

# Shipping in ice conditions in the Baltic Sea

Level playing field for ice-strengthened ships  
needed to secure sustainable maritime transport

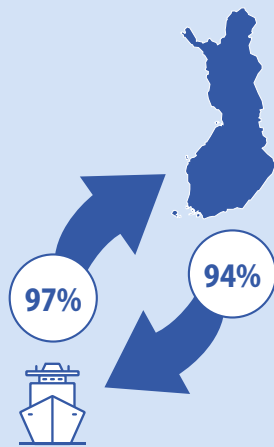


# Northern Europe is known for its four seasons, winter being one of them. Due to winter and low salinity, the northern parts of the Baltic Sea freeze every year for several months.

In winter, marine conditions in the northern Baltic Sea are demanding. Although global warming reduces the average annual amount of ice, the variability of winters and changing weather patterns make ice conditions more challenging. In other words, climate change will not necessarily ease the ice conditions in the Baltic Sea but make them even more varied and harder to predict than before.

Ice, snow and the cold require much more from ships than navigation in open water. Ice navigation requires a lot from the entire maritime transport system. It impacts everything: the safety of ships, fuel consumption and greenhouse gas emissions.





Maritime transport is vital for Finland. Approximately 94.4% of goods exports and 96.7% of goods imports are carried by sea.

Due to Finland's geographical location, there is no realistic alternative to maritime transport. Finland is dependent on efficient shipping in ice conditions.



## The subarctic Baltic Sea freezes every year

The conditions in the northern Baltic Sea are severe in winter. In the open sea, thick ice moves and drifts into layers and heaps, and on shipping lanes also into thick belts of brash ice. They slow down and even jeopardise the movement of merchant ships.



# Ships need icebreaker assistance

During an average winter, ships arriving in Finland need to pass more than 200 nautical miles or over 370 kilometres through ice. If the winter is severe, the distance navigated through ice is approximately 600 nautical miles or over 1,110 kilometres.

In harsh conditions, not even the most powerful ships can manage the entire journey to the northernmost ports of the Baltic Sea on their own but need to be assisted by icebreakers. The need for icebreaking may increase in the future.

Due to global environmental regulation, there is an increasing number of ships with low engine powers navigating the seas that often need icebreaker assistance.

Icebreakers are ships that open frozen shipping lanes and assist ships in the middle of ice. In the Baltic Sea, during an average winter assistance is provided to approximately 4,000 ships, and during a harsh winter to almost 11,000 ships (incl. assists to/from Russian ports). For safety reasons, icebreakers only assist ships of a certain size that are able to navigate in ice.

	Assists (incl. towing)	Icebreakers' operating days
2018–2019	2165	1059
2019–2020	927	568
2020–2021	2326	1151
2021–2022	3432	1583
2022–2023	2065	1224
2023–2024	4172	1921
<b>Average</b>	<b>2515</b>	<b>1251</b>

Assists provided by Finnish and Swedish icebreakers 2018–2024

Source: Finnish Transport Infrastructure Agency





Harsh conditions are also a challenge to icebreakers. A fairway broken through ice closes and freezes quickly.



## BALTIC SEA

Due to low salinity, the northern parts of the Baltic Sea freeze every year for several months.

The average duration of sea-ice is approximately six months, usually from November to May. In winter, approximately one third of the Baltic Sea is normally covered with ice.

**54 m**  
average depth  
(cf. the Mediterranean 1,500 m)

**50–75 cm**  
fast-ice thickness of  
Finnish ports in winter

**~6 months**  
average duration of ice winter

**0.5%**  
average salinity in the  
northernmost parts of  
the Baltic Sea  
(cf. the Mediterranean 3.5%)  
The sea freezes more easily  
due to low salinity.



**AVERAGE ICE CONDITIONS ON THE BALTIC SEA**

- Harshest ice conditions every year
- Difficult ice conditions every year
- Ice conditions almost every year
- Usually open water in wintertime



The ringed seal (*Pusa hispida botnica*) is a subspecies of ringed seal living in the Baltic Sea. It lives in areas of the Gulf of Bothnia and the Gulf of Finland that freeze over in winter.



### ICEBREAKER

Fairway icebreakers are special-purpose ships that open frozen shipping lanes and assist ships in the middle of ice.

Normal merchant ships that are ice-strengthened and able to navigate in ice conditions safely. Depending on ice conditions, they navigate in ice on their own or assisted by an icebreaker.

### ICE-CLASSED SHIP



# Transport must be guaranteed throughout the year

A maritime transport system that takes account of ice conditions ensures safe and efficient maritime transport in the Baltic Sea. As a result, the northernmost countries of Europe can be reached all year round.

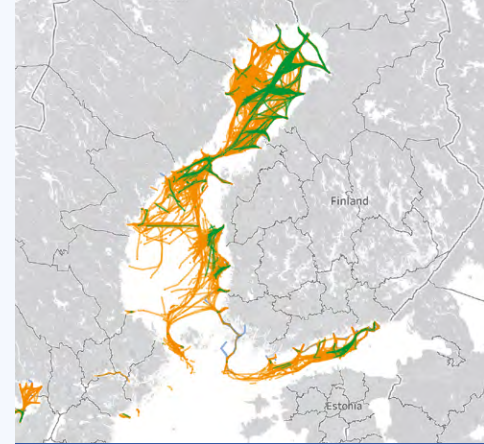
Due to Finland's location, it is not possible to any significant extent to shift from maritime transport to, for example, road transport. Maritime transport is also generally an option with lower emissions compared to road transport.

Seamless cooperation between the authorities, merchant ships, maritime pilots and other maritime operators is key to successful navigation in ice. In the Baltic Sea region, shipping in ice is managed in cooperation with all the countries in the region. The system supports the ships of all flag states. In the Bay of Bothnia, ships usually need icebreakers for at least five months, in the Gulf of Finland for three months each year.

The ice class indicates the engine output of the ship and the thickness of ice through which it can pass without being assisted by an icebreaker. The port-specific assistance restrictions are based on ice classes. The aim is to guarantee the safety of merchant ships. Furthermore, the rules ensure that the ship can proceed in ice conditions along a fairway opened by an icebreaker. Still, in heavy ice conditions, icebreakers often need to tow some merchant ships for dozens of nautical miles.



The northern parts of the Baltic Sea are busy all year round. In this heat map, the assists made by icebreakers are marked with yellow and the tows are marked with green.



The conditions differ from year to year. It is very difficult to predict the severity of annual ice conditions. To keep the logistics working, the northern Baltic Sea must be operated using merchant ships with the highest ice classes and having a sufficient number of icebreakers standing by. Finnish merchant shipping is mainly assisted by seven large fairway icebreakers.

The icebreaker fleet is monitored and controlled using an information system called the IBNet. This tailor-

made system uses satellite images as well as weather and ice forecasts to predict the ice situation.

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## THE BASIC PILLARS OF SHIPPING IN ICE CONDITIONS:



Efficient icebreakers



Coordination of icebreaking capacity



Ice classes for merchant ships and their ice navigation characteristics



Up-to-date situational awareness of maritime transport



Forecasts of weather and conditions



In ports, restrictions on the type of ships to be assisted in accordance with the prevailing conditions



Seafarers' competence



Shared information systems of the Baltic Sea states



# Navigation in ice challenges the safety of maritime traffic

In the northern Baltic Sea, ships with a weak structure and low engine power are prone to higher risks when navigating in ice than during the open water season. A ship may get stuck in ice, and the deck structures may collect ice that endangers the ship's stability. There is also a risk of damage to the ship's hull and propulsion systems.

There are a lot of oil and chemical tankers navigating the busy Gulf of Finland. The risk of an environmental accident is always present. In ice conditions, it is more difficult to prevent accidents and, as a result, the impacts on the environment are more extensive than in open water. Using ships with sufficient ice strengthening protects both transport and the environment.

↑ A merchant ship in the port of Pietarsaari. A thick layer of ice has built up on the ship's structures and deck.

↖ The risk of oil spills increases in ice conditions. It is more difficult to collect oil from icy water than from open water. The ice strengthening of ships reduces the risk of oil spills.

← Navigating in ice conditions and, in particular, assisting other ships in the dark or in heavy snowfall requires special skills. Experienced seafarers working on icebreakers are familiar with these conditions.



The risk of collision increases when ships navigate in a broken ice field or in a convoy behind an icebreaker. Ships with a strong structure, separate ice strengthening, and high engine power need less assistance. This lowers the risk of accidents and reduces the need for icebreaking services provided by Finnish authorities.



# Navigation in ice increases fuel consumption and emissions

In open water, an ice-strengthened ship consumes more fuel than a ship designed for open water only. The average fuel consumption and carbon dioxide emissions of an ice-strengthened ship in open water are approximately 5% higher than those of a ship designed for open water.

In ice conditions, all ships consume more fuel than when sailing in the same sea area in open water. Navigating in ice increases fuel consumption and carbon dioxide emissions by approximately 20–60%. In addition, emissions are caused by icebreakers assisting ships.

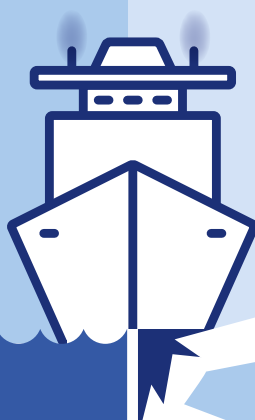
Finland is committed to the emission reduction targets of the International Maritime Organisation (IMO). Finland

considers it important that ice navigation is taken into account in international regulation and that all ships are treated equally. For example, in the regulation on the energy efficiency of ships, ice navigation has been taken into account with clear correction factors.

Taking ice navigation into account in international emission regulation of maritime transport does not need to lower the level of climate ambition of the regulation. It only ensures that all ships are treated equally. Ice-strengthened ships must also reduce their emissions in accordance with international targets. It is essential to avoid regulation that would increase total emissions in ice-covered sea areas.

## ICE-CLASSED SHIP SAILING IN OPEN WATER

Fuel consumption and CO<sub>2</sub> emissions  
**5% HIGHER**  
compared to ships built to  
sail in open water only.



## ICE-CLASSED SHIP SAILING IN ICE CONDITIONS

Fuel consumption and CO<sub>2</sub> emissions  
**INCREASE BY UP TO  
20–60%**

# Ice conditions increase the cost of foreign trade

The Finnish national economy is dependent on foreign trade, imports and exports transported by sea. Maritime transport accounts for a significant share of the transport costs of Finnish companies. In companies operating internationally, maritime transport accounts for an estimated 50% of transport costs. Finland's position differs from that of Central Europe since the bulk of Finland's maritime transport volume cannot be transferred by other modes of transport.

The year-round use and operation of ice-strengthened ships in ice conditions entails additional costs for maritime traffic to Finland compared to countries with no sea ice. In addition, investments in ice-strengthened ships that are more expensive than conventional ships increase the capital costs of shipping companies. The purchase prices of ships and thus capital costs for ships belonging to the Finnish-Swedish ice classes IA and IA Super are on average 8% higher than those for other ships.

The additional costs lower the competitiveness of Finnish businesses. The total direct costs to Finnish business and industry caused by ice conditions are estimated to be approximately EUR 200 million per year.

In addition, sufficient icebreaking capacity is needed to ensure safe and undisturbed transport throughout the year under varying ice conditions. The average cost of icebreaking for the Government of Finland is approximately EUR 60 million per year. As a result of the renewal of the ageing icebreaker fleet and the tightening international environmental regulations, the costs are expected to rise to at least EUR 100 million by the end of the 2020s. Environmental regulation is expected to increase the number of weak commercial ships in the Baltic Sea, which increases the need for assistance and fuel costs. Greenhouse gas emissions at the level of the transport system do not necessarily decrease, as a weaker fleet needs more assistance from icebreakers.

	Additional engine power	Additional annual fuel cost per average ship in Finnish foreign trade, €
Dry bulk-ship	29%	490,000
Tanker	23%	340,000
Ro-Ro	15%	400,000
General cargo ship	30%	200,000
Container ship	10%	210,000

Additional engine power of IAS/IA ships compared to open water ships by type in 2020

On-going research by Solakivi & Ojala (2021)

Ice covers the northern parts of the Baltic Sea for about half a year. Climate change will reduce the thickness of the ice cover. However, ice conditions affecting merchant shipping will become more varied and harder to predict.

Ice navigation requires a lot from the entire maritime transport system. It impacts everything: the safety of ships, fuel consumption and greenhouse gas emissions. This must be taken into account in the international regulation of maritime transport.

If the principle of level playing field is to be adhered to in the future, ice-strengthened ships must be considered in maritime traffic regulation. It is essential to avoid regulation that would reduce safety or increase total emissions in ice-covered sea areas.

*This brochure provides basic information on maritime transport in the subarctic conditions of the northern Baltic Sea. Finnish representatives will be happy to tell you more about the subject.*



FINNISH  
GOVERNMENT

Ministry of Transport  
and Communications

**TRAFICOM**  
Finnish Transport and Communications Agency



ILMATIETEEN LAITOS  
METEOROLOGISKA INSTITUTET  
FINNISH METEOROLOGICAL INSTITUTE



Finnish Transport  
Infrastructure Agency

To ask more about shipping in ice conditions, please send an email to [registry.lvm@gov.fi](mailto:registry.lvm@gov.fi)

**IMAGES** Page 1: Flying Focus and Arctia Ltd. | Page 2: Jaakko Salo, Kvarken Ports | Page 3: Port of Pietarsaari; Ville Suni, Arctia Ltd.  
Page 5: Ville Suni, Arctia Ltd.; Mervi Kunnasranta, Natural Resources Institute Finland LUKE | Page 6–7: Flying Focus and Arctia Ltd.  
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