EFFECT OF WINTER ON SEA TRAFFIC SAFETY IN THE BALTIC SEA

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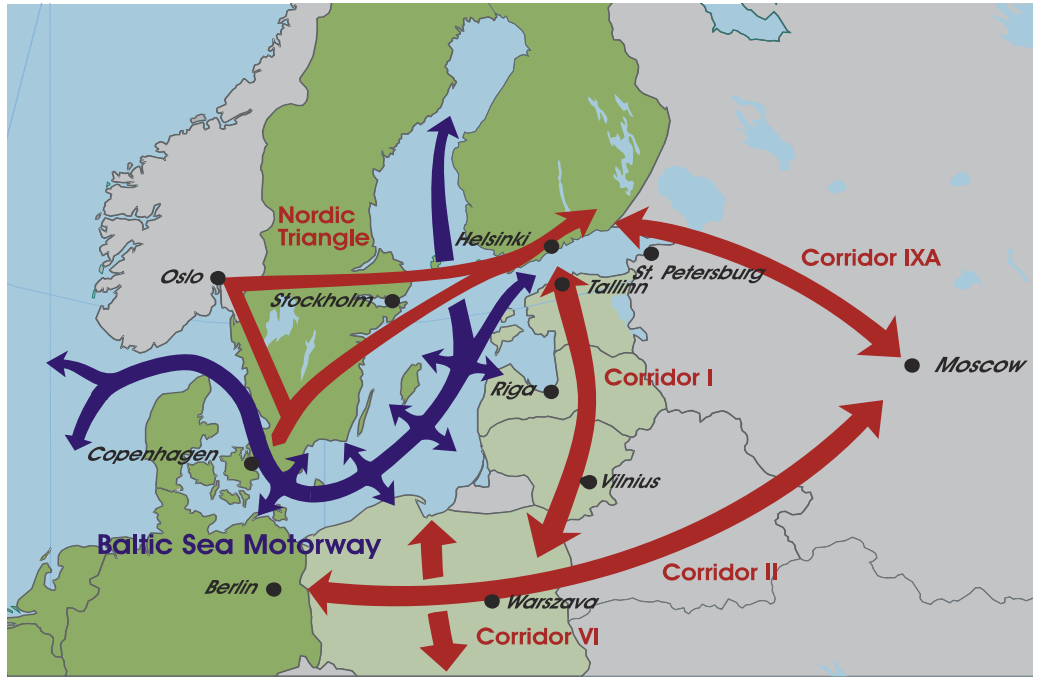
Meri-Kotka

- Meri-Kotka marine research association will conduct research related to marine safety, logistics of transport and the marine environment, especially in the Gulf of Finland and the Baltic Sea.
- The objective is to strengthen research and development in the maritime arena on the basis of a broad international co-operation network.
- The research staff are under the administrative jurisdiction of the Helsinki University of Technology, Kymenlaakso University of Applied Sciences, University of Helsinki and University of Turku.

The Baltic Sea – An Inland Sea of the Enlarged Union

- 150 million people live around the Baltic Sea
- High reliance on sea transport
  - (e.g. 85 % Finland's foreign trade is transported by sea)
- 500 million freight tons
- 7,5 million containers (TEU) or trailers on sea vessels
- 30 million sea passengers
- Estimated increase of transport volumes 4-5 % per year
- Severe winter adds to the costs (icebreaking etc.)

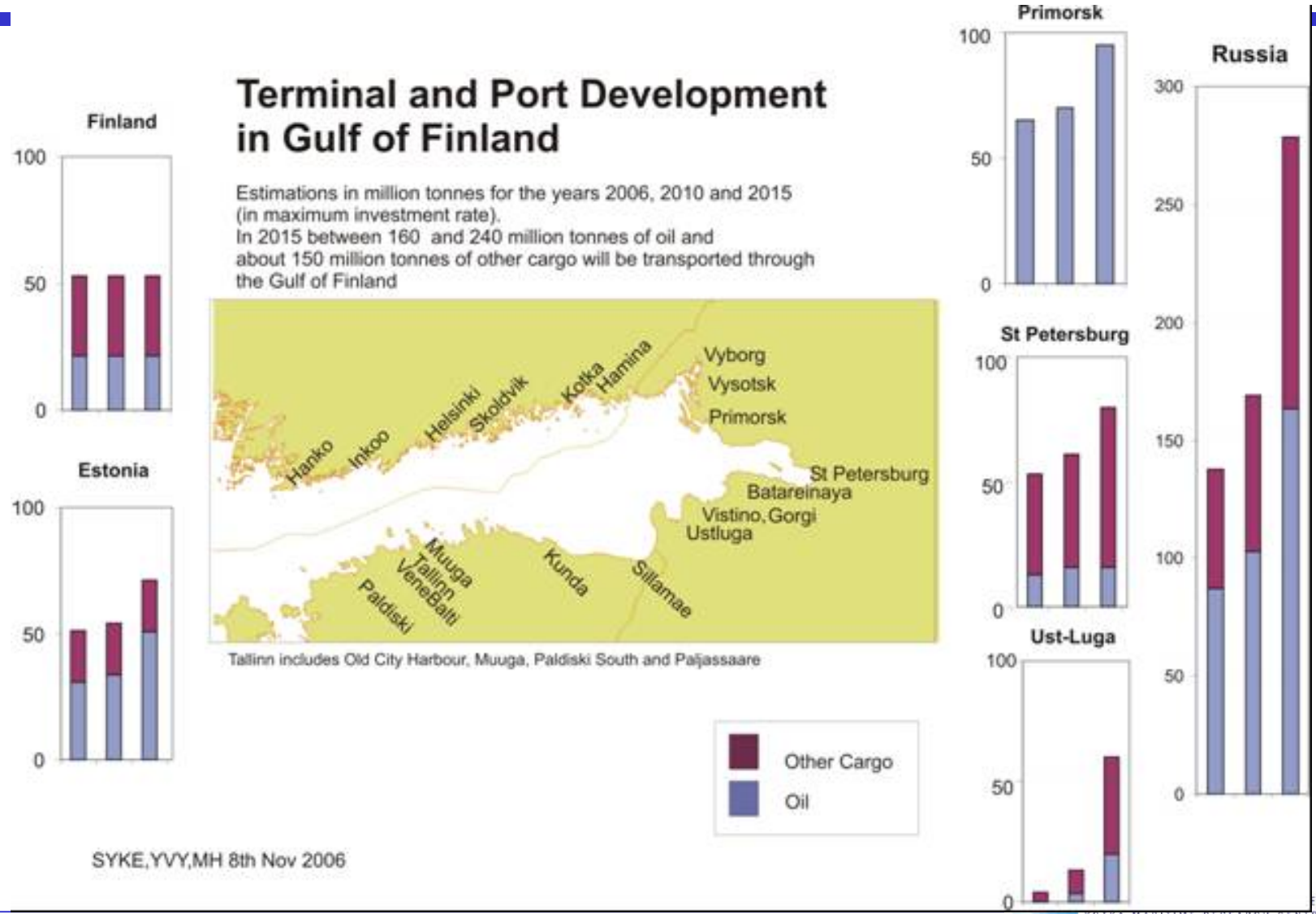
Source: Mintc, Finland



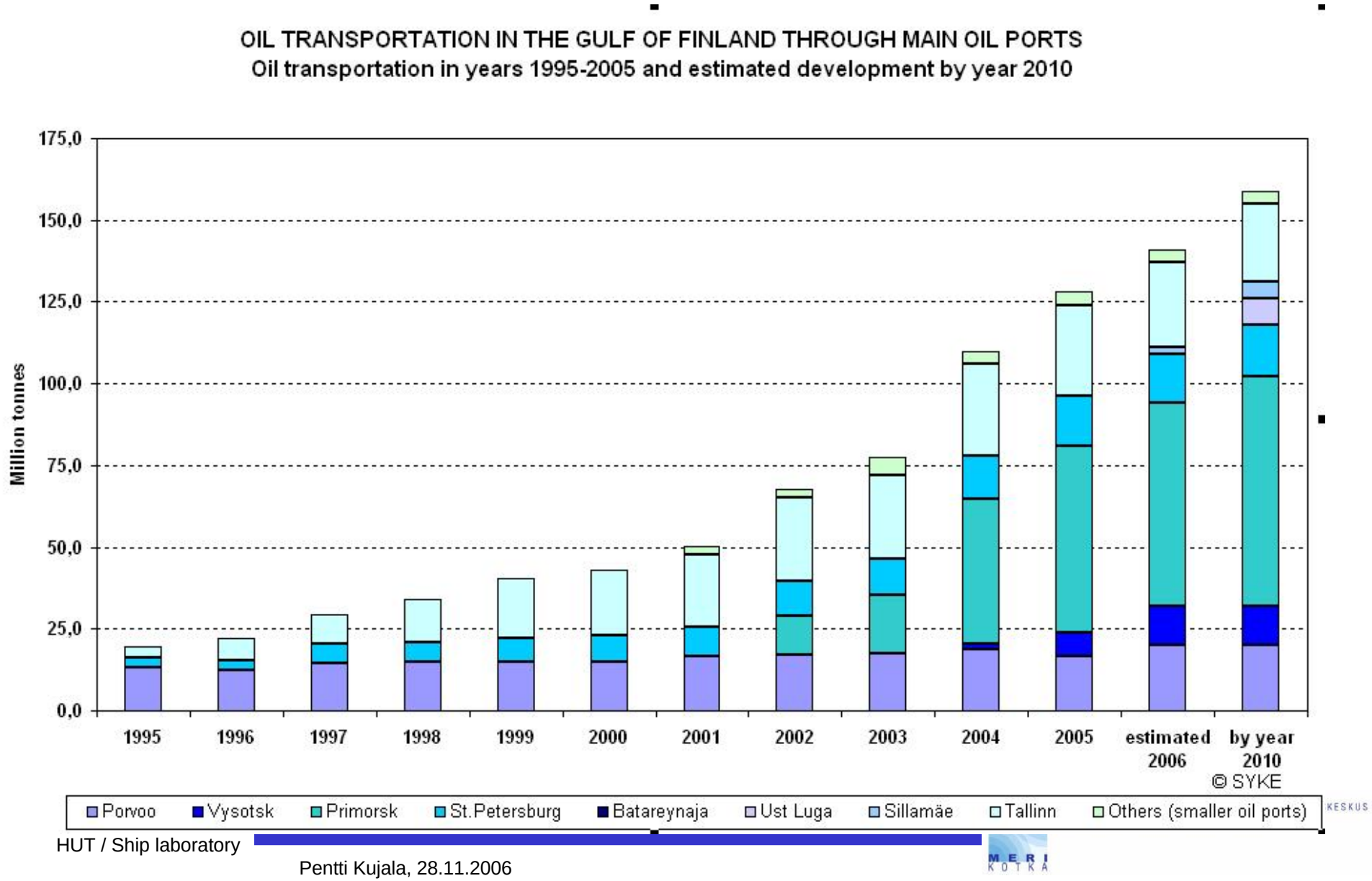
Main transport corridors

Source:Vehviläinen/Stora Enso

Increasing traffic in the Gulf of Finland

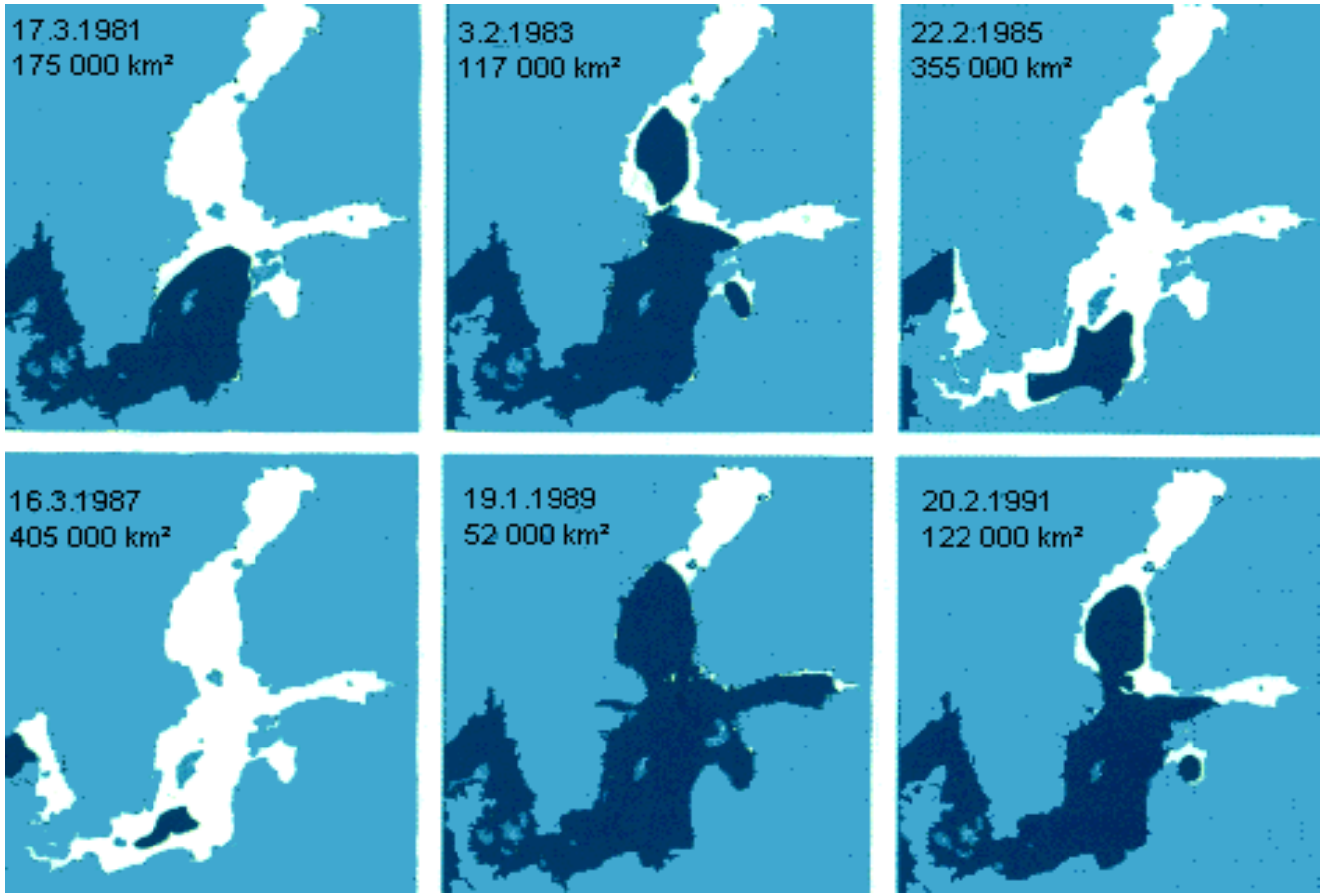


Increasing oil traffic



Ice-coverage

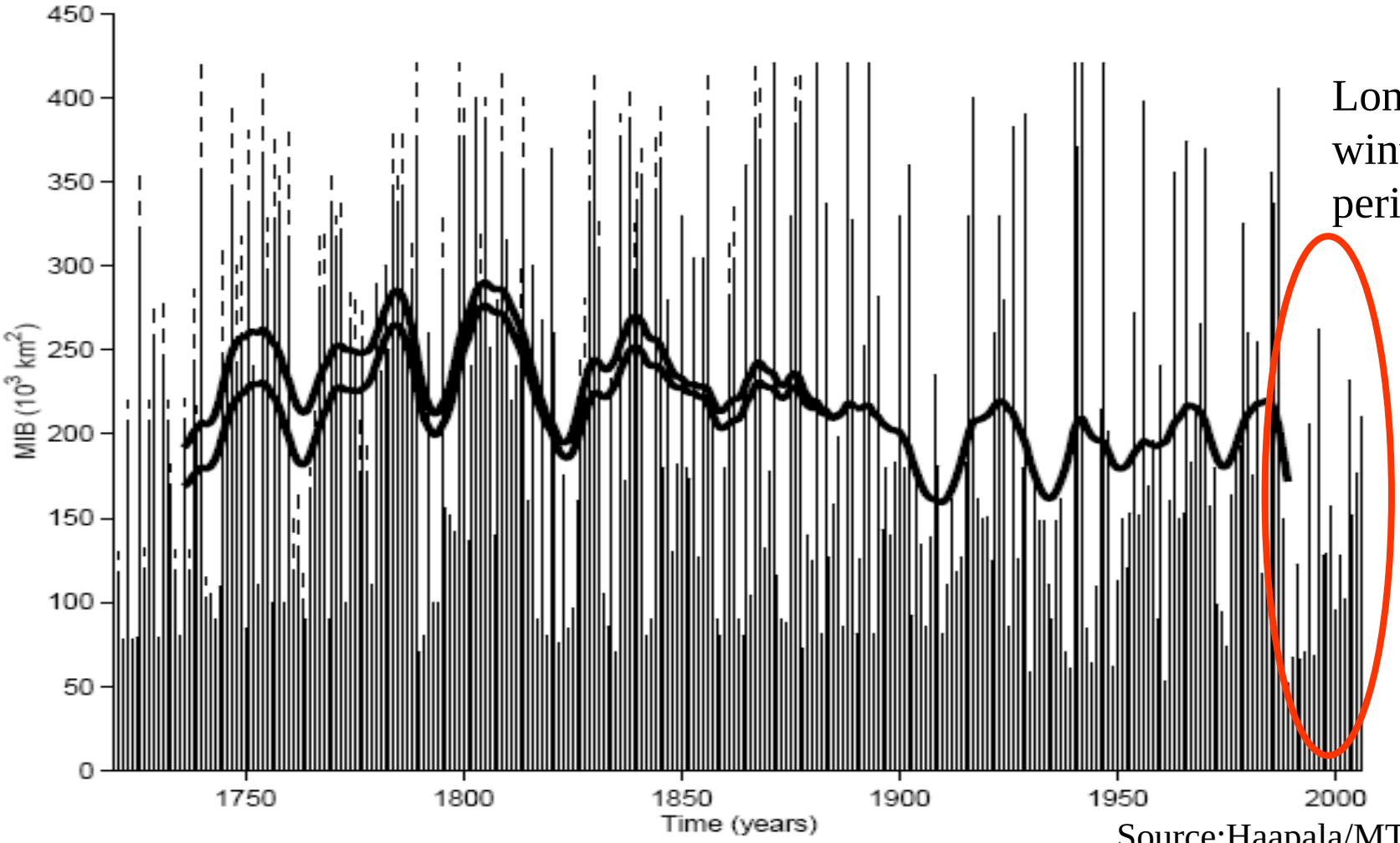
Source: FMA



= Ice coverage = Open sea = Land

- Area of ice-coverage varies much in different years.
- Problem lasts some 2-5 months regionally.
- Special shipping tonnage is needed.
- Schedules are subject to assistance of ice-breakers.
- High extra cost as ice-breaking cost is covered with national fairway dues or alike.

Long-term statistics of ice cover



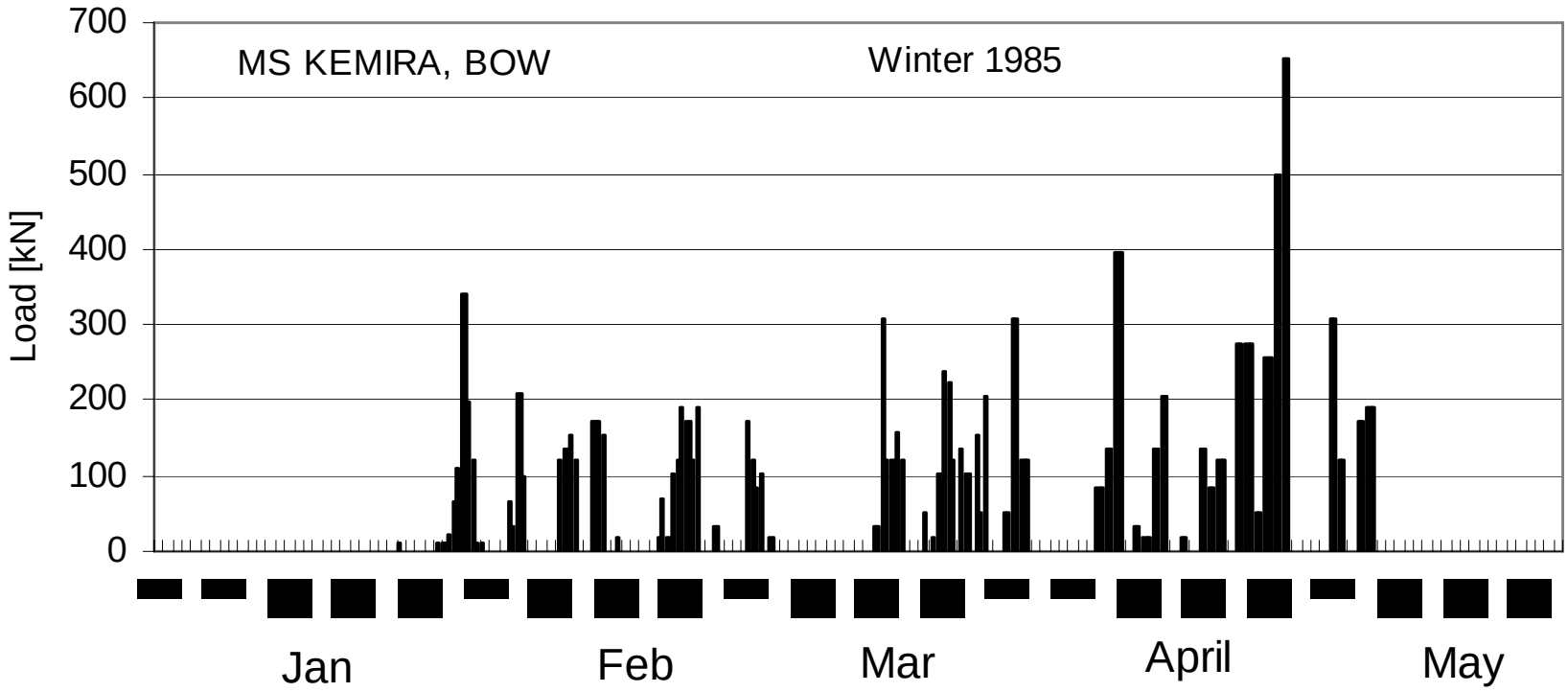
Long mild winters period

Source:Haapala/MTL

– 15 years average

Statistical nature of ice induced loads

The varying ice conditions and operations situations cause a high scatter on the ice induced loads on ships

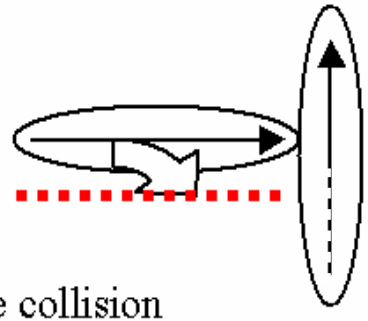


Compressive ice can cause high loads

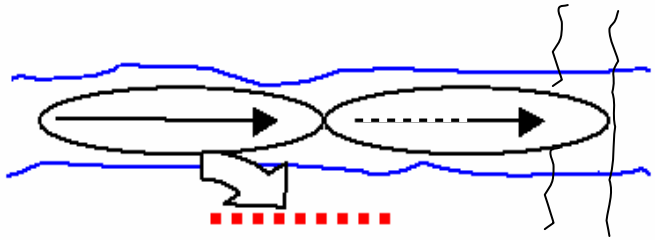
Source:Finstaship

Collision scenarios in winter navigation

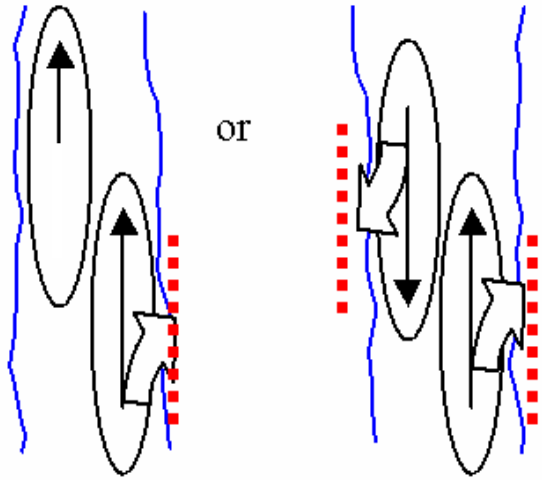
a) bow / bow collision



b) bow / side collision

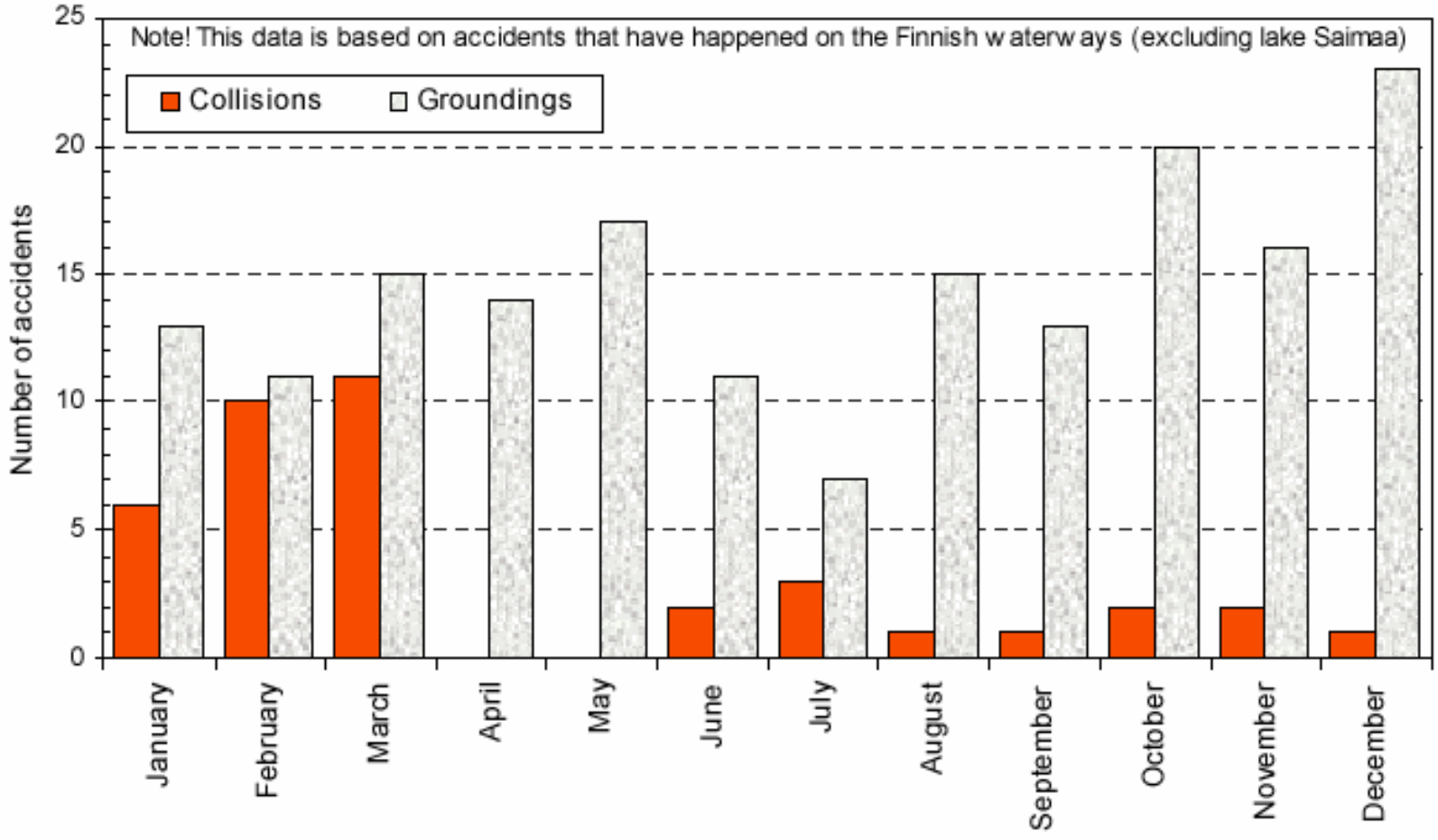


c) bow / rear end collision



d) side / side collision

Collisions in winter navigation

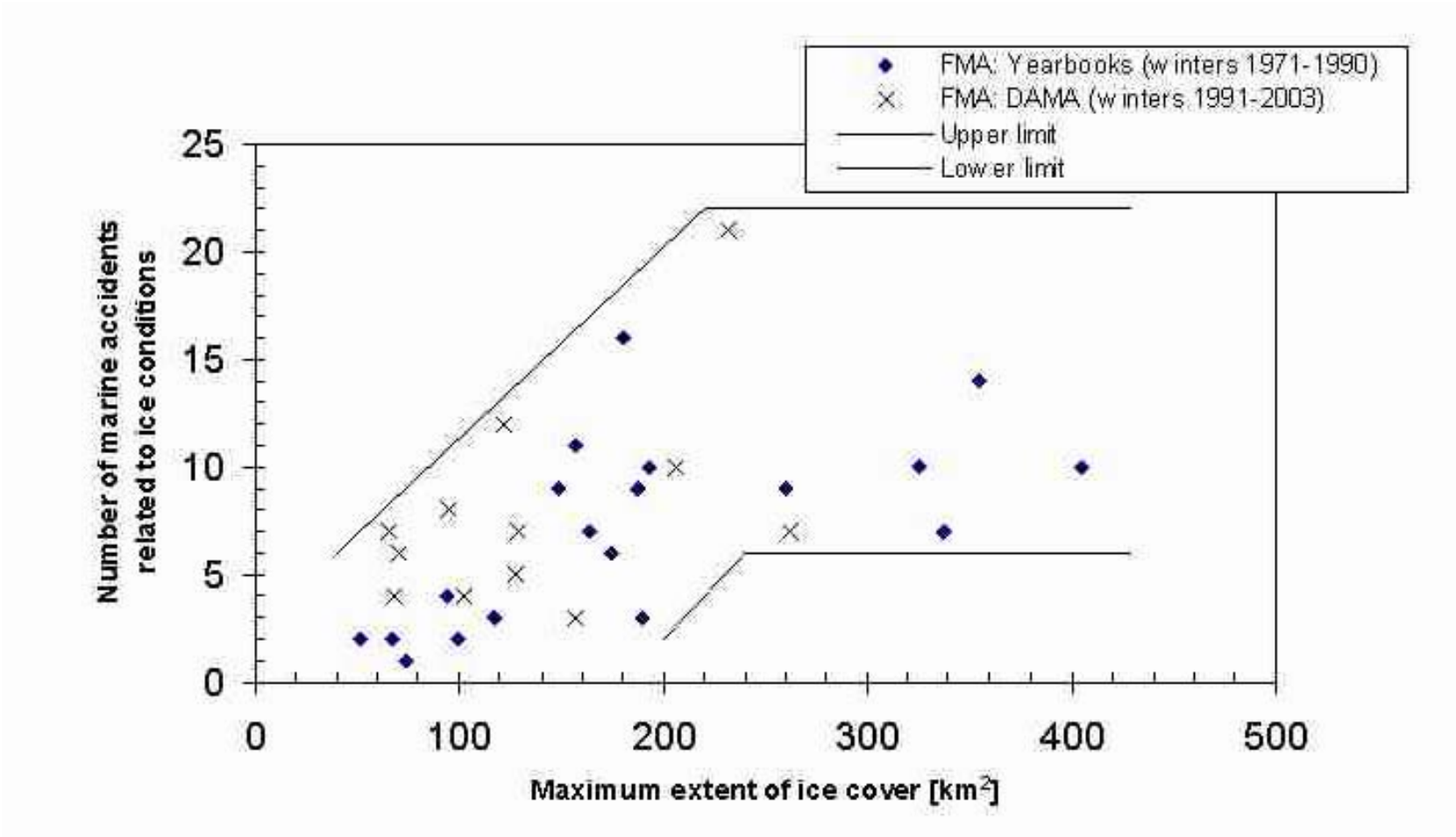


During 1990-2000 (FMA, 2001)

Collisions statistics

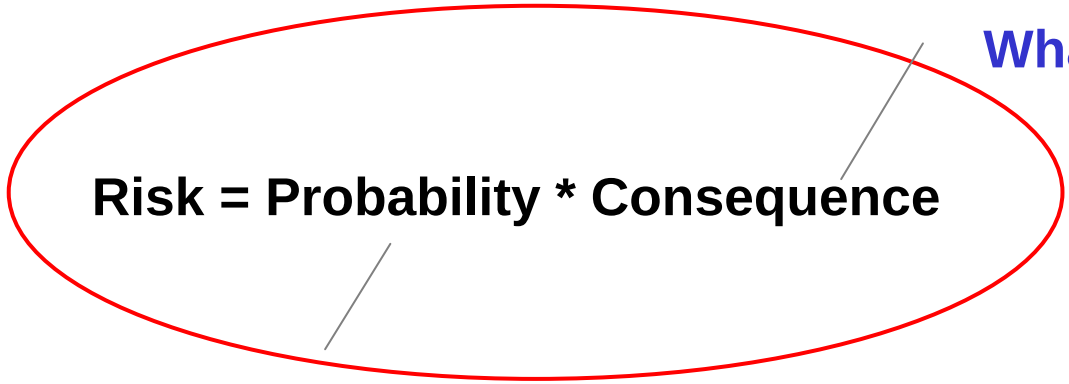
Ships involved:		Type of accident or incident:	Cases	Share
Icebreaker and the assisted vessel	58 %	Impact on the aft end of the icebreaker	20	26 %
		Impact on the assisted vessel	9	12 %
		Structural damage during towage	15	20 %
Other vessels	42 %	Bow/bow collision in ice channel	10	13 %
		Bow/aft collision in ice channel	7	9 %
		Collision, when aside (overtaking)	6	8 %
		Collision, when aside (passing by)	2	3 %
		Other collision	4	5 %
		Collision/allision with a light ice bridge or ice channel ferryboat	3	4 %
Note! In about 95 % of these cases there was no damage or only minor damage			76	100 %

ACCIDENTS RELATED TO WINTER & ICE



In 1970-1990 & 1991-2003 (FMA)

Definition of risk



What are the consequences?

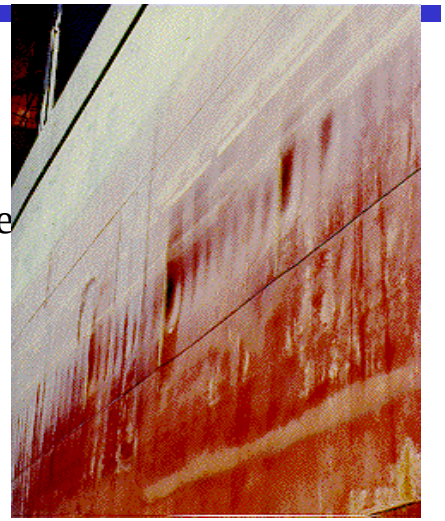
How often will it happen?

- **Loss of life**
- **Environmental damage**
- **Material damage => Loss of property**

The following risks analysis is presented on the report: Jalonen et al., 2005. A preliminary risk analysis of winter navigation in the Baltic Sea. Winter Navigation Research Board. Research report no 57.

WINTER & ICE RELATED ACCIDENTS AND INCIDENTS

ICE DAMAGE:



Hull damage:

- damage to plating
- damage to hull inner structures (e.g. frame
- damage to bilge keels

Propeller damage:

- propeller blade(s) lost
- propeller lost
- thruster damage

Rudder damage

Machinery damage

Collision:

Grounding:

- powered grounding
- drif grounding

Icing

Risk assessment: Some other restrictions made

The risk analysis was based on three different types of winter

	Mild winter	Normal winter	Severe winter
Maximum extent of ice cover during winter	94 000 km^2	160 000 km^2	265 000 km^2
Number of port visits in Estonia, Finland and Russia (in ice conditions)	13 000	16 000	20 000
Average ice thickness encountered	0.13 m	0.23 m	0.38 m
Average distance from ice edge to port & back	65 nm	111 nm	184 nm

	Mild winter	Normal winter	Severe winter
Estimated risk: Hull ice damage in winter	2 - 4	8 - 13	> 28 – 46 ships per

Risk assesment

Distance traveled in ice*ice thickness [nm*m] used as reference for amount of ice navigation

- The probability/frequency of structural hull damage due to ice load was assessed using different data from winters 1984-1987 and 2002-2003 with the result of:

  - an average frequency range of 13 - 150 x 10-6 cases of hull ice damage / (nm x m)

Based on all the reference data in use and it's applicability it was stated that the frequency or probability of ice loads causing a **rupture** of the plate would be roughly about :

- 5 x 10^{-6} cases / (nm x m)

when a generic ship, with no information of it's ice class, is considered

Quantification of the probability and consequences

•According to all available data (including even some relevant data from Russia and Canada) it was found that about **3 - 5 %** of the cases with rupture in the plate caused by ice ended up with the **loss of the ship**

• The probability of fatalities was assessed to be **10 - 33 %** of the probability of total loss

• Based on information from contact accidents (in open water) it was deduce that some pollution might occur in **5-10 %** of the cases with a rupture in the outer plating of the ship

Note! See the note on the previous page.

Obtained probabilities

Type of accident/ incident	Probability of accident / incident $\times 10^{-6}$	Probability of total loss $\times 10^{-6}$	Probability of fatalities $\times 10^{-6}$	Probability of pollution $\times 10^{-6}$
	per (distance traveled in ice conditions [nm]) × (ice thickness [m])			
Hull ice damage	20 - 33	0.2 – 0.3	0.01 – 0.1	0.25 – 0.5
Collision	~ 20	0.3 – 0.4	~ 0.11	~ 0.16
Grounding	2 - 4	0.02-0.08	0.004 – 0.016	0.12 – 0.4

Note! In the case of collision and grounding only such cases that take place in the ice conditions or are directly or indirectly related to ice or snowfall are included.

Results of risk analysis

	Fatalities (one or more)	Polution (minor)	Total loss
Mild winter	Once in 40-75 years	Once in 8-17 years	Once in 12-20 years
Normal winter	Once in 10-20 years	Once in 2-5 years	Once in 3-5 years
Severe winter	Once in 3-6 years	Yearly	Once in 1-2 years

Note: The data include all ice classes

Risk control options:

Finnish-Swedish winter navigation system

- Ice strengthening (hull strength & machinery power etc.) => Ice class requirements
- Restrictions to navigation (ice class & ship size)
- Icebreaker assistance

HUT / Ship laboratory

Other options (in use or to be considered):

- Double hull requirements
- Ice navigator
- Ice service
- Manoeuvrability requirements
- Escort towing
- New oil spill combating equipment (better suited for ice conditions)
- Emergency towing
- SAR units & equipment (better suited for for ice conditions)
- Crew training / use of crew with experience in winter navigati
- etc.

Technical Operational

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SAFEICE - research project (2004-2007),

The work with risks (and ice loads on ship hull) continues in the EU-funded reserach project with the following strategic objectives:

1. Decrease the environmental and material **risks** to **shipping in ice covered waters** by creating a unified basis for **winter navigation** system for first year ice conditions including the methods to get the required ice class
2. Develop semi-empirical methods based on measurements and advanced theoretical models to determine the **ice loads on ship hull** and relate these to the operational scenarios and the ice conditions
3. Develop **ship-ice interaction models** and **stochastic models** to assess the design loads on ship hull. The outcome is a description of the ice load versus ice and operational parameters.
4. Create a framework to develop design codes and regulations for plastic design basis for icebound ships

Coordinator: Helsinki University of Technology, Finland (HUT) / Prof. Pentti Kujala

Partners:

Chalmers University of Technology, Sweden (CUT),
Finnish Maritime Administration, Finland (FMA),
Germanicher Lloyd, Germany (GL),
Antarctic and Arctic Research Institute, Russia (AARI),
National Maritime Research Institute, Japan (NMRI).
Tallinn Technical University, Estonia (TTU),
Swedish Maritime Administration, Sweden (SMA),
Hamburg Ship Research Institute, Germany (HSVA),
National Research Council, Canada (NRC),

MS-GOF research project

- Analysis of traffic flow, risk modeling and classification of risks
- Effect of winter navigation on the risks
- The new possibilities offered by new technologies such as AIS for development of reliable risk models and related distributions
- Development of simulation of ice navigation and training methods
- Improving the co-operation around the Baltic Sea

- Finnish partners:TKK, KyAMK
- Russian partners: Admiral Makadov Marine Institute and St. Petersburg Marine University

CONCLUSIONS

In winter 2003 lots of data from incidents and accidents in winter navigation was collected in a database by the Helsinki University of Technology/Ship laboratory. Such an incident/accident- database turned out to be very useful to be used in risk assessments.

• The work with the database should be continued in order to increase it's size to support future risk assessments related to winter navigation.

• Additionally, it is important to develop risk models based on physical models, including e.g. simulation of ship operations in ice, development of compressive ice situation.

The ships, their operators, ports and the fairways to them, the volume of traffic and it's patterns and many other factors are under continuous development in the Baltic Sea.

• Therefore, we must continue our efforts to increase our knowledge related to the risks in winter navigation

THANK YOU!