of the pre-EEDI vessels' ice classes.

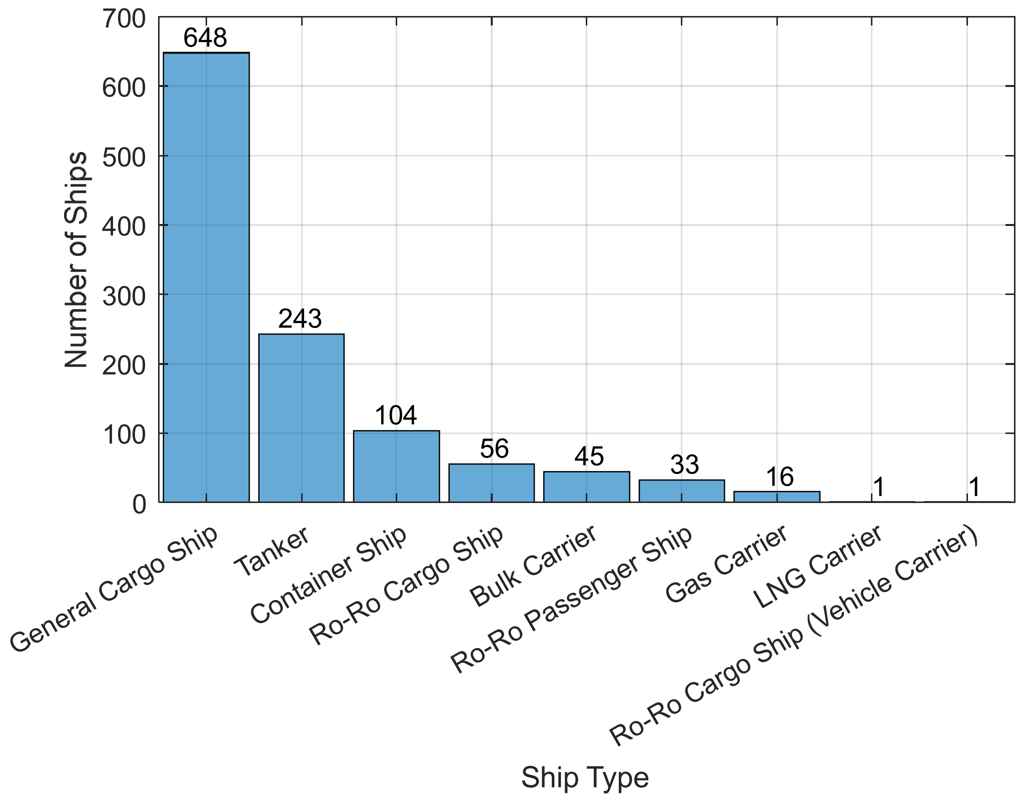


Figure 4-4: Summary of the pre-EEDI vessels' ship types.

4.2.1 EEDI VALUES FOR THE PRE-EEDI VESSELS

This chapter presents the calculated EEDI values for the pre-EEDI vessels in order to have reference information how close the older vessels are to the EEDI requirements. The EEDI values are calculated with methods described in chapter 2.1.

The calculated EEDI values for different vessel types of the data set are presented in Figure 4-5 through Figure 4-12. It should be noted that the figures contain also vessels which are below the deadweight cut-off limits. This is done in order to have information also about the energy-efficiency of the smaller vessels which are common in the Baltic Sea.

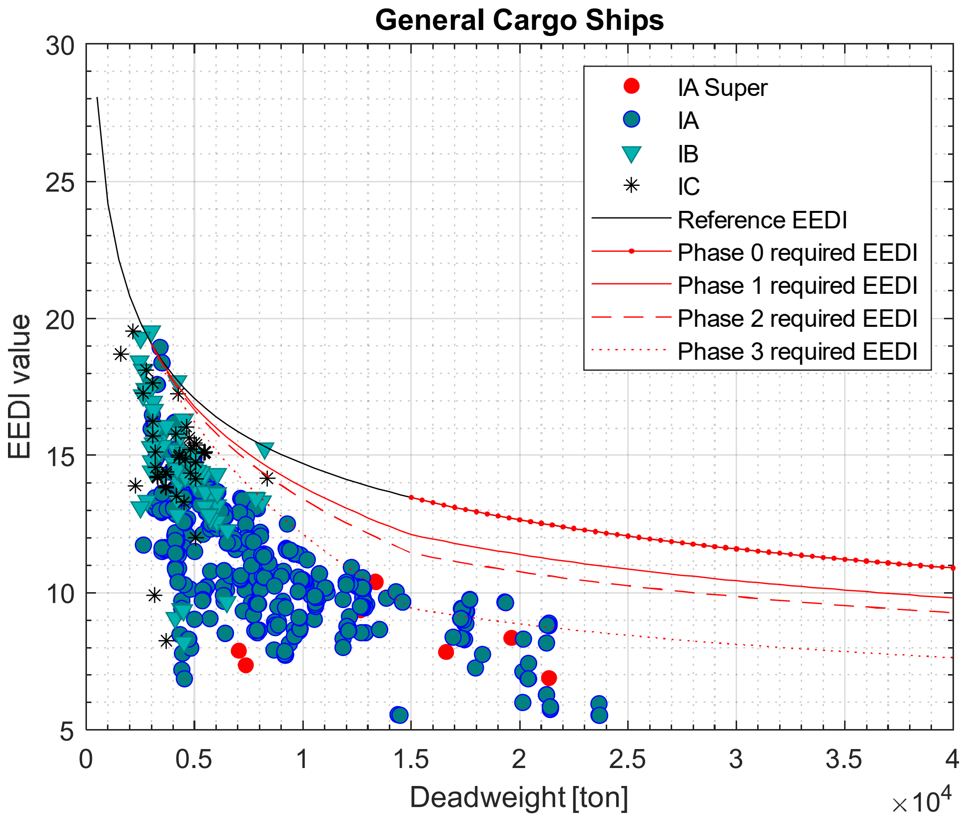


Figure 4-5: Calculated EEDI values of the general cargo ships in the data set.

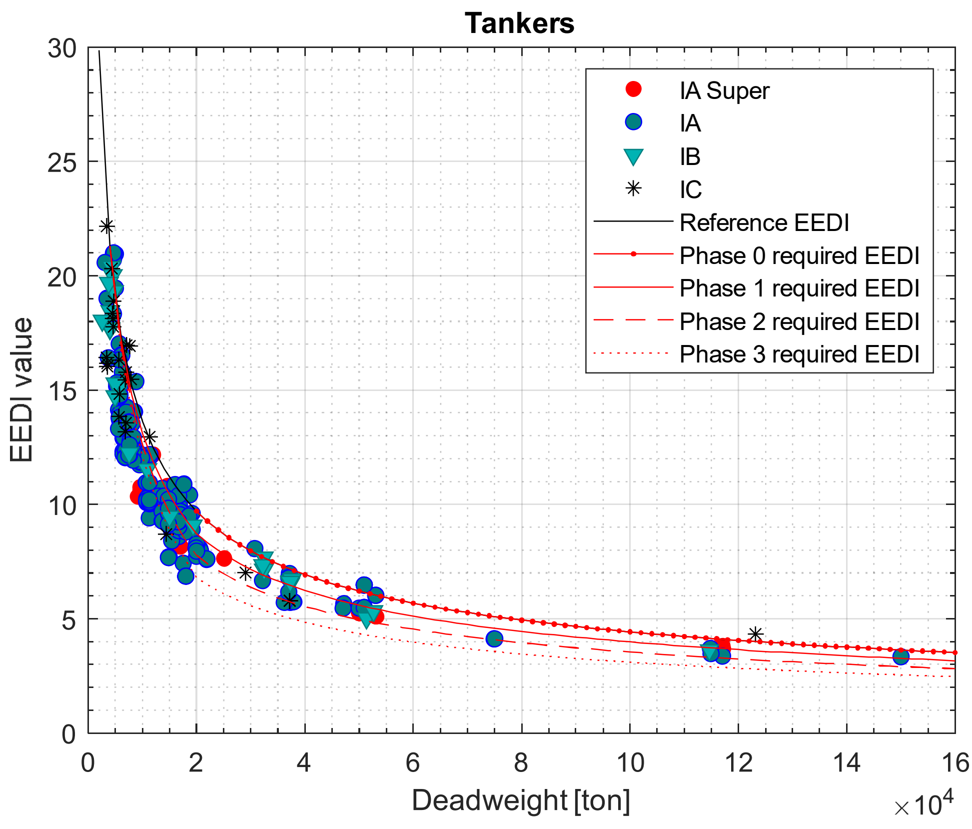


Figure 4-6: Calculated EEDI values of the tankers in the data set.

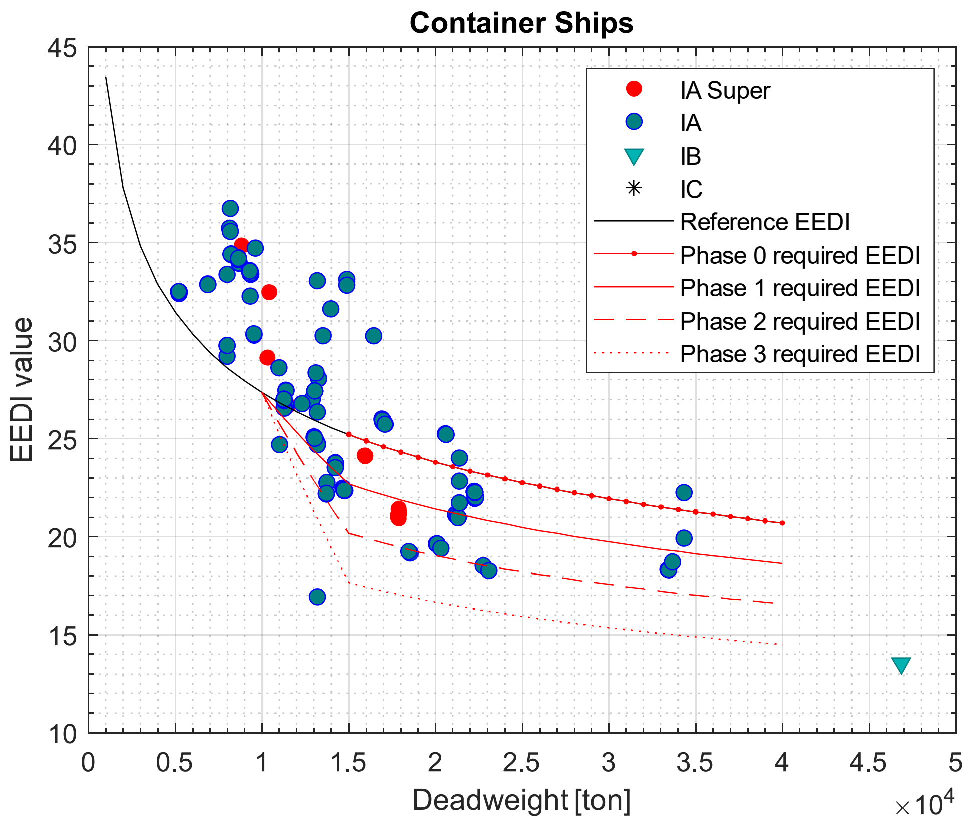


Figure 4-7: Calculated EEDI values of the container ships in the data set.

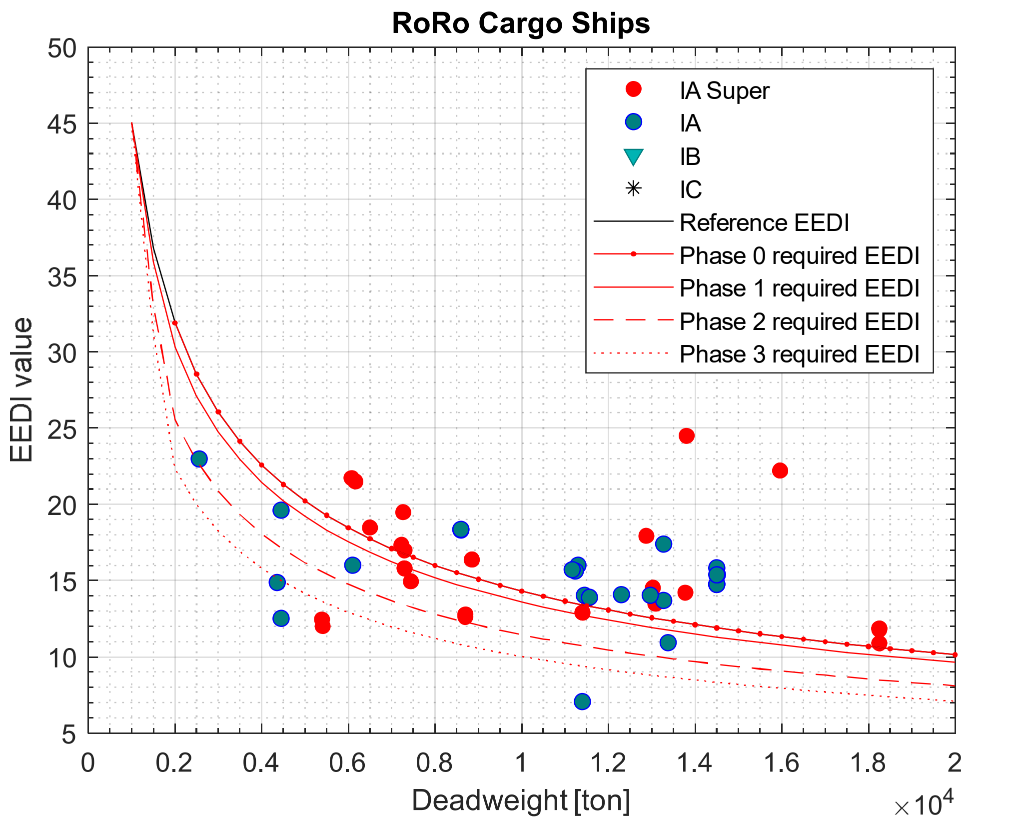


Figure 4-8: Calculated EEDI values of the RoRo cargo ships in the data set.

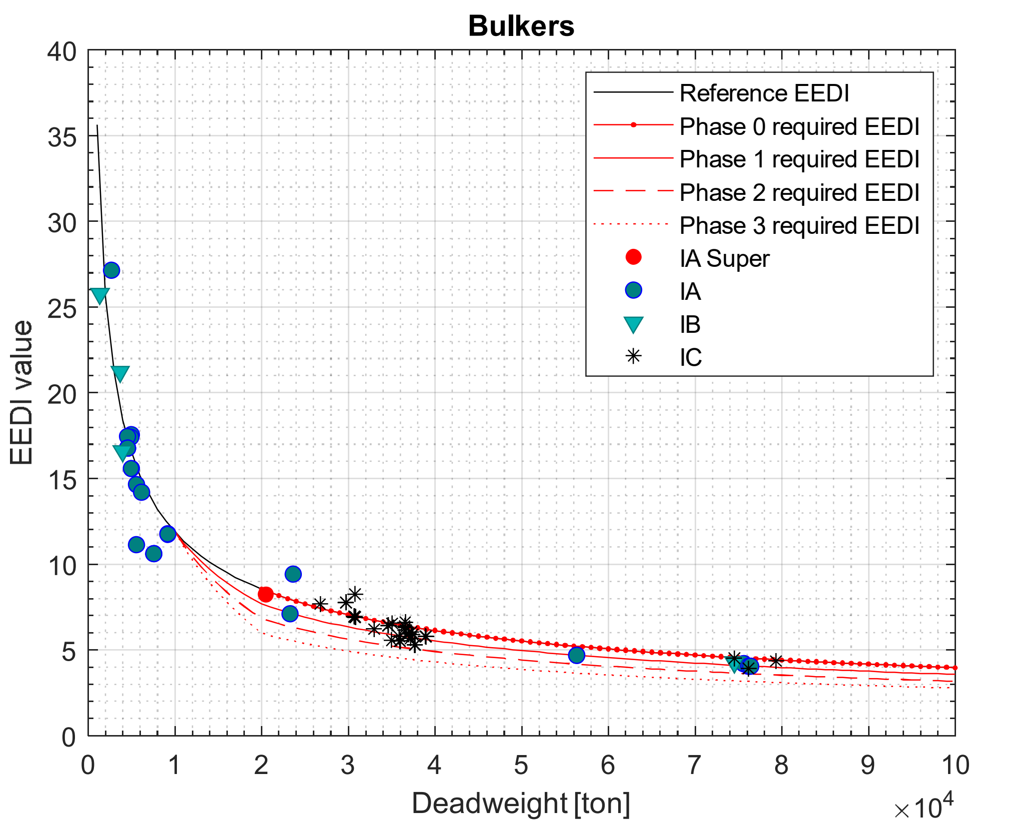


Figure 4-9: Calculated EEDI values of the bulk carriers in the data set.

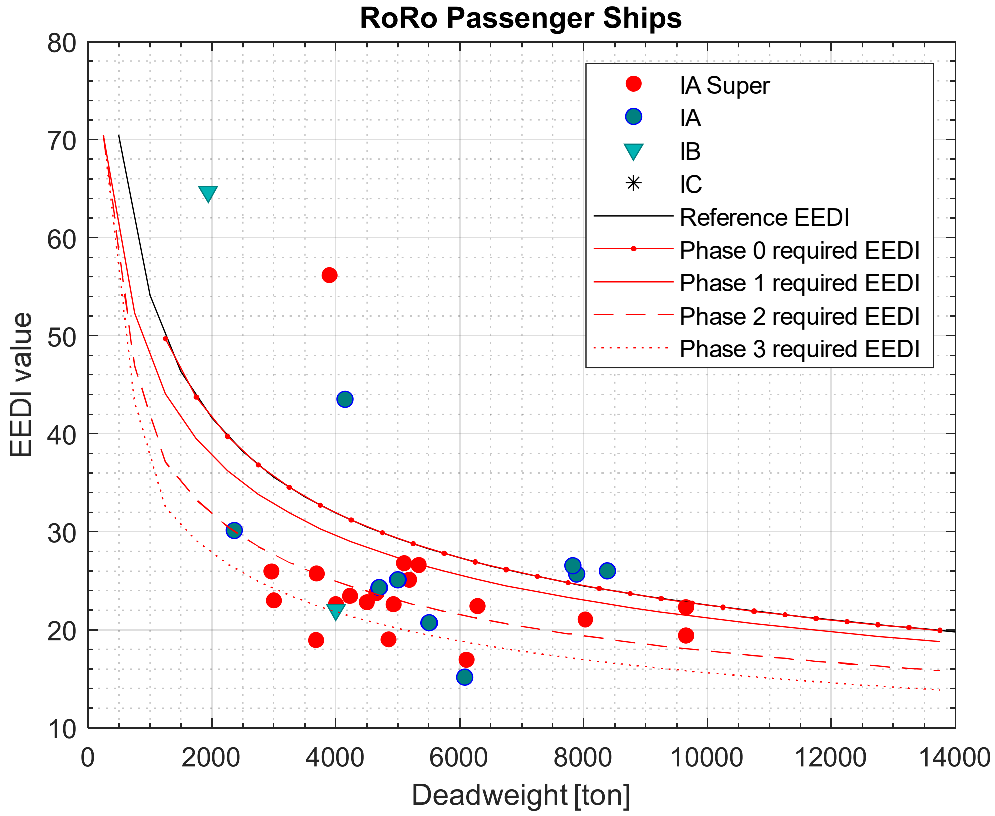


Figure 4-10: Calculated EEDI values of the RoRo passenger ships in the data set The three vessels with clearly higher EEDI value are built in the 1970's.

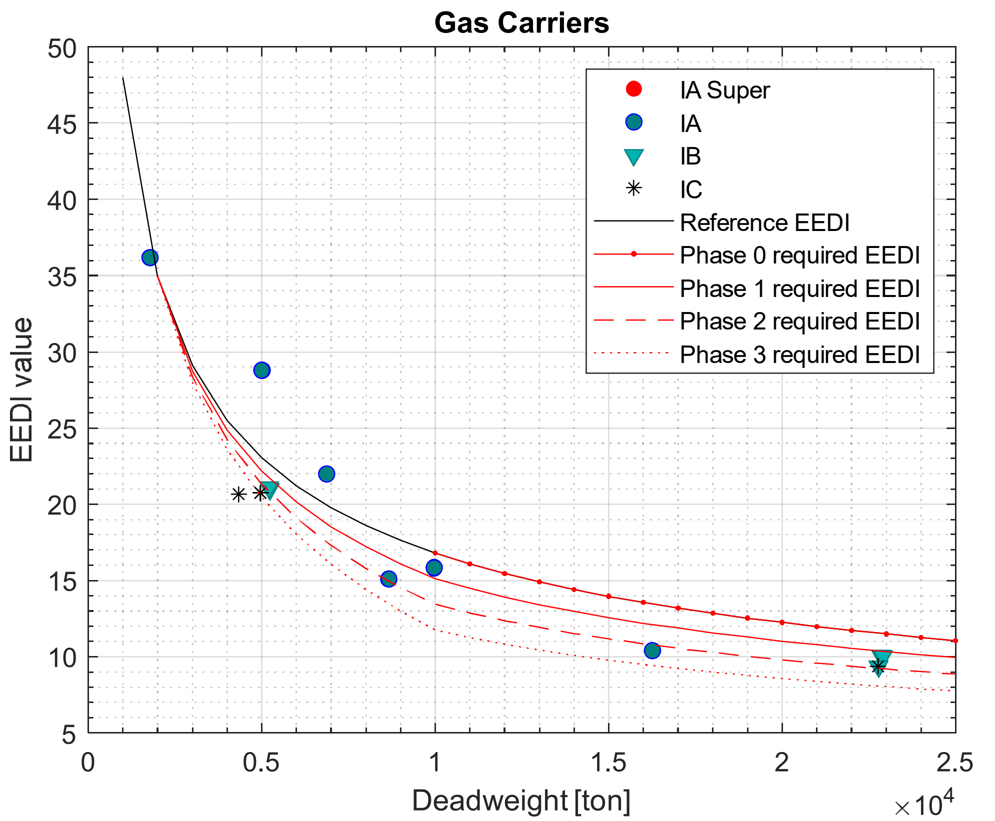


Figure 4-11: Calculated EEDI values of the gas carriers in the data set.

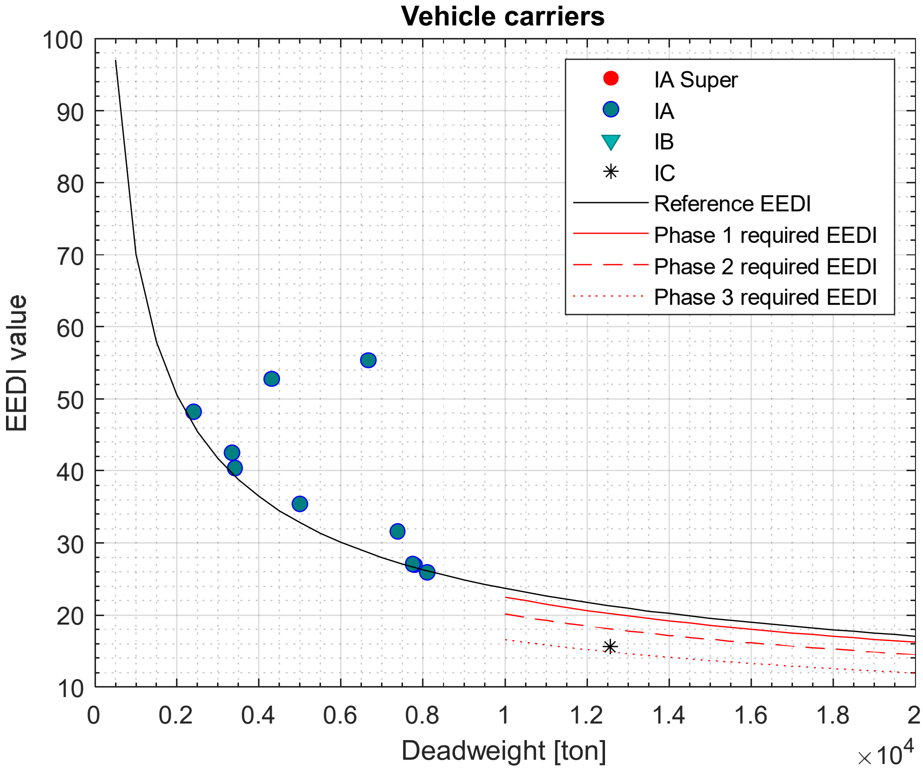


Figure 4-12: Calculated EEDI values of the vehicle carriers in the data set.

4.3 COMPARISON OF VESSEL PARAMETERS BETWEEN EEDI VESSELS AND OLDER PRE-EEDI VESSELS

From chapters 4.1 and 4.2 it can be seen that the new EEDI compliant ice classed vessels are differently weighted than the pre-EEDI vessels: majority of the new vessels are built to ice class IC while majority of the pre-EEDI vessels operating in the northern Baltic Sea during winter time have ice class IA. General cargo ships are the dominant ship type for the older vessels while the Bulk Carriers and tankers are most common new ships. This makes the comparison of the vessel parameters difficult as either new or old ships have very few references. Therefore, it is not possible to do the comparison for all ship types with all ice classes as this could result into distorted conclusions due to too few samples.

The comparison has been done for ship type and ice class combinations which have more than 10 samples:

- General cargo ships with ice-classes IA and IC
- Tankers with ice-classes IA, IB and IC
- Container ships with ice-class IA
- Bulk carriers with ice-class IC

The cases in which the some of the investigated parameter has been missing from ship data have been disregarded in the subchapters below. The pre-EEDI vessels are referred as “Old ships” in the figure legends of the following subchapters.

4.3.1 POWER-DEADWEIGHT RATIO

Power-deadweight ratio is an important parameter related to the vessel's ice-going capability as it describes how powerful the vessel is in relation to its size. This ratio is often used by the icebreaker crews to estimate ice-going capability of the assisted merchant vessel. From the figures below it can be seen that the powers are dropping especially for IA ice-classed vessels which are the most relevant for the winter navigation system. For example, for IA general cargo ships which are most common merchant vessels observed in the northern Baltic sea, the new EEDI vessels have P/DWT ratio of 0.33 kW/ton while the pre-EEDI vessels have ratio of 0.48 kW/ton which means approximately 30% reduction.

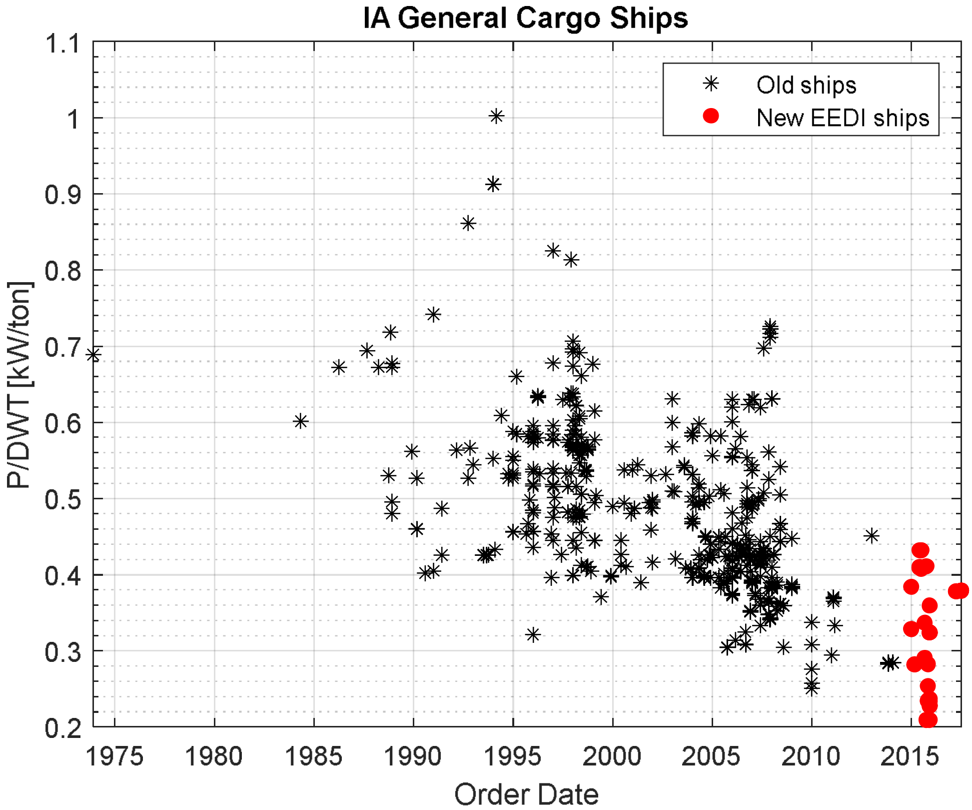


Figure 4-13: Power-deadweight ratio of the IA general cargo ships.

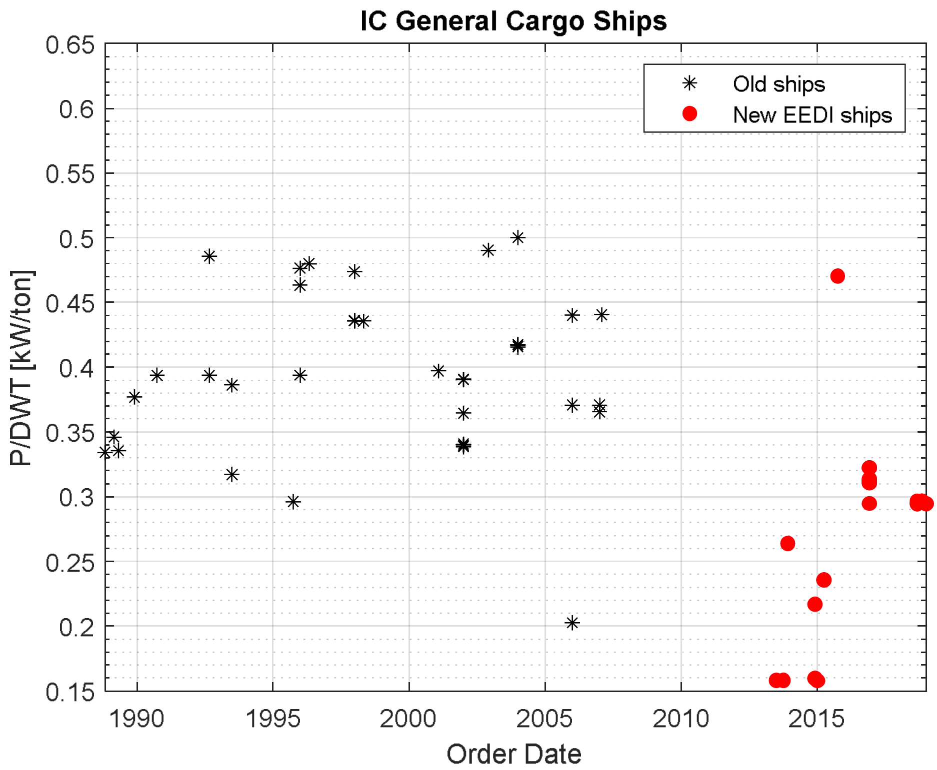


Figure 4-14: Power-deadweight ratio of the IC general cargo ships.

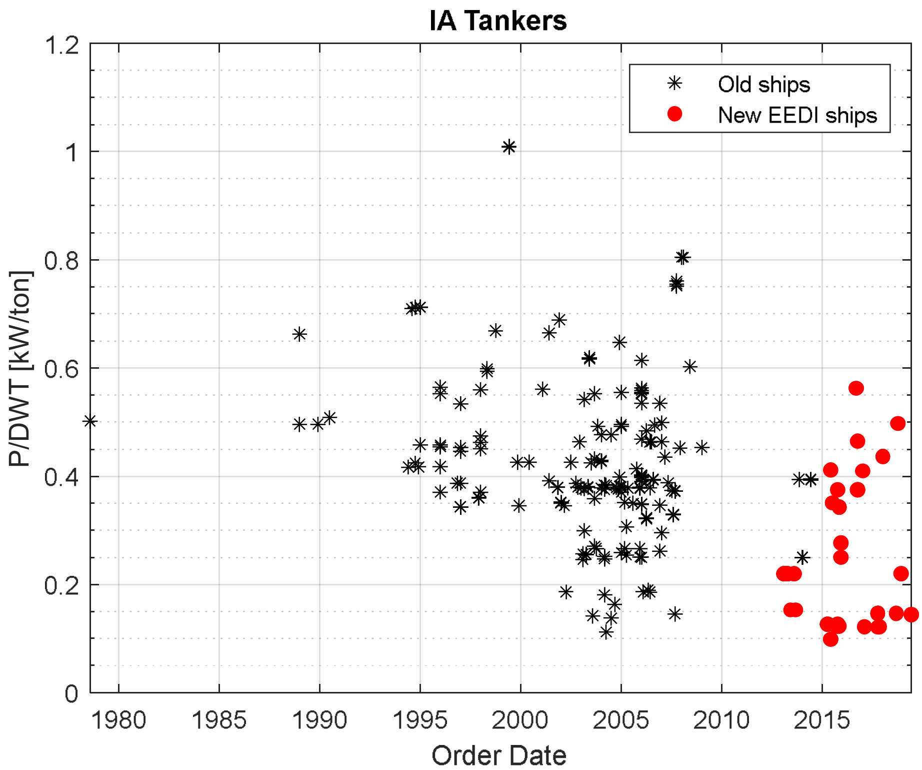


Figure 4-15: Power-deadweight ratio of the IA tankers.

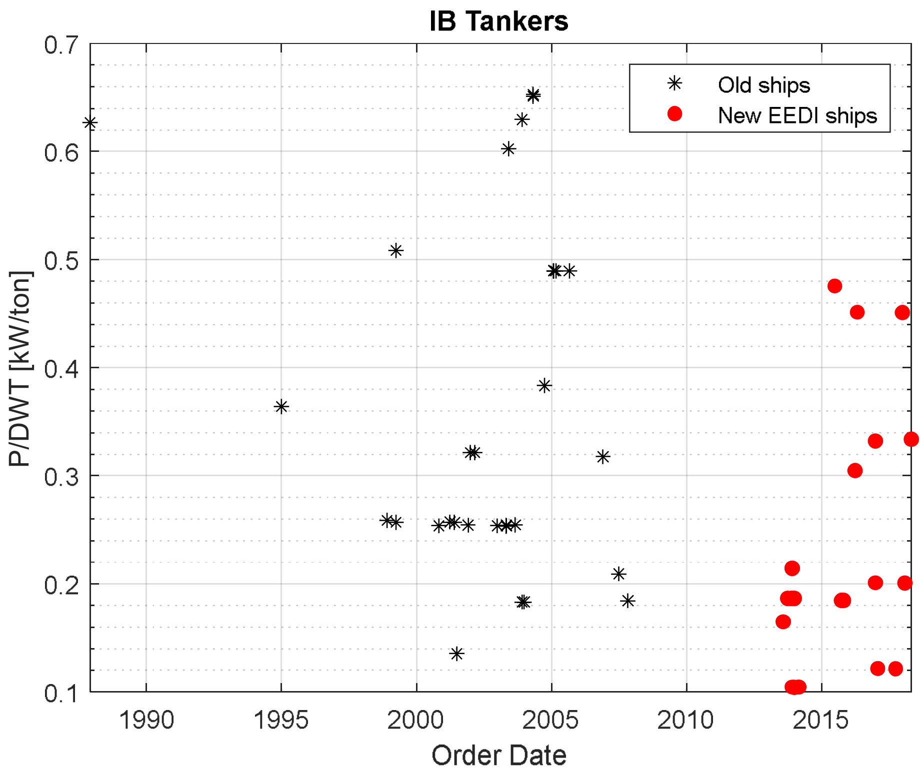


Figure 4-16: Power-deadweight ratio of the IB tankers.

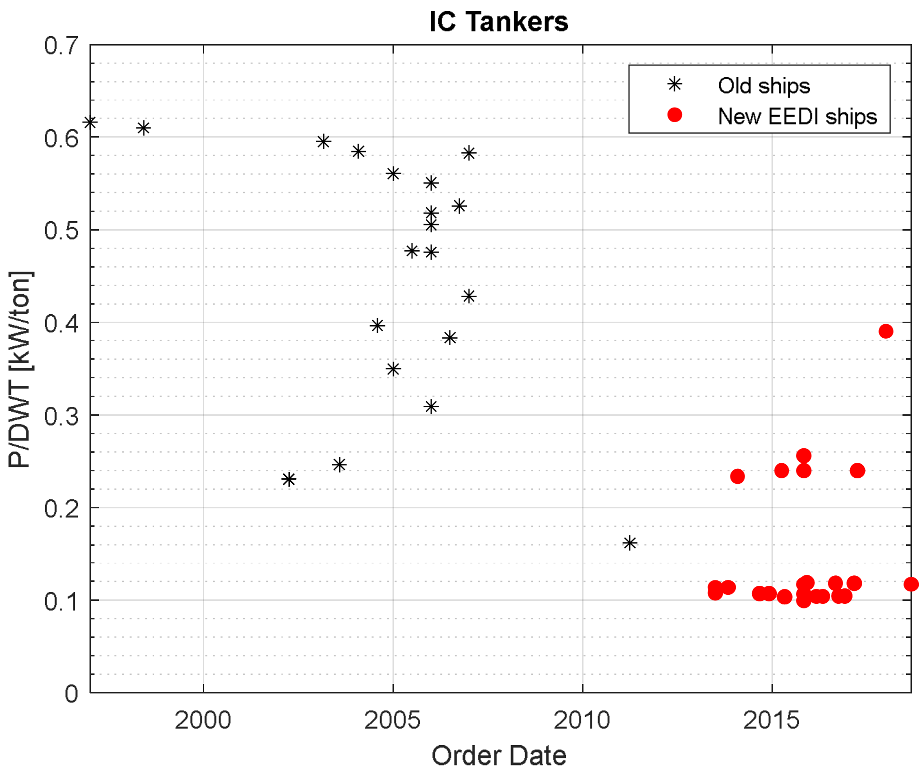


Figure 4-17: Power-deadweight ratio of the IC tankers.

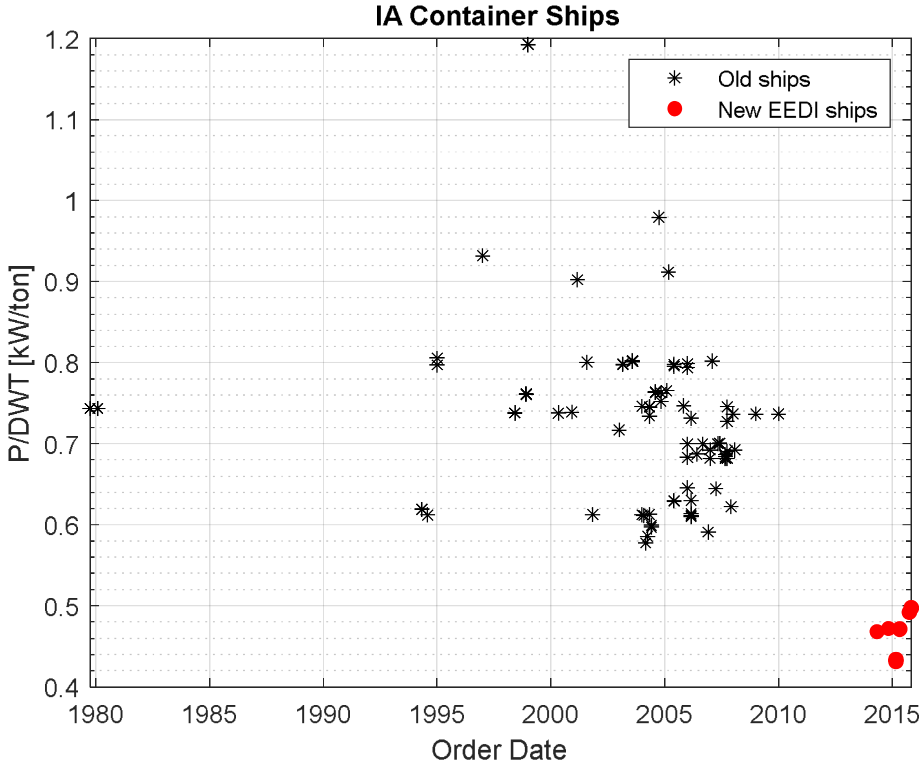


Figure 4-18: Power-deadweight ratio of the IA container ships.

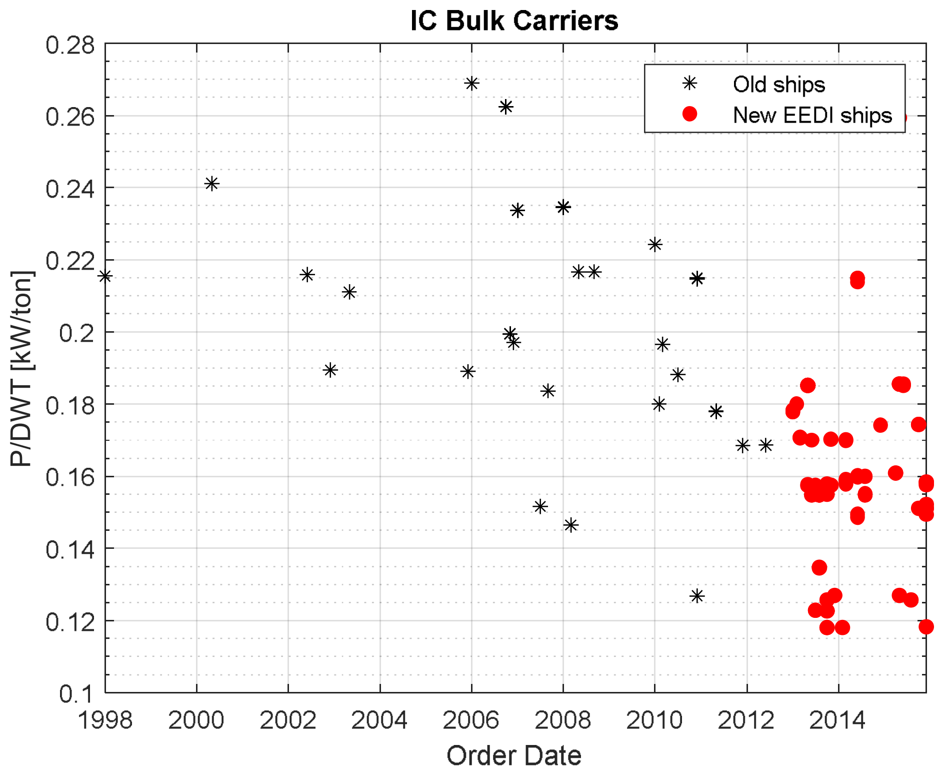


Figure 4-19: Power-deadweight ratio of the IC bulk carriers.

4.3.2 SERVICE SPEED

Service speed is not directly connected to the ice-going capability of the vessel. However, it gives indications whether the lower installed power is related to reduced speeds or more efficient hull-form. The hull-form of the vessel is likely to be more open-water optimized if the vessel is able to achieve the same service speed with lower power level compared to other vessels. From the figures below there is no clear trend indicating that the service speeds of the new EEDI vessels would be distinctively lower.

It should be noted that the service speed is not necessarily defined similarly for all vessels in the IHS sea-web.

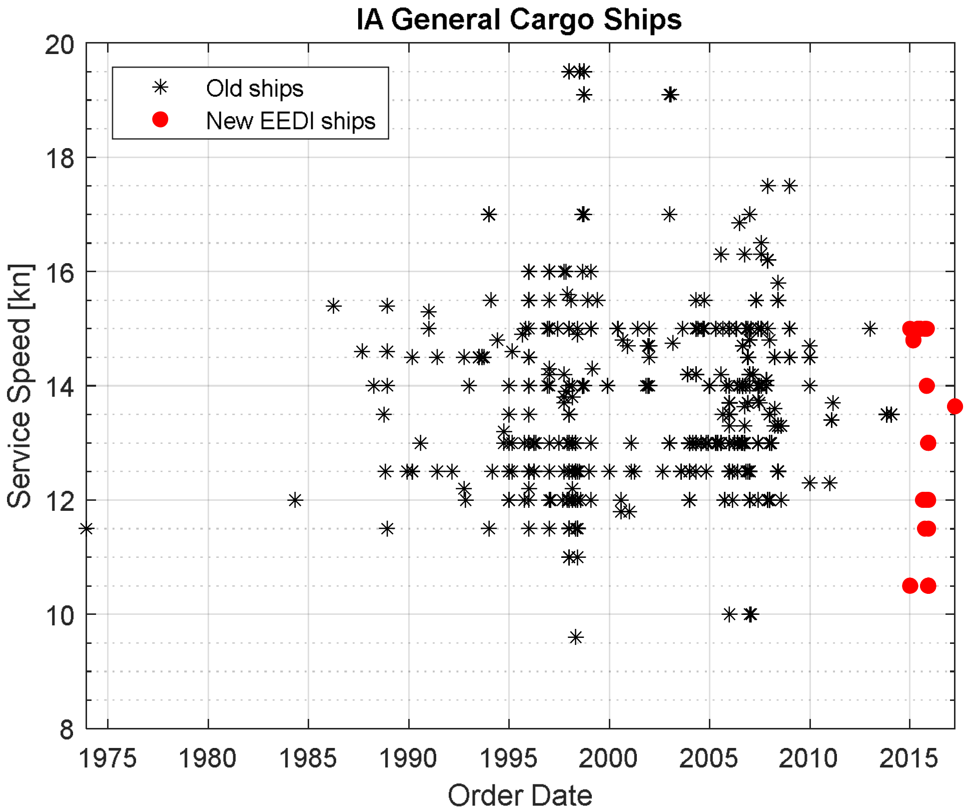


Figure 4-20: Service speed of the IA general cargo ships.

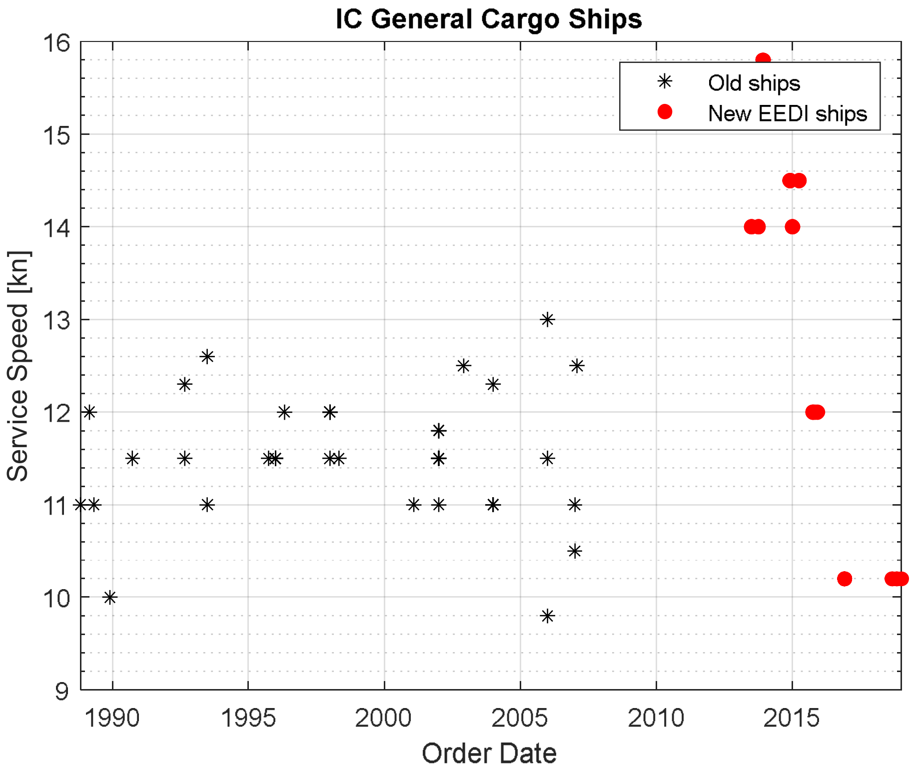


Figure 4-21: Service speed of the IC general cargo ships.

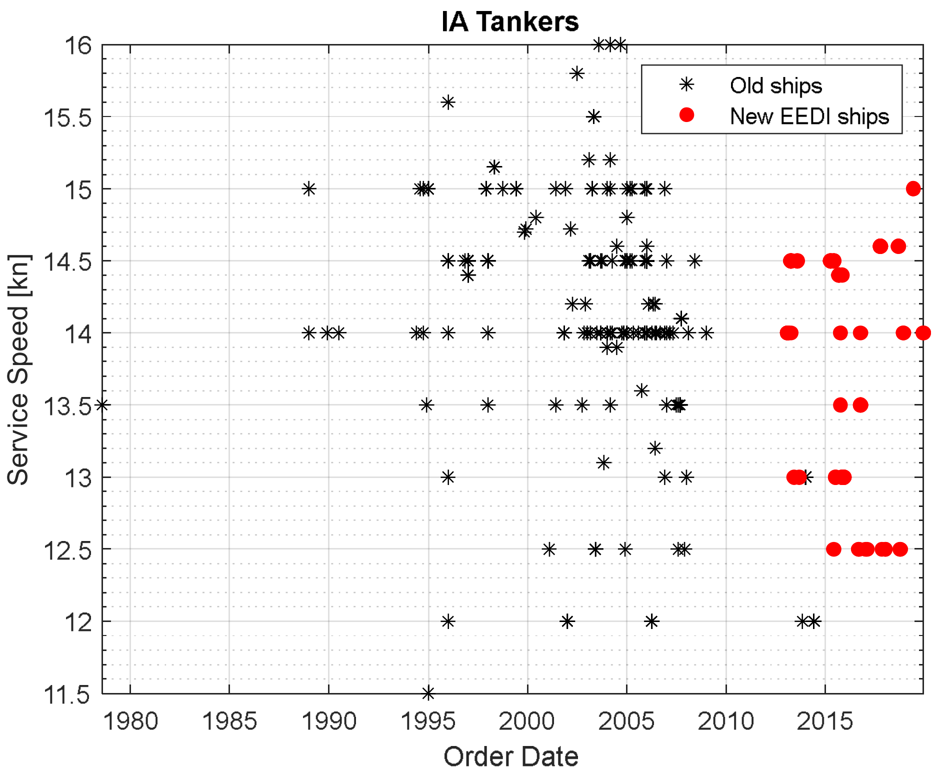


Figure 4-22: Service speed of the IA tankers.

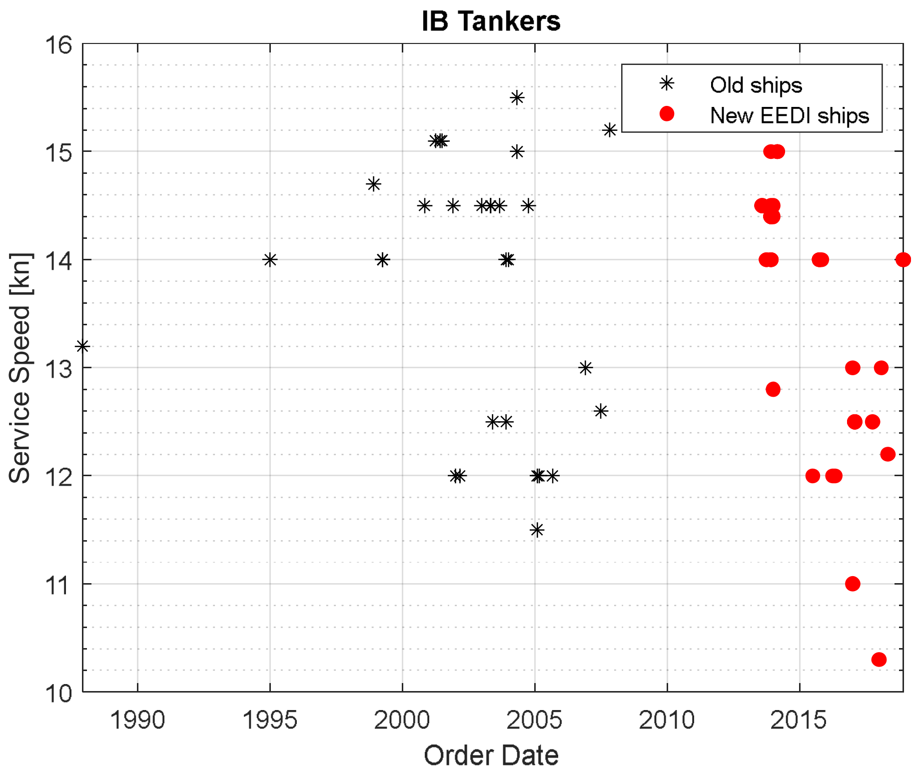


Figure 4-23: Service speed of the IB tankers.

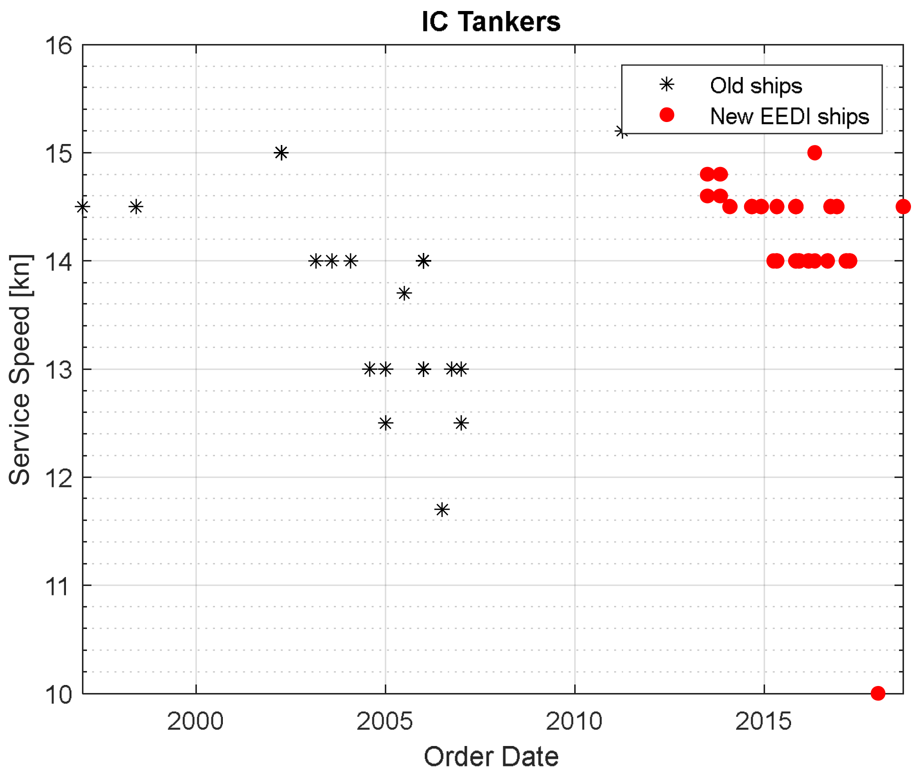


Figure 4-24: Service speed of the IC tankers.

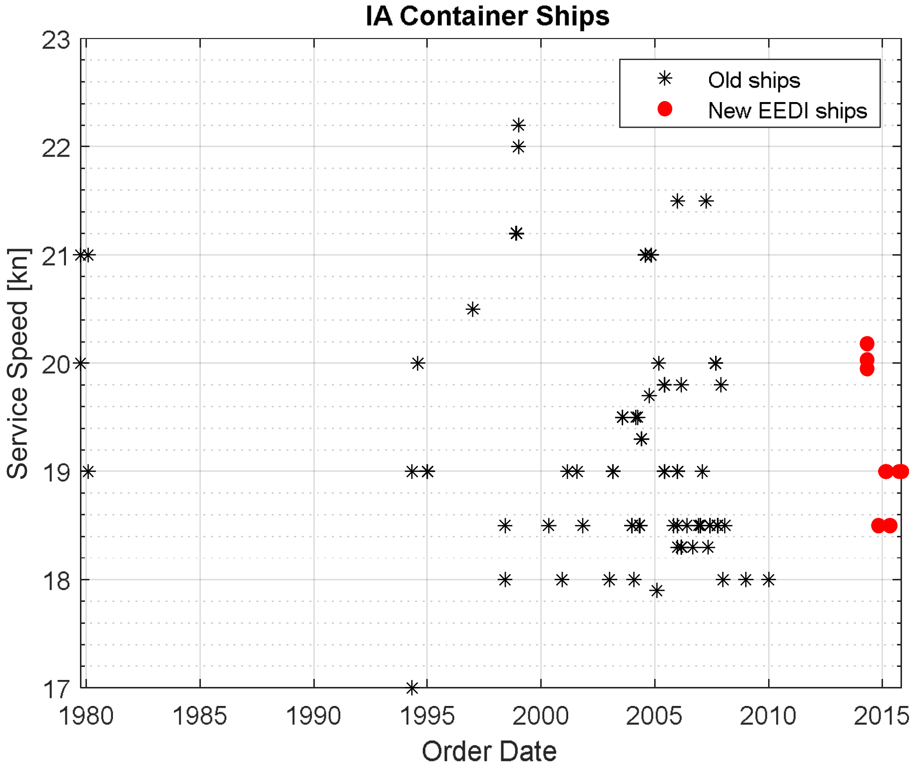


Figure 4-25: Service speed of the IA container ships.

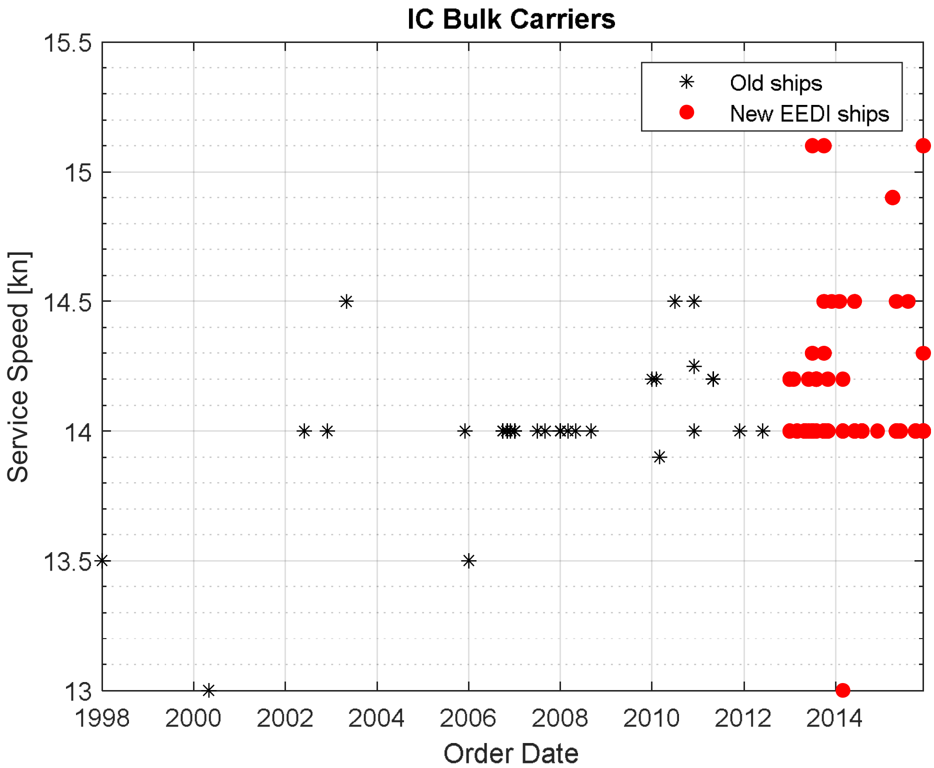


Figure 4-26: Service speed of the IC bulk carriers.

4.3.3 FROUDE NUMBER

Froude number $\left({}^{v}/_{\sqrt{gL}} \right)$ gives information relating the open water powering requirements of the vessels. Smaller Froude number reduces the open-water resistance. From previous chapter it can be seen that different vessel types have almost fixed service speeds. This would mean that the smaller Froude number is obtained by increasing the waterline length.

The figures below indicate that the new EEDI vessels are operating with smaller Froude numbers.

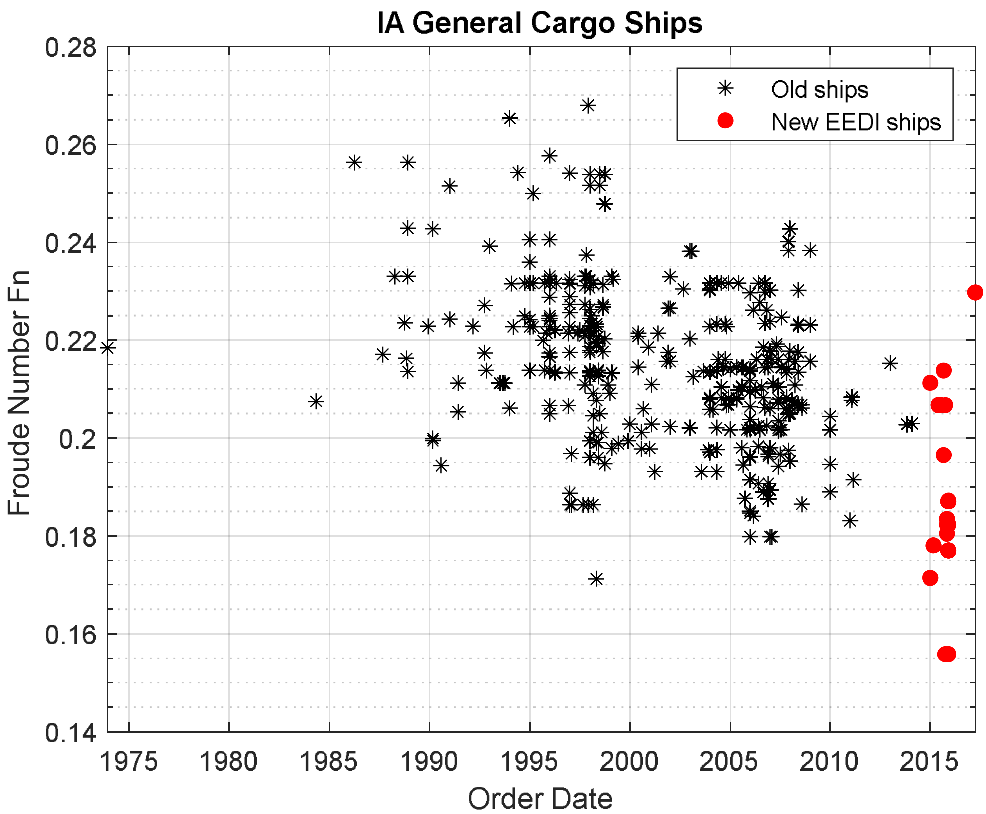


Figure 4-27: Froude number of the IA general cargo ships.

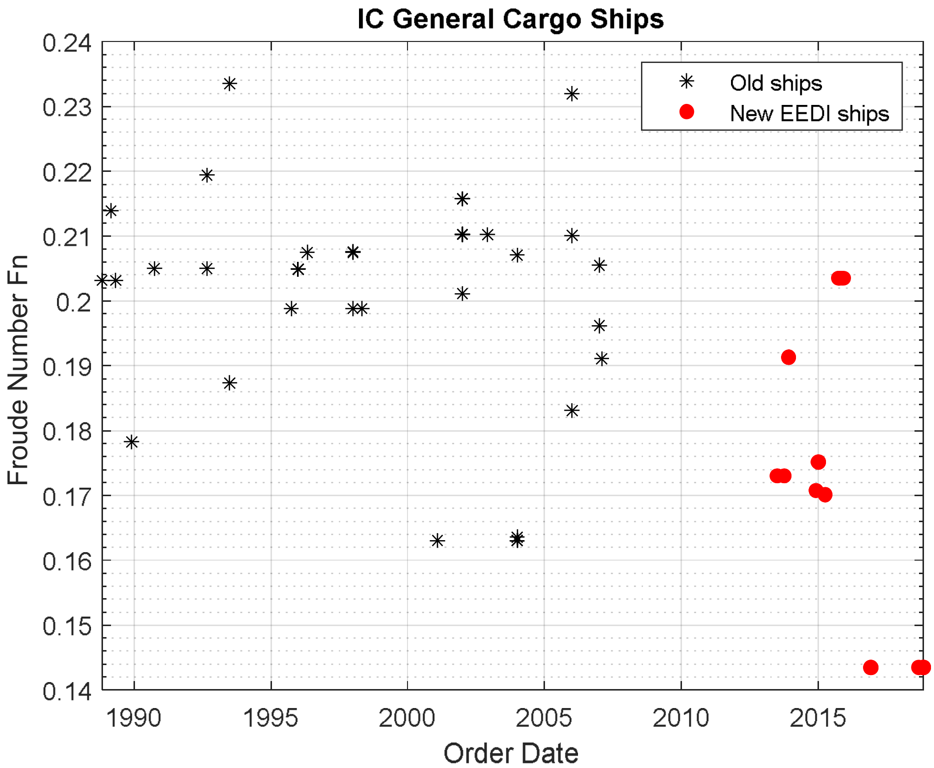


Figure 4-28: Froude number of the IC general cargo ships.

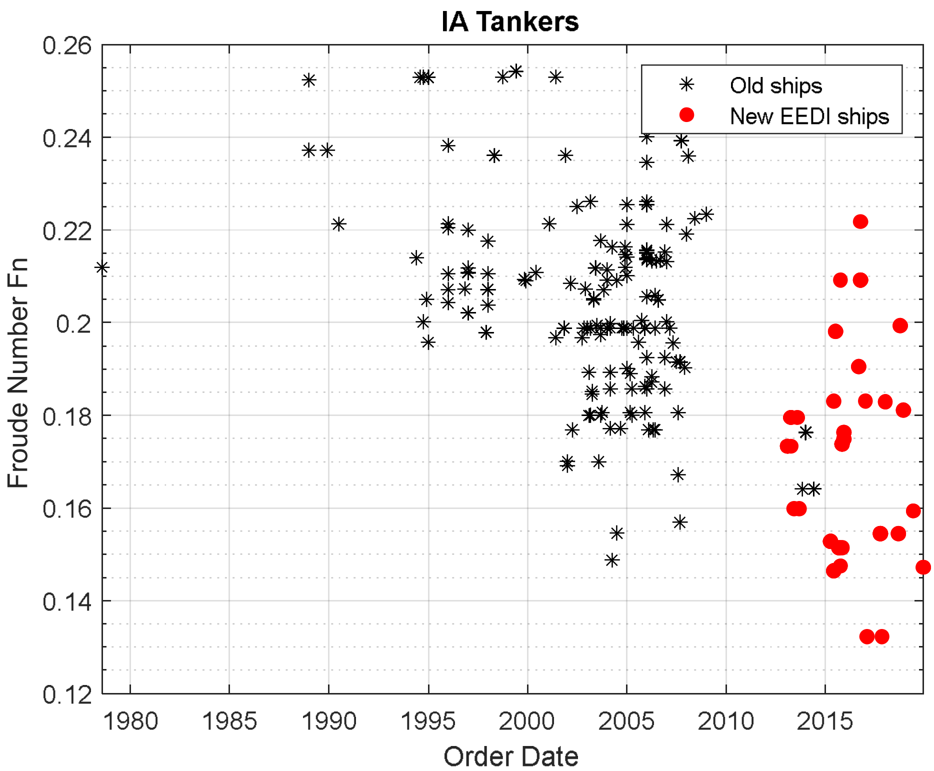


Figure 4-29: Froude number of the IA tankers.

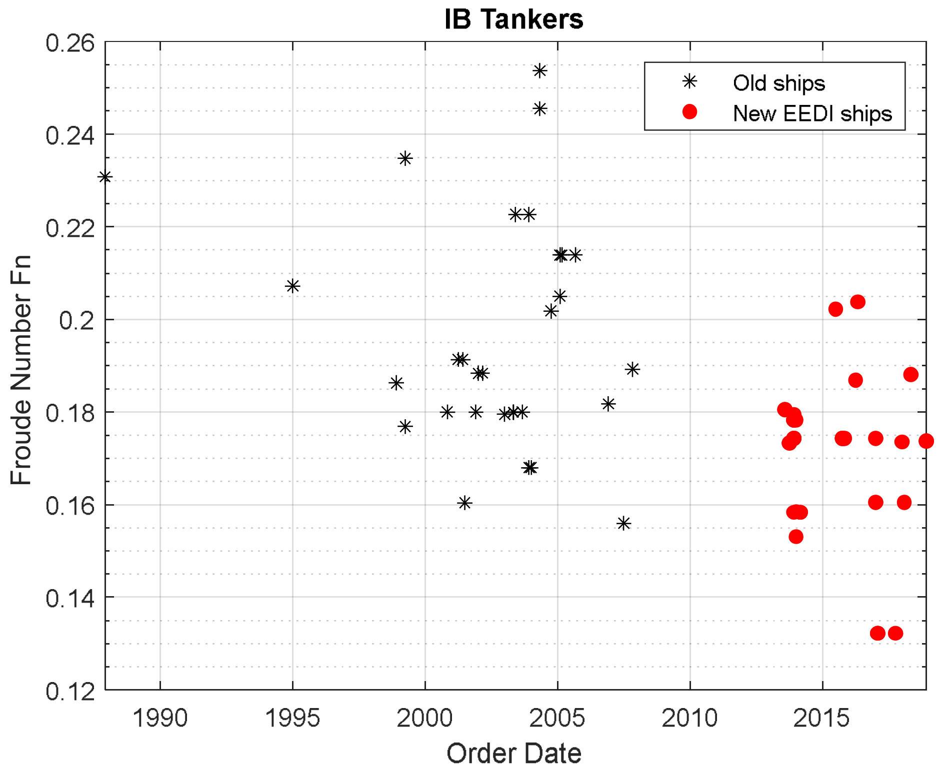


Figure 4-30: Froude number of the IB tankers.

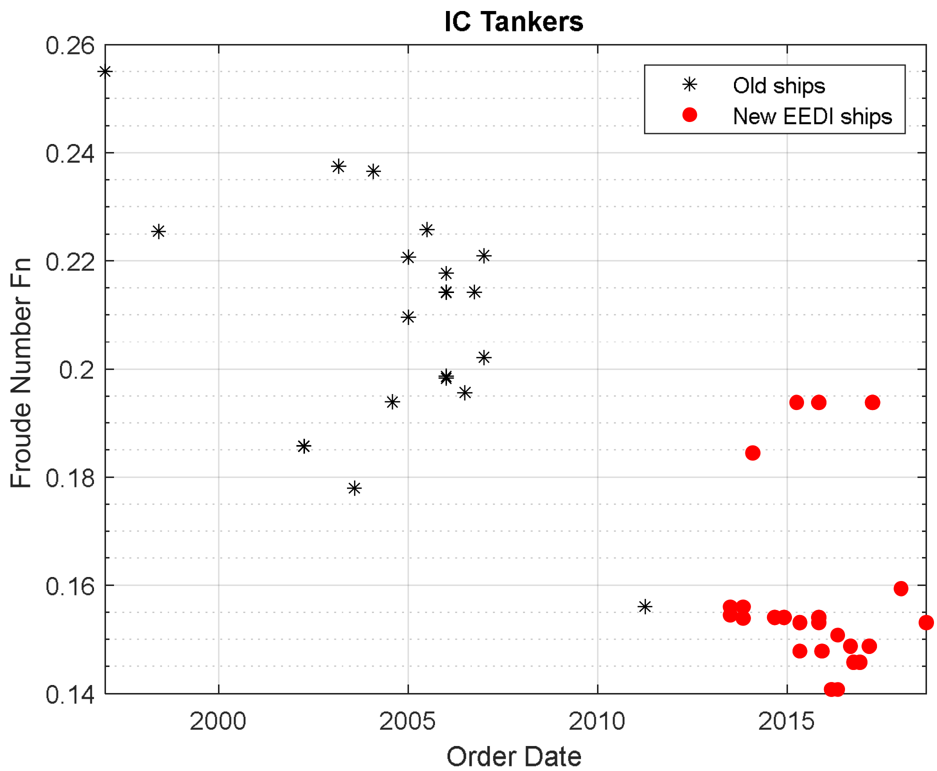


Figure 4-31: Froude number of the IC tankers.

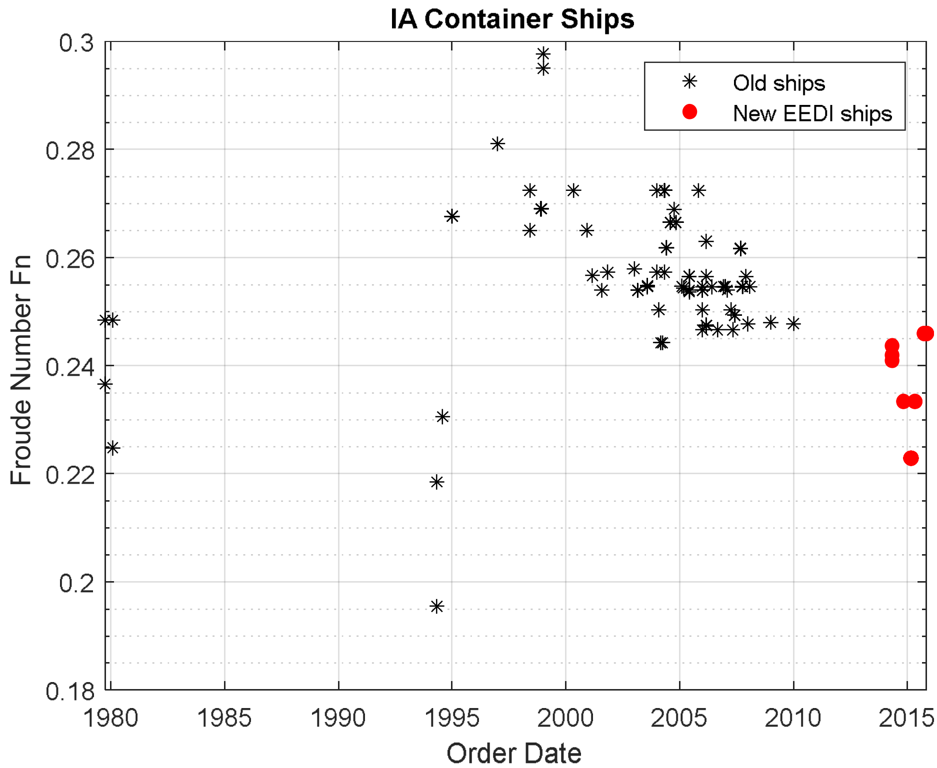


Figure 4-32: Froude number of the IA container ships.

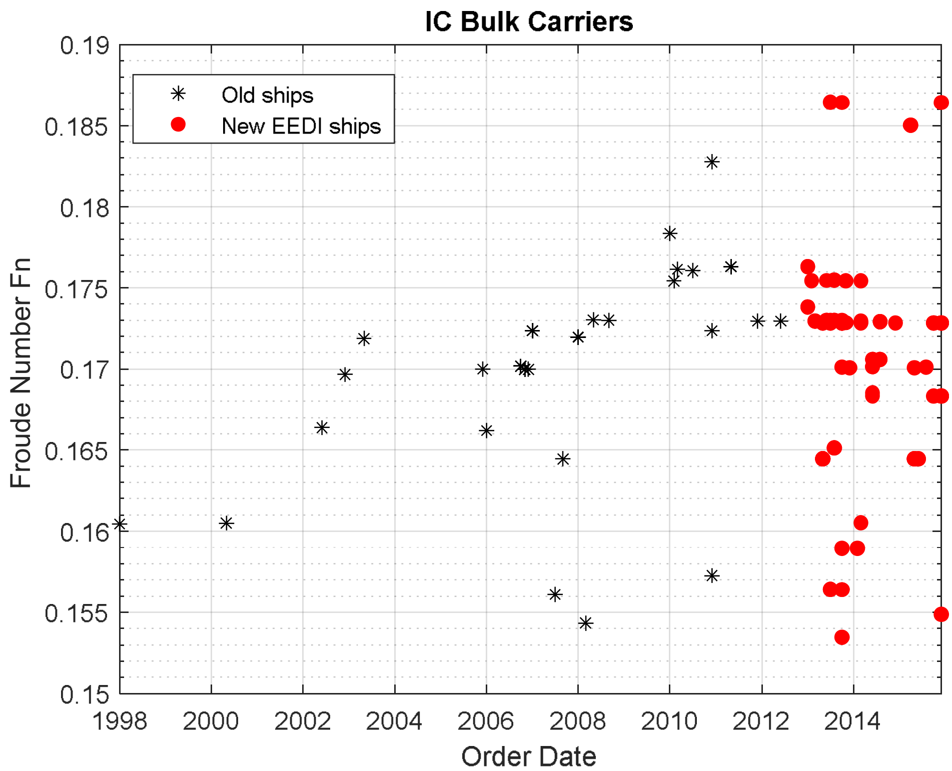


Figure 4-33: Froude number of the IC bulk carriers.

4.3.4 L_{PP}/L RATIO

Based on visual observations, some new EEDI compliant vessels have basically vertical bow (Figure 4-34). The purpose of this is most likely to increase waterline length in order to reduce the Froude number and therefore reduce the open-water resistance at same speed. Also, the vertical bow could have some beneficial effects in waves. However, the vertical bow basically always has a negative influence on the ice-going capability of the vessel. As the verticals are nearly 90°, the frame angles will be also very steep which means that the vessel will be pushing the ice mass. In case of independent operation in for example in level ice, the vertical bow will be crushing the ice with high resistance. This means that the vessels ability to operate independently is weak and it needs assistance.

In principle the L_{pp}/L ratio should be high for a vessel which has a vertical bow. The ratios for different cases are presented in the following figures. There seems to be a trend that the new EEDI vessels have bigger L_{pp}/L ratio which could indicate the they vertical bows in larger numbers. However, this should be reviewed with caution as the definition of L_{pp} could differ for different vessels in the IHS sea-web database.

Figure 4-34: Example of an vertical bow of an EEDI compliant IA general cargo ship.

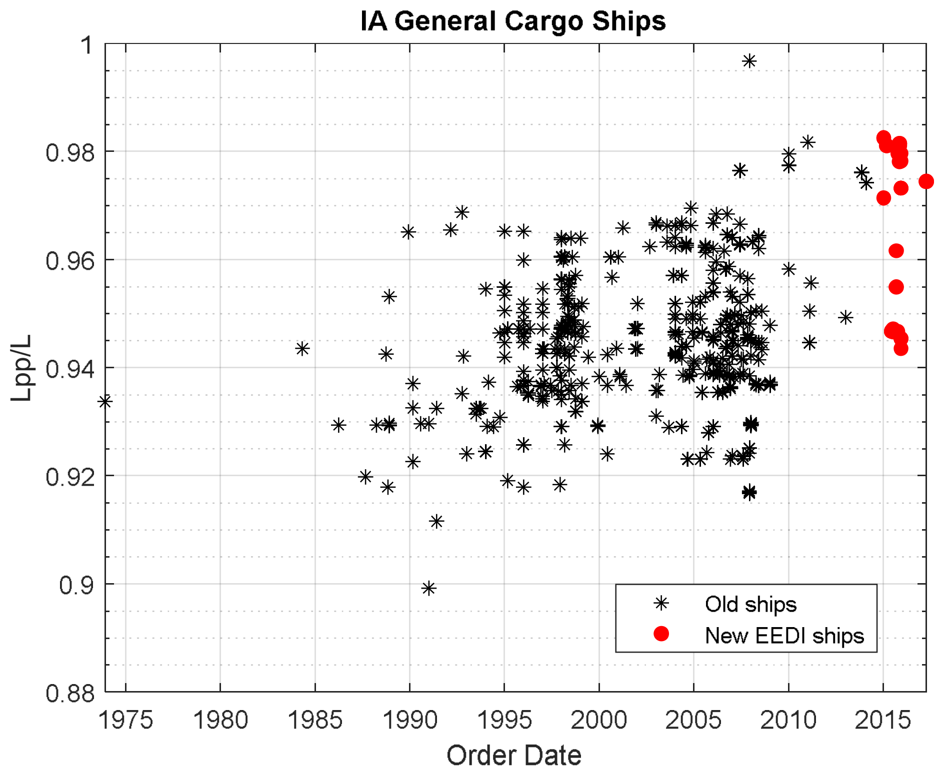


Figure 4-35: L_{pp}/L ratio for the IA general cargo ships.

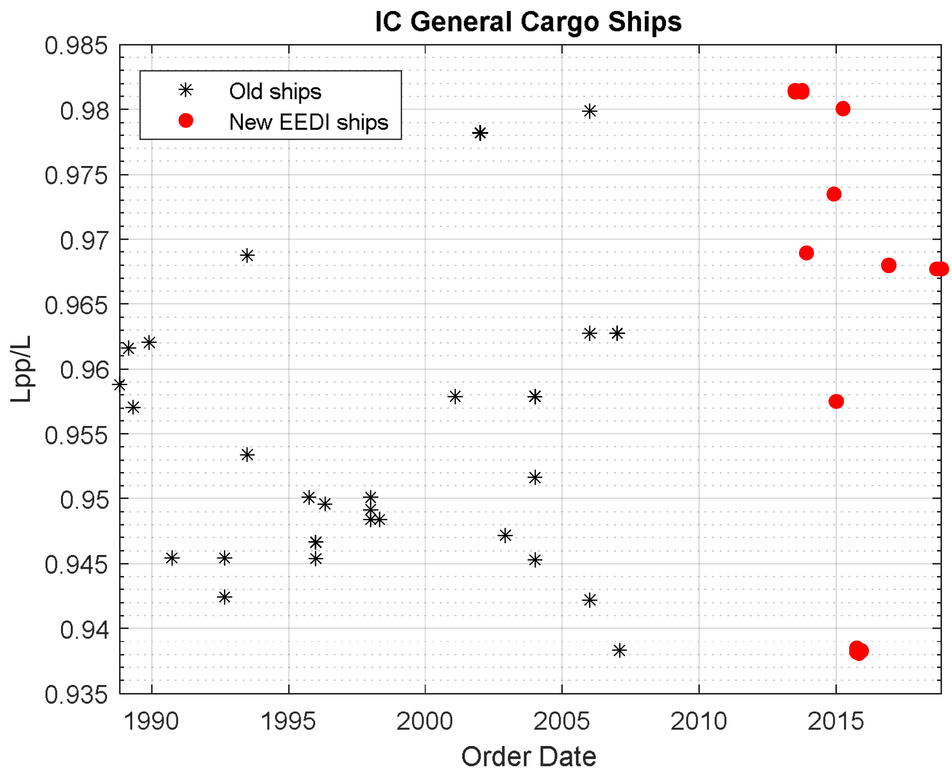


Figure 4-36: L_{pp}/L ratio for the IC general cargo ships.

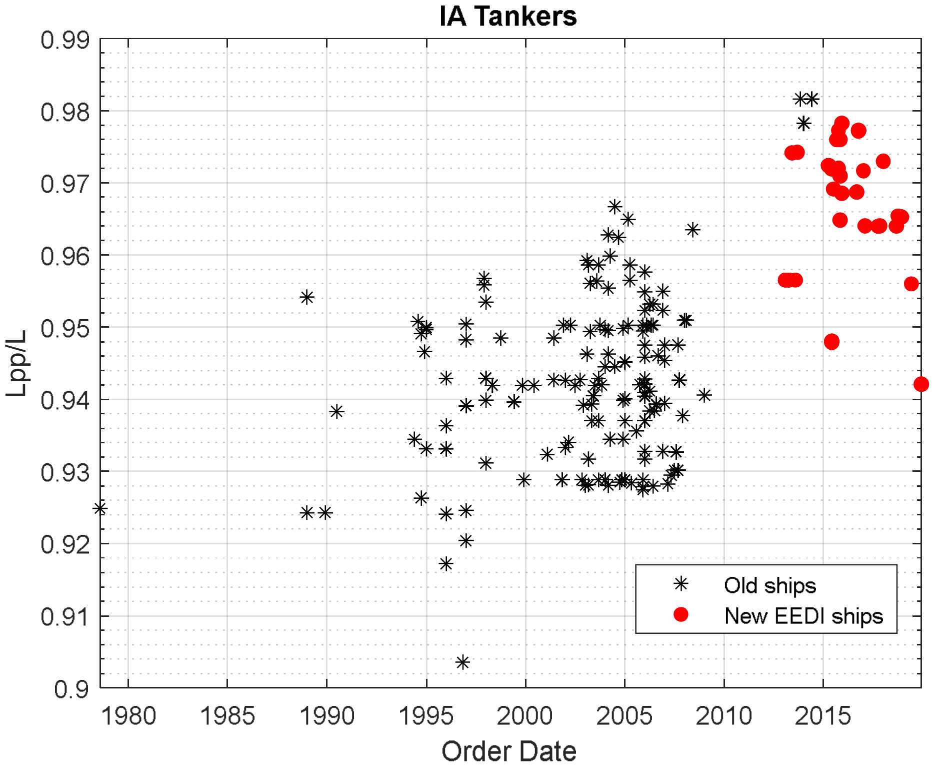


Figure 4-37: L_{pp}/L ratio for the IA tankers.

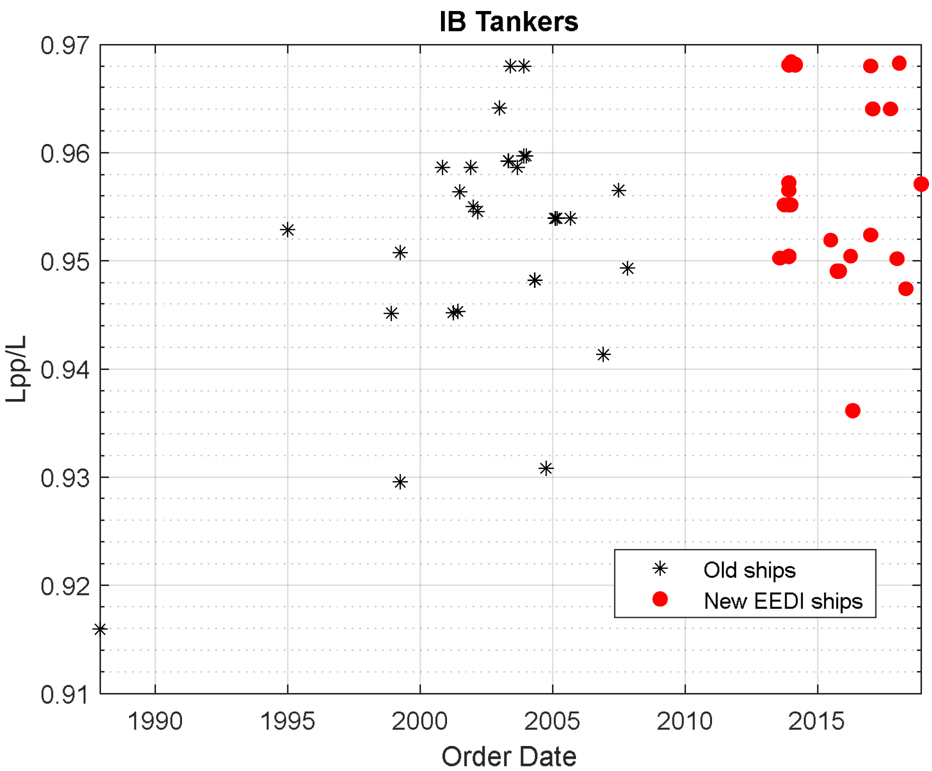


Figure 4-38: L_{pp}/L ratio for the IB tankers.

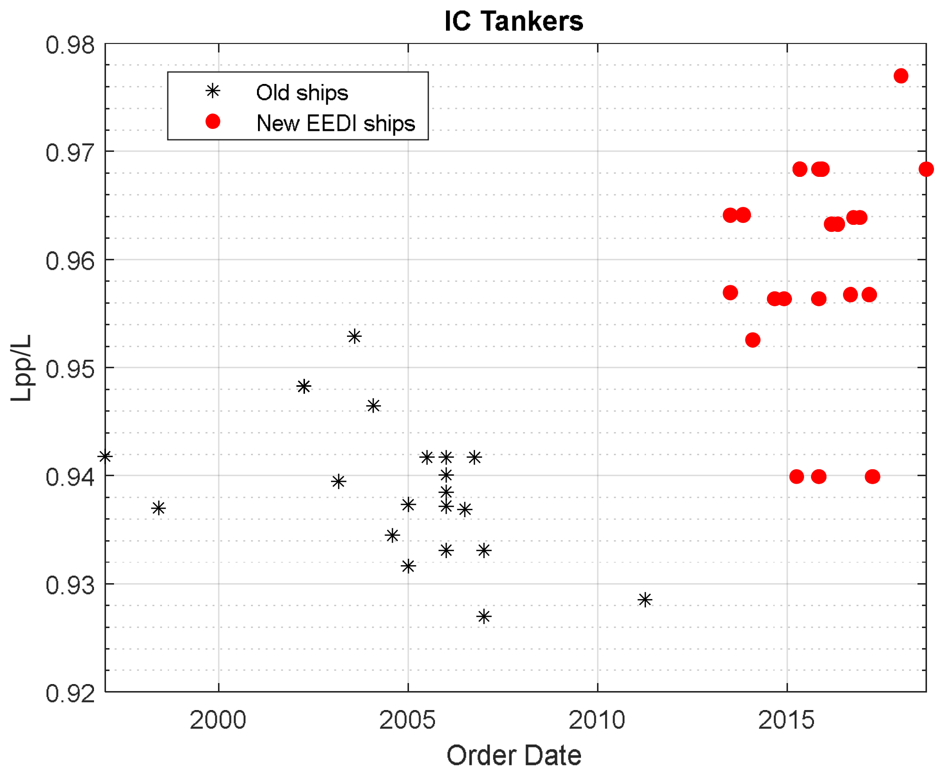


Figure 4-39: L_{pp}/L ratio for the IC tankers.

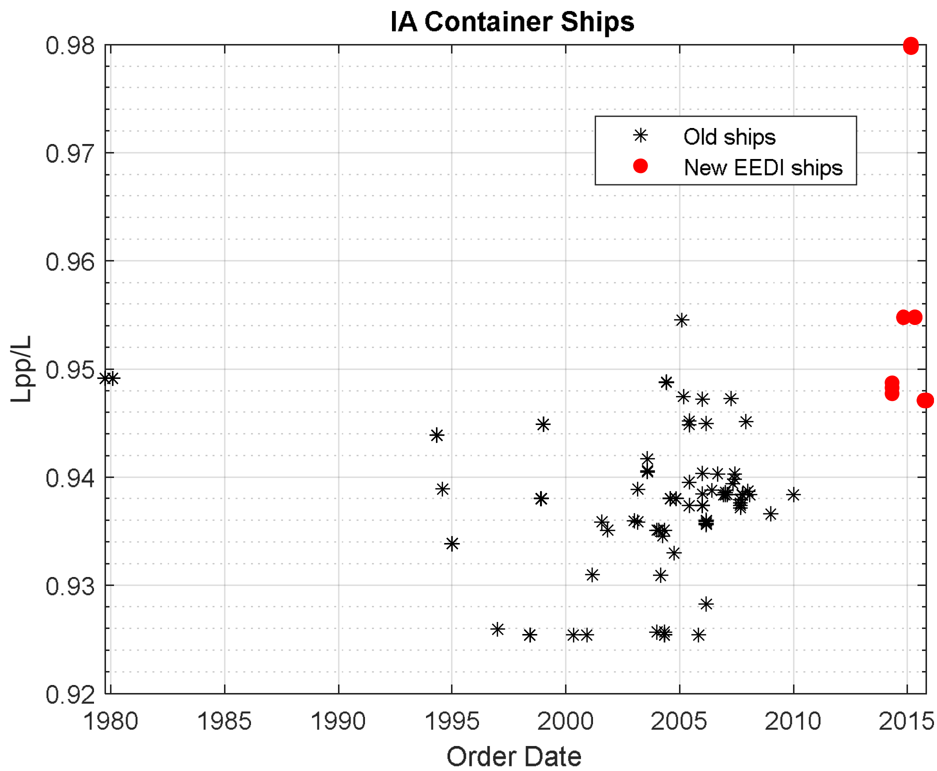


Figure 4-40: L_{pp}/L ratio for the IA container ships.

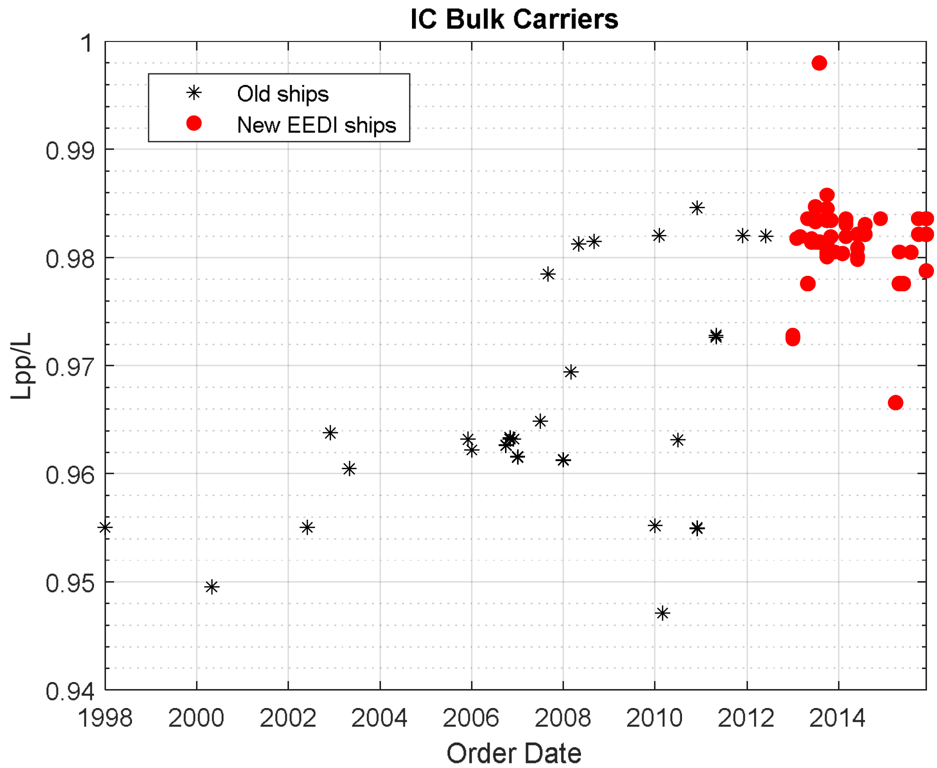


Figure 4-41: L_{pp}/L ratio for the IC bulk carriers.

4.3.5 L_{PP}/L AND P/DWT RELATION

As discussed in the previous subchapter, the higher L_{pp}/L ratio most likely reduces the open-water resistance at same speed. This chapter investigates whether smaller power-deadweight ratio is linked to higher L_{pp}/L ratio. Based on the figures below, there seems to be a trend that vessels with higher L_{pp}/L ratio are also less powerful.

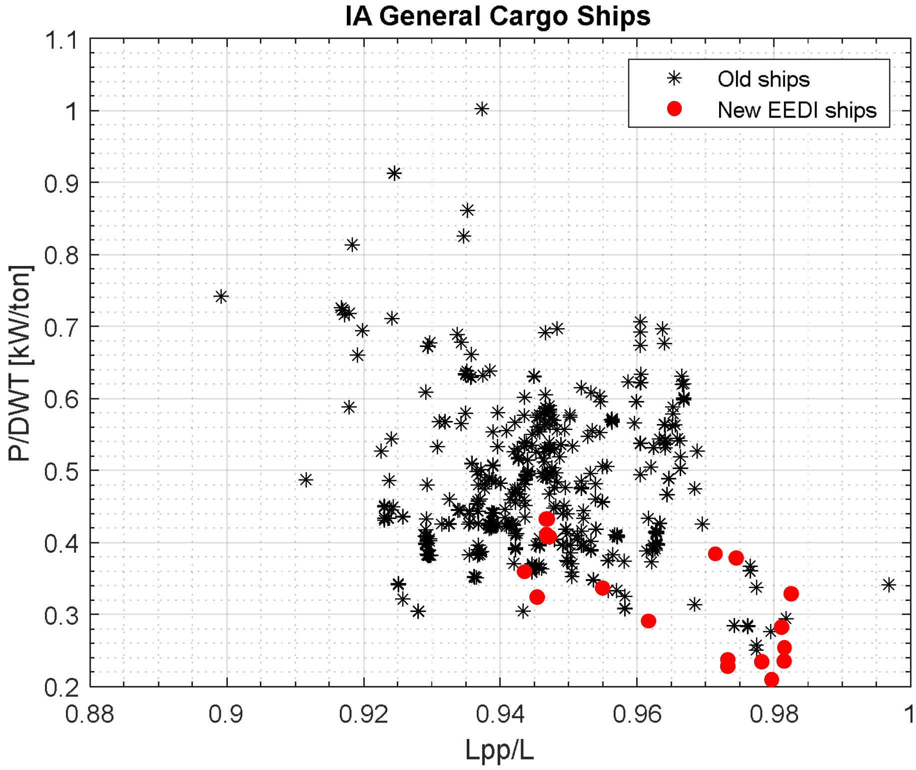


Figure 4-42: P/DWT vs. L_{pp}/L for the IA general cargo ships.

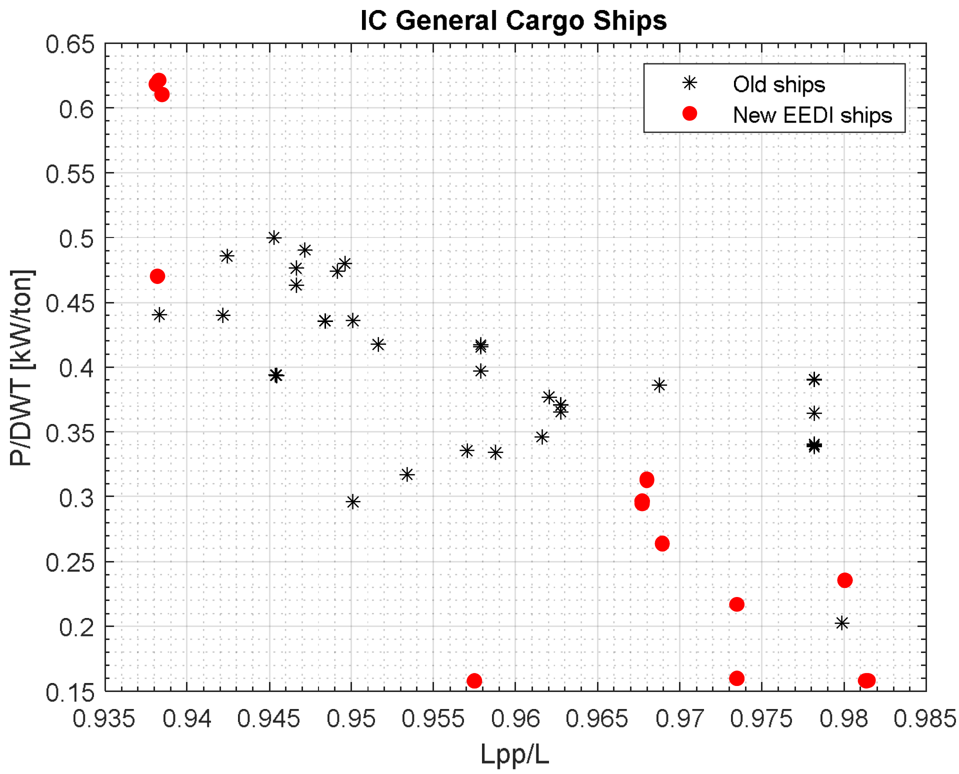


Figure 4-43: P/DWT vs. L_{pp}/L for the IC general cargo ships.

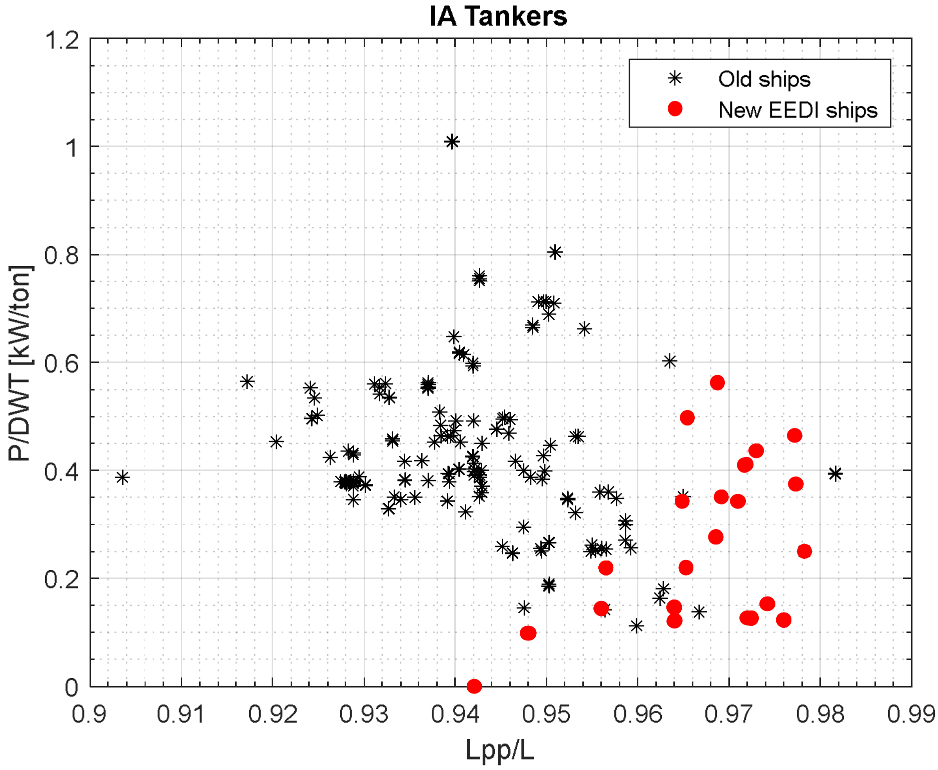


Figure 4-44: P/DWT vs. L_{pp}/L for the IA tankers.

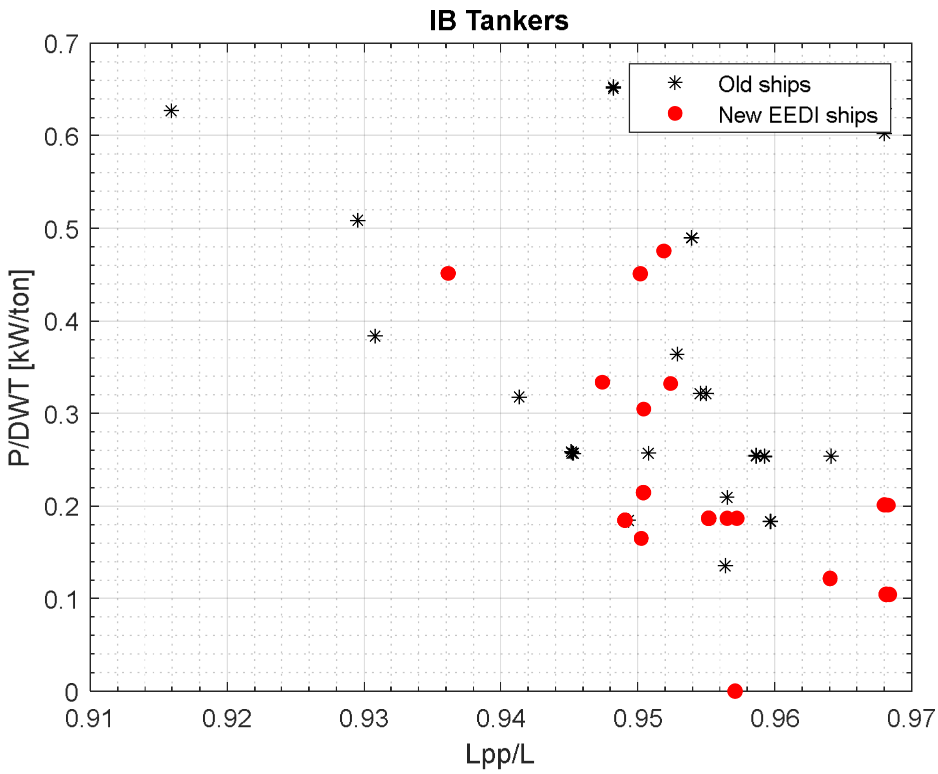


Figure 4-45: P/DWT vs. L_{pp}/L for the IB tankers.

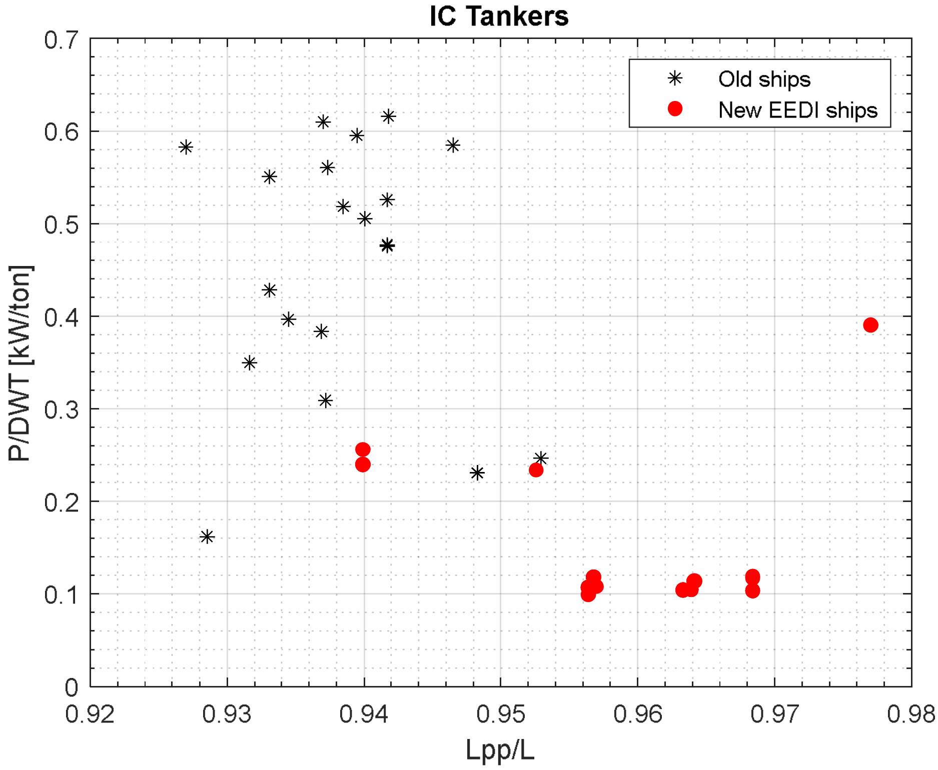


Figure 4-46: P/DWT vs. L_{pp}/L for the IC tankers.

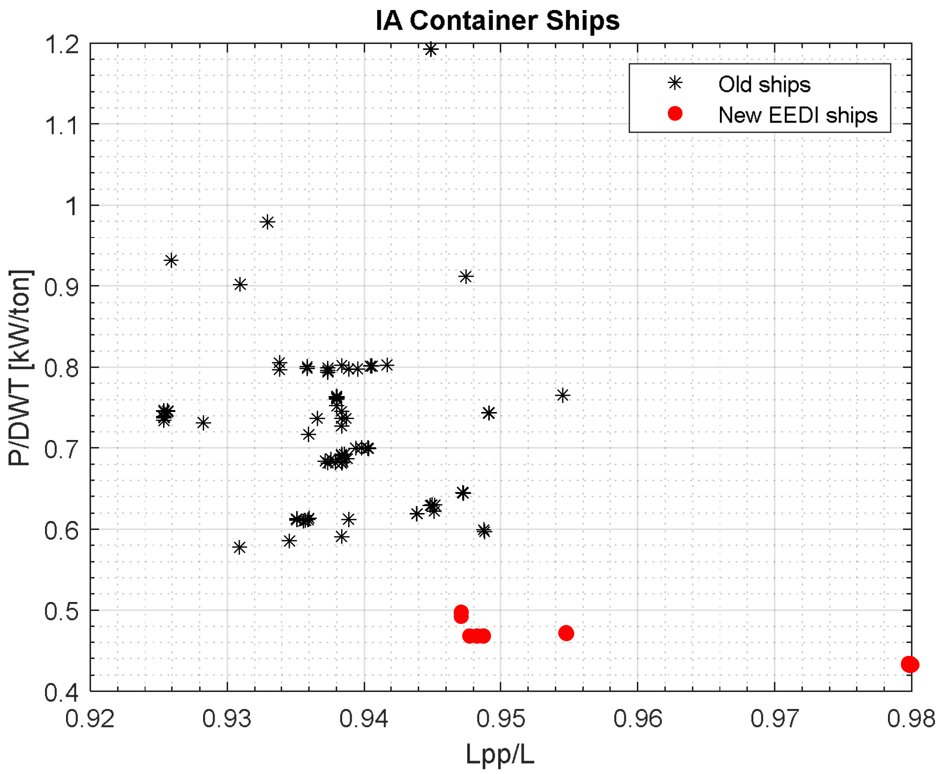


Figure 4-47: P/DWT vs. L_{pp}/L for the IA container ships.

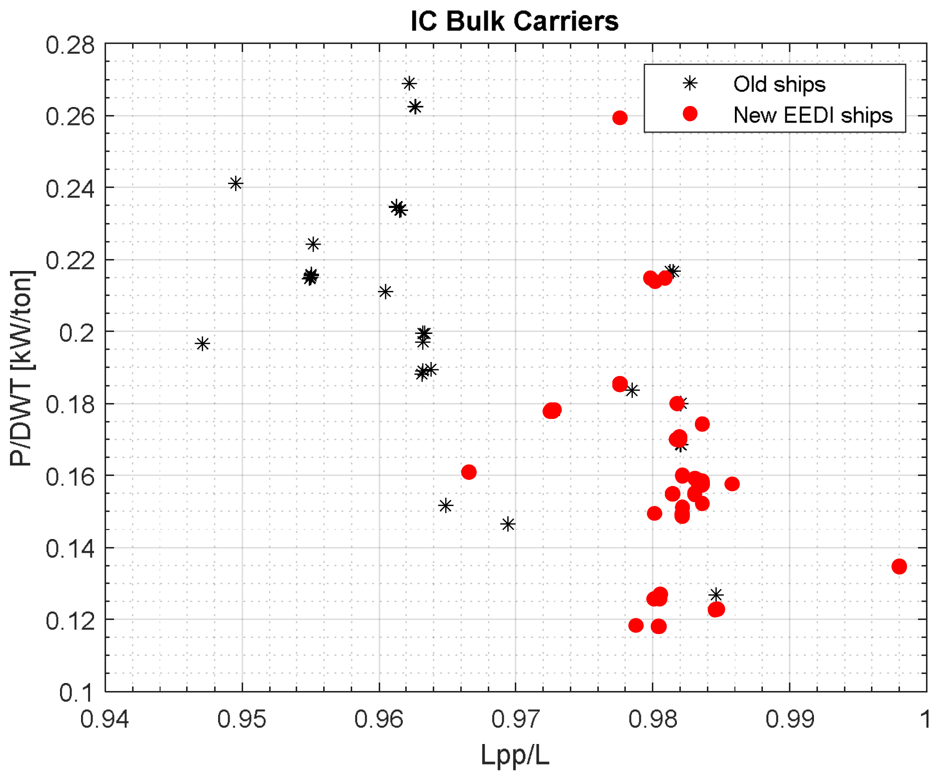


Figure 4-48: P/DWT vs. L_{pp}/L for the IC bulk carriers.

4.3.6 BLOCK COEFFICIENT

The block coefficient gives information how “full” the hull-form is. Bigger block coefficient could relate into steeper verticals at the bow increasing the ice resistance.

The block coefficient data presented below should be viewed cautiously. The displacement data is not included for all ships meaning that the data set is not as big as it could be. In addition, there is no knowledge whether the displacement is “correct” especially for newbuildings and whether the displacement is related to the same draft which is used to calculate the block coefficient.

The block coefficient is presented as a function of deadweight as the size of the vessel is related to the length of the parallel midship. Based on this data set, it is not possible to draw conclusions that the block coefficient would be at least bigger for the new ships.

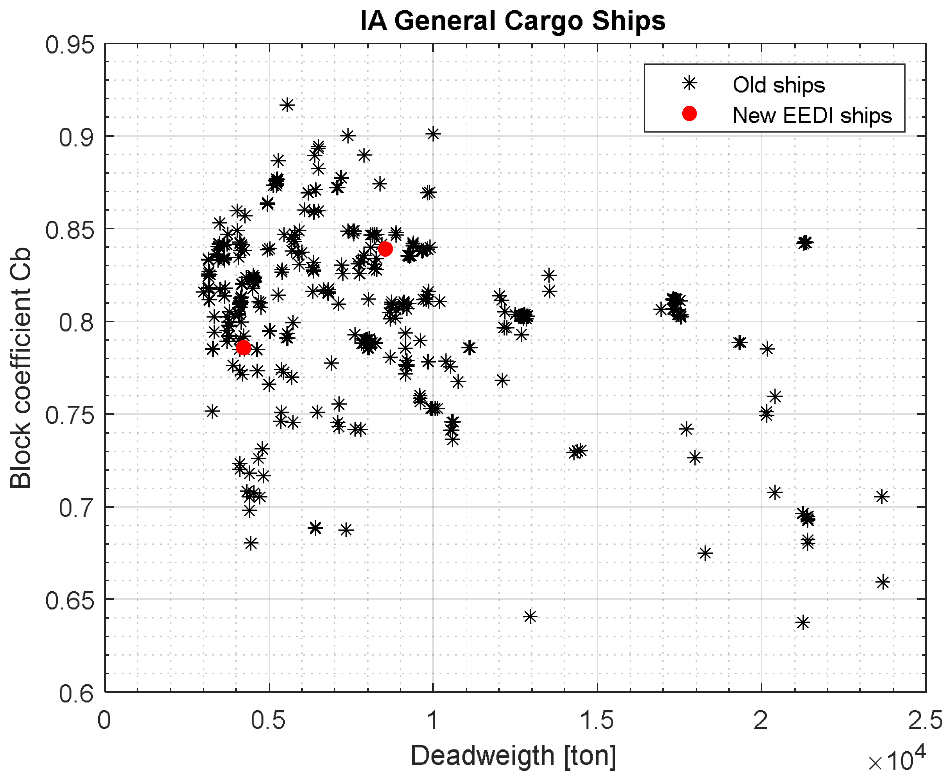


Figure 4-49: Block coefficient vs. deadweight for the IA general cargo ships.

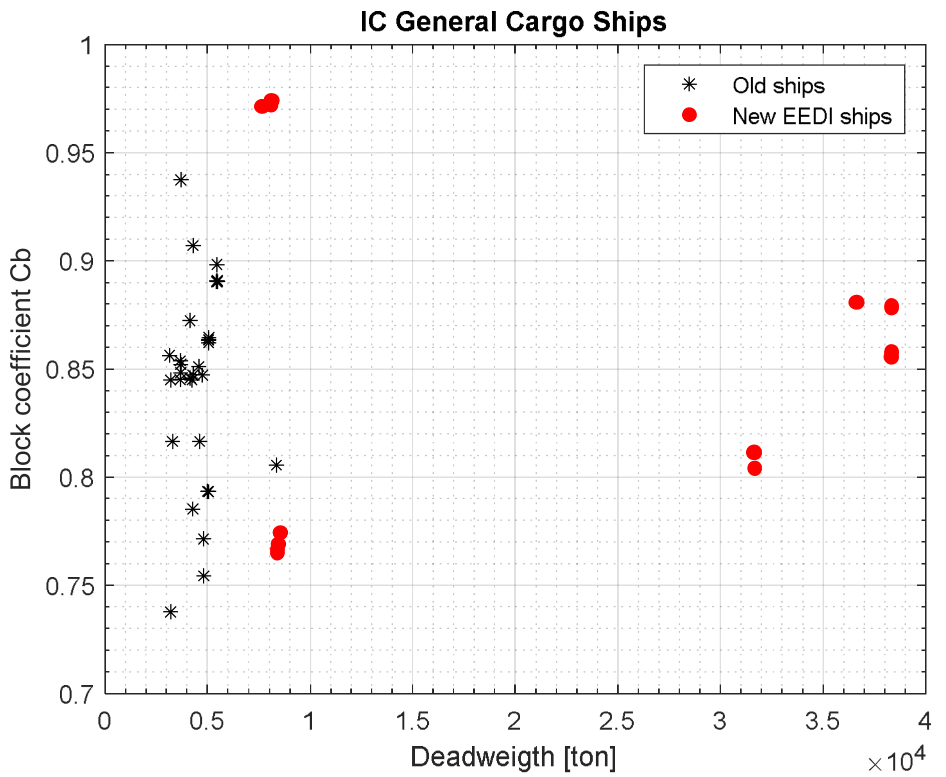


Figure 4-50: Block coefficient vs. deadweight for the IC general cargo ships.

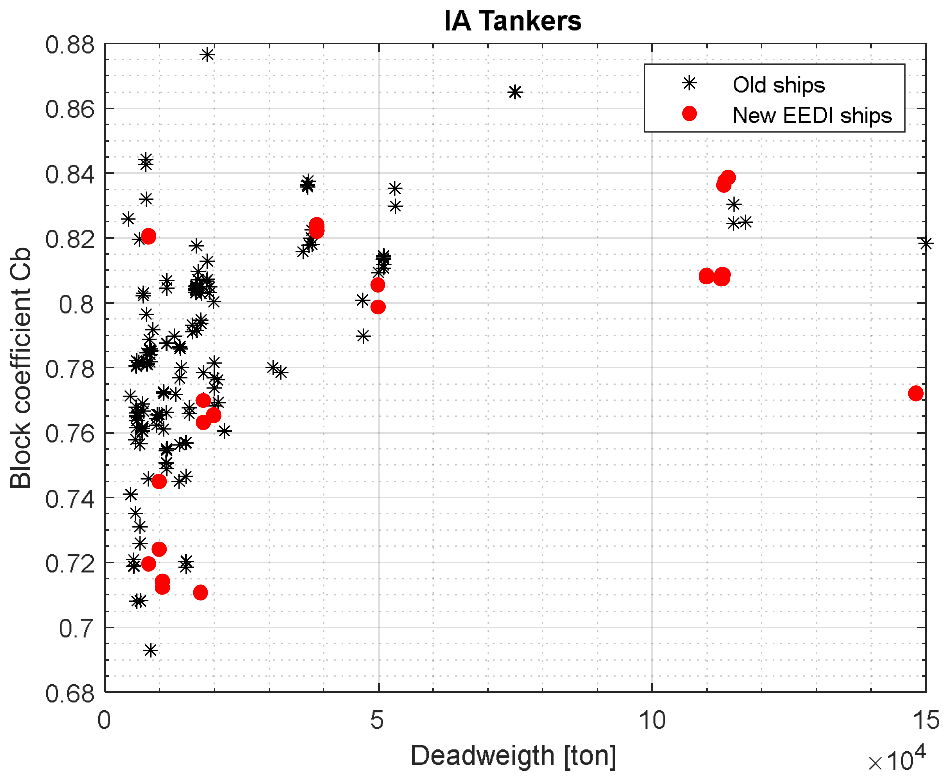


Figure 4-51: Block coefficient vs. deadweight for the IA tankers.

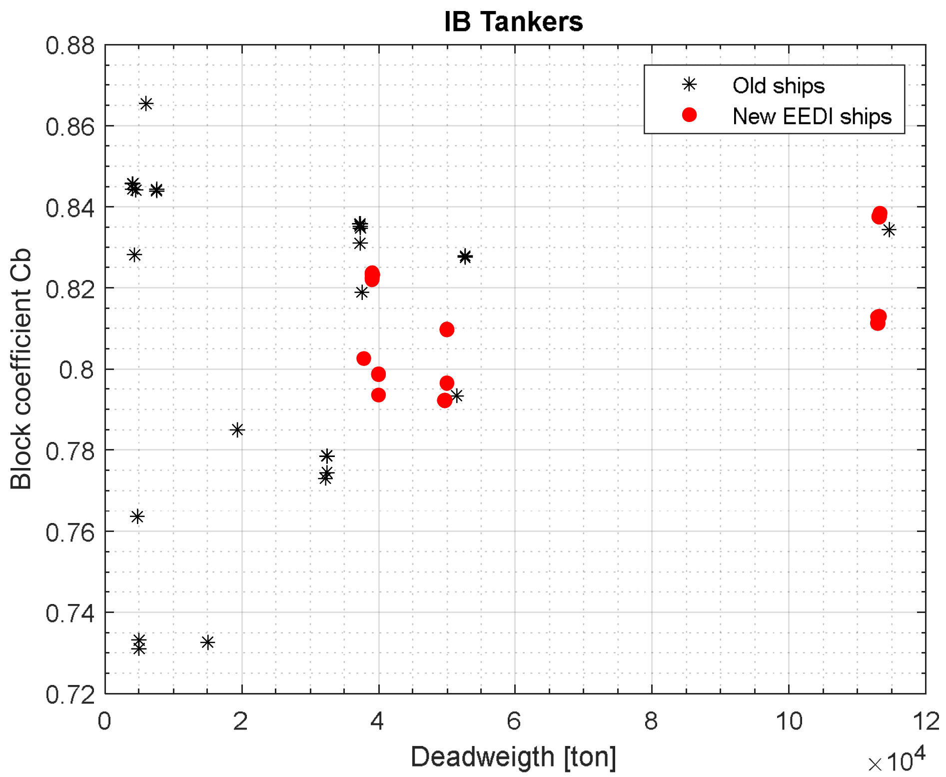


Figure 4-52: Block coefficient vs. deadweight for the IB tankers.

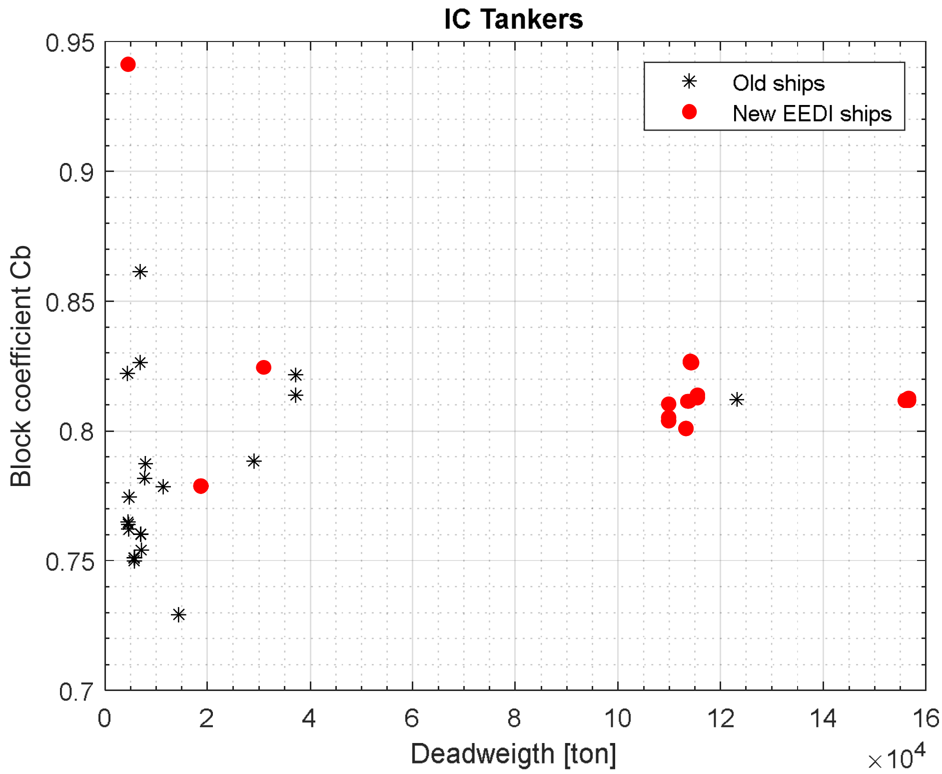


Figure 4-53: Block coefficient vs. deadweight for the IC tankers.

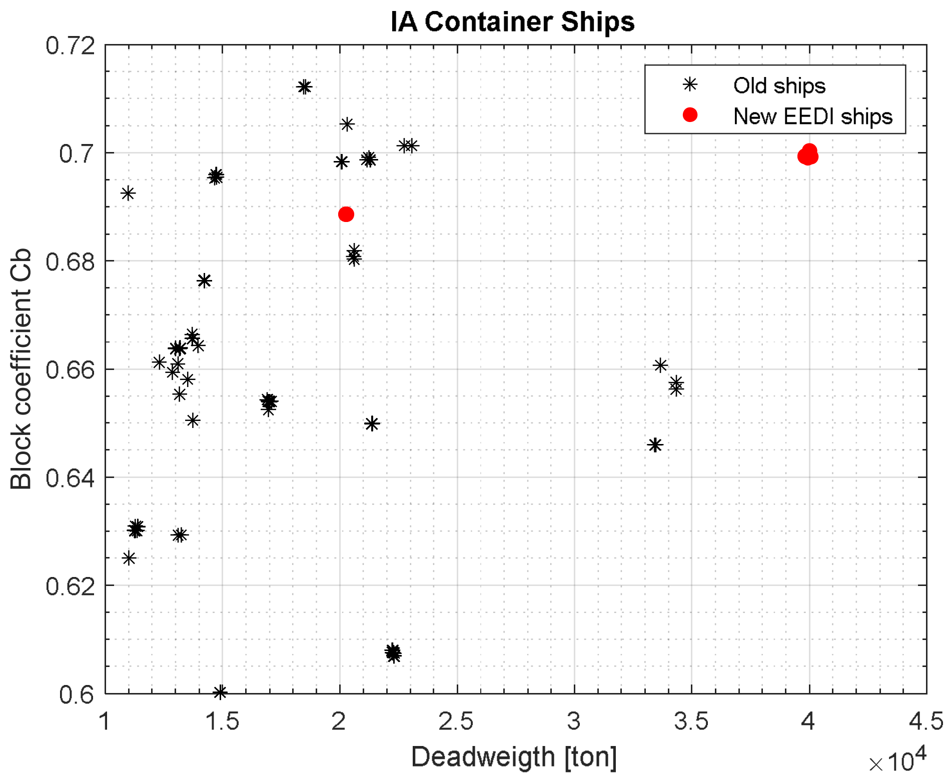


Figure 4-54: Block coefficient vs. deadweight for the IA container ships.

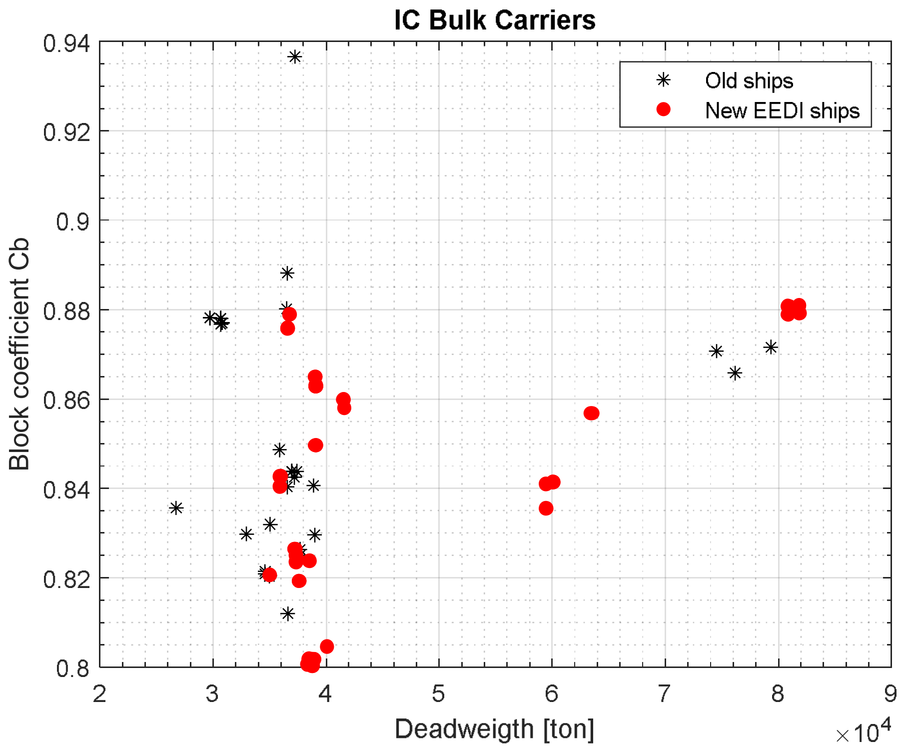


Figure 4-55: Block coefficient vs. deadweight for the IC bulk carriers.

4.3.7 OTHER PARAMETERS

Also, other parameters were investigated in order to find differences between different era vessels. These include following parameters:

- Length as function of deadweight
- Breadth as function of deadweight
- Length/breadth ratio

Examples of the parameters are presented in Figure 4-56 and Figure 4-57 but these parameters are not reported in detail as it is not possible to find differences between the different era vessels: the main particulars of the new EEDI vessels seem to follow same trends as for the older pre-EEDI vessels. In a way this is interesting as slender hull with smaller breadth would reduce both the open-water and ice resistance. However, the length is typically the most expensive parameter in the vessel's price, which probably explains why the breadths have not reduced.

Also, ratio between the parallel midship and overall length was planned to be investigated as this could have influence on the vessel's maneuverability in ice. However, it was not possible to conduct this investigation as the parallel midship length is seldomly available.

Finally, the used primary fuels for different vessels is presented in Figure 4-58 and Figure 4-59. The used fuel in principle does not affect to the vessels ice-going capability but it is interesting to notice the increasing use of LNG.

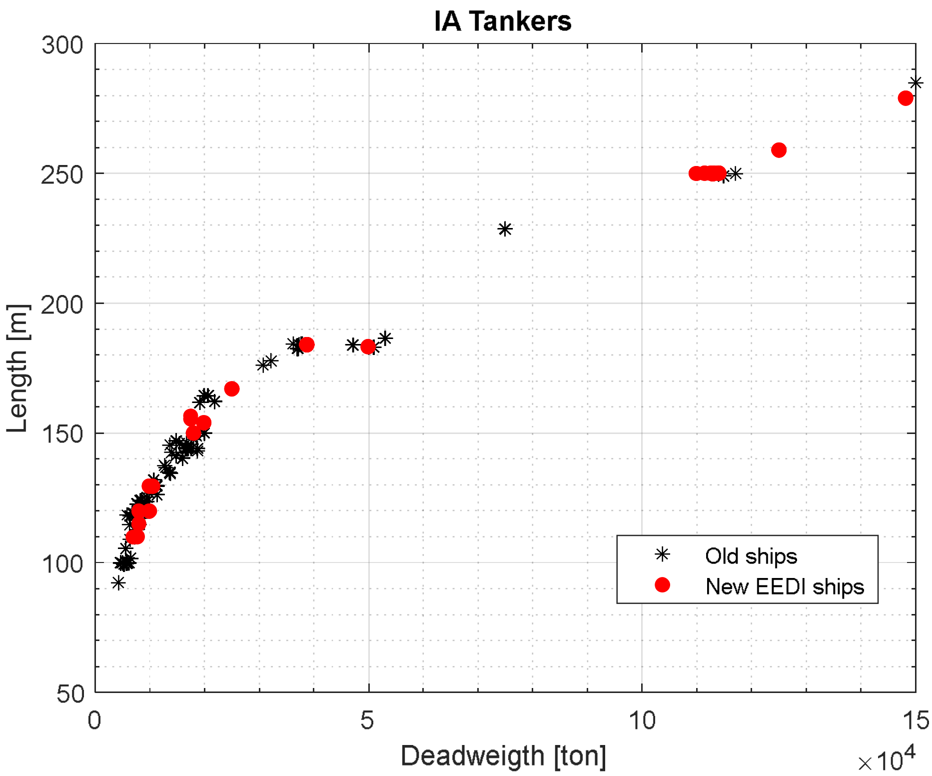


Figure 4-56: Length as function of the deadweight for IA tankers.

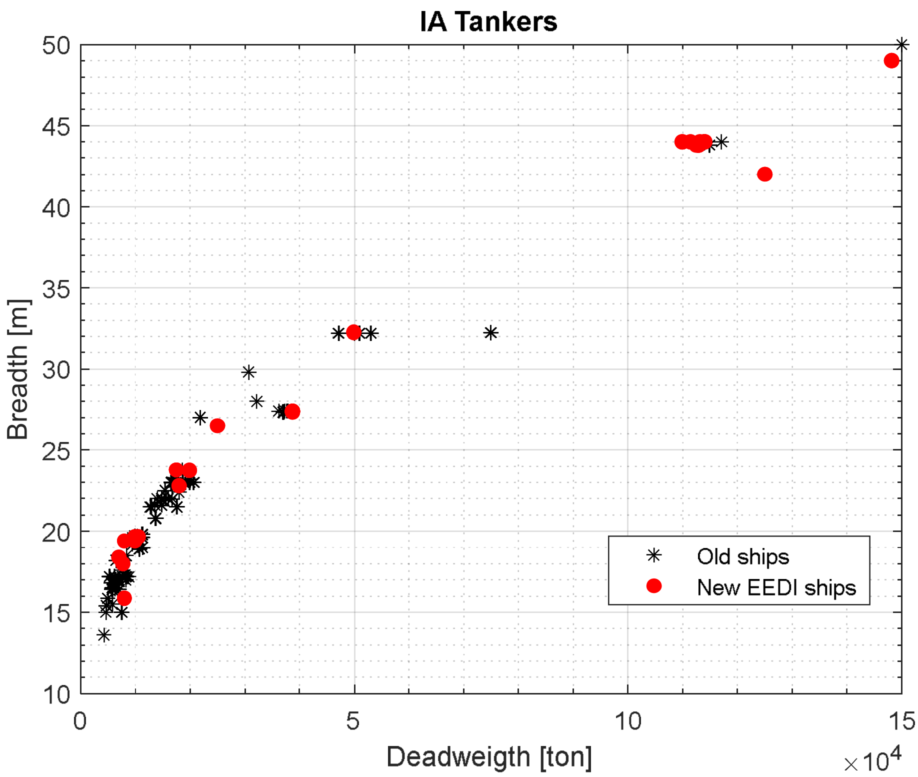


Figure 4-57: Breadth as function of the deadweight for IA tankers.

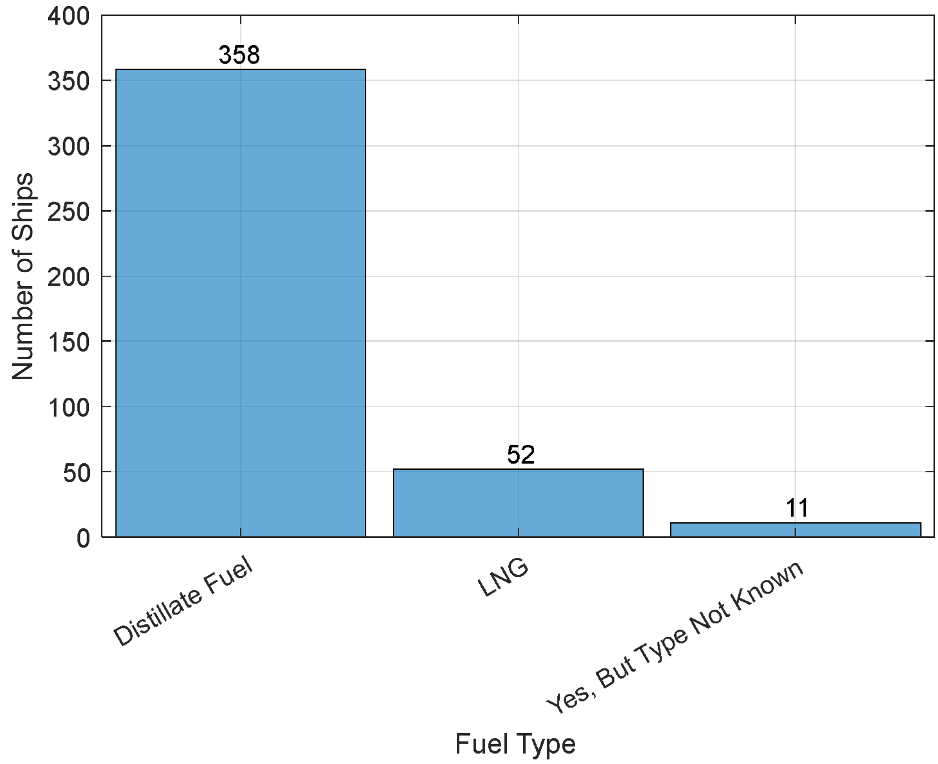


Figure 4-58: Summary of used fuel types for the new EEDI vessels. The *Yes, but Type Not Known* dataset refers to a case in which the fuel type has not been informed to HIS Sea-web

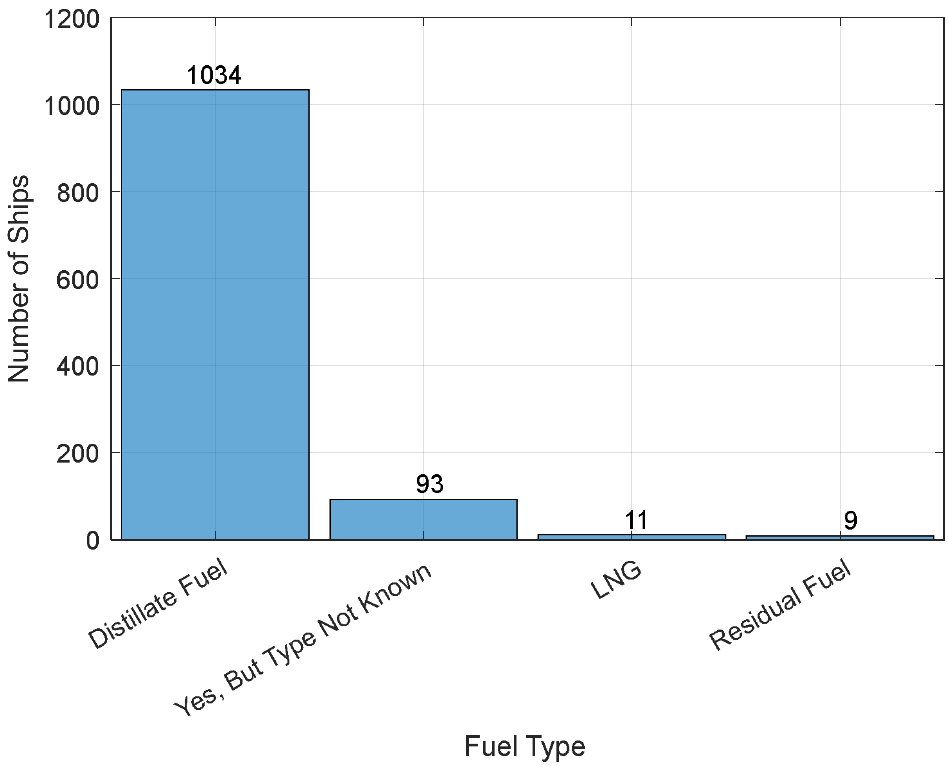


Figure 4-59: Summary of used fuel types for the older vessels. The *Yes, but Type Not Known* dataset refers to a case in which the fuel type has not been informed to HIS Sea-web

5 ICEBREAKER ASSISTANCE ANALYSIS AND RESULTS

The analysis of the icebreaker assistance is done in similar way as in the previous research project in order to have good comparability.

As described in chapter 3.2.1, the vessels are categorized based on their EEDI compliancy (only ice classes IA-Super, IA, IB and IC are included) and also the ports are categorized into different groups. In addition, the data is also categorized based on the time of the winter. Following categories are used in the analysis:

- Period 1: Beginning of the season to mid-January (15. day)
- Period 2: Mid-January to mid-February
- Period 3: Mid-February to mid-March
- Period 4: Mid-March to mid-April
- Period 5: Mid-April to the end of the season

Categorization of the ports and the period allows to have relatively fair comparison between the different vessels as comparison is done in somewhat similar ice conditions based on the geographical location and time of the winter.

Example ice charts for each winter are presented in Appendix 2 (charts for the 1. and 15. day of the month). The winter 2018-2019 is described as mild compared to the long-term average but drifting ice made the winter traffic difficult. Winter 2019-2020 was one the mildest for in the history.

The need for ice icebreaker assistance, average assistance speed, distance and duration are presented in the following chapters. Results are presented separately for each EEDI-compliancy, port group and period combination. The results are presented also for all voyages of each port group and period. This is referred as “total” in the following chapters.

The same analyses are also done for towing. In the analyses each port call is divided into arrival and departure and the above-mentioned quantities are investigated separately for both. The arrivals and departures are referred as voyages in the analysis. need for Icebreaker assistance

The need for icebreaker assistance is presented as a percentage on how many voyages there was icebreaker assistance for each vessel group. The need for icebreaker assistances are presented in Table 5-1 to Table 5-2. It should be noted that in some cases there has been only few vessels from which the relative proportion is calculated. More detailed statistics about how many voyages have been done totally and how much icebreaker assistance was needed are presented in Appendix 3. The port groups are defined in Figure 3-1 and in APPENDIX 1: List of ports.

Table 5-1: Summary on the need for icebreaker assistance during winter 2018-2019. Only the period and port group combinations in which there has been voyages are shown.

PERIOD	PORT_Group	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	36 %	88 %	45 %	12 %	50 %
	FIN_2	2 %		2 %	0 %	5 %
	FIN_6	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %	0 %	0 %
	SWE_3	0 %		0 %		
2	FIN_1	64 %	100 %	80 %	35 %	57 %
	FIN_2	42 %	53 %	56 %	6 %	23 %
	FIN_3	3 %		4 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %	0 %	1 %	0 %	0 %
	FIN_6	10 %	5 %	11 %	4 %	14 %
	SWE_1	59 %	100 %	69 %	10 %	63 %
	SWE_2	53 %	80 %	64 %	9 %	33 %
	SWE_3	6 %		7 %	0 %	0 %
	SWE_4	1 %	8 %	1 %	0 %	0 %
3	FIN_1	65 %	100 %	82 %	40 %	50 %
	FIN_2	72 %	100 %	88 %	15 %	96 %
	FIN_3	5 %	0 %	6 %	0 %	17 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %	0 %	0 %	0 %	0 %
	FIN_6	0 %	0 %	0 %	0 %	0 %
	SWE_1	22 %	10 %	23 %	17 %	29 %
	SWE_2	31 %	38 %	35 %	0 %	38 %
	SWE_3	0 %	0 %	0 %	0 %	0 %
	SWE_4	0 %	0 %	0 %	0 %	0 %
4	FIN_1	57 %	83 %	71 %	32 %	57 %
	FIN_2	60 %	74 %	75 %	19 %	65 %
	FIN_3	0 %		0 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %		0 %	0 %	0 %
	FIN_6	0 %		0 %	0 %	0 %
	SWE_1	17 %	17 %	23 %	5 %	8 %
	SWE_2	28 %	60 %	31 %	0 %	0 %
	SWE_3	1 %	0 %	1 %	0 %	
5	FIN_1	17 %	0 %	23 %	3 %	27 %
	FIN_2	20 %	20 %	26 %	3 %	6 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		
	SWE_3	0 %		0 %		

Table 5-2: Summary on the need for icebreaker assistance during winter 2019-2020. Only the period and port group combinations in which there has been voyages are shown.

PERIOD	PORT_Group	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	32 %	55 %	50 %	4 %	6 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		0 %
	SWE_3	0 %		0 %		
2	FIN_1	46 %	67 %	65 %	14 %	30 %
	FIN_2	4 %	0 %	3 %	0 %	11 %
	SWE_1	19 %	14 %	22 %	8 %	21 %
	SWE_2	20 %	0 %	25 %		0 %
	SWE_3	0 %		0 %		
3	FIN_1	77 %		92 %	44 %	93 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	28 %	22 %	35 %	16 %	21 %
	SWE_2	40 %	0 %	47 %	0 %	0 %
	SWE_3	0 %		0 %		
4	FIN_1	75 %	100 %	94 %	40 %	92 %
	FIN_2	0 %	0 %	1 %	0 %	0 %
	SWE_1	6 %	8 %	5 %	0 %	9 %
	SWE_2	19 %	0 %	23 %		0 %
	SWE_3	0 %		0 %		
5	FIN_1	29 %	0 %	37 %	14 %	40 %
	FIN_2	55 %	13 %	66 %	25 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		
	SWE_3	0 %		0 %		

5.1 ASSISTANCE DURATION

The average assistance durations for different EEDI-categories are presented in Table 5-3 to Table 5-4. Assistance times are based on icebreakers' notifications on how long they have been assisting the vessels.

Table 5-3: Average assistance durations [minutes] during winter 2018-2019. Only the period and port group combinations in which there has been assistance are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	100	97	77	78
	FIN_2		35		45
2	FIN_1	191	163	138	151
	FIN_2	126	114	135	40
	FIN_3		97		
	FIN_5		100		
	FIN_6	45	102	78	80
	SWE_1	133	205	187	168
	SWE_2	159	201	345	231
	SWE_3		82		
	SWE_4	74	373		
3	FIN_1	243	243	153	123
	FIN_2	109	120	99	154
	FIN_3		21		23
	FIN_6		30		
	SWE_1	53	245	150	184
	SWE_2	320	178		43
	SWE_3		40		
4	FIN_1	172	176	143	165
	FIN_2	101	116	81	137
	SWE_1	220	174	72	177
	SWE_2	222	131		
	SWE_3		125		
5	FIN_1		78	53	150
	FIN_2	63	53	95	35

Table 5-4: Average assistance durations [minutes] during winter 2019-2020. Only the period and port group combinations in which there has been assistance are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	70.0	53.1	35.0	17.5
2	FIN_1	71.3	102.6	70.4	117.7
	FIN_2		36.5		35.0
	SWE_1	30.0	55.4	25.0	37.0
	SWE_2		86.2		
3	FIN_1		157.7	95.9	121.2
	SWE_1	122.0	116.9	124.3	114.0
	SWE_2		112.2		
4	FIN_1	150.5	162.6	116.8	160.9
	FIN_2		49.0		
	SWE_1	48.0	55.2		23.7
	SWE_2		136.6		
5	FIN_1		86.3	96.3	93.8
	FIN_2	15.0	67.3	85.0	

5.2 ASSISTANCE DISTANCE

The average assistance distances are presented in Table 5-5 to Table 5-6. The assisted distance is based on the position information of the merchant vessels.

Table 5-5: Average assistance distance [nautical miles] during winter 2018-2019. Only the period and port group combinations in which there has been assistance are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	16.5	14.9	15.6	14.4
	FIN_2		4.9		7.2
2	FIN_1	37.2	26.5	25.5	25.8
	FIN_2	20.0	17.6	21.5	6.4
	FIN_3		12.1		
	FIN_5		16.1		
	FIN_6	5.6	12.8	8.3	8.8
	SWE_1	23.3	32.3	40.1	28.6
	SWE_2	22.8	32.3	47.4	37.1
	SWE_3		13.1		
	SWE_4	12.7	88.8		
3	FIN_1	31.3	37.5	24.6	22.5
	FIN_2	15.0	16.9	16.7	23.4
	FIN_3		3.1		3.2
	FIN_6		3.9		
	SWE_1	11.1	37.9	28.2	37.5
	SWE_2	54.3	29.7		7.0
	SWE_3		2.4		
4	FIN_1	28.5	26.6	25.3	25.3
	FIN_2	15.9	16.7	11.9	19.3
	SWE_1	41.2	27.8	13.2	28.4
	SWE_2	35.7	20.4		
	SWE_3		15.8		
5	FIN_1		12.6	10.0	29.5
	FIN_2	11.9	8.6	11.6	6.0

Table 5-6: Average assistance distance [nautical miles] during winter 2019-2020. Only the period and port group combinations in which there has been assistance are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	12.9	8.7	6.7	3.5
2	FIN_1	12.3	15.6	13.4	24.5
	FIN_2		5.3		6.5
	SWE_1	3.2	8.1	4.9	6.0
	SWE_2		12.8		
3	FIN_1		24.2	19.1	21.9
	SWE_1	23.1	19.3	23.1	19.0
	SWE_2		17.1		
4	FIN_1	17.0	25.1	22.6	27.1
	FIN_2		9.4		
	SWE_1	5.6	9.2		5.1
	SWE_2		23.3		
5	FIN_1		15.8	20.9	18.0
	FIN_2	2.8	11.0	14.7	

5.3 ASSISTANCE SPEED

The average assistance speeds are presented in Table 5-7 to Table 5-8. The average assistance speed is calculated based on the assistance distance and duration.

In order to have direct comparability to the previous research, the data has been filtered by excluding average assistance speeds above 15 knots and below 5 knots. This is done because the assistance durations are informed by the icebreaker and the distances are calculated from merchant vessel's AIS data. The different data sources could generate some uncertainty to calculated speed. The speeds above 15 knots are considered unrealistically high while the speeds below 5 knots too low. However, as it is possible that very difficult assistance could result into assistance speeds below 5 knots, also results including cases with speeds below 5 knots are presented as separate tables. It should be noted that generally the amount slow < 5 knots assistance speeds have been relatively rare: ~4.4% of all cases on winter 2019 and ~1.5% of all cases on winter 2020.

Table 5-7: Average assistance speeds [knots] during winter 2018-2019. Only the period and port group combinations in which there has been assistance are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	9.3	10.0	12.2	11.3
	FIN_2		8.5		9.6
2	FIN_1	11.4	9.7	11.4	10.4
	FIN_2	9.2	9.3	10.2	9.0
	FIN_3		8.1		
	FIN_5		9.6		
	FIN_6	7.5	8.2	7.8	7.7
	SWE_1	10.8	9.7	13.0	10.6
	SWE_2	8.5	9.5	9.7	9.3
	SWE_3		9.4		
	SWE_4	10.3	14.3		
3	FIN_1	8.2	9.4	10.6	10.0
	FIN_2	9.2	8.5	10.0	10.1
	FIN_3		8.9		8.5
	FIN_6		7.7		
	SWE_1	12.6	9.7	11.6	12.3
	SWE_2	10.8	10.0		10.4
	SWE_3				
4	FIN_1	9.7	9.3	10.9	9.9
	FIN_2	9.6	9.0	9.9	9.7
	SWE_1	11.2	10.1	11.0	11.9
	SWE_2	9.7	9.2		
	SWE_3		7.6		
5	FIN_1		10.2	12.0	11.9
	FIN_2	11.4	9.6	7.3	10.3

Table 5-8: Average assistance speeds [knots] during winter 2019-2020. Only the period and port group combinations in which there has been assistance are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	10.2	9.8	11.3	12.1
2	FIN_1	10.3	9.3	11.3	12.3
	FIN_2		8.7		11.2
	SWE_1	6.4	9.0	11.8	9.6
	SWE_2		9.1		
3	FIN_1		9.4	12.0	11.0
	SWE_1	11.2	10.4	10.9	10.1
	SWE_2		9.2		
4	FIN_1	9.6	9.4	11.3	10.3
	FIN_2		11.5		
	SWE_1	7.0	9.8		12.8
	SWE_2		10.3		
5	FIN_1		11.0	13.1	11.8
	FIN_2	11.1	9.8	10.4	

Table 5-9: Average assistance speeds [knots] during winter 2018-2019 including the speeds below 5 knots.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	9.3	9.5	12.2	11.3
	FIN_2		8.5		9.6
2	FIN_1	11.4	9.6	11.4	10.4
	FIN_2	9.2	9.1	10.2	9.0
	FIN_3		8.1		
	FIN_5		9.6		
	FIN_6	7.5	6.8	6.0	6.6
	SWE_1	10.8	9.6	13.0	10.6
	SWE_2	8.5	9.4	9.7	9.3
	SWE_3		9.0		
	SWE_4	10.3	14.3		
3	FIN_1	8.2	9.3	10.0	10.0
	FIN_2	8.6	8.3	10.0	9.7
	FIN_3		8.9		8.5
	FIN_6		7.7		
	SWE_1	12.6	9.7	11.6	12.3
	SWE_2	10.8	10.0		8.0
	SWE_3		3.6		
4	FIN_1	9.7	9.1	10.6	8.9
	FIN_2	9.1	8.6	9.1	9.3
	SWE_1	11.2	9.8	11.0	9.6
	SWE_2	9.7	9.2		
	SWE_3		7.6		
5	FIN_1		9.9	12.0	11.9
	FIN_2	11.4	9.6	7.3	10.3

Table 5-10: Average assistance speeds [knots] during winter 2019-2020 including the speeds below 5 knots.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	10.2	9.8	11.3	12.1
2	FIN_1	10.3	9.3	11.3	12.3
	FIN_2		8.7		11.2
	SWE_1	6.4	8.4	11.8	9.6
	SWE_2		9.1		
3	FIN_1		9.3	12.0	11.0
	SWE_1	11.2	10.1	10.9	10.1
	SWE_2		9.2		
4	FIN_1	8.0	9.2	11.0	10.3
	FIN_2		11.5		
	SWE_1	7.0	9.8		12.8
	SWE_2		10.3		
5	FIN_1		11.0	13.1	11.8
	FIN_2	11.1	9.8	10.4	

5.4 NEED FOR TOWING

The need for towing is presented as a percentage on how many voyages the merchant vessel has been towed for each vessel group. The need for towing is presented in Table 5-11 to Table 5-12. It should be noted that in some cases there has been only a couple of vessels from which the relative proportion is calculated. More detail statistics about how many voyages have been done totally and how much icebreaker towing was needed is presented in Appendix 4.

Table 5-11: Summary on the need for towing during winter 2018-2019. Only the period and port group combinations in which there has been voyages are shown.

PERIOD	PORT_Group	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	3 %	13 %	3 %	0 %	0 %
	FIN_2	0 %		0 %	0 %	0 %
	FIN_6	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %	0 %	0 %
	SWE_3	0 %		0 %		
2	FIN_1	9 %	0 %	14 %	0 %	10 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	FIN_3	0 %		0 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %	0 %	0 %	0 %	0 %
	FIN_6	0 %	0 %	0 %	0 %	2 %
	SWE_1	5 %	0 %	8 %	0 %	3 %
	SWE_2	4 %	20 %	5 %	0 %	0 %
	SWE_3	0 %		0 %	0 %	0 %
	SWE_4	0 %	0 %	0 %	0 %	0 %
3	FIN_1	13 %	0 %	19 %	3 %	13 %
	FIN_2	13 %	8 %	19 %	0 %	11 %
	FIN_3	0 %	0 %	0 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %	0 %	0 %	0 %	0 %
	FIN_6	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	2 %	8 %	1 %	0 %	0 %
	SWE_3	0 %	0 %	0 %	0 %	0 %
	SWE_4	0 %	0 %	0 %	0 %	0 %
4	FIN_1	8 %	0 %	13 %	0 %	7 %
	FIN_2	8 %	0 %	14 %	0 %	2 %
	FIN_3	0 %		0 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %		0 %	0 %	0 %
	FIN_6	0 %		0 %	0 %	0 %
	SWE_1	1 %	0 %	1 %	0 %	0 %
	SWE_2	1 %	0 %	1 %	0 %	0 %
	SWE_3	0 %	0 %	0 %	0 %	
5	FIN_1	2 %	0 %	4 %	0 %	0 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		
	SWE_3	0 %		0 %		

Table 5-12: Summary on the need for towing during winter 2019-2020. Only the period and port group combinations in which there has been voyages are shown.

PERIOD	PORT_Group	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	0 %	0 %	0 %	0 %	0 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		0 %
	SWE_3	0 %		0 %		
2	FIN_1	2 %	0 %	4 %	0 %	0 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		0 %
	SWE_3	0 %		0 %		
3	FIN_1	7 %		10 %	0 %	0 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %	0 %	0 %
	SWE_3	0 %		0 %		
4	FIN_1	15 %	50 %	22 %	4 %	0 %
	FIN_2	0 %	0 %	1 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		0 %
	SWE_3	0 %		0 %		
5	FIN_1	0 %	0 %	0 %	0 %	0 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		
	SWE_3	0 %		0 %		

5.5 TOWING DURATION

The average towing durations for different EEDI-categories are presented in Table 5-13 to Table 5-14. Towing times are based on icebreakers notifications how long they have been towing the vessels. It should be noted that in some cases the average duration has been calculated only from couple events.

Table 5-13: Average towing durations [minutes] during winter 2018-2019. Only the period and port group combinations in which there has been towing are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	30.0	45.0		
2	FIN_1		135.9		113.3
	FIN_6				95.0
	SWE_1		126.8		30.0
	SWE_2	81.0	93.3		
3	FIN_1		152.9	102.5	200.0
	FIN_2	72.5	78.3		43.3
	SWE_2	50.0	140.0		
4	FIN_1		191.0		160.0
	FIN_2		102.1		50.0
	SWE_1		180.0		
	SWE_2		67.0		
5	FIN_1		55.0		

Table 5-14: Average towing durations [minutes] during winter 2019-2020. Only the period and port group combinations in which there has been towing are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
2	FIN_1		67.9		
3	FIN_1		116.9		
4	FIN_1	67.5	144.1	53.3	
	FIN_2		175.0		

5.6 TOWING DISTANCE

The average towing distances are presented in Table 5-15 to Table 5-16. The towing distance is based on the position information of the merchant vessels. In some cases, there have been gaps in the position information which distorts the distance data. Due to gaps in the position data, the distance data shall be regarded as less reliable than the duration data and should be considered indicative. It should be noted that in some cases the average distance has been calculated only from couple events.

Table 5-15: Average towing distance [nautical miles] during winter 2018-2019. Only the period and port group combinations in which there has been towing are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	1.0	6.0		
2	FIN_1		19.0		16.7
	FIN_6				3.5
	SWE_1		14.7		1.5
	SWE_2	8.7	9.5		
3	FIN_1		16.3	4.6	26.9
	FIN_2	5.9	7.7		3.0
	SWE_2	3.2	11.5		
4	FIN_1		22.3		20.6
	FIN_2		12.0		2.4
	SWE_1		28.3		
	SWE_2		5.3		
5	FIN_1		5.1		

Table 5-16: Average towing distance [nautical miles] during winter 2019-2020. Only the period and port group combinations in which there has been assistance are shown.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
2	FIN_1		8.1		
3	FIN_1		14.1		
4	FIN_1	6.4	17.1	3.8	
	FIN_2		20.8		

5.7 TOWING SPEED

The average towing speeds are presented in Table 5-17 to Table 5-18. The average towing speed is calculated based on the assistance distance and duration. The towing speed information shall be considered indicative due to limitations of the distance data.

Table 5-17: Average towing speeds [knots] during winter 2018-2019.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	2.0	5.1		
2	FIN_1		8.4		8.9
	FIN_6				2.2
	SWE_1		5.9		3.0
	SWE_2	6.4	6.5		
3	FIN_1		5.7	2.4	7.9
	FIN_2	5.0	4.9		4.0
	SWE_2	3.9	4.9		
4	FIN_1		6.8		7.7
	FIN_2		6.4		2.8
	SWE_1		9.4		
	SWE_2		4.8		
5	FIN_1		5.0		

Table 5-18: Average towing speeds [knots] during winter 2019-2020.

PERIOD	PORT_Group	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
2	FIN_1		7.1		
3	FIN_1		7.0		
4	FIN_1	5.4	6.9	4.4	
	FIN_2		7.1		

5.8 SUMMARY ON ASSISTANCE AND TOWING

Summaries of the icebreaker assistance and towing related quantities are presented in Table 5-19 and Table 5-20. The tables present the average values which have been calculated for the whole winter in all port groups. The averages calculated for the whole winter and whole area indicate that the new vessels built to EEDI Phase 0 and 1 regulations and old EEDI compliant vessels need more icebreaker assistance and towing compared to non-compliant vessels. In addition, the assisted and towed times and distance are longer, and speeds are lower compared to non-compliant vessels.

However, it should be noted that calculating the averages for the whole winter and whole area is quite big simplification as different ice conditions are mixed. A more detailed picture can be obtained by investigating the tables of the previous chapters.

Table 5-19: Summary for icebreaker assistance.

	Year	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
Need for assistance	2018-2019	16.8 %	29.2 %	20.6 %	5.6 %	17.7 %
	2019-2020	18.0 %	14.7 %	22.6 %	10.4 %	17.0 %
Time [h]	2018-2019		145.8	131.9	129.0	116.6
	2019-2020		72.4	91.2	81.1	80.1
Distance [NM]	2018-2019		23.9	21.2	21.4	19.4
	2019-2020		11.0	14.7	15.7	14.6
Speed [kn]	2018-2019		10.0	9.4	10.5	10.2
	2019-2020		9.4	9.8	11.5	11.3
Speed [kn]* <5 kn included	2018-2020		9.9	9.0	10.3	9.7
	2019-2021		9.2	9.7	11.5	11.3

Table 5-20: Summary for icebreaker towing.

	Year	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
Need for towing	2018-2019	1.7 %	1.5 %	2.6 %	0.1 %	1.3 %
	2019-2020	1.0 %	2.6 %	1.5 %	0.2 %	0.0 %
Time [h]	2018-2019		58.4	113.9	102.5	98.8
	2019-2020		67.5	126.0	53.3	-
Distance [NM]	2018-2019		4.7	13.1	4.6	10.6
	2019-2020		6.4	15.0	3.8	-
Speed [kn]	2018-2019		4.3	6.2	2.4	5.2
	2019-2020		5.4	7.0	4.4	-

5.9 ASSISTANCE BY MORE THAN ONE ICEBREAKER

The port call data also contained information about whether the merchant vessel has been assisted simultaneously by more than one icebreaker as well whether the merchant vessel was being towed and also simultaneously assisted by another icebreaker. It should be noted that it is difficult to distinguish when the vessel has been actually assisted by more than one icebreaker and in which cases the assisting icebreaker has changed and there has been two icebreakers operating in the vicinity of the merchant vessel for a while. Initially the port call data was based on 15 minutes threshold for determining the merchant vessel being assisted by more than one icebreaker. An additional 5 minutes threshold was added in the analysis phase of this project as there were some cases in which the merchant vessel was being assisted by more than one icebreaker for less than 5 minutes. It is possible that the data still contains situations in which the simultaneous assistance is not correctly recognized causing uncertainty to the results. Therefore, the results of this chapter should be viewed carefully.

Situations in which the merchant vessel has been being assisted by more than one icebreaker are rare:

- Winter 2018-2019: 17 cases from total of 8857 port calls
- Winter 2019-2020: 13 cases from total of 3353 port calls

Towing while being also assisted is even more rare:

- Winter 2018-2019: 4 cases from total of 8857 port calls
- Winter 2019-2020: 0 cases from total of 3353 port calls

Table 5-21 presents the summary of winter 2019. The few cases are randomly distributed for different EEDI-compliancy categories.

As there are only few cases in which the merchant vessel has been assisted by several icebreakers and the cases are also distributed randomly, no detail analysis are presented for this assistance situation. In addition, it should be noted that it is difficult to distinguish when the vessel has been actually assisted by more than one icebreaker and in which cases the assisting icebreaker has changed and there has been two icebreakers operating in the vicinity of the merchant vessel for a while. Initially the port call data was based on 15 minutes threshold for determining the merchant vessel being assisted by more than one icebreaker. An additional 5 minutes threshold was added in the analysis phase of this project as there were some cases in which the merchant vessel was being assisted by more than one icebreaker for less than 5 minutes.

Table 5-21: Summary on the need for icebreaker assistance by many icebreakers during winter 2018-2019. Only the period and port group combinations in which there has been voyages are shown.

PERIOD	PORT_Group	Total	Phase_0_1	EEDI_compliant	Non_compliant	NA
1	FIN_1	0 %	0 %	0 %	0 %	0 %
	FIN_2	0 %		0 %	0 %	0 %
	FIN_6	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %	0 %	0 %
	SWE_3	0 %		0 %		
2	FIN_1	1 %	0 %	1 %	0 %	0 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	FIN_3	0 %		0 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %	0 %	0 %	0 %	0 %
	FIN_6	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %	0 %	0 %
	SWE_3	0 %		0 %	0 %	0 %
	SWE_4	0 %	0 %	0 %	0 %	0 %
3	FIN_1	0 %	0 %	0 %	1 %	0 %
	FIN_2	2 %	4 %	1 %	2 %	4 %
	FIN_3	0 %	0 %	0 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %	0 %	0 %	0 %	0 %
	FIN_6	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %	0 %	0 %
	SWE_3	0 %	0 %	0 %	0 %	0 %
	SWE_4	0 %	0 %	0 %	0 %	0 %
4	FIN_1	1 %	0 %	1 %	1 %	0 %
	FIN_2	1 %	0 %	0 %	2 %	2 %
	FIN_3	0 %		0 %	0 %	0 %
	FIN_4	0 %	0 %	0 %	0 %	0 %
	FIN_5	0 %		0 %	0 %	0 %
	FIN_6	0 %		0 %	0 %	0 %
	SWE_1	1 %	0 %	1 %	0 %	0 %
	SWE_2	0 %	0 %	0 %	0 %	0 %
	SWE_3	0 %	0 %	0 %	0 %	
5	FIN_1	0 %	0 %	0 %	0 %	0 %
	FIN_2	0 %	0 %	0 %	0 %	0 %
	SWE_1	0 %	0 %	0 %	0 %	0 %
	SWE_2	0 %	0 %	0 %		
	SWE_3	0 %		0 %		

5.11 EFFECT OF POWER-DEADWEIGHT RATIO

AS done in the previous research, the effect of the power-deadweight ratio is investigated by focusing on port group FIN_1 (Oulu, Kemi, Tornio) from mid-February to mid-April on winter 2019 (periods 3 and 4). The ice conditions are considered to be most difficult on this location-period combination from the whole data set.

The power-deadweight ratio has been compared to the assistance speed, duration and distance in Figure 5-1 to Figure 5-3. There is quite lot of scatter in the figures, but it seems that there are slight trends that the assistance duration and distance increase as the power-deadweight ratio decreases and the assistance speed decreases as the power-deadweight ratio decreases.

In Figure 5-4 and Figure 5-5 is presented the power-deadweight ratio distribution of assisted and non-assisted vessels. The distributions are normalized based on probability in order to compare different sample sizes. It is clearly visible that the vessels which have needed icebreaker assistance have lower power-deadweight ratio compared to vessels which have not needed assistance.

In Figure 5-6 and Figure 5-7 is presented the power-deadweight ratio of towed and non-towed vessels. Similar trends as for assistance can be seen although it is not as clear. Similarly like in the previous research, no vessels with 1.0 or higher power-deadweight ratio have been towed in the investigated sample.

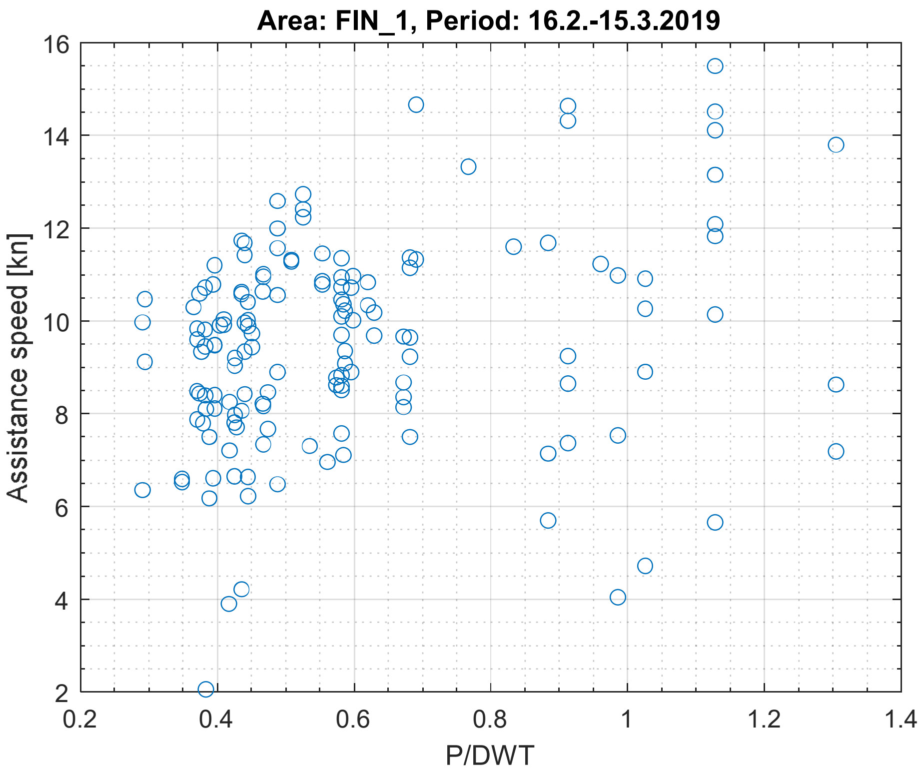


Figure 5-1: Power-deadweight ratio versus assistance speed.

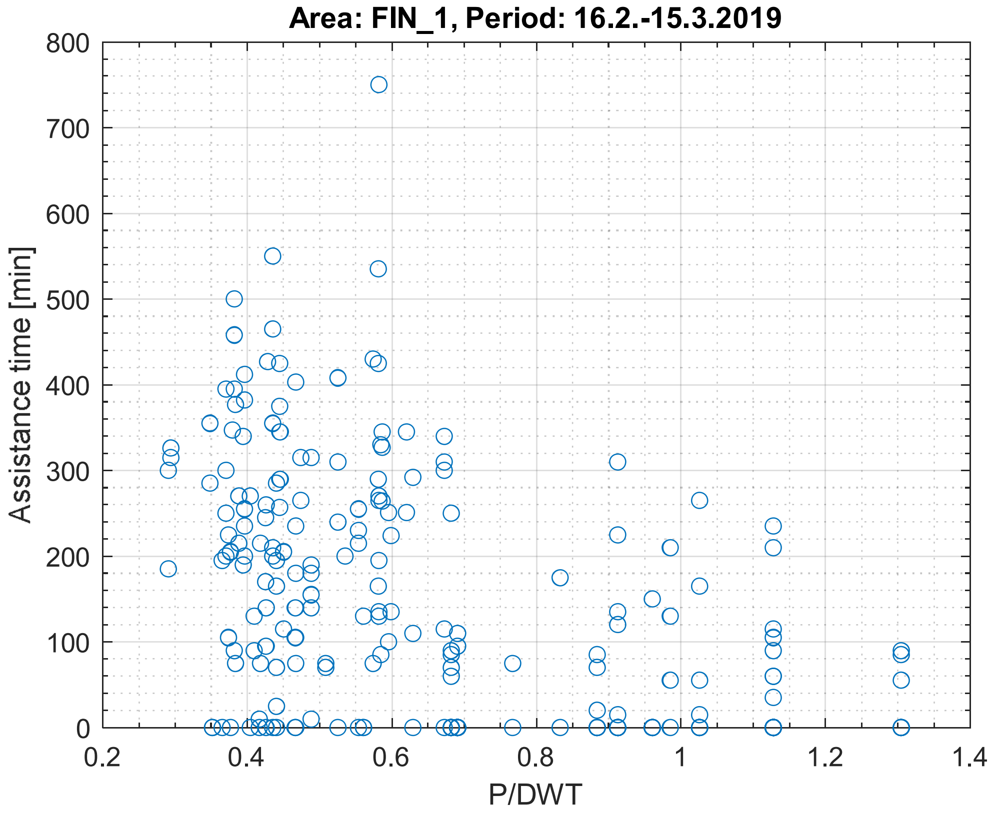


Figure 5-2: Power-deadweight ratio versus assistance duration.

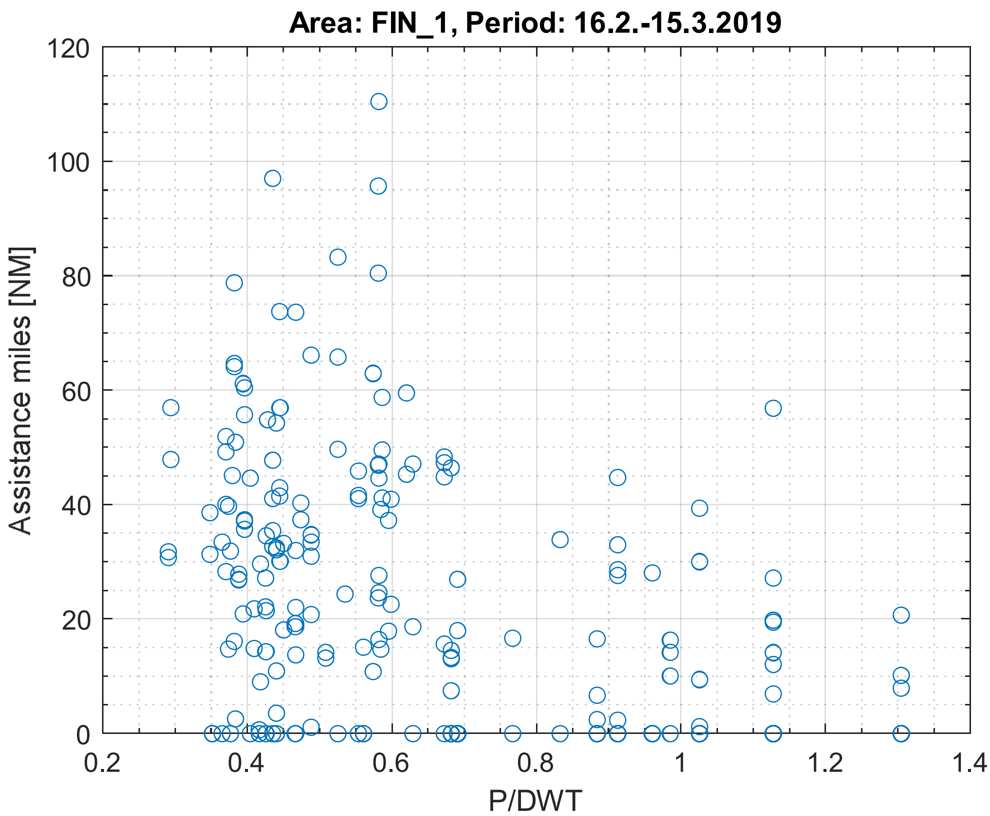


Figure 5-3: Power-deadweight ratio versus assistance miles.

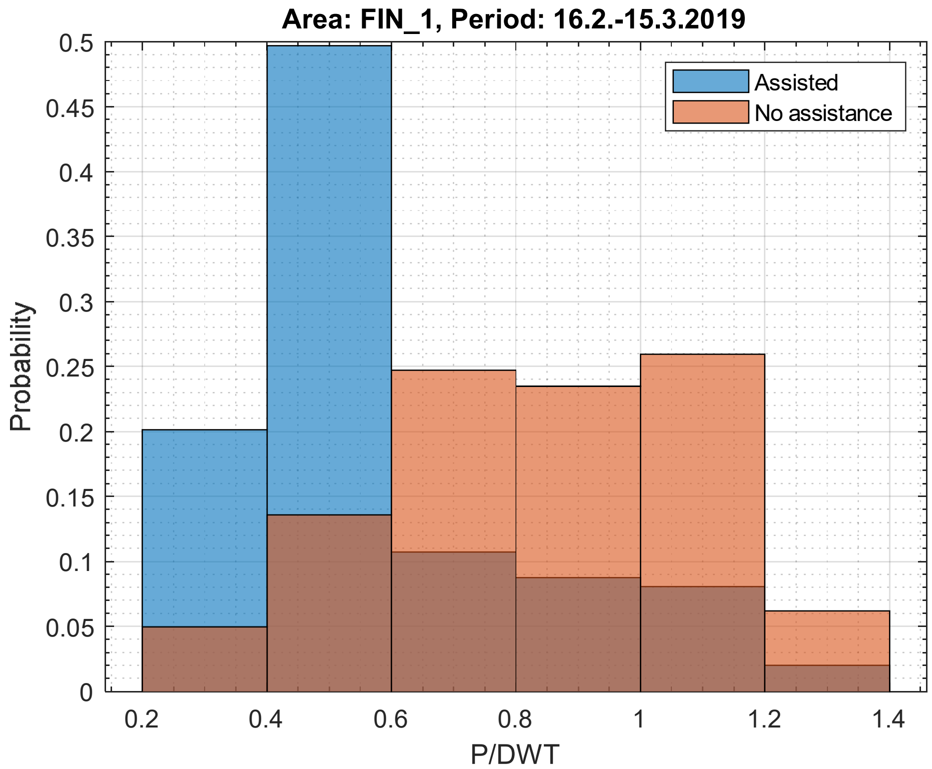


Figure 5-4: Power-deadweight distribution of the assisted and non-assisted vessels, period 3. The dark brown color refers to a case where the two distributions overlap.

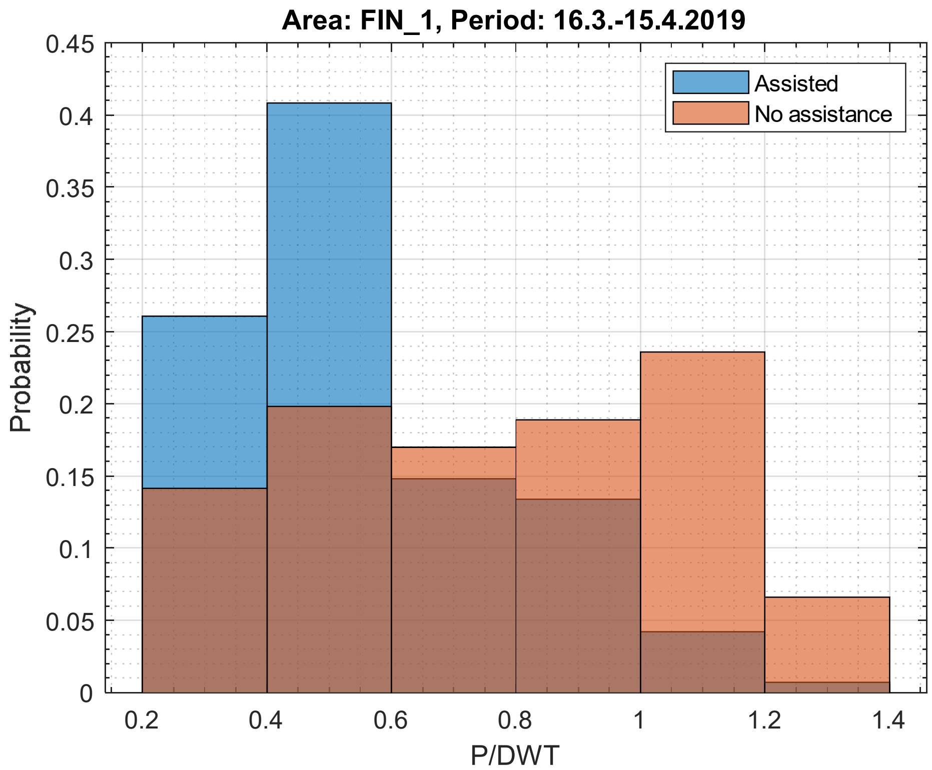


Figure 5-5: Power-deadweight distribution of the assisted and non-assisted vessels, period 4. The dark brown color refers to a case where the two distributions overlap.

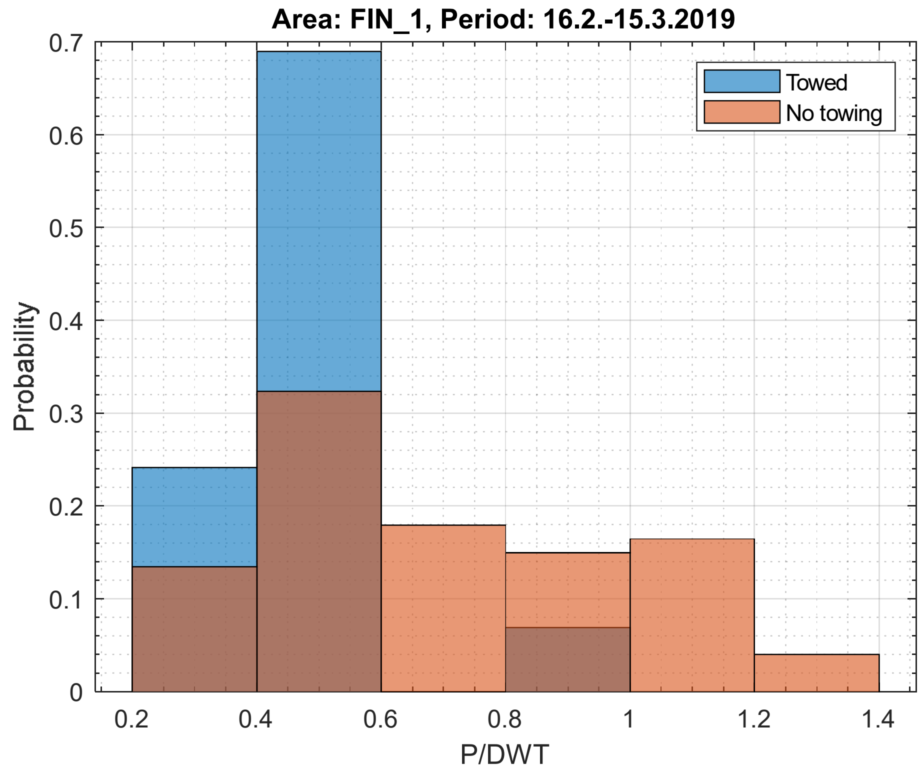


Figure 5-6: Power-deadweight distribution of the towed and non-towed vessels, period 3. The dark brown color refers to a case where the two distributions overlap.

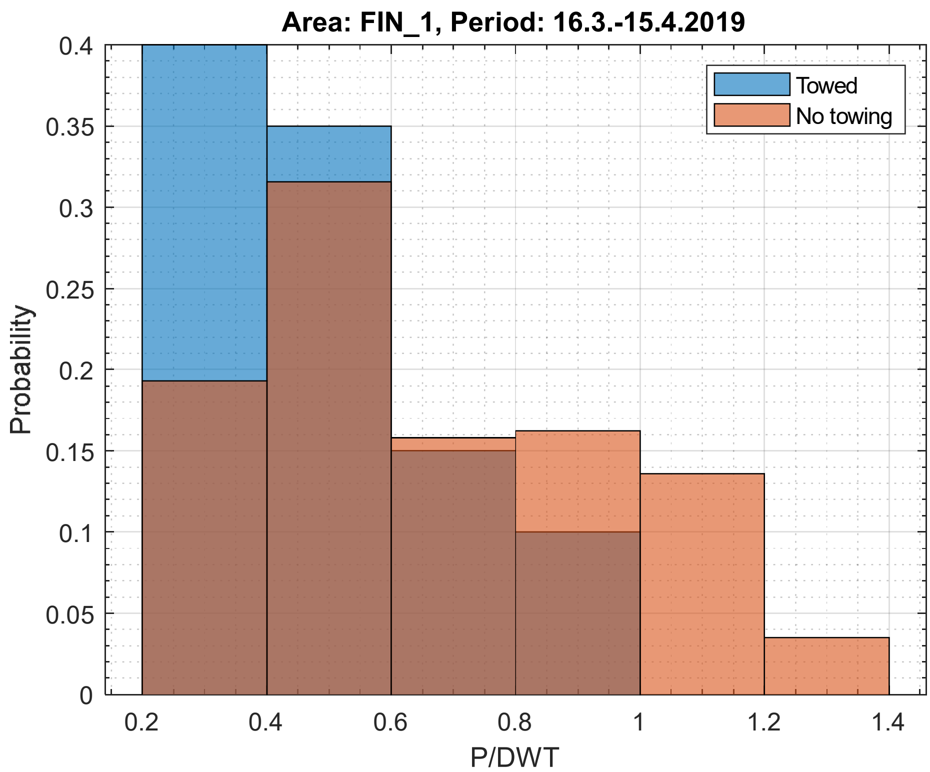


Figure 5-7: Power-deadweight distribution of the towed and non-towed vessels, period 4. The dark brown color refers to a case where the two distributions overlap.

6 CONCLUSIONS

The ice-going performance of different EEDI-category vessels has been investigated in this report. The investigation has been done for the past two winters 2018-2019 and 2019-2020. Unfortunately, the winter 2019-2020 was one of the mildest ever recorded, which decreases the amount of information. In addition to the need for icebreaker assistance, also the vessel parameters between the new ice-classed EEDI vessels and older vessels observed at the Baltic Sea were compared in this report.

The number of EEDI vessels is still relatively small but the number of vessels is increasing. During winters 2018-2019 and 2019-2020 48 different ice-classed EEDI vessels were observed while only 23 different EEDI vessels were observed during the preceding three winters 2015-2016 to 2017-18 which were investigated in the previous research project. Currently there are total of 421 ice-classed vessels built/being built according to the EEDI regulations and 336 of these vessels are currently in service.

On winter 2018-2019 approximately 3% of all port calls were done by actual Phase 0 and 1 EEDI vessels and these vessels accounted approximately for 6% of all assistance events. For winter 2019-2020 the corresponding numbers are ~5% (port calls) and ~2.5% (assistance events).

On winter 2018-2019 approximately 30% of the actual EEDI vessels and ~20% of the older EEDI compliant vessels have needed assistance. This is approximately the same magnitude as observed in the previous research project. The non-compliant vessels need clearly less assistance. However, it should be noted that this is a very rough estimate based on the averages of the whole winter. On the other hand, it is interesting to notice that in the middle of winter 2018-2019 basically all new EEDI vessels have needed assistance when visiting ports from port group FIN_2 (Raahe to Vaasa) and there has been clearly more EEDI vessels visiting these ports than to the port group FIN_1 which typically has more difficult ice conditions.

Regarding assistance time, distance and speed, there are no such clear trends between the different EEDI-compliances which were observed in the previous research project. The most distinct differences are observed for the need for icebreaker assistance and for towing which is clearly lower for the non-compliant vessels.

Comparison of vessel parameters indicated that the new ice-classed EEDI vessels are less powerful than the older pre-EEDI ice-classed vessels. For example for IA general cargo ships, which are most common merchant vessels observed in the northern Baltic sea during the past winters, the new EEDI vessels have P/DWT ratio of 0.33 kW/ton while the older vessels have ratio of 0.48 kW/ton which means approximately 30% reduction. Based on this research and also the previous research, there seems to be a clear correlation between the power-deadweight ratio of the merchant vessel and the need for icebreaker assistance and towing. The need for icebreaker assistance increases as the power-deadweight ratio decreases.

The service speeds seem to be the same for older and newer EEDI vessels but the new vessels have a smaller Froude number. This is obtained by increasing the waterline length. Therefore, the new EEDI vessels have a higher L_{pp}/L ratio than the older pre-EEDI vessels. This most likely results into very steep frame angles at the bow which is unfavorable for ice-going capability. With steep frame angles the vessel will be pushing the ice mass. In case of independent operation in for example in level ice, the vertical bow will be crushing the ice with high resistance. This means that the vessels ability to operate independently is weak and it needs assistance. Unfortunately, the vessel data does not contain information about the actual angles at the bow and therefore it is not possible to make definite conclusions about the bow form.

Based on the vessel data, the small P/DWT ratio of the new vessels is linked to high L_{pp}/L ratio. Both factors could result that more icebreaker capacity is needed in the future. In addition, the upcoming EEXI regulations most likely decreases ice-going capability also for older vessels, which could increase the need for icebreakers in the future.

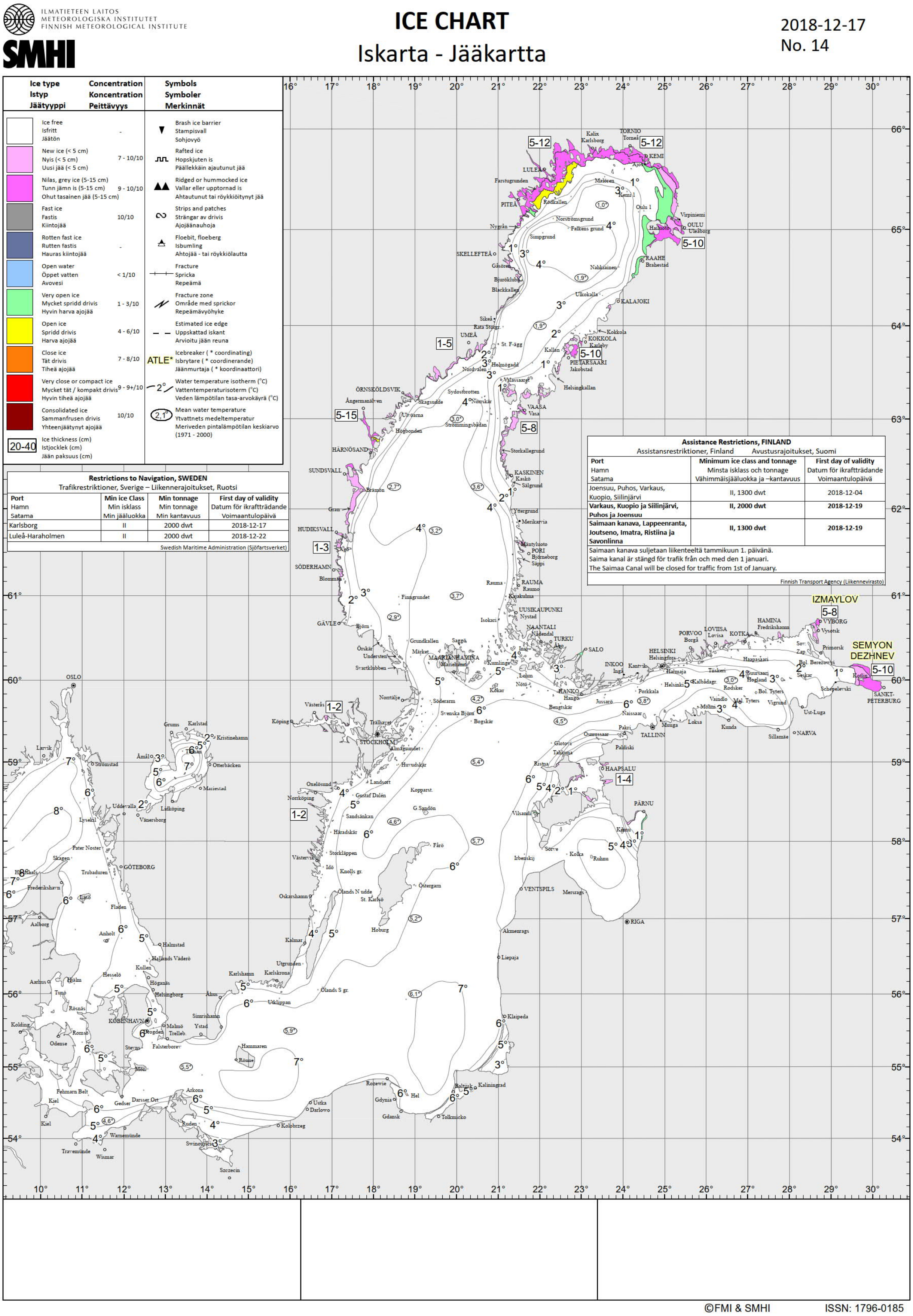
Typically, the ice resistance research has focused on hull forms which have some sort of icebreaking capability. Nearly vertical bows could generate phenomena that are not present with more typical bows and therefore are not fully taken into account in for example ice resistance calculations. Future research on the vertical bows could be beneficial as well as further investigation about the ice-going capability of the EEDI vessels as more vessels enter service. In addition, the effects of EEXI should be also investigated.

APPENDIX 1: LIST OF PORTS

FINLAND	
Port	**Group**
'KEMI'	FIN_1
'OULU'	FIN_1
'TORNIO'	FIN_1
'KALAJOKI'	FIN_2
'KOKKOLA'	FIN_2
'RAAHE'	FIN_2
'VAASA'	FIN_2
PIETARSAARI'	FIN_2
'KASKINEN'	FIN_3
'KRISTIINANKAUPUNKI'	FIN_3
'PORI'	FIN_3
'RAUMA'	FIN_3
'FÖRBY'	FIN_4
'NAANTALI'	FIN_4
'TURKU'	FIN_4
'UUSIKAUPUNKI'	FIN_4
'HANKO'	FIN_5
TAALINTEHDAS'	FIN_5
HELSINKI'	FIN_5
'INKOO'	FIN_5
'KANTVIK'	FIN_5
'KOVERHAR'	FIN_5
'LOVIISA'	FIN_5
'SKÖLDVIK'	FIN_5
'KOTKA'	FIN_6
MUSSALO'	FIN_6
'HAMINA'	FIN_6

SWEDEN	
Port	**Group**
'HARAHOLMEN'	SWE_1
'LULEÅ'	SWE_1
'HOLMSUND'	SWE_2
'KARLSBORG'	SWE_2
SKELLEFTEHAMN'	SWE_2
'HUDIKSVALL'	SWE_3
'HUSUM'	SWE_3
'HÄRNÖSAND'	SWE_3
'IGGESUND'	SWE_3
'RUNDVIK'	SWE_3
'SUNDSVALL'	SWE_3
'SÖRÅKER'	SWE_3
ÅNGERMANÄLVEN'	SWE_3
ÖRNSKÖLDSVIK'	SWE_3
'GRISSLEHAMN'	SWE_4
'GÄVLE'	SWE_4
'HALLSTAVIK'	SWE_4
'HARGSHAMN'	SWE_4
KAPELLSKÄR'	SWE_4
NORRSUNDET'	SWE_4
'ORRSKÄR'	SWE_4
SKUTSKÄR'	SWE_4
'STOCKHOLM'	SWE_4
'SÖDERHAMN'	SWE_4

APPENDIX 2: ICE CHARTS



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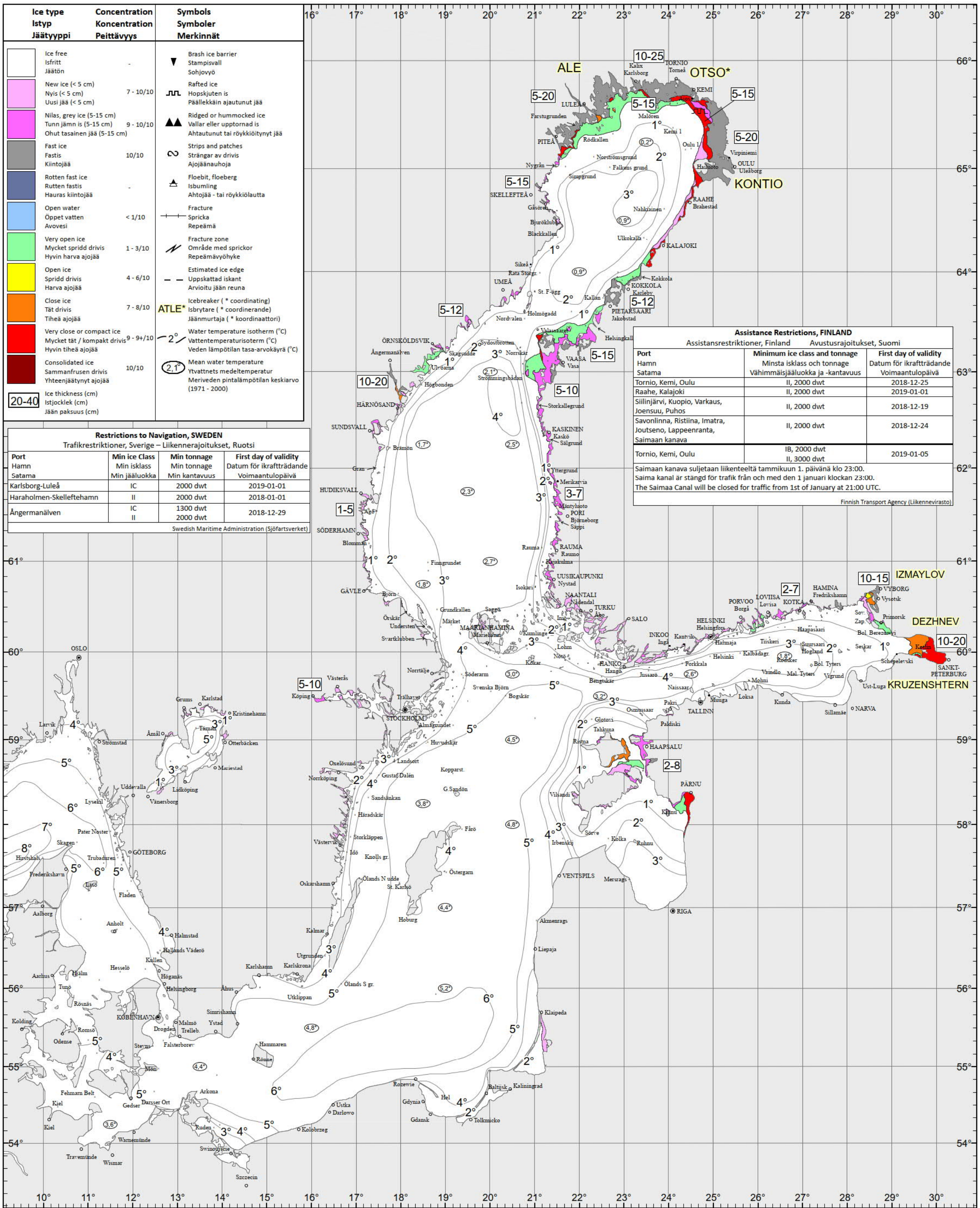
FINNISH METEOROLOGICAL INSTITUTE

SMHI

ICE CHART

Iskarta - Jääkartta

2019-01-01
No. 29



Restrictions to Navigation, SWEDEN Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi			
Port Hamn Satama	Min ice Class Min isklass Min jääluokka	Min tonnage Min tonnage Min kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
Karlsborg-Luleå	IC	2000 dwt	2019-01-01
Haraholmen-Skelleftehamn	II	2000 dwt	2018-01-01
Ångermanälven	IC II	1300 dwt 2000 dwt	2018-12-29

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND Assistansrestriktioner, Finland Avustusrajoitukset, Suomi		
Port Hamn Satama	Minimum ice class and tonnage Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	II, 2000 dwt	2018-12-25
Raahe, Kalajoki	II, 2000 dwt	2019-01-01
Siilinjärvi, Kuopio, Varkaus, Joensuu, Puhos	II, 2000 dwt	2018-12-19
Savonlinna, Ristiina, Imatra, Joutseno, Lappeenranta, Saimaan kanava	II, 2000 dwt	2018-12-24
Tornio, Kemi, Oulu	IB, 2000 dwt II, 3000 dwt	2019-01-05

Saimaan kanava suljetaan liikenteeltä tammikuun 1. päivänä klo 23:00.
Saima kanal är stängd för trafik från och med den 1 januari klockan 23:00.
The Saimaa Canal will be closed for traffic from 1st of January at 21:00 UTC.

Finnish Transport Agency (Liikennevirasto)

Vessels bound for Gulf of Bothnia ports in which traffic restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Fartyg destinerade till hamnar med trafikrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa liikennerajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

ISSN: 1796-0185

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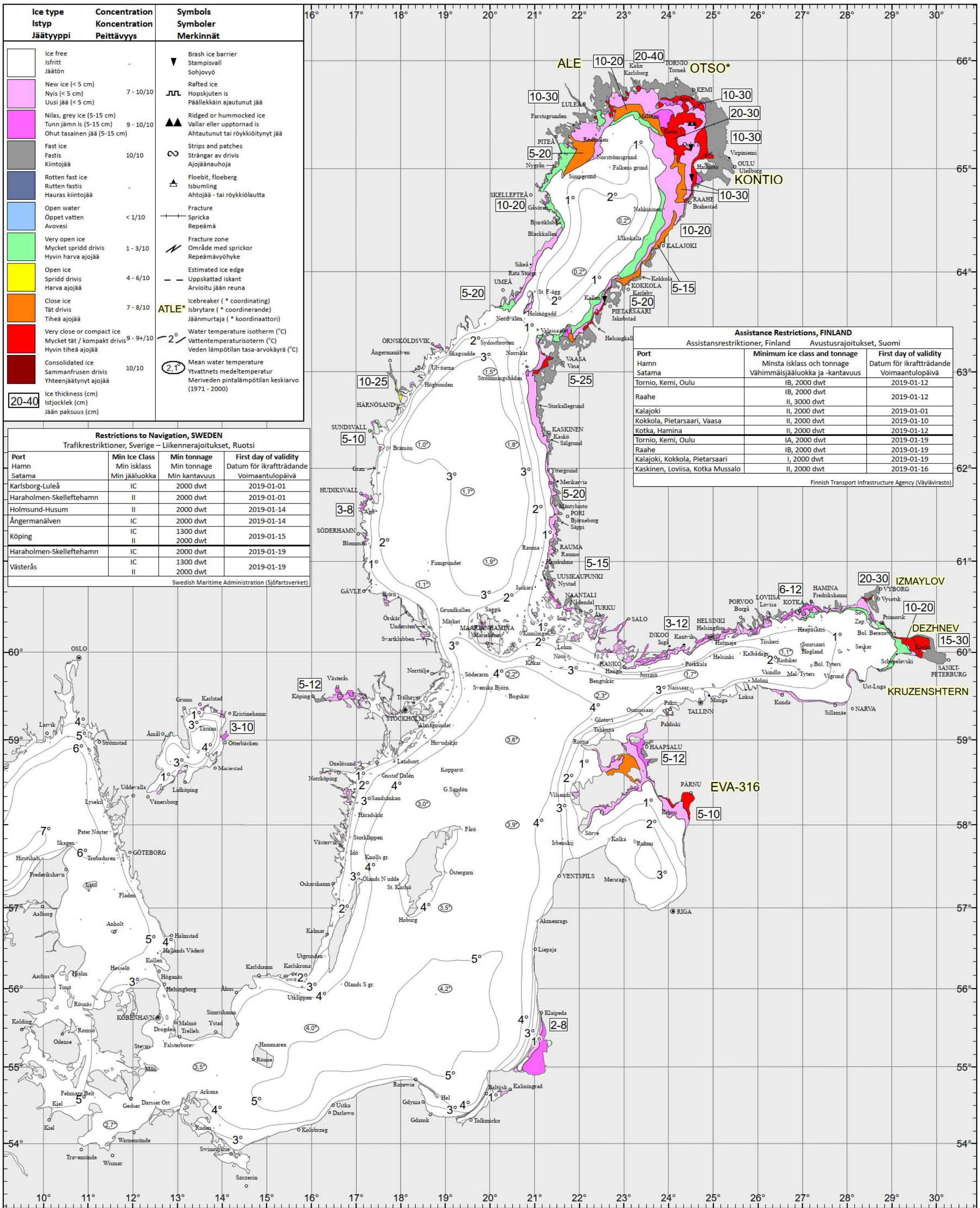
ICE CHART

Iskarta - Jääkartta

2019-01-15
No. 43



Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port Hamn Satama	Min Ice Class Min isklass Min jääluokka	Min tonnage Min tonnage Min kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
Karlsborg-Luleå	IC	2000 dwt	2019-01-01
Haraholmen-Skelleftehamn	II	2000 dwt	2019-01-01
Holmsund-Husum	II	2000 dwt	2019-01-14
Ångermanälven	IC	2000 dwt	2019-01-14
Köping	IC II	1300 dwt 2000 dwt	2019-01-15
Haraholmen-Skelleftehamn	IC	2000 dwt	2019-01-19
Västerås	IC II	1300 dwt 2000 dwt	2019-01-19

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port Hamn Satama	Minimum ice class and tonnage Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IB, 2000 dwt	2019-01-12
Raahe	IB, 2000 dwt II, 3000 dwt	2019-01-12
Kalajoki	II, 2000 dwt	2019-01-01
Kokkola, Pietarsaari, Vaasa	II, 2000 dwt	2019-01-10
Kotka, Hamina	II, 2000 dwt	2019-01-12
Tornio, Kemi, Oulu	IA, 2000 dwt	2019-01-19
Raahe	IB, 2000 dwt	2019-01-19
Kalajoki, Kokkola, Pietarsaari	I, 2000 dwt	2019-01-19
Kaskinen, Loviisa, Kotka Mussalo	II, 2000 dwt	2019-01-16

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.

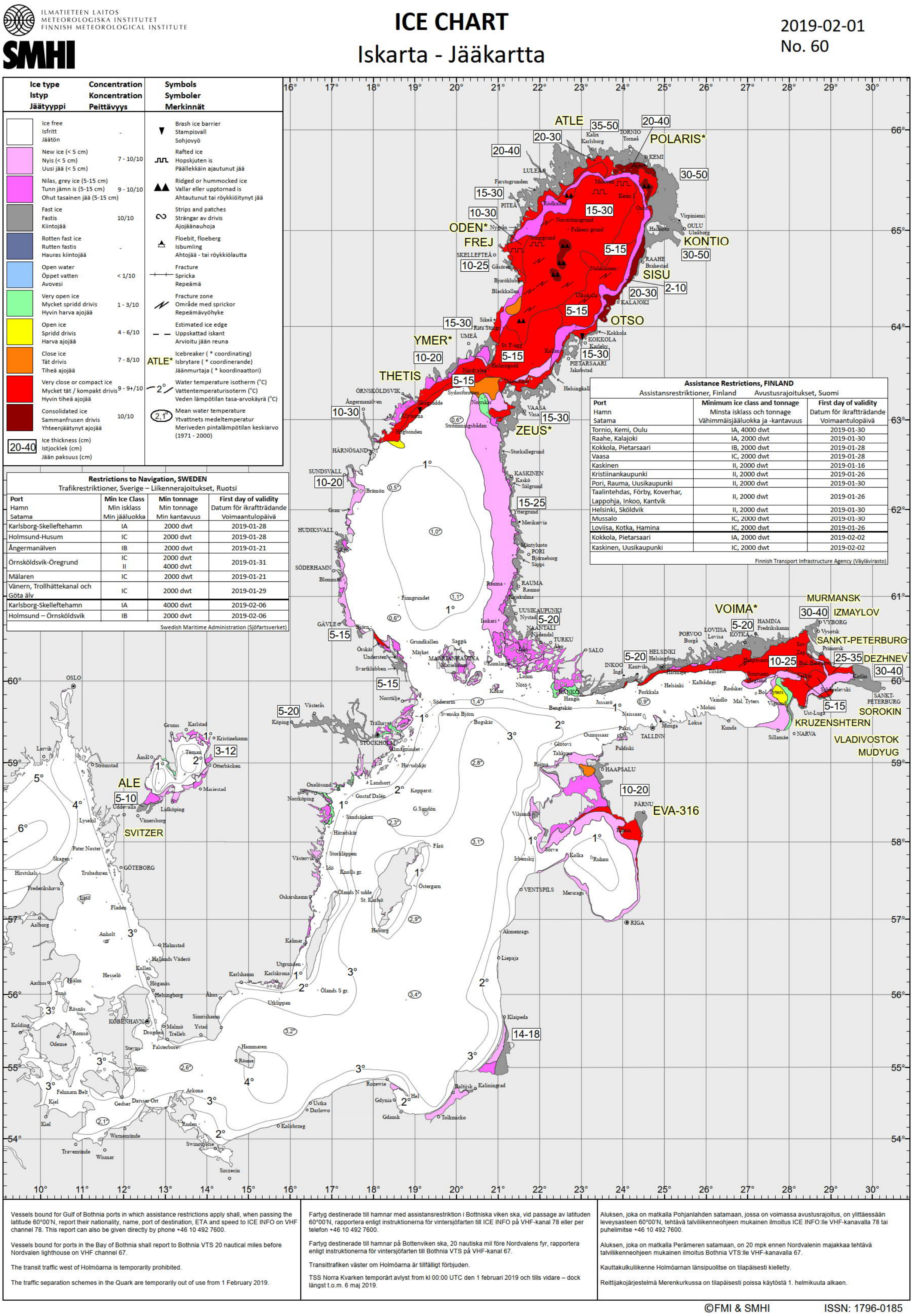
Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

ISSN: 1796-0185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SMHI
ICE CHART
Iskarta - Jääkartta
2019-02-01
No. 60
Ice type
Istyp
Jäätyyppi
Concentration
Koncentration
Peittävyys
Symbols
Symboler
Merkinnät
Ice free
Isfritt
Jäätön
New ice (< 5 cm)
Nyis (< 5 cm)
Uusi jää (< 5 cm)
7 - 10/10
Nilas, grey ice (5-15 cm)
Tunn jämn is (5-15 cm)
Ohut tasainen jää (5-15 cm)
9 - 10/10
Fast ice
Fastis
Kiintojää
10/10
Rotten fast ice
Rutten fastis
Hauras kiintojää
Open water
Öppet vatten
Avovesi
< 1/10
Very open ice
Mycket spridd drivis
Hyvin harva ajojää
1 - 3/10
Open ice
Spridd drivis
Harva ajojää
4 - 6/10
Close ice
Tät drivis
Tiheä ajojää
7 - 8/10
Very close or compact ice
Mycket tät / kompakt drivis
Hyvin tiheä ajojää
9 - 9+/10
Consolidated ice
Sammanfrusen drivis
Yhteenjäätynyt ajojää
10/10
Ice thickness (cm)
Istjocklek (cm)
Jään paksuus (cm)
Brash ice barrier
Stampisvall
Sohjovyö
Rafted ice
Hopskjuten is
Päällekkäin ajautunut jää
Ridged or hummocked ice
Vallar eller upptornad is
Ahtautunut tai röykkiöitynyt jää
Strips and patches
Strängar av drivis
Ajojäänauhoja
Floebit, floeberg
Isbumling
Ahtojää - tai röykkiölautta
Fracture
Spricka
Repeämä
Fracture zone
Område med sprickor
Repeämävyöhyke
Estimated ice edge
Uppskattad iskant
Arvioitu jään reuna
Icebreaker (* coordinating)
Isbrytare (* coordinerande)
Jäänmurtaja (* koordinaattori)
Water temperature isotherm (°C)
Vattentemperaturisoterm (°C)
Veden lämpötilan tasa-arvokäyrä (°C)
Mean water temperature
Ytvattnets medeltemperatur
Meriveden pintalämpötilan keskiarvo
(1971 - 2000)
Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi
Port / Hamn / Satama | Min Ice Class / Min isklass / Min jääluokka | Min tonnage / Min tonnage / Min kantavuus | First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Karlsborg-Skelleftehamn | IA | 2000 dwt | 2019-01-28
Holmsund-Husum | IC | 2000 dwt | 2019-01-28
Ångermanälven | IB | 2000 dwt | 2019-01-21
Örnsköldsvik-Öregrund | IC, II | 2000 dwt, 4000 dwt | 2019-01-31
Mälaren | IC | 2000 dwt | 2019-01-21
Vänern, Trollhättekanal och Göta älv | IC | 2000 dwt | 2019-01-29
Karlsborg-Skelleftehamn | IA | 4000 dwt | 2019-02-06
Holmsund – Örnsköldsvik | IB | 2000 dwt | 2019-02-06
Swedish Maritime Administration (Sjöfartsverket)
Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi
Port / Hamn / Satama | Minimum ice class and tonnage / Minsta isklass och tonnage / Vähimmäisjääluokka ja -kantavuus | First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Tornio, Kemi, Oulu | IA, 4000 dwt | 2019-01-30
Raahe, Kalajoki | IA, 2000 dwt | 2019-01-30
Kokkola, Pietarsaari | IB, 2000 dwt | 2019-01-28
Vaasa | IC, 2000 dwt | 2019-01-28
Kaskinen | II, 2000 dwt | 2019-01-16
Kristiinankaupunki | II, 2000 dwt | 2019-01-26
Pori, Rauma, Uusikaupunki | II, 2000 dwt | 2019-01-30
Taalintehdas, Förby, Koverhar, Lappohja, Inkoo, Kantvik | II, 2000 dwt | 2019-01-26
Helsinki, Sköldvik | II, 2000 dwt | 2019-01-30
Mussalo | IC, 2000 dwt | 2019-01-30
Loviisa, Kotka, Hamina | IC, 2000 dwt | 2019-01-26
Kokkola, Pietarsaari | IA, 2000 dwt | 2019-02-02
Kaskinen, Uusikaupunki | IC, 2000 dwt | 2019-02-02
Finnish Transport Infrastructure Agency (Väylävirasto)
ATLE
POLARIS*
ODEN*
FREJ
KONTIO
SISU
OTSO
YMER*
THETIS
ZEUS*
VOIMA*
MURMANSK
IZMAYLOV
SANKT-PETERBURG
DEZHNEV
KRUZENSHTERN
VLADIVOSTOK
MUDYUG
SOROKIN
EVA-316
ALE
SVITZER
Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.
Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.
The transit traffic west of Holmöarna is temporarily prohibited.
The traffic separation schemes in the Quark are temporarily out of use from 1 February 2019.
Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.
Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.
Transittrafiken väster om Holmöarna är tillfälligt förbjuden.
TSS Norra Kvarken temporärt avlyst from kl 00:00 UTC den 1 februari 2019 och tills vidare – dock längst t.o.m. 6 maj 2019.
Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.
Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.
Kauttakulkuliikenne Holmöarnan länsipuolitse on tilapäisesti kielletty.
Reittijakojärjestelmä Merenkurkussa on tilapäisesti poissa käytöstä 1. helmikuuta alkaen.
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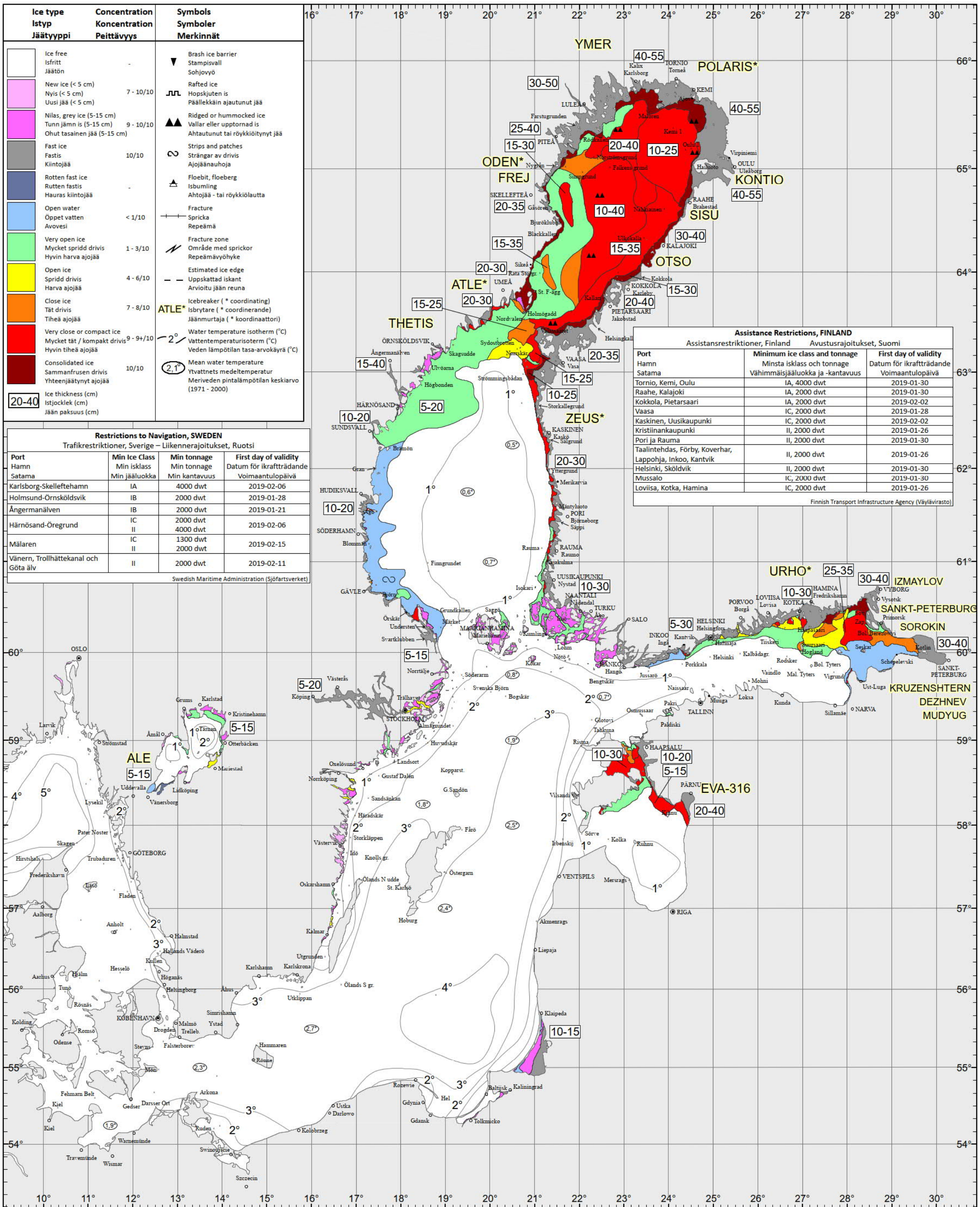
ICE CHART

Iskarta - Jääkartta

2019-02-15
No. 74



Restrictions to Navigation, SWEDEN Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi			
Port Hamn Satama	**Min Ice Class** Min isklass Min jääluokka	**Min tonnage** Min tonnage Min kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Karlsborg-Skelleftehamn	IA	4000 dwt	2019-02-06
Holmsund-Örnsköldsvik	IB	2000 dwt	2019-01-28
Ångermanälven	IB	2000 dwt	2019-01-21
Härnösand-Öregrund	IC II	2000 dwt 4000 dwt	2019-02-06
Mälaren	IC II	1300 dwt 2000 dwt	2019-02-15
Vänern, Trollhättekanal och Göta älv	II	2000 dwt	2019-02-11

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND Assistansrestriktioner, Finland Avustusrajoitukset, Suomi		
Port Hamn Satama	**Minimum ice class and tonnage** Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 4000 dwt	2019-01-30
Raahe, Kalajoki	IA, 2000 dwt	2019-01-30
Kokkola, Pietarsaari	IA, 2000 dwt	2019-02-02
Vaasa	IC, 2000 dwt	2019-01-28
Kaskinen, Uusikaupunki	IC, 2000 dwt	2019-02-02
Kristiinankaupunki	II, 2000 dwt	2019-01-26
Pori ja Rauma	II, 2000 dwt	2019-01-30
Taalintehdas, Förby, Koverhar, Lappohja, Inkoo, Kantvik	II, 2000 dwt	2019-01-26
Helsinki, Sköldvik	II, 2000 dwt	2019-01-30
Mussalo	IC, 2000 dwt	2019-01-30
Loviisa, Kotka, Hamina	IC, 2000 dwt	2019-01-26

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.

The transit traffic west of Holmöarna is temporarily prohibited.

The traffic separation schemes in the Quark are temporarily out of use from 1 February 2019.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.

Transittrafiken väster om Holmöarna är tillfälligt förbjuden.

TSS Norra Kvarken temporärt avlyst from kl 00:00 UTC den 1 februari 2019 och tills vidare – dock längst t.o.m. 6 maj 2019.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Kauttakulkuliikenne Holmöarnan länsipuolitse on tilapäisesti kielletty.

Reittijakojärjestelmä Merenkurkussa on tilapäisesti poissa käytöstä 1. helmikuuta alkaen.

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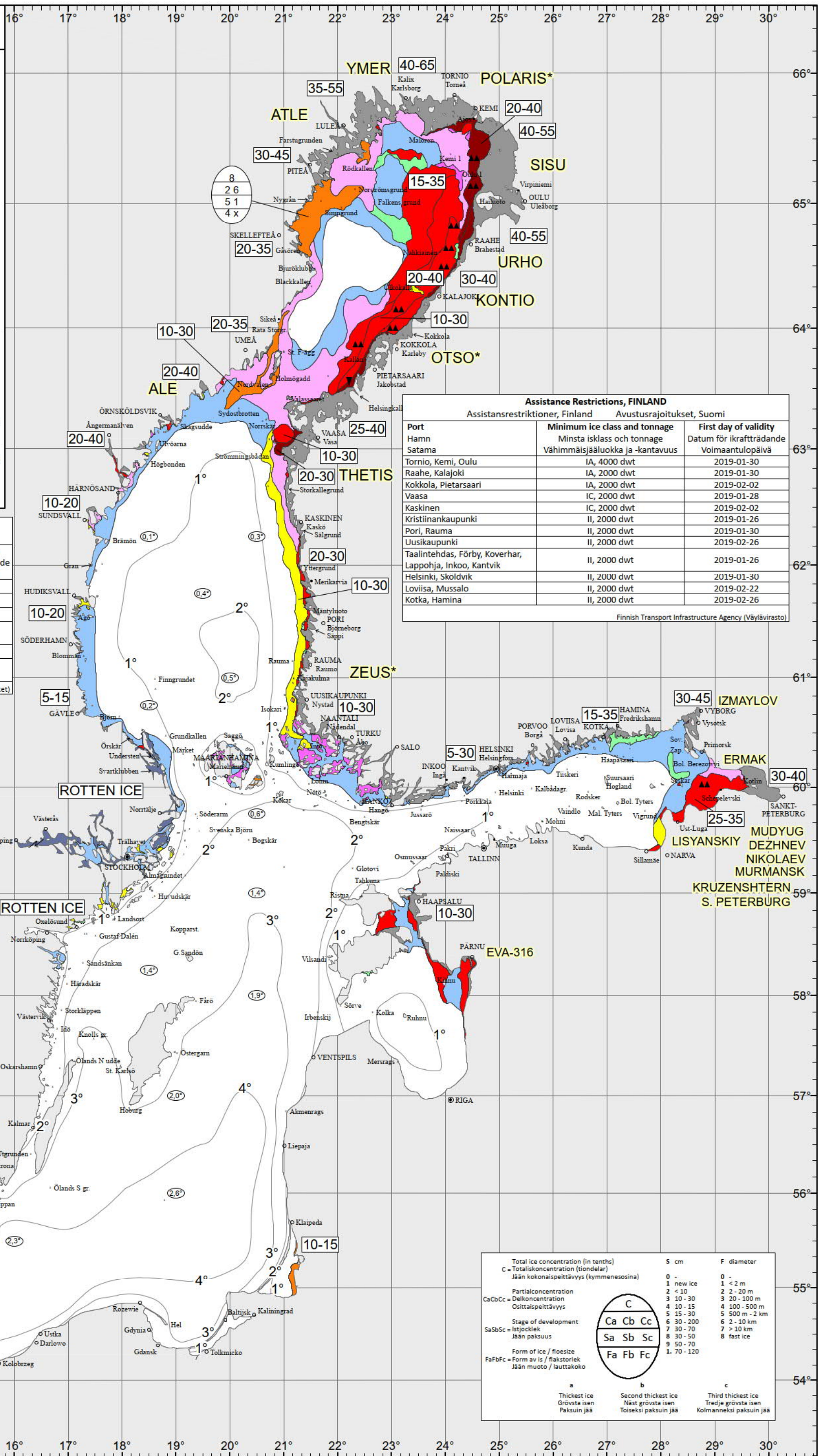
ICE CHART
Iskarta - Jääkartta

2019-03-01
No. 88



Ice type / Istyp / Jäätyyppi	Concentration / Koncentration / Peittävyys
Ice free / Isfritt / Jäätön	-
New ice (< 5 cm) / Nyis (< 5 cm) / Uusi jää (< 5 cm)	7 - 10/10
Nilas, grey ice (5-15 cm) / Tunn jämn is (5-15 cm) / Ohut tasainen jää (5-15 cm)	9 - 10/10
Fast ice / Fastis / Kiintojää	10/10
Rotten fast ice / Rutten fastis / Hauras kiintojää	-
Open water / Öppet vatten / Avovesi	< 1/10
Very open ice / Mycket spridd drivis / Hyvin harva ajojää	1 - 3/10
Open ice / Spridd drivis / Harva ajojää	4 - 6/10
Close ice / Tät drivis / Tiheä ajojää	7 - 8/10
Very close or compact ice / Mycket tät / kompakt drivis / Hyvin tiheä ajojää	9 - 9+/10
Consolidated ice / Sammanfrusen drivis / Yhteenjäätynyt ajojää	10/10
20-40 Ice thickness (cm) / Istjocklek (cm) / Jään paksuus (cm)	

Symbols / Symboler / Merkinnät
- Brash ice barrier / Stampisvall / Sohjovyö
- Rafted ice / Hopskjuten is / Päällekkäin ajautunut jää
- Ridged or hummocked ice / Vallar eller upptornad is / Ahtautunut tai röykkiöitynyt jää
- Strips and patches / Strängar av drivis / Ajojäänauhoja
- Floebit, floeberg / Isbumling / Ahtojää - tai röykkiölautta
- Fracture / Spricka / Repeämä
- Fracture zone / Område med sprickor / Repeämävyöhyke
- Estimated ice edge / Uppskattad iskant / Arvioitu jään reuna
- ATLE* Icebreaker (* coordinating) / Isbrytare (* coordinerande) / Jäänmurtaja (* koordinaattori)
- Water temperature isotherm (°C) / Vattentemperaturisoterm (°C) / Veden lämpötilan tasa-arvokäyrä (°C)
- 2,1° Mean water temperature / Ytvattnets medeltemperatur / Meriveden pintalämpötilan keskiarvo (1971 - 2000)

Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port / Hamn / Satama	Min ice class / Min isklass / Min jääluokka	Min tonnage / Min tonnage / Min kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Karlsborg-Skelleftehamn	IA	4000 dwt	2019-02-06
Holmsund-Örnsköldsvik	IB	2000 dwt	2019-01-28
Ångermanälven	IB	2000 dwt	2019-01-21
Härnösand	IC II	2000 dwt 4000 dwt	2019-02-06
Söråker-Öregrund	II	2000 dwt	2019-02-18
Mälaren	IC II	1300 dwt 2000 dwt	2019-02-15

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port / Hamn / Satama	Minimum ice class and tonnage / Minsta isklass och tonnage / Vähimmäisjääluokka ja -kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 4000 dwt	2019-01-30
Raahe, Kalajoki	IA, 2000 dwt	2019-01-30
Kokkola, Pietarsaari	IA, 2000 dwt	2019-02-02
Vaasa	IC, 2000 dwt	2019-01-28
Kaskinen	IC, 2000 dwt	2019-02-02
Kristiinankaupunki	II, 2000 dwt	2019-01-26
Pori, Rauma	II, 2000 dwt	2019-01-30
Uusikaupunki	II, 2000 dwt	2019-02-26
Taalintehdas, Förby, Koverhar, Lappohja, Inkoo, Kantvik	II, 2000 dwt	2019-01-26
Helsinki, Sköldvik	II, 2000 dwt	2019-01-30
Loviisa, Mussalo	II, 2000 dwt	2019-02-22
Kotka, Hamina	II, 2000 dwt	2019-02-26

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.

The traffic separation schemes in the Quark are temporarily out of use from 1 February 2019.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.

TSS Norra Kvarken temporärt avlyst from kl 00:00 UTC den 1 februari 2019 och tills vidare – dock längst t.o.m. 6 maj 2019.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Reittijakojärjestelmä Merenkurkussa on tilapäisesti poissa käytöstä 1. helmikuuta alkaen.

ISSN: 1796-0185

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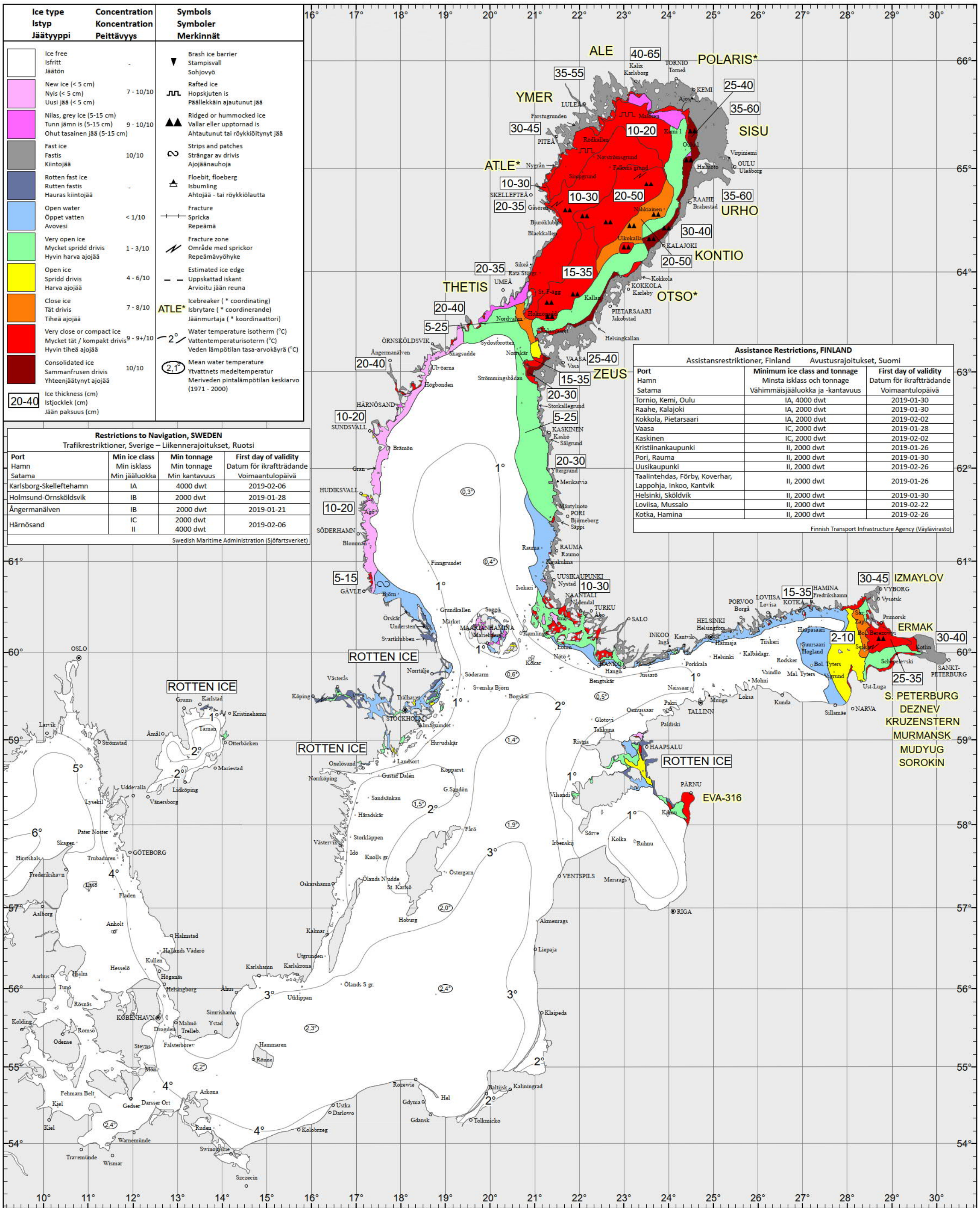
SMHI

ICE CHART
Iskarta - Jääkartta

2019-03-15
No. 102



Restrictions to Navigation, SWEDEN Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi			
Port Hamn Satama	**Min ice class** Min isklass Min jääluokka	**Min tonnage** Min tonnage Min kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Karlsborg-Skelleftehamn	IA	4000 dwt	2019-02-06
Holmsund-Örnsköldsvik	IB	2000 dwt	2019-01-28
Ångermanälven	IB	2000 dwt	2019-01-21
Härnösand	IC II	2000 dwt 4000 dwt	2019-02-06

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND Assistansrestriktioner, Finland Avustusrajoitukset, Suomi		
Port Hamn Satama	**Minimum ice class and tonnage** Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 4000 dwt	2019-01-30
Raahe, Kalajoki	IA, 2000 dwt	2019-01-30
Kokkola, Pietarsaari	IA, 2000 dwt	2019-02-02
Vaasa	IC, 2000 dwt	2019-01-28
Kaskinen	IC, 2000 dwt	2019-02-02
Kristiinankaupunki	II, 2000 dwt	2019-01-26
Pori, Rauma	II, 2000 dwt	2019-01-30
Uusikaupunki	II, 2000 dwt	2019-02-26
Taalintehdas, Förby, Koverhar, Lappohja, Inkoo, Kantvik	II, 2000 dwt	2019-01-26
Helsinki, Sköldvik	II, 2000 dwt	2019-01-30
Loviisa, Mussalo	II, 2000 dwt	2019-02-22
Kotka, Hamina	II, 2000 dwt	2019-02-26

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.

The traffic separation schemes in the Quark are temporarily out of use from 1 February 2019.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.

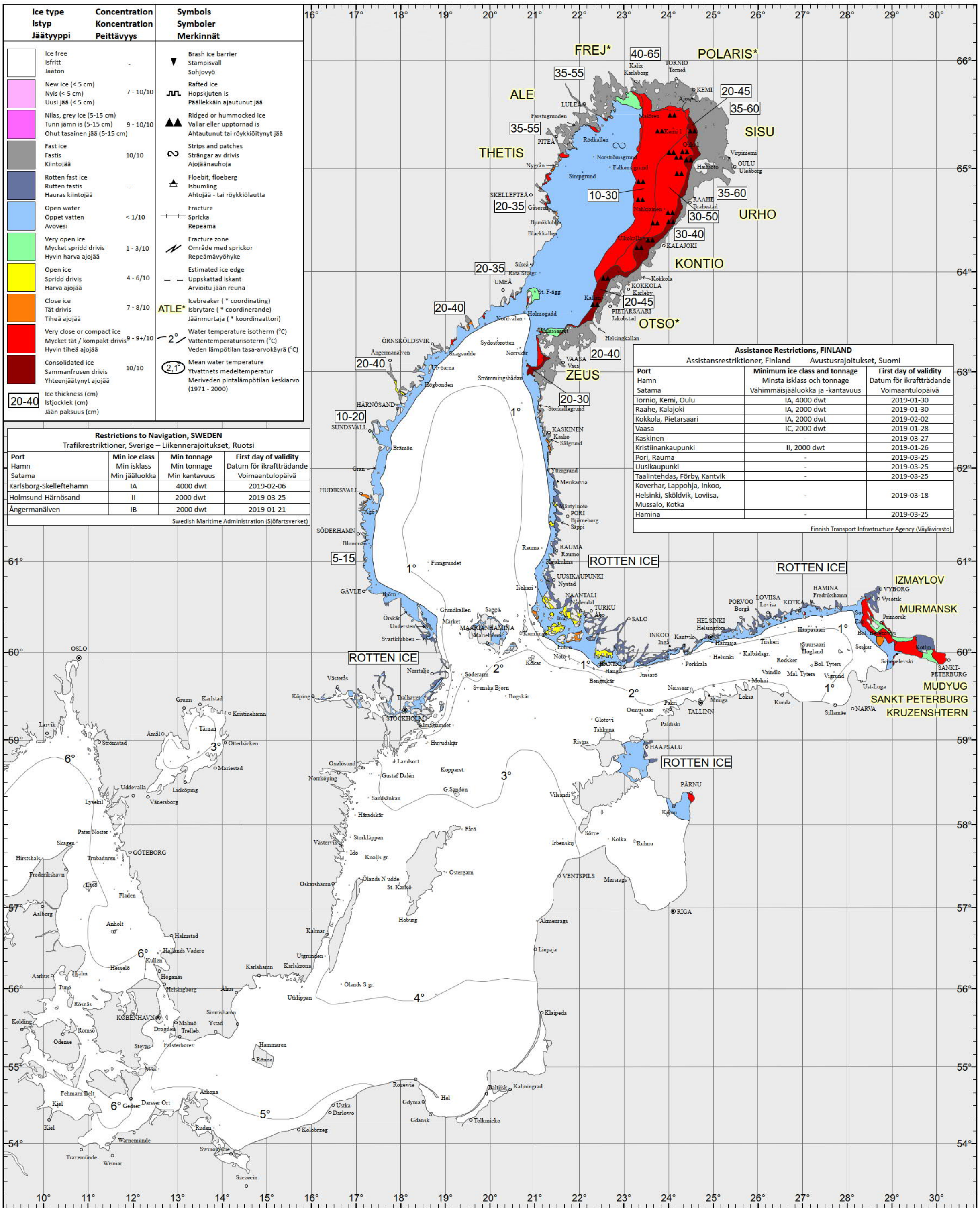
TSS Norra Kvarken temporärt avlyst from kl 00:00 UTC den 1 februari 2019 och tills vidare – dock längst t.o.m. 6 maj 2019.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Reittijakojärjestelmä Merenkurkussa on tilapäisesti poissa käytöstä 1. helmikuuta alkaen.

ISSN: 1796-0185



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FINNISH METEOROLOGICAL INSTITUTE

SMHI

ICE CHART
Iskarta - Jääkartta

2019-04-01
No. 119

Ice type / Istyp / Jäätyyppi	Concentration / Koncentration / Peittävyys
Ice free / Isfritt / Jäätön	-
New ice (< 5 cm) / Nyis (< 5 cm) / Uusi jää (< 5 cm)	7 - 10/10
Nilas, grey ice (5-15 cm) / Tunn jämn is (5-15 cm) / Ohut tasainen jää (5-15 cm)	9 - 10/10
Fast ice / Fastis / Kiintojää	10/10
Rotten fast ice / Rutten fastis / Hauras kiintojää	-
Open water / Öppet vatten / Avovesi	< 1/10
Very open ice / Mycket spridd drivis / Hyvin harva ajojää	1 - 3/10
Open ice / Spridd drivis / Harva ajojää	4 - 6/10
Close ice / Tät drivis / Tiheä ajojää	7 - 8/10
Very close or compact ice / Mycket tät / kompakt drivis / Hyvin tiheä ajojää	9 - 9+/10
Consolidated ice / Sammanfrusen drivis / Yhteenjäätynyt ajojää	10/10
20-40 Ice thickness (cm) / Istjocklek (cm) / Jään paksuus (cm)	

Symbols / Symboler / Merkinnät	
▼	Brash ice barrier / Stampisvall / Sohjovyö
⎍⎍	Rafted ice / Hopskjuten is / Päällekkäin ajautunut jää
▲▲	Ridged or hummocked ice / Vallar eller upptornad is / Ahtautunut tai röykkiöitynyt jää
∾	Strips and patches / Strängar av drivis / Ajojäänauhoja
△	Floebit, floeberg / Isbumling / Ahtojää - tai röykkiölautta
–+–+–	Fracture / Spricka / Repeämä
⫽	Fracture zone / Område med sprickor / Repeämävyöhyke
– –	Estimated ice edge / Uppskattad iskant / Arvioitu jään reuna
ATLE*	Icebreaker (* coordinating) / Isbrytare (* coordinerande) / Jäänmurtaja (* koordinaattori)
2°	Water temperature isotherm (°C) / Vattentemperaturisoterm (°C) / Veden lämpötilan tasa-arvokäyrä (°C)
(2,1°)	Mean water temperature / Ytvattnets medeltemperatur / Meriveden pintalämpötilan keskiarvo (1971 - 2000)

Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port / Hamn / Satama	Min ice class / Min isklass / Min jääluokka	Min tonnage / Min tonnage / Min kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Karlsborg-Skelleftehamn	IA	4000 dwt	2019-02-06
Holmsund-Härnösand	II	2000 dwt	2019-03-25
Ångermanälven	IB	2000 dwt	2019-01-21

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port / Hamn / Satama	Minimum ice class and tonnage / Minsta isklass och tonnage / Vähimmäisjääluokka ja -kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 4000 dwt	2019-01-30
Raahe, Kalajoki	IA, 2000 dwt	2019-01-30
Kokkola, Pietarsaari	IA, 2000 dwt	2019-02-02
Vaasa	IC, 2000 dwt	2019-01-28
Kaskinen	-	2019-03-27
Kristiinankaupunki	II, 2000 dwt	2019-01-26
Pori, Rauma	-	2019-03-25
Uusikaupunki	-	2019-03-25
Taalintehdas, Förby, Kantvik	-	2019-03-25
Koverhar, Lappohja, Inkoo, Helsinki, Sköldvik, Loviisa, Mussalo, Kotka	-	2019-03-18
Hamina	-	2019-03-25

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.

The traffic separation schemes in the Quark are temporarily out of use from 1 February 2019.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.

TSS Norra Kvarken temporärt avlyst from kl 00:00 UTC den 1 februari 2019 och tills vidare – dock längst t.o.m. 6 maj 2019.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Reittijakojärjestelmä Merenkurkussa on tilapäisesti poissa käytöstä 1. helmikuuta alkaen.

ISSN: 1796-0185

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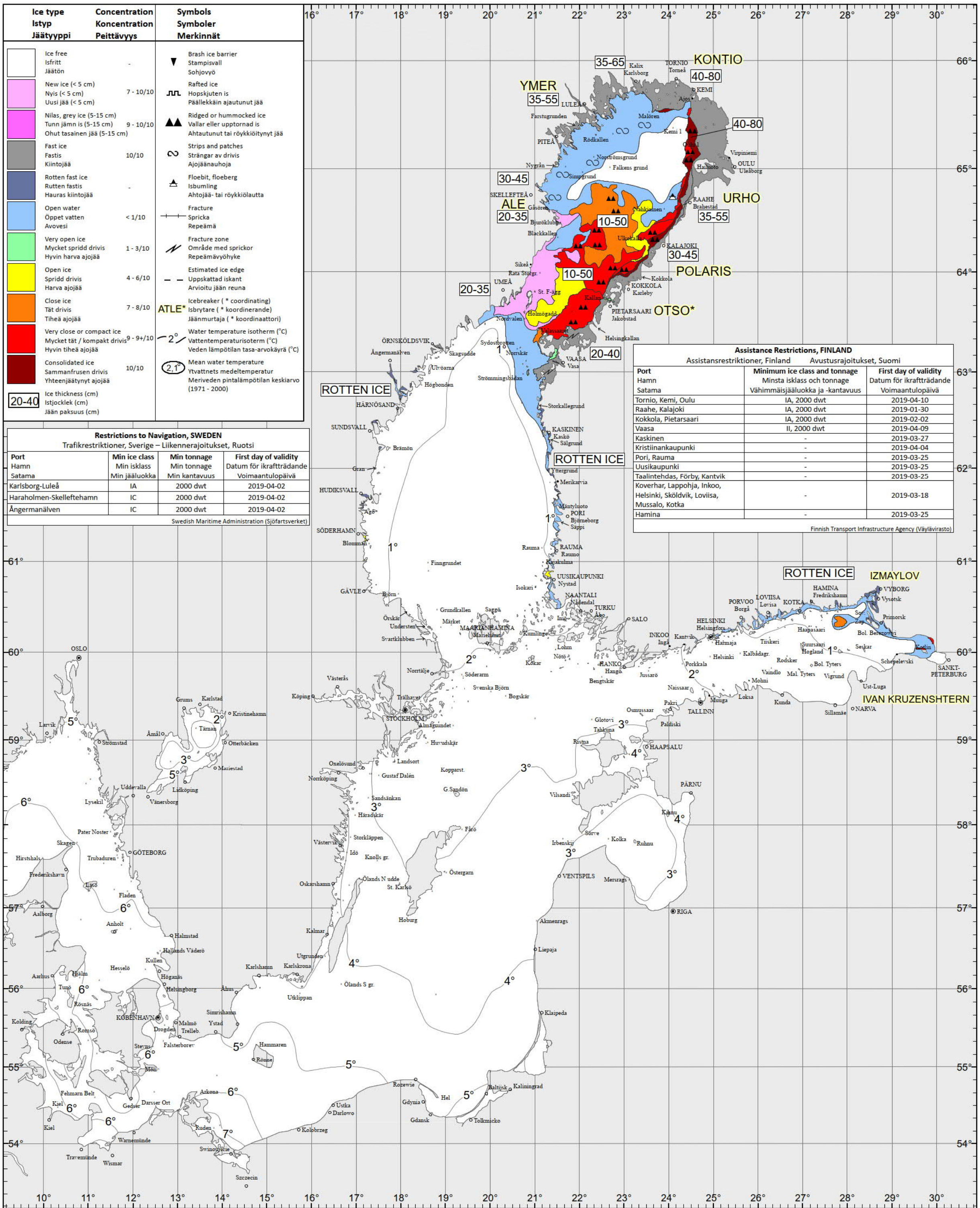
ICE CHART

Iskarta - Jääkartta

2019-04-15
No. 133

Ice type / Istyp / Jäätyyppi	Concentration / Koncentration / Peittävyys	Symbols / Symboler / Merkinnät
Ice free / Isfritt / Jäätön	-	Brash ice barrier / Stampisvall / Sohjovyö
New ice (< 5 cm) / Nyis (< 5 cm) / Uusi jää (< 5 cm)	7 - 10/10	Rafted ice / Hopskjuten is / Päällekkäin ajautunut jää
Nilas, grey ice (5-15 cm) / Tunn jämn is (5-15 cm) / Ohut tasainen jää (5-15 cm)	9 - 10/10	Ridged or hummocked ice / Vallar eller upptornad is / Ahtautunut tai röykkiöitynyt jää
Fast ice / Fastis / Kiintojää	10/10	Strips and patches / Strängar av drivis / Ajojäänauhoja
Rotten fast ice / Rutten fastis / Hauras kiintojää	-	Floebit, floeberg / Isbumling / Ahtojää- tai röykkiölautta
Open water / Öppet vatten / Avovesi	< 1/10	Fracture / Spricka / Repeämä
Very open ice / Mycket spridd drivis / Hyvin harva ajojää	1 - 3/10	Fracture zone / Område med sprickor / Repeämävyöhyke
Open ice / Spridd drivis / Harva ajojää	4 - 6/10	Estimated ice edge / Uppskattad iskant / Arvioitu jään reuna
Close ice / Tät drivis / Tiheä ajojää	7 - 8/10	ATLE* Icebreaker (* coordinating) / Isbrytare (* koordinerande) / Jäänmurtaja (* koordinaattori)
Very close or compact ice / Mycket tät / kompakt drivis / Hyvin tiheä ajojää	9 - 9+/10	2° Water temperature isotherm (°C) / Vattentemperaturisoterm (°C) / Veden lämpötilan tasa-arvokäyrä (°C)
Consolidated ice / Sammanfrusen drivis / Yhteenjäätynyt ajojää	10/10	2,1° Mean water temperature / Ytvattnets medeltemperatur / Meriveden pintalämpötilan keskiarvo (1971 - 2000)
20-40 Ice thickness (cm) / Istjocklek (cm) / Jään paksuus (cm)		



Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port / Hamn / Satama	Min ice class / Min isklass / Min jääluokka	Min tonnage / Min tonnage / Min kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Karlsborg-Luleå	IA	2000 dwt	2019-04-02
Haraholmen-Skelleftehamn	IC	2000 dwt	2019-04-02
Ångermanälven	IC	2000 dwt	2019-04-02

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port / Hamn / Satama	Minimum ice class and tonnage / Minsta isklass och tonnage / Vähimmäisjääluokka ja -kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 2000 dwt	2019-04-10
Raahe, Kalajoki	IA, 2000 dwt	2019-01-30
Kokkola, Pietarsaari	IA, 2000 dwt	2019-02-02
Vaasa	II, 2000 dwt	2019-04-09
Kaskinen	-	2019-03-27
Kristiinankaupunki	-	2019-04-04
Pori, Rauma	-	2019-03-25
Uusikaupunki	-	2019-03-25
Taalintehdas, Förby, Kantvik	-	2019-03-25
Koverhar, Lappohja, Inkoo, Helsinki, Sköldvik, Loviisa, Mussalo, Kotka	-	2019-03-18
Hamina	-	2019-03-25

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.

The traffic separation schemes in the Quark are temporarily out of use from 1 February 2019.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.

TSS Norra Kvarken temporärt avlyst from kl 00:00 UTC den 1 februari 2019 och tills vidare – dock längst t.o.m. 6 maj 2019.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Reittijakojärjestelmä Merenkurkussa on tilapäisesti poissa käytöstä 1. helmikuuta alkaen.

ISSN: 1796-0185

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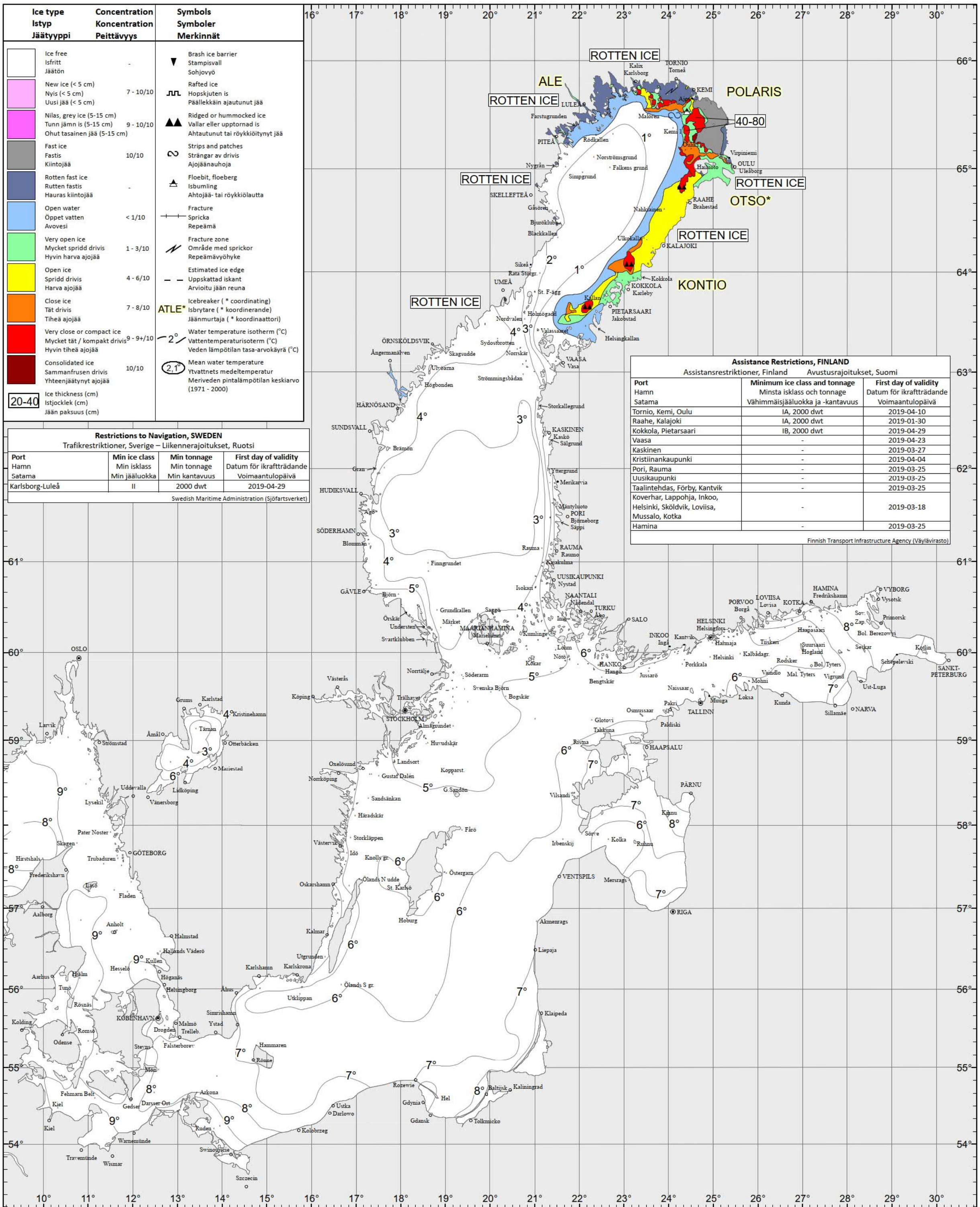
ICE CHART

Iskarta - Jääkartta

2019-05-01
No. 149



Restrictions to Navigation, SWEDEN Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi			
Port Hamn Satama	**Min ice class** Min isklass Min jääluokka	**Min tonnage** Min tonnage Min kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Karlsborg-Luleå	II	2000 dwt	2019-04-29

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND Assistansrestriktioner, Finland Avustusrajoitukset, Suomi		
Port Hamn Satama	**Minimum ice class and tonnage** Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 2000 dwt	2019-04-10
Raahe, Kalajoki	IA, 2000 dwt	2019-01-30
Kokkola, Pietarsaari	IB, 2000 dwt	2019-04-29
Vaasa	-	2019-04-23
Kaskinen	-	2019-03-27
Kristiinankaupunki	-	2019-04-04
Pori, Rauma	-	2019-03-25
Uusikaupunki	-	2019-03-25
Taalintehdas, Förby, Kantvik	-	2019-03-25
Koverhar, Lappohja, Inkoo, Helsinki, Sköldvik, Loviisa, Mussalo, Kotka	-	2019-03-18
Hamina	-	2019-03-25

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for ports in the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen lighthouse on VHF channel 67.

The traffic separation schemes in the Quark are temporarily out of use from 1 February 2019.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till hamnar på Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera enligt instruktionerna för vintersjöfarten till Bothnia VTS på VHF-kanal 67.

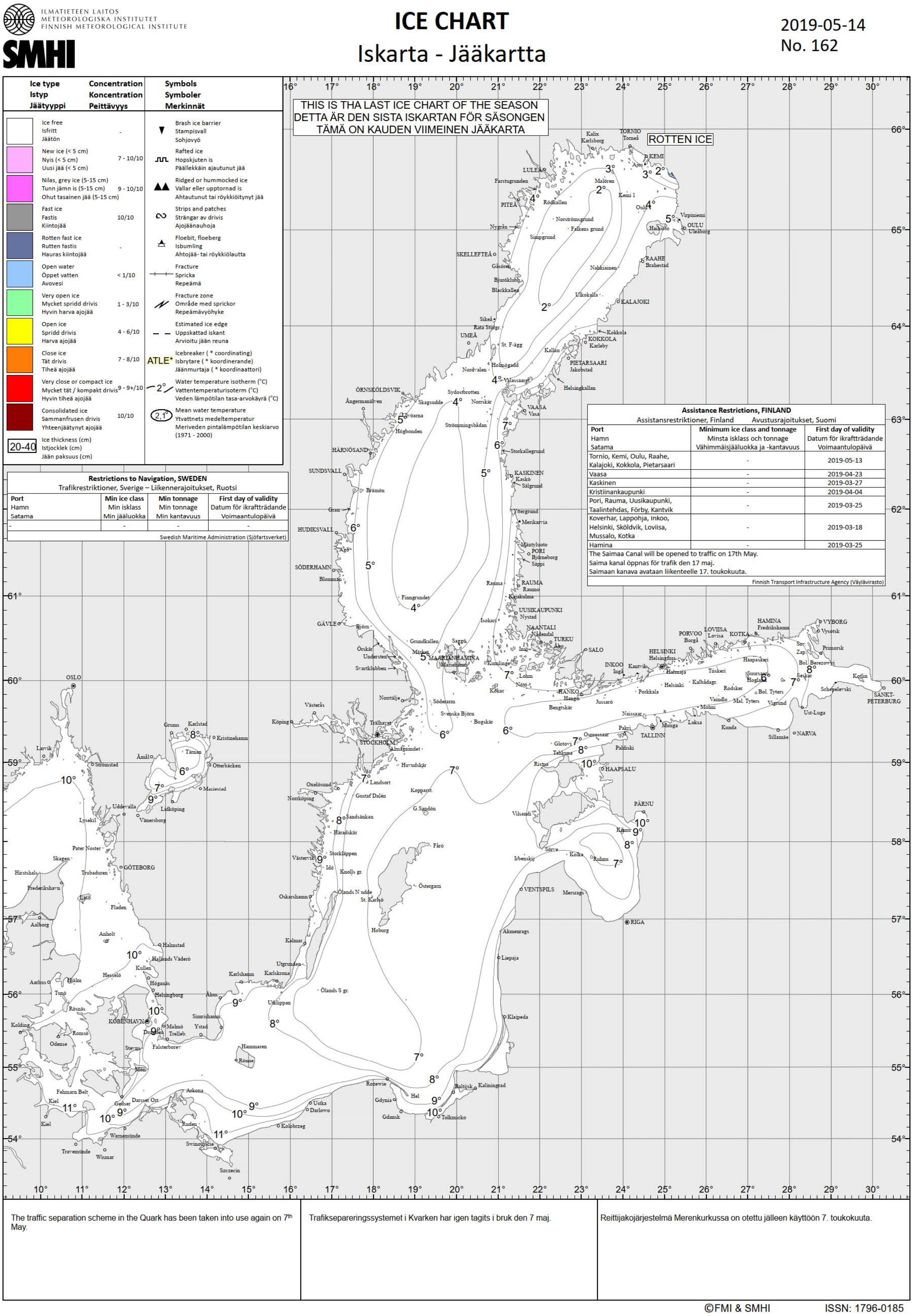
TSS Norra Kvarken temporärt avlyst from kl 00:00 UTC den 1 februari 2019 och tills vidare – dock längst t.o.m. 6 maj 2019.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä talviliikenneohjeen mukainen ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Reittijakojärjestelmä Merenkurkussa on tilapäisesti poissa käytöstä 1. helmikuuta alkaen.

ISSN: 1796-0185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SMHI
ICE CHART
Iskarta - Jääkartta
2019-05-14
No. 162
THIS IS THA LAST ICE CHART OF THE SEASON
DETTA ÄR DEN SISTA ISKARTAN FÖR SÄSONGEN
TÄMÄ ON KAUDEN VIIMEINEN JÄÄKARTA
ROTTEN ICE
Ice type / Istyp / Jäätyyppi
Concentration / Koncentration / Peittävyys
Symbols / Symboler / Merkinnät
Ice free / Isfritt / Jäätön
New ice (< 5 cm) / Nyis (< 5 cm) / Uusi jää (< 5 cm) 7 - 10/10
Nilas, grey ice (5-15 cm) / Tunn jämn is (5-15 cm) / Ohut tasainen jää (5-15 cm) 9 - 10/10
Fast ice / Fastis / Kiintojää 10/10
Rotten fast ice / Rutten fastis / Hauras kiintojää
Open water / Öppet vatten / Avovesi < 1/10
Very open ice / Mycket spridd drivis / Hyvin harva ajojää 1 - 3/10
Open ice / Spridd drivis / Harva ajojää 4 - 6/10
Close ice / Tät drivis / Tiheä ajojää 7 - 8/10
Very close or compact ice / Mycket tät / kompakt drivis / Hyvin tiheä ajojää 9 - 9+/10
Consolidated ice / Sammanfrusen drivis / Yhteenjäätynyt ajojää 10/10
20-40 Ice thickness (cm) / Istjocklek (cm) / Jään paksuus (cm)
Brash ice barrier / Stampisvall / Sohjovyö
Rafted ice / Hopskjuten is / Päällekkäin ajautunut jää
Ridged or hummocked ice / Vallar eller upptornad is / Ahtautunut tai röykkiöitynyt jää
Strips and patches / Strängar av drivis / Ajojäänauhoja
Floebit, floeberg / Isbumling / Ahtojää- tai röykkiölautta
Fracture / Spricka / Repeämä
Fracture zone / Område med sprickor / Repeämävyöhyke
Estimated ice edge / Uppskattad iskant / Arvioitu jään reuna
ATLE* Icebreaker (* coordinating) / Isbrytare (* koordinerande) / Jäänmurtaja (* koordinaattori)
Water temperature isotherm (°C) / Vattentemperaturisoterm (°C) / Veden lämpötilan tasa-arvokäyrä (°C)
2,1° Mean water temperature / Ytvattnets medeltemperatur / Meriveden pintalämpötilan keskiarvo (1971 - 2000)
Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi
Port / Hamn / Satama | Min ice class / Min isklass / Min jääluokka | Min tonnage / Min tonnage / Min kantavuus | First day of validity / Datum för ikraftträdande / Voimaantulopäivä
- | - | - | -
Swedish Maritime Administration (Sjöfartsverket)
Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi
Port / Hamn / Satama | Minimum ice class and tonnage / Minsta isklass och tonnage / Vähimmäisjääluokka ja -kantavuus | First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Tornio, Kemi, Oulu, Raahe, Kalajoki, Kokkola, Pietarsaari | - | 2019-05-13
Vaasa | - | 2019-04-23
Kaskinen | - | 2019-03-27
Kristiinankaupunki | - | 2019-04-04
Pori, Rauma, Uusikaupunki, Taalintehdas, Förby, Kantvik | - | 2019-03-25
Koverhar, Lappohja, Inkoo, Helsinki, Sköldvik, Loviisa, Mussalo, Kotka | - | 2019-03-18
Hamina | - | 2019-03-25
The Saimaa Canal will be opened to traffic on 17th May.
Saima kanal öppnas för trafik den 17 maj.
Saimaan kanava avataan liikenteelle 17. toukokuuta.
Finnish Transport Infrastructure Agency (Väylävirasto)
The traffic separation scheme in the Quark has been taken into use again on 7th May.
Trafikseparerringssystemet i Kvarken har igen tagits i bruk den 7 maj.
Reittijakojärjestelmä Merenkurkussa on otettu jälleen käyttöön 7. toukokuuta.
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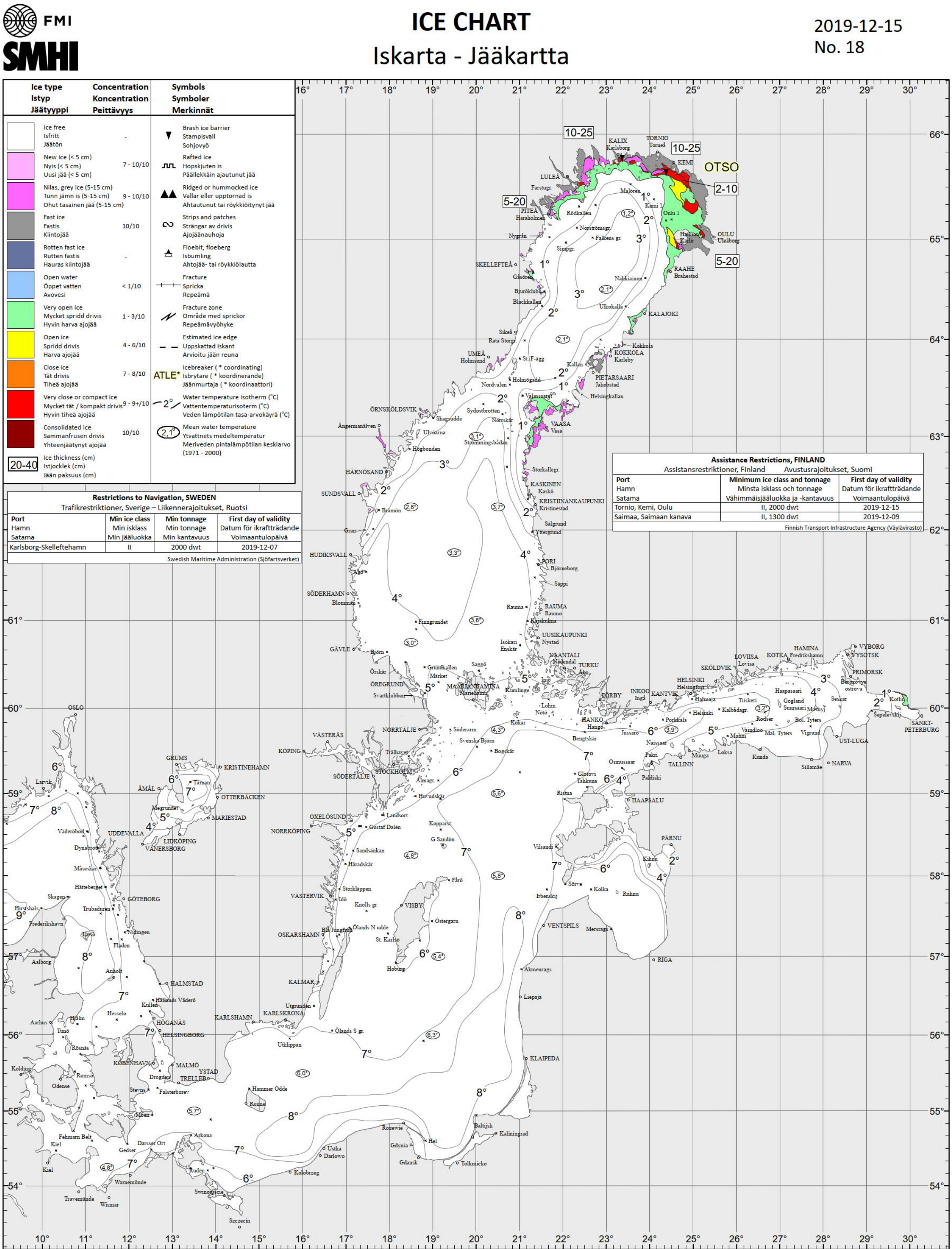

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall give an advance report to Bothnia VTS 20 nautical miles before Nordvalen Lighthouse on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Partly based on EU Copernicus data

ISSN: 1796-0185

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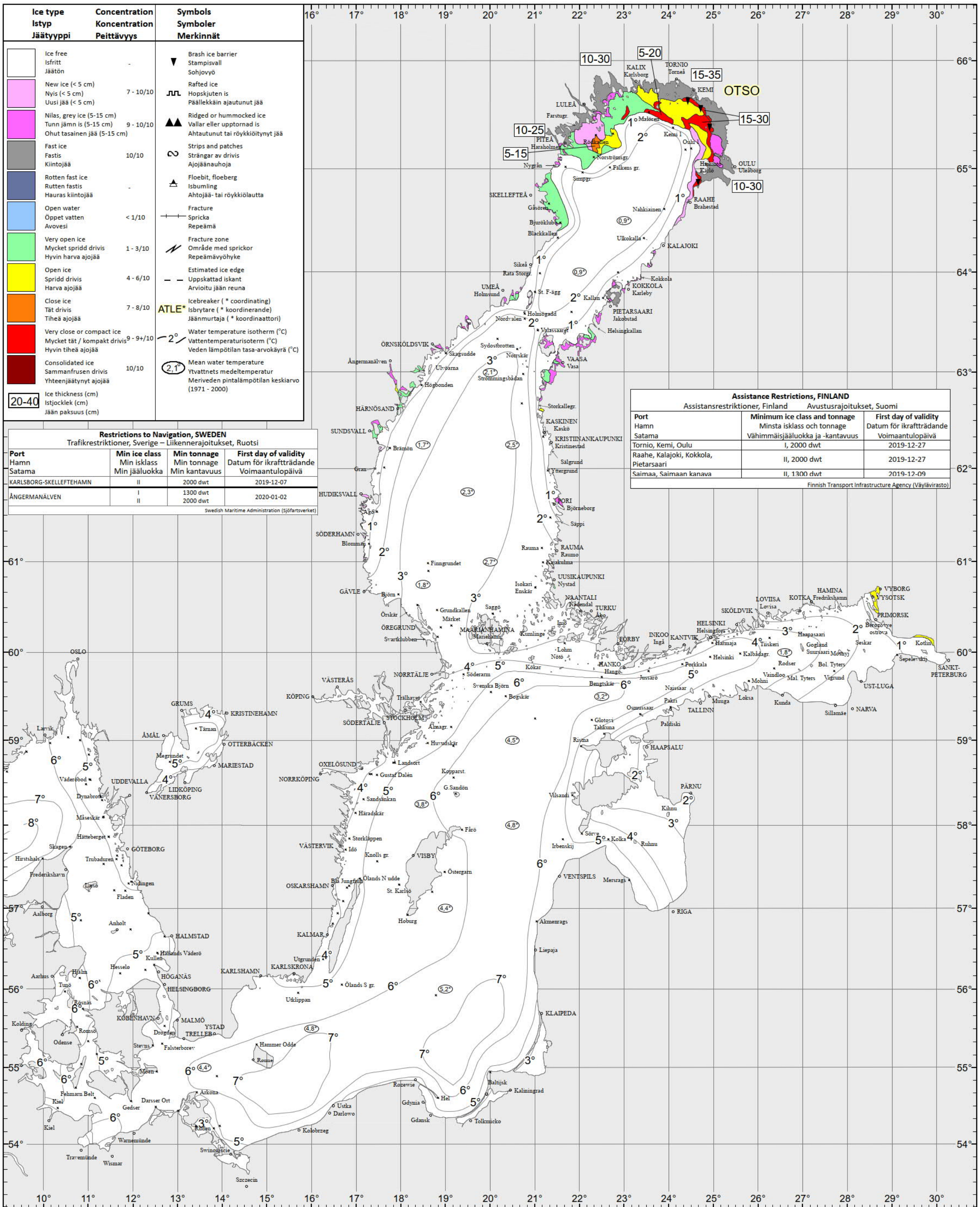
ICE CHART

Iskarta - Jääkartta

2020-01-01
No. 35



Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port Hamn Satama	**Min ice class** Min isklass Min jääluokka	**Min tonnage** Min tonnage Min kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
KARLSBORG-SKELLEFTEHAMN	II	2000 dwt	2019-12-07
ÅNGERMANÄLVEN	I II	1300 dwt 2000 dwt	2020-01-02

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port Hamn Satama	**Minimum ice class and tonnage** Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	I, 2000 dwt	2019-12-27
Raahe, Kalajoki, Kokkola, Pietarsaari	II, 2000 dwt	2019-12-27
Saimaa, Saimaan kanava	II, 1300 dwt	2019-12-09

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen Lighthouse on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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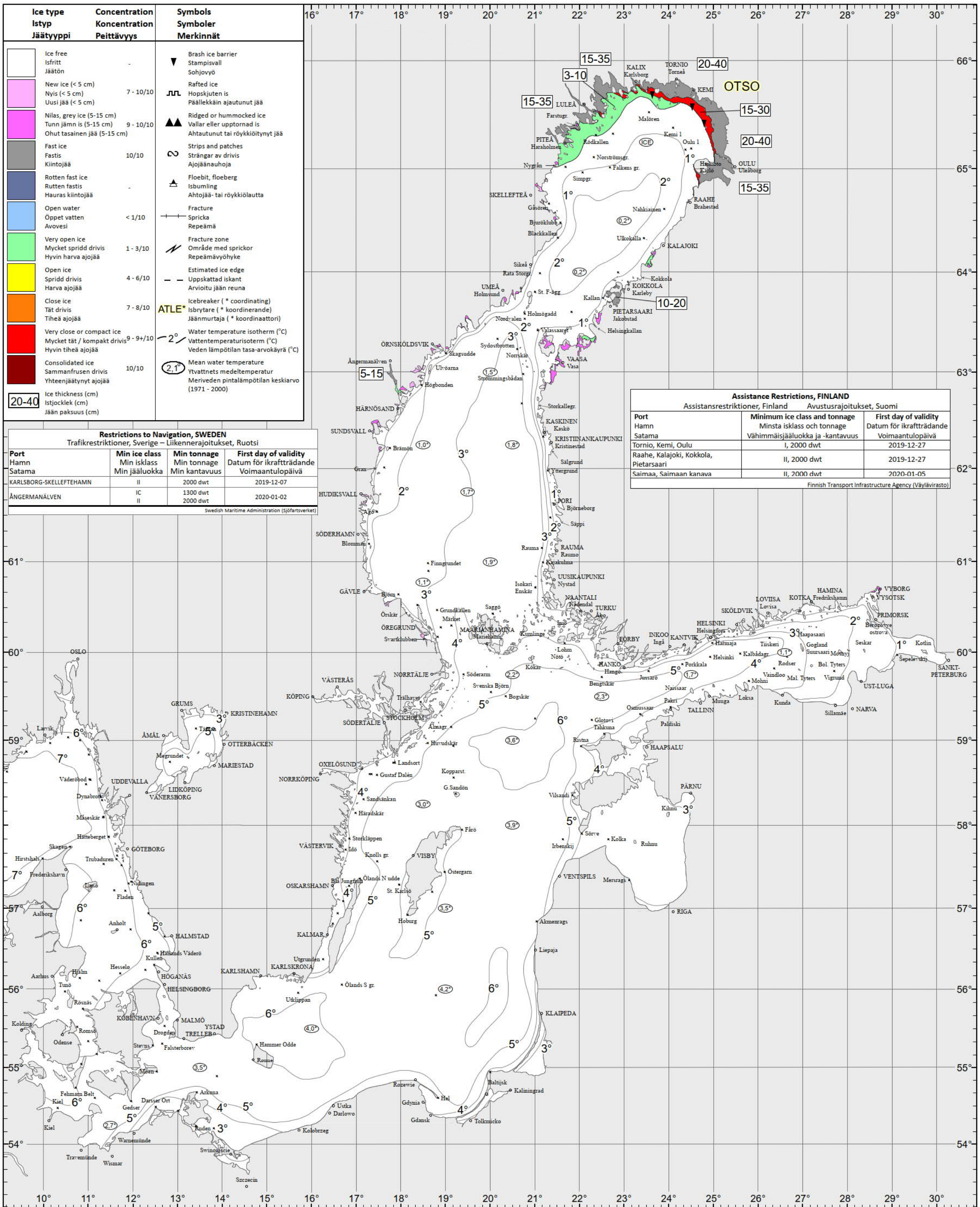

Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port / Hamn / Satama	Min ice class / Min isklass / Min jääluokka	Min tonnage / Min tonnage / Min kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
KARLSBORG-SKELLEFTEHAMN	II	2000 dwt	2019-12-07
ÅNGERMANÄLVEN	IC II	1300 dwt 2000 dwt	2020-01-02

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port / Hamn / Satama	Minimum ice class and tonnage / Minsta isklass och tonnage / Vähimmäisjääluokka ja -kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Tornio, Kemi, Oulu	I, 2000 dwt	2019-12-27
Raahe, Kalajoki, Kokkola, Pietarsaari	II, 2000 dwt	2019-12-27
Saimaa, Saimaan kanava	II, 2000 dwt	2020-01-05

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen Lighthouse on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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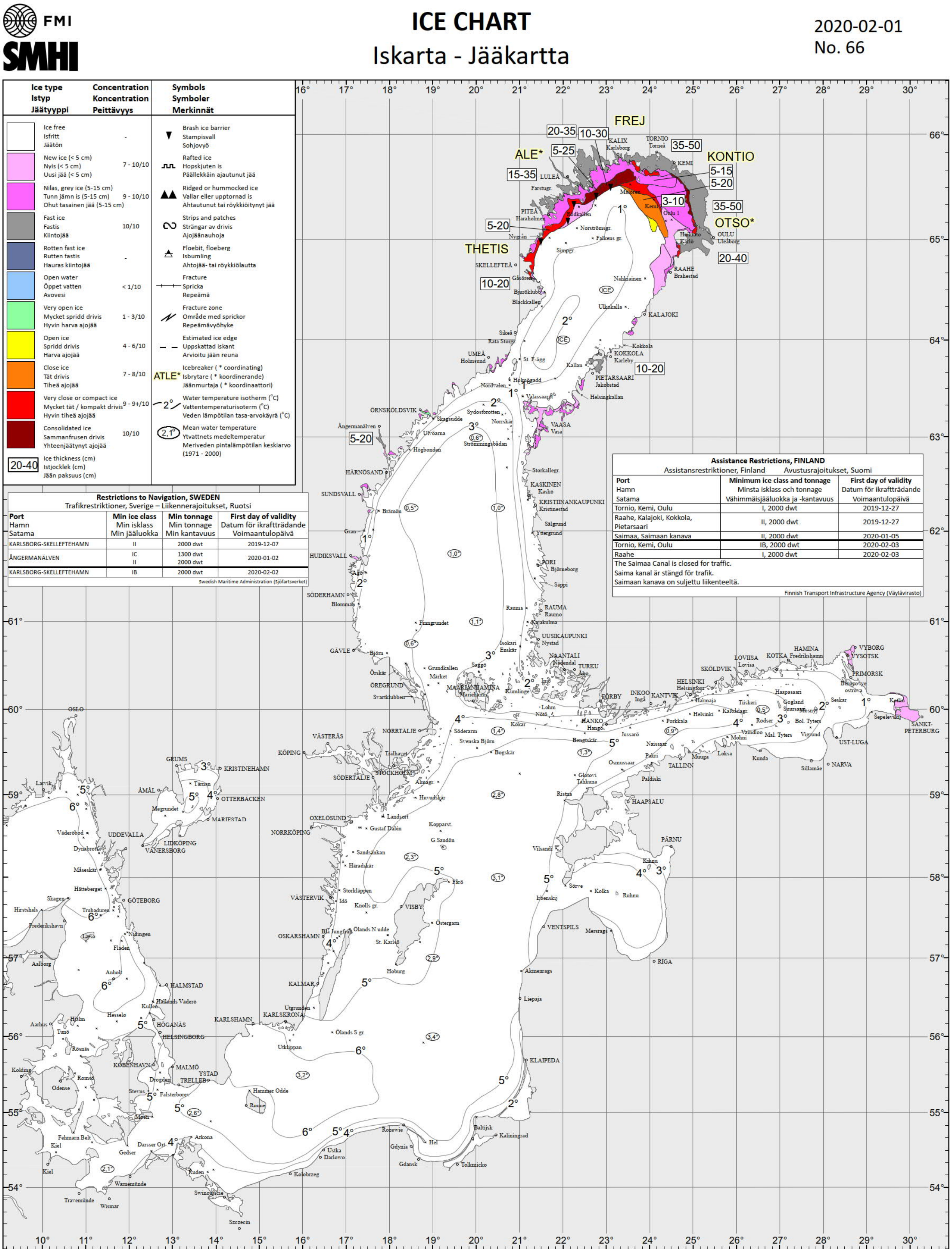

Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port Hamn Satama	Min ice class Min isklass Min jääluokka	Min tonnage Min tonnage Min kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
KARLSBORG-SKELLEFTEHAMN	II	2000 dwt	2019-12-07
ÅNGERMANÄLVEN	IC II	1300 dwt 2000 dwt	2020-01-02
KARLSBORG-SKELLEFTEHAMN	IB	2000 dwt	2020-02-02

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port Hamn Satama	Minimum ice class and tonnage Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	I, 2000 dwt	2019-12-27
Raahe, Kalajoki, Kokkola, Pietarsaari	II, 2000 dwt	2019-12-27
Saimaa, Saimaan kanava	II, 2000 dwt	2020-01-05
Tornio, Kemi, Oulu	IB, 2000 dwt	2020-02-03
Raahe	I, 2000 dwt	2020-02-03

The Saimaa Canal is closed for traffic.
Saima kanal är stängd för trafik.
Saimaan kanava on suljettu liikenteeltä.

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS 20 nautical miles before Nordvalen Lighthouse on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktioner i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, 20 nautiska mil före Nordvalens fyr, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on 20 mpk ennen Nordvalenin majakkaa tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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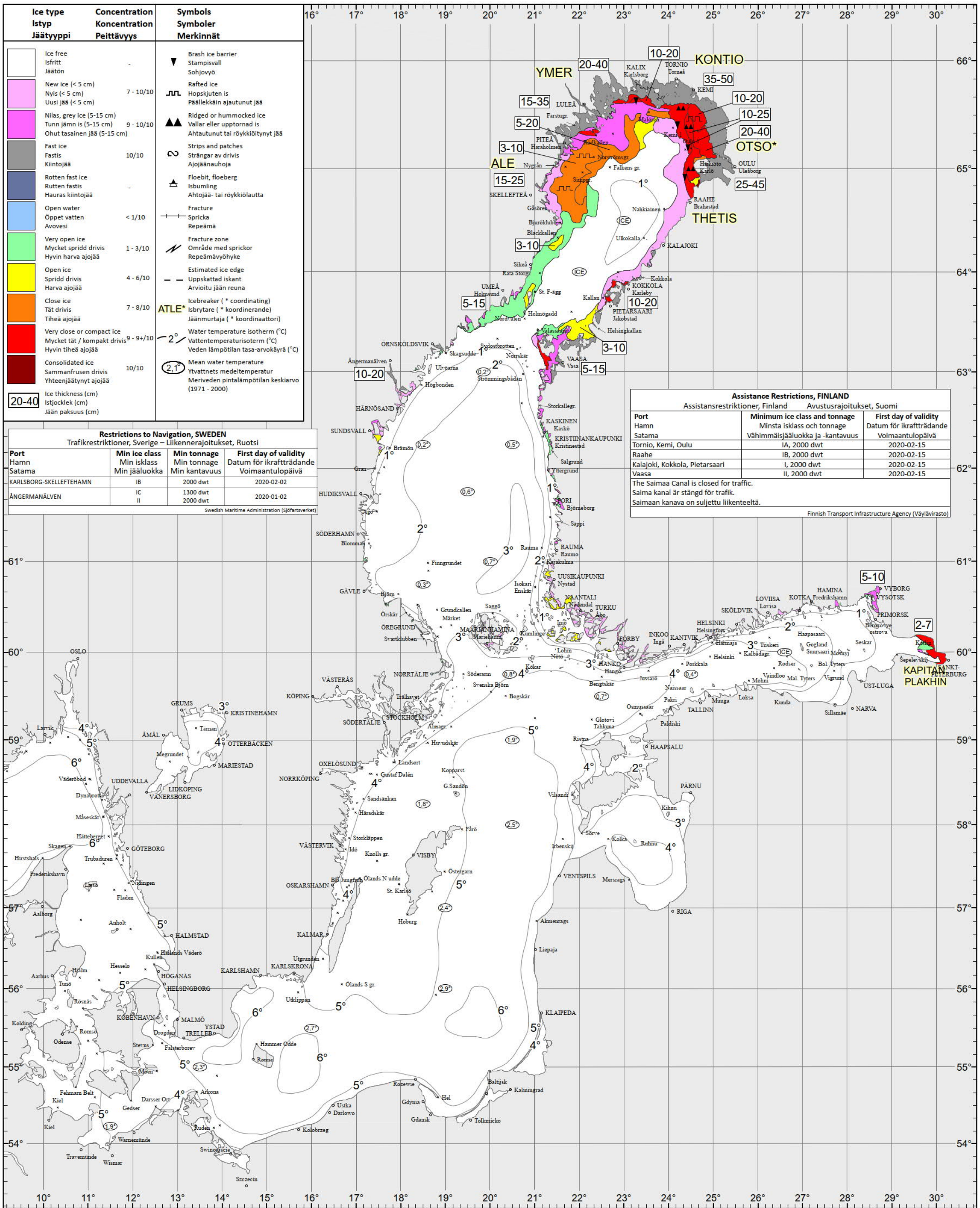

Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port Hamn Satama	Min ice class Min isklass Min jääluokka	Min tonnage Min tonnage Min kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
KARLSBORG-SKELLEFTEHAMN	IB	2000 dwt	2020-02-02
ÅNGERMANÄLVEN	IC II	1300 dwt 2000 dwt	2020-01-02

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port Hamn Satama	Minimum ice class and tonnage Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 2000 dwt	2020-02-15
Raahe	IB, 2000 dwt	2020-02-15
Kalajoki, Kokkola, Pietarsaari	I, 2000 dwt	2020-02-15
Vaasa	II, 2000 dwt	2020-02-15

The Saimaa Canal is closed for traffic.
Saima kanal är stängd för trafik.
Saimaan kanava on suljettu liikenteeltä.

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS when passing the latitude 63°15'N on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, vid passage av latituden 63°15'N, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on ylittäessään leveysasteen 63°15'N, tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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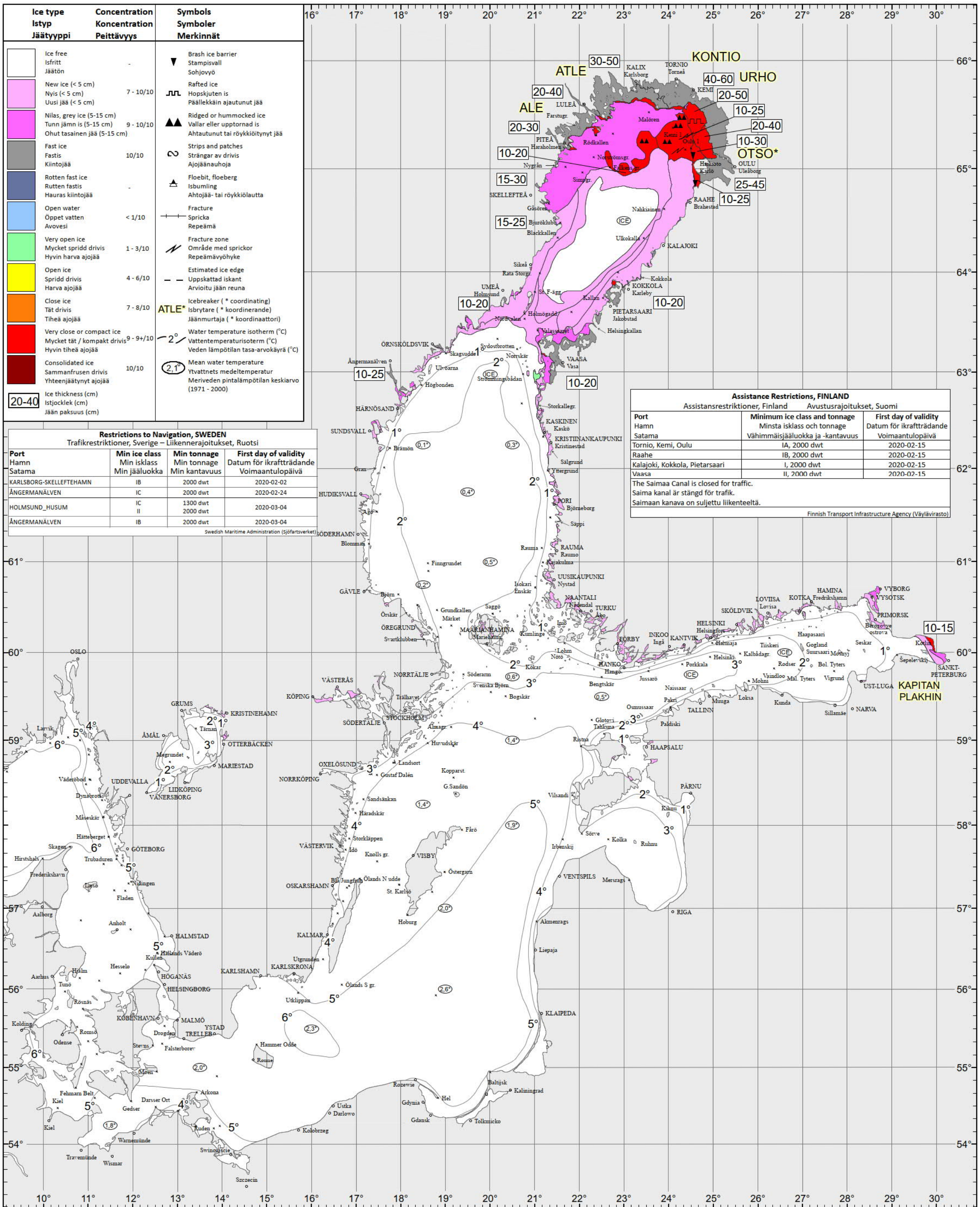

Restrictions to Navigation, SWEDEN Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi			
Port Hamn Satama	**Min ice class** Min isklass Min jääluokka	**Min tonnage** Min tonnage Min kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
KARLSBORG-SKELLEFTEHAMN	IB	2000 dwt	2020-02-02
ÅNGERMANÄLVEN	IC	2000 dwt	2020-02-24
HOLMSUND_HUSUM	IC II	1300 dwt 2000 dwt	2020-03-04
ÅNGERMANÄLVEN	IB	2000 dwt	2020-03-04

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND Assistansrestriktioner, Finland Avustusrajoitukset, Suomi		
Port Hamn Satama	**Minimum ice class and tonnage** Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 2000 dwt	2020-02-15
Raahe	IB, 2000 dwt	2020-02-15
Kalajoki, Kokkola, Pietarsaari	I, 2000 dwt	2020-02-15
Vaasa	II, 2000 dwt	2020-02-15

The Saimaa Canal is closed for traffic.
Saima kanal är stängd för trafik.
Saimaan kanava on suljettu liikenteeltä.

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS when passing the latitude 63°15'N on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, vid passage av latituden 63°15'N, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on ylittäessään leveysasteen 63°15'N, tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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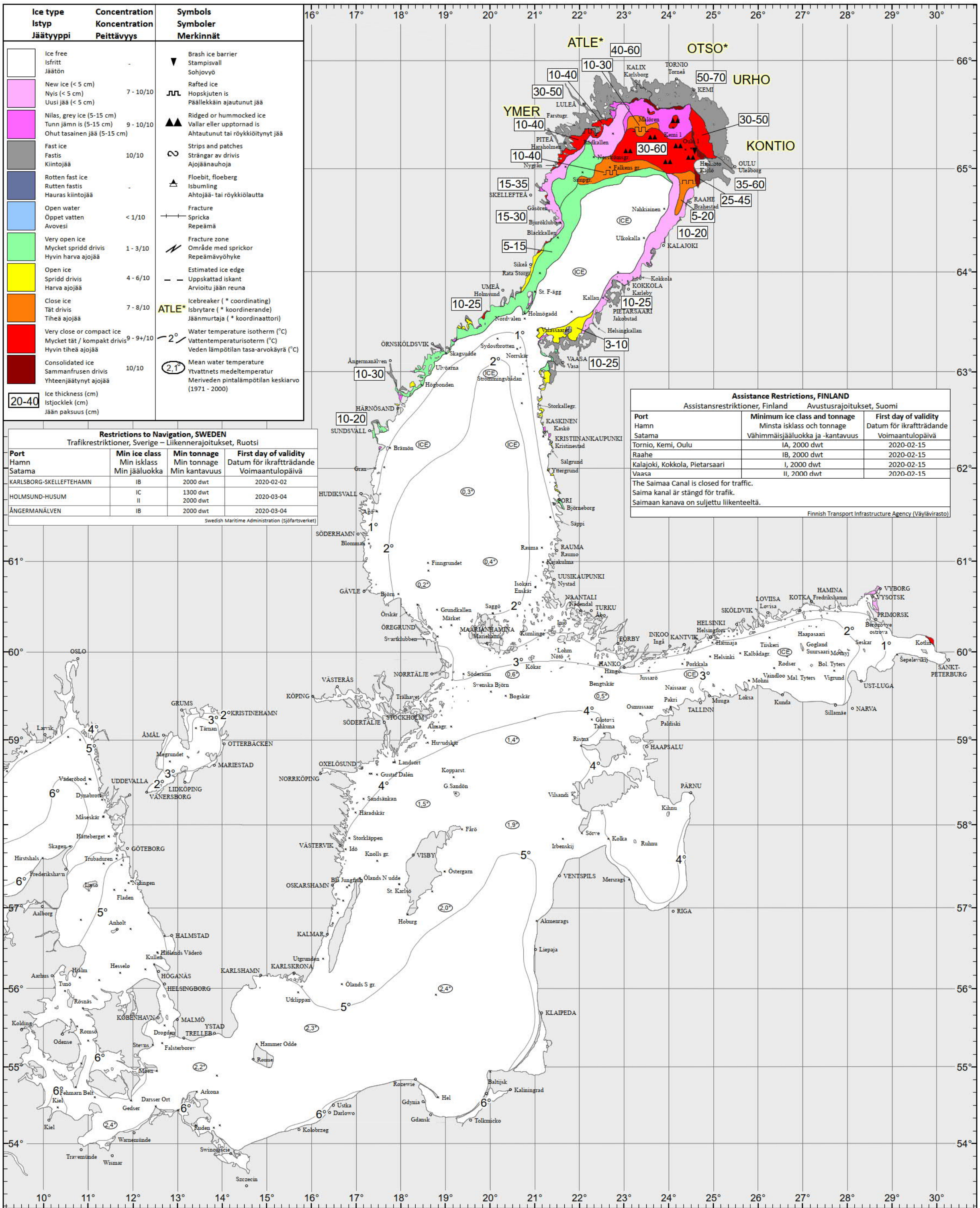

Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port Hamn Satama	Min ice class Min isklass Min jääluokka	Min tonnage Min tonnage Min kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
KARLSBORG-SKELLEFTEHAMN	IB	2000 dwt	2020-02-02
HOLMSUND-HUSUM	IC II	1300 dwt 2000 dwt	2020-03-04
ÅNGERMANÄLVEN	IB	2000 dwt	2020-03-04

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port Hamn Satama	Minimum ice class and tonnage Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	First day of validity Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 2000 dwt	2020-02-15
Raahe	IB, 2000 dwt	2020-02-15
Kalajoki, Kokkola, Pietarsaari	I, 2000 dwt	2020-02-15
Vaasa	II, 2000 dwt	2020-02-15

The Saimaa Canal is closed for traffic.
Saima kanal är stängd för trafik.
Saimaan kanava on suljettu liikenteeltä.

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS when passing the latitude 63°15'N on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, vid passage av latituden 63°15'N, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on ylittäessään leveysasteen 63°15'N, tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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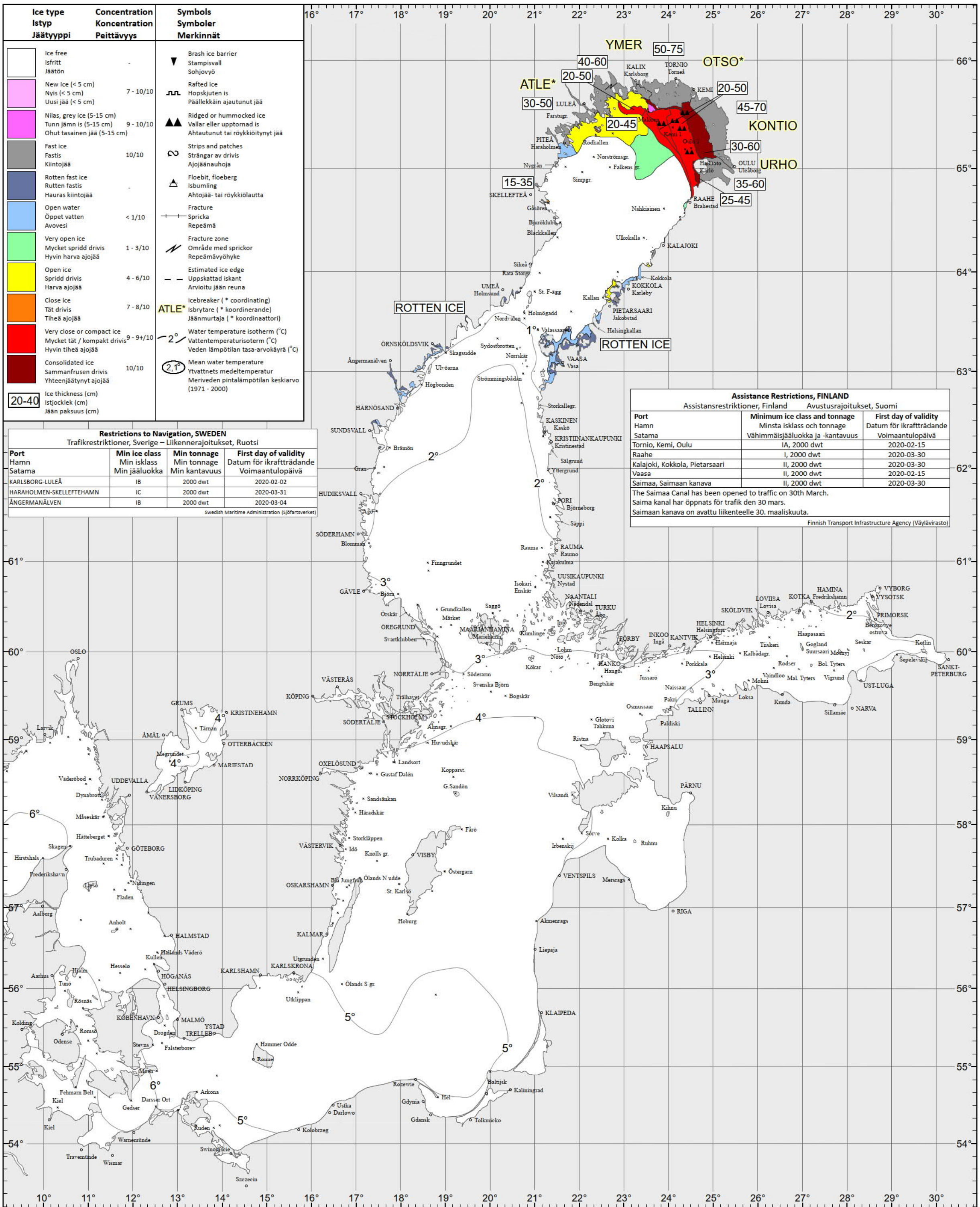

Restrictions to Navigation, SWEDEN Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi			
Port Hamn Satama	**Min ice class** Min isklass Min jääluokka	**Min tonnage** Min tonnage Min kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
KARLSBORG-LULEÅ	IB	2000 dwt	2020-02-02
HARAHOLMEN-SKELLEFTEHAMN	IC	2000 dwt	2020-03-31
ÅNGERMANÄLVEN	IB	2000 dwt	2020-03-04

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND Assistansrestriktioner, Finland Avustusrajoitukset, Suomi		
Port Hamn Satama	**Minimum ice class and tonnage** Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 2000 dwt	2020-02-15
Raahe	I, 2000 dwt	2020-03-30
Kalajoki, Kokkola, Pietarsaari	II, 2000 dwt	2020-03-30
Vaasa	II, 2000 dwt	2020-02-15
Saimaa, Saimaan kanava	II, 2000 dwt	2020-03-30

The Saimaa Canal has been opened to traffic on 30th March.
Saima kanal har öppnats för trafik den 30 mars.
Saimaan kanava on avattu liikenteelle 30. maaliskuuta.

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS when passing the latitude 63°15'N on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, vid passage av latituden 63°15'N, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on ylittäessään leveysasteen 63°15'N, tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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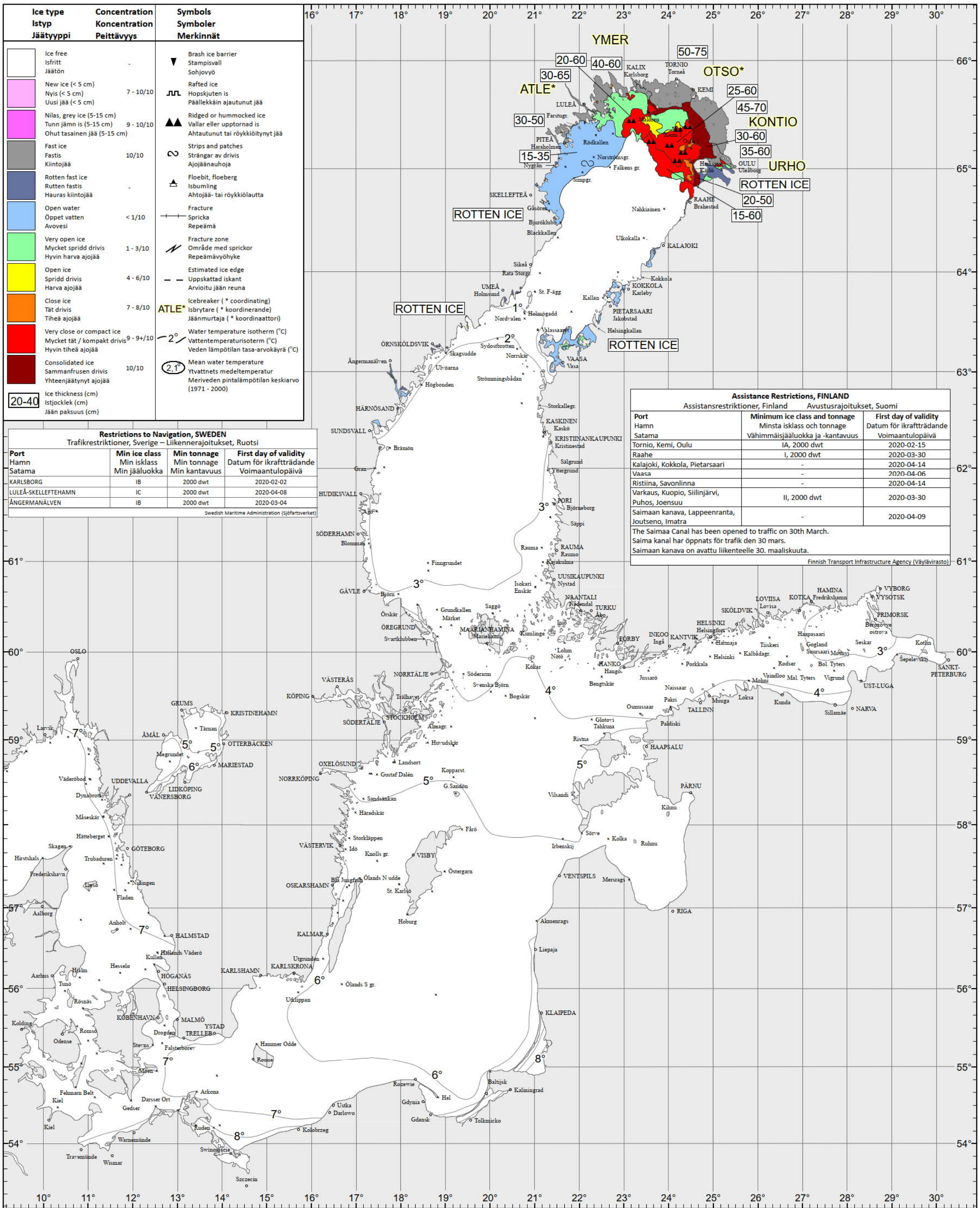

Restrictions to Navigation, SWEDEN Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi			
Port Hamn Satama	**Min ice class** Min isklass Min jääluokka	**Min tonnage** Min tonnage Min kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
KARLSBORG	IB	2000 dwt	2020-02-02
LULEÅ-SKELLEFTEHAMN	IC	2000 dwt	2020-04-08
ÅNGERMANÄLVEN	IB	2000 dwt	2020-03-04

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND Assistansrestriktioner, Finland Avustusrajoitukset, Suomi		
Port Hamn Satama	**Minimum ice class and tonnage** Minsta isklass och tonnage Vähimmäisjääluokka ja -kantavuus	**First day of validity** Datum för ikraftträdande Voimaantulopäivä
Tornio, Kemi, Oulu	IA, 2000 dwt	2020-02-15
Raahe	I, 2000 dwt	2020-03-30
Kalajoki, Kokkola, Pietarsaari	-	2020-04-14
Vaasa	-	2020-04-06
Ristiina, Savonlinna	-	2020-04-14
Varkaus, Kuopio, Siilinjärvi, Puhos, Joensuu	II, 2000 dwt	2020-03-30
Saimaan kanava, Lappeenranta, Joutseno, Imatra	-	2020-04-09

The Saimaa Canal has been opened to traffic on 30th March.
Saima kanal har öppnats för trafik den 30 mars.
Saimaan kanava on avattu liikenteelle 30. maaliskuuta.

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS when passing the latitude 63°15'N on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, vid passage av latituden 63°15'N, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveyssasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on ylittäessään leveyssasteen 63°15'N, tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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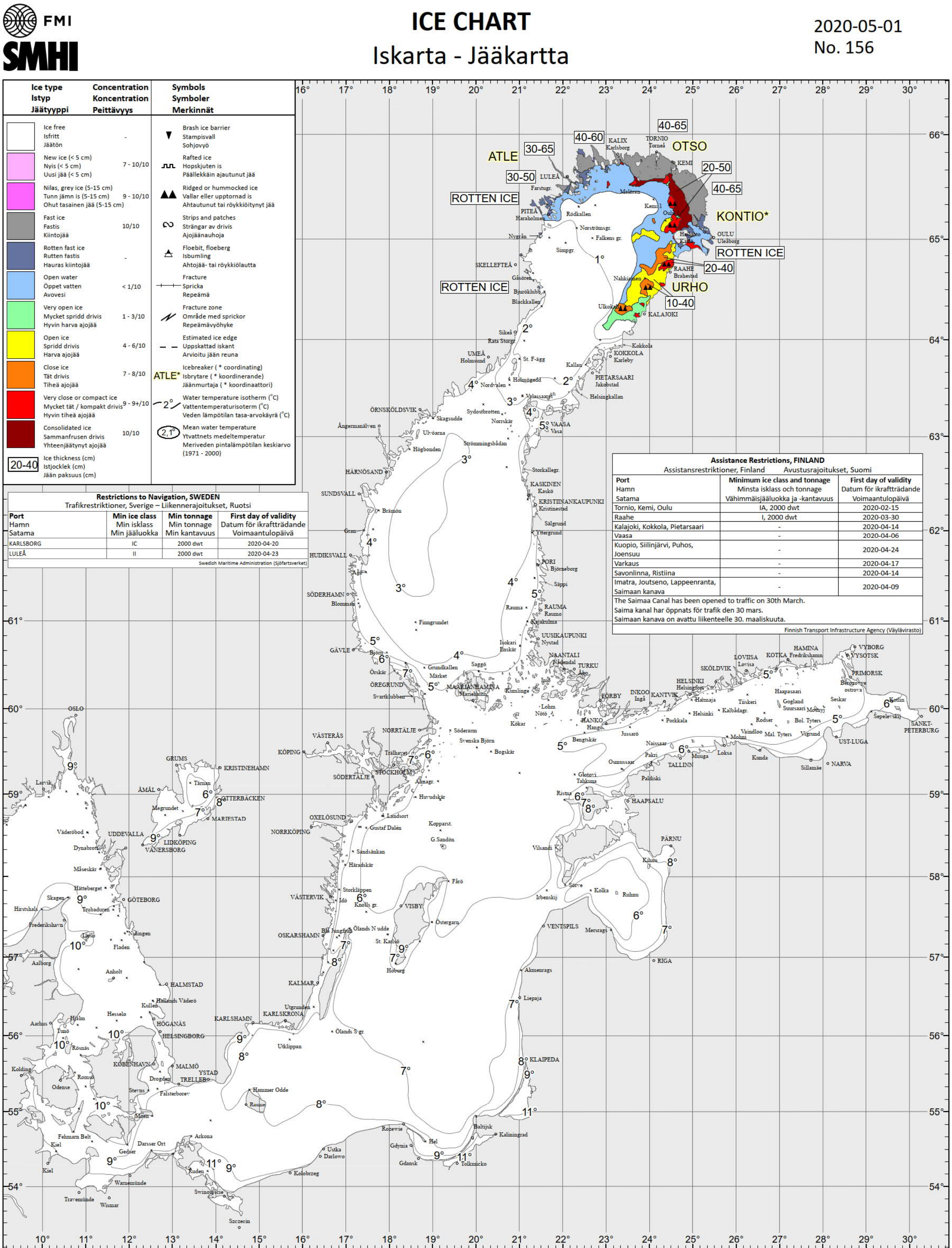

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS when passing the latitude 63°15'N on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, vid passage av latituden 63°15'N, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on ylittäessään leveysasteen 63°15'N, tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

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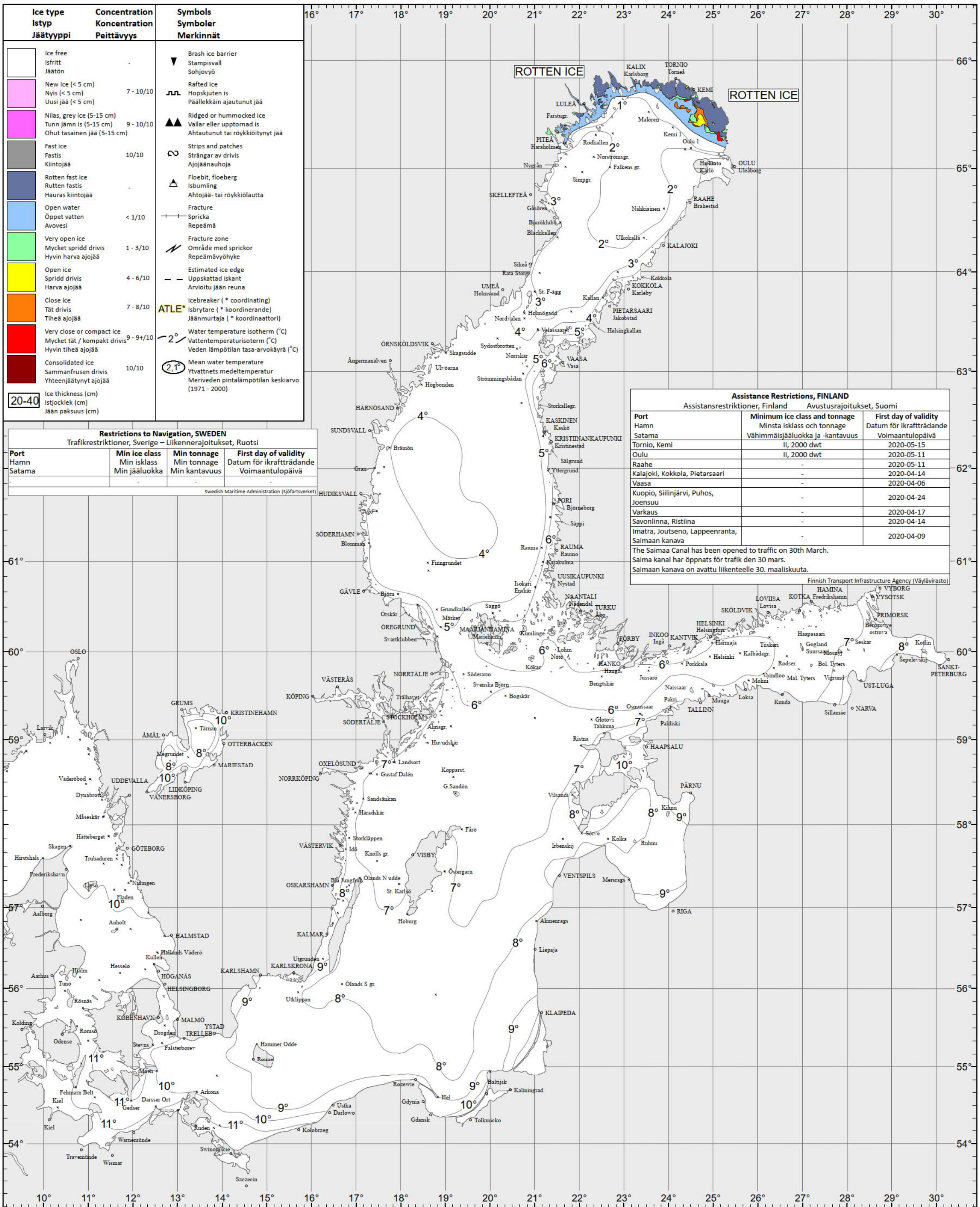
FMI
SMHI

ICE CHART
Iskarta - Jääkartta

2020-05-15
No. 170



Ice type / Istyp / Jäätyyppi	Concentration / Koncentration / Peittävyys	Symbols / Symboler / Merkinnät
Ice free / Isfritt / Jäätön	-	Brash ice barrier / Stampisvall / Sohjovyö
New ice (< 5 cm) / Nyis (< 5 cm) / Uusi jää (< 5 cm)	7 - 10/10	Rafted ice / Hopskjuten is / Päällekkäin ajautunut jää
Nilas, grey ice (5-15 cm) / Tunn jämn is (5-15 cm) / Ohut tasainen jää (5-15 cm)	9 - 10/10	Ridged or hummocked ice / Vallar eller upptornad is / Ahtautunut tai röykkiöitynyt jää
Fast ice / Fastis / Kiintojää	10/10	Strips and patches / Strängar av drivis / Ajojäänauhoja
Rotten fast ice / Rutten fastis / Hauras kiintojää	-	Floebit, floeberg / Isbumling / Ahtojää- tai röykkiölautta
Open water / Öppet vatten / Avovesi	< 1/10	Fracture / Spricka / Repeämä
Very open ice / Mycket spridd drivis / Hyvin harva ajojää	1 - 3/10	Fracture zone / Område med sprickor / Repeämävyöhyke
Open ice / Spridd drivis / Harva ajojää	4 - 6/10	Estimated ice edge / Uppskattad iskant / Arvioitu jään reuna
Close ice / Tät drivis / Tiheä ajojää	7 - 8/10	ATLE* Icebreaker (* coordinating) / Isbrytare (* koordinerande) / Jäänmurtaja (* koordinaattori)
Very close or compact ice / Mycket tät / kompakt drivis / Hyvin tiheä ajojää	9 - 9+/10	2° Water temperature isotherm (°C) / Vattentemperaturisoterm (°C) / Veden lämpötilan tasa-arvokäyrä (°C)
Consolidated ice / Sammanfrusen drivis / Yhteenjäätynyt ajojää	10/10	2,1° Mean water temperature / Ytvattnets medeltemperatur / Meriveden pintalämpötilan keskiarvo (1971 - 2000)
20-40 Ice thickness (cm) / Istjocklek (cm) / Jään paksuus (cm)		

Restrictions to Navigation, SWEDEN
Trafikrestriktioner, Sverige – Liikennerajoitukset, Ruotsi

Port / Hamn / Satama	Min ice class / Min isklass / Min jääluokka	Min tonnage / Min tonnage / Min kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
-	-	-	-

Swedish Maritime Administration (Sjöfartsverket)

Assistance Restrictions, FINLAND
Assistansrestriktioner, Finland Avustusrajoitukset, Suomi

Port / Hamn / Satama	Minimum ice class and tonnage / Minsta isklass och tonnage / Vähimmäisjääluokka ja -kantavuus	First day of validity / Datum för ikraftträdande / Voimaantulopäivä
Tornio, Kemi	II, 2000 dwt	2020-05-15
Oulu	II, 2000 dwt	2020-05-11
Raahe	-	2020-05-11
Kalajoki, Kokkola, Pietarsaari	-	2020-04-14
Vaasa	-	2020-04-06
Kuopio, Siilinjärvi, Puhos, Joensuu	-	2020-04-24
Varkaus	-	2020-04-17
Savonlinna, Ristiina	-	2020-04-14
Imatra, Joutseno, Lappeenranta, Saimaan kanava	-	2020-04-09

The Saimaa Canal has been opened to traffic on 30th March.
Saima kanal har öppnats för trafik den 30 mars.
Saimaan kanava on avattu liikenteelle 30. maaliskuuta.

Finnish Transport Infrastructure Agency (Väylävirasto)

Vessels bound for Gulf of Bothnia ports in which assistance restrictions apply shall, when passing the latitude 60°00'N, report their nationality, name, port of destination, ETA and speed to ICE INFO on VHF channel 78. This report can also be given directly by phone +46 10 492 7600.

Vessels bound for a Finnish or Swedish port in the Quark or the Bay of Bothnia shall report to Bothnia VTS when passing the latitude 63°15'N on VHF channel 67.

Fartyg destinerade till hamnar med assistansrestriktion i Bottniska viken ska, vid passage av latituden 60°00'N, rapportera enligt instruktionerna för vintersjöfarten till ICE INFO på VHF-kanal 78 eller per telefon +46 10 492 7600.

Fartyg destinerade till finska eller svenska hamnar i Kvarken och Bottenviken ska, vid passage av latituden 63°15'N, rapportera till Bothnia VTS på VHF-kanal 67.

Aluksen, joka on matkalla Pohjanlahden satamaan, jossa on voimassa avustusrajoitus, on ylittäessään leveysasteen 60°00'N, tehtävä talviliikenneohjeen mukainen ilmoitus ICE INFO:lle VHF-kanavalla 78 tai puhelimitse +46 10 492 7600.

Aluksen, joka on matkalla suomalaiseen tai ruotsalaiseen Merenkurkun tai Perämeren satamaan, on ylittäessään leveysasteen 63°15'N, tehtävä ilmoitus Bothnia VTS:lle VHF-kanavalla 67.

Partly based on EU Copernicus data

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APPENDIX 3: SUMMARY OF THE ASSISTANCE EVENTS

Icebreaker Assistance: winter 2018-2019

PERIOD	PORT_Group	LED	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	No	102	1	47	50	4
		Yes	57	7	39	7	4
	FIN_2	No	86	0	56	9	21
		Yes	2	0	1	0	1
	FIN_6	No	20	2	9	6	3
		Yes	0	0	0	0	0
	SWE_1	No	131	4	69	15	43
		Yes	0	0	0	0	0
	SWE_2	No	44	5	33	2	4
		Yes	0	0	0	0	0
	SWE_3	No	17	0	17	0	0
		Yes	0	0	0	0	0
2	FIN_1	No	99	0	31	55	13
		Yes	173	4	123	29	17
	FIN_2	No	177	8	82	63	24
		Yes	126	9	106	4	7
	FIN_3	No	175	0	131	36	8
		Yes	5	0	5	0	0
	FIN_4	No	76	2	39	22	13
		Yes	0	0	0	0	0
	FIN_5	No	963	27	717	152	67
		Yes	4	0	4	0	0
	FIN_6	No	449	18	270	111	50
		Yes	49	1	35	5	8
	SWE_1	No	58	0	25	19	14
		Yes	83	2	55	2	24
	SWE_2	No	58	1	31	20	6
		Yes	65	4	56	2	3
	SWE_3	No	265	0	218	43	4
		Yes	17	0	17	0	0
	SWE_4	No	151	12	112	17	10
		Yes	2	1	1	0	0
3	FIN_1	No	81	0	23	46	12
		Yes	149	2	104	31	12
	FIN_2	No	95	0	24	70	1
		Yes	239	25	175	12	27
	FIN_3	No	281	8	212	51	10
		Yes	15	0	13	0	2
	FIN_4	No	122	4	47	43	28
		Yes	0	0	0	0	0
	FIN_5	No	1468	31	1127	220	90
		Yes	0	0	0	0	0
	FIN_6	No	465	20	331	93	21
		Yes	1	0	1	0	0
	SWE_1	No	90	9	49	15	17
		Yes	26	1	15	3	7
	SWE_2	No	83	8	54	16	5
		Yes	37	5	29	0	3
	SWE_3	No	254	3	208	35	8
		Yes	1	0	1	0	0
	SWE_4	No	146	2	116	14	14
		Yes	0	0	0	0	0
4	FIN_1	No	106	1	40	53	12
		Yes	142	5	96	25	16
	FIN_2	No	160	7	56	81	16
		Yes	240	20	171	19	30
	FIN_3	No	97	0	79	15	3
		Yes	0	0	0	0	0
	FIN_4	No	57	2	30	14	11
		Yes	0	0	0	0	0
	FIN_5	No	91	0	78	11	2
		Yes	0	0	0	0	0
	FIN_6	No	51	0	44	5	2
		Yes	0	0	0	0	0
	SWE_1	No	133	5	72	21	35
		Yes	27	1	22	1	3
	SWE_2	No	68	2	51	10	5
		Yes	26	3	23	0	0
	SWE_3	No	89	1	84	4	0
		Yes	1	0	1	0	0
5	FIN_1	No	191	2	106	64	19
		Yes	40	0	31	2	7
	FIN_2	No	190	12	115	32	31
		Yes	47	3	41	1	2
	SWE_1	No	63	8	25	8	22
		Yes	0	0	0	0	0
	SWE_2	No	25	2	23	0	0
		Yes	0	0	0	0	0
	SWE_3	No	6	0	6	0	0
		Yes	0	0	0	0	0

Icebreaker Assistance: winter 2019-2020

PERIOD	PORT_Group	LED	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	No	173	5	69	69	30
		Yes	80	6	69	3	2
	FIN_2	No	135	11	99	16	9
		Yes	0	0	0	0	0
	SWE_1	No	185	11	121	33	20
		Yes	0	0	0	0	0
	SWE_2	No	87	7	71	0	9
		Yes	0	0	0	0	0
	SWE_3	No	6	0	6	0	0
		Yes	0	0	0	0	0
2	FIN_1	No	130	2	48	59	21
		Yes	111	4	88	10	9
	FIN_2	No	246	16	167	22	41
		Yes	11	0	6	0	5
	SWE_1	No	107	6	46	22	33
		Yes	25	1	13	2	9
	SWE_2	No	52	7	40	0	5
		Yes	13	0	13	0	0
	SWE_3	No	14	0	14	0	0
		Yes	0	0	0	0	0
3	FIN_1	No	46	0	10	35	1
		Yes	154	0	114	27	13
	FIN_2	No	313	19	176	92	26
		Yes	0	0	0	0	0
	SWE_1	No	84	7	39	16	22
		Yes	32	2	21	3	6
	SWE_2	No	45	1	34	6	4
		Yes	30	0	30	0	0
	SWE_3	No	38	0	38	0	0
		Yes	0	0	0	0	0
4	FIN_1	No	61	0	9	51	1
		Yes	184	4	135	34	11
	FIN_2	No	329	24	177	94	34
		Yes	1	0	1	0	0
	SWE_1	No	154	11	89	22	32
		Yes	9	1	5	0	3
	SWE_2	No	43	6	33	0	4
		Yes	10	0	10	0	0
	SWE_3	No	18	0	18	0	0
		Yes	0	0	0	0	0
5	FIN_1	No	182	6	99	71	6
		Yes	74	0	58	12	4
	FIN_2	No	27	7	16	3	1
		Yes	33	1	31	1	0
	SWE_1	No	72	8	55	7	2
		Yes	0	0	0	0	0
	SWE_2	No	36	6	30	0	0
		Yes	0	0	0	0	0
	SWE_3	No	3	0	3	0	0
		Yes	0	0	0	0	0

APPENDIX 4: SUMMARY OF THE TOWING EVENTS

Icebreaker Towing: winter 2018-2019

PERIOD	PORT_Group	TOW	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	No	155	7	83	57	8
		Yes	4	1	3	0	0
	FIN_2	No	88	0	57	9	22
		Yes	0	0	0	0	0
	FIN_6	No	20	2	9	6	3
		Yes	0	0	0	0	0
	SWE_1	No	131	4	69	15	43
		Yes	0	0	0	0	0
	SWE_2	No	44	5	33	2	4
		Yes	0	0	0	0	0
	SWE_3	No	17	0	17	0	0
		Yes	0	0	0	0	0
2	FIN_1	No	247	4	132	84	27
		Yes	25	0	22	0	3
	FIN_2	No	303	17	188	67	31
		Yes	0	0	0	0	0
	FIN_3	No	180	0	136	36	8
		Yes	0	0	0	0	0
	FIN_4	No	76	2	39	22	13
		Yes	0	0	0	0	0
	FIN_5	No	967	27	721	152	67
		Yes	0	0	0	0	0
	FIN_6	No	497	19	305	116	57
		Yes	1	0	0	0	1
	SWE_1	No	134	2	74	21	37
		Yes	7	0	6	0	1
	SWE_2	No	118	4	83	22	9
		Yes	5	1	4	0	0
	SWE_3	No	282	0	235	43	4
		Yes	0	0	0	0	0
	SWE_4	No	153	13	113	17	10
		Yes	0	0	0	0	0
3	FIN_1	No	201	2	103	75	21
		Yes	29	0	24	2	3
	FIN_2	No	291	23	161	82	25
		Yes	43	2	38	0	3
	FIN_3	No	296	8	225	51	12
		Yes	0	0	0	0	0
	FIN_4	No	122	4	47	43	28
		Yes	0	0	0	0	0
	FIN_5	No	1468	31	1127	220	90
		Yes	0	0	0	0	0
	FIN_6	No	466	20	332	93	21
		Yes	0	0	0	0	0
	SWE_1	No	116	10	64	18	24
		Yes	0	0	0	0	0
	SWE_2	No	118	12	82	16	8
		Yes	2	1	1	0	0
	SWE_3	No	255	3	209	35	8
		Yes	0	0	0	0	0
	SWE_4	No	146	2	116	14	14
		Yes	0	0	0	0	0
4	FIN_1	No	228	6	118	78	26
		Yes	20	0	18	0	2
	FIN_2	No	368	27	196	100	45
		Yes	32	0	31	0	1
	FIN_3	No	97	0	79	15	3
		Yes	0	0	0	0	0
	FIN_4	No	57	2	30	14	11
		Yes	0	0	0	0	0
	FIN_5	No	91	0	78	11	2
		Yes	0	0	0	0	0
	FIN_6	No	51	0	44	5	2
		Yes	0	0	0	0	0
	SWE_1	No	159	6	93	22	38
		Yes	1	0	1	0	0
	SWE_2	No	93	5	73	10	5
		Yes	1	0	1	0	0
	SWE_3	No	90	1	85	4	0
		Yes	0	0	0	0	0
5	FIN_1	No	226	2	132	66	26
		Yes	5	0	5	0	0
	FIN_2	No	237	15	156	33	33
		Yes	0	0	0	0	0
	SWE_1	No	63	8	25	8	22
		Yes	0	0	0	0	0
	SWE_2	No	25	2	23	0	0
		Yes	0	0	0	0	0
	SWE_3	No	6	0	6	0	0
		Yes	0	0	0	0	0

Icebreaker Towing: winter 2019-2020

PERIOD	PORT_Group	TOW	Total	Phase 0 & 1	EEDI-compliant	Non-compliant	N/A
1	FIN_1	No	253	11	138	72	32
		Yes	0	0	0	0	0
	FIN_2	No	135	11	99	16	9
		Yes	0	0	0	0	0
	SWE_1	No	185	11	121	33	20
		Yes	0	0	0	0	0
	SWE_2	No	87	7	71	0	9
		Yes	0	0	0	0	0
	SWE_3	No	6	0	6	0	0
		Yes	0	0	0	0	0
2	FIN_1	No	235	6	130	69	30
		Yes	6	0	6	0	0
	FIN_2	No	257	16	173	22	46
		Yes	0	0	0	0	0
	SWE_1	No	132	7	59	24	42
		Yes	0	0	0	0	0
	SWE_2	No	65	7	53	0	5
		Yes	0	0	0	0	0
	SWE_3	No	14	0	14	0	0
		Yes	0	0	0	0	0
3	FIN_1	No	187	0	111	62	14
		Yes	13	0	13	0	0
	FIN_2	No	313	19	176	92	26
		Yes	0	0	0	0	0
	SWE_1	No	116	9	60	19	28
		Yes	0	0	0	0	0
	SWE_2	No	75	1	64	6	4
		Yes	0	0	0	0	0
	SWE_3	No	38	0	38	0	0
		Yes	0	0	0	0	0
4	FIN_1	No	208	2	112	82	12
		Yes	37	2	32	3	0
	FIN_2	No	329	24	177	94	34
		Yes	1	0	1	0	0
	SWE_1	No	163	12	94	22	35
		Yes	0	0	0	0	0
	SWE_2	No	53	6	43	0	4
		Yes	0	0	0	0	0
	SWE_3	No	18	0	18	0	0
		Yes	0	0	0	0	0
5	FIN_1	No	256	6	157	83	10
		Yes	0	0	0	0	0
	FIN_2	No	60	8	47	4	1
		Yes	0	0	0	0	0
	SWE_1	No	72	8	55	7	2
		Yes	0	0	0	0	0
	SWE_2	No	36	6	30	0	0
		Yes	0	0	0	0	0
	SWE_3	No	3	0	3	0	0
		Yes	0	0	0	0	0