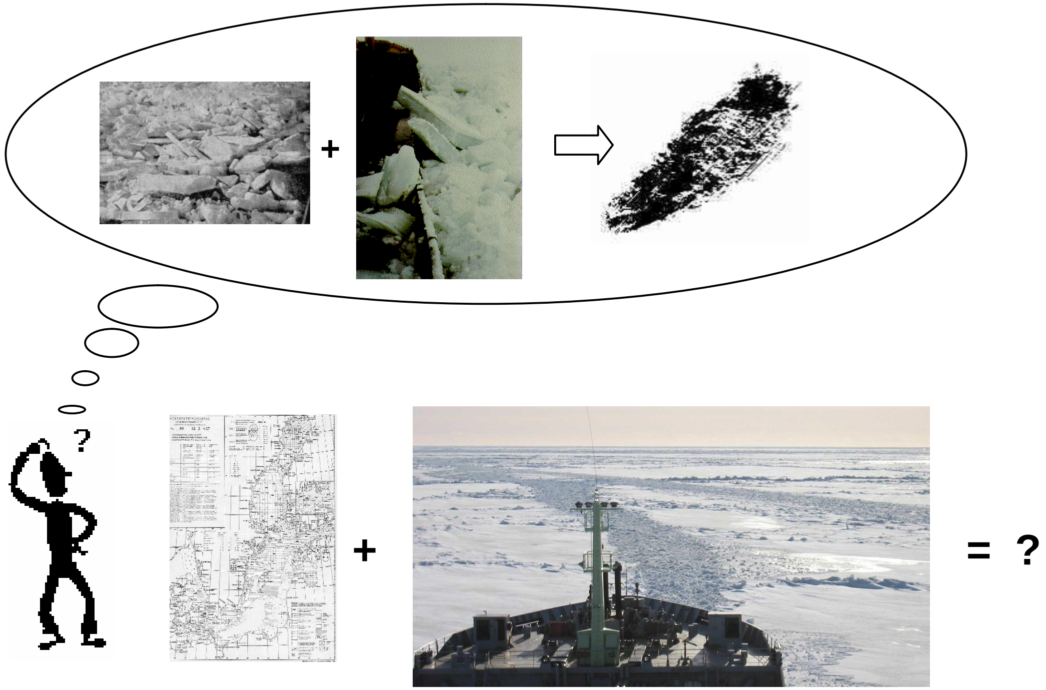
RISKS related to WINTER NAVIGATION



This presentation is planned to give a short overview of the preliminary:

RISK ANALYSIS related to
WINTER NAVIGATION in the BALTIC SEA

The contents of the presentation is based mainly on the work carried out in 2003 / 2004 by the

HELSINKI UNIVERSITY OF TECHNOLOGY / SHIP LABORATORY

for the HELCOM Ice Expert Working Group.

Finnish Maritime Administration and the Winter Navigation Research Board, which published the whole work in one report:

Jalonen, Risto, Riska, Kaj & Hänninen, Samuli, 2005: A Preliminary Risk Analysis of Winter Navigation in the Baltic Sea. Winter Navigation Research Board, Research Report No 57, Finnish Maritime Administration & Swedish Maritime Administration, Edita Prima Oy, Helsinki, 172 p. + app. 34 p.

Contents of the work

1) Introduction

2) Hazard identification

3) Risk assessment

- Risk model
- Probability
- Consequences

4) Risk control options

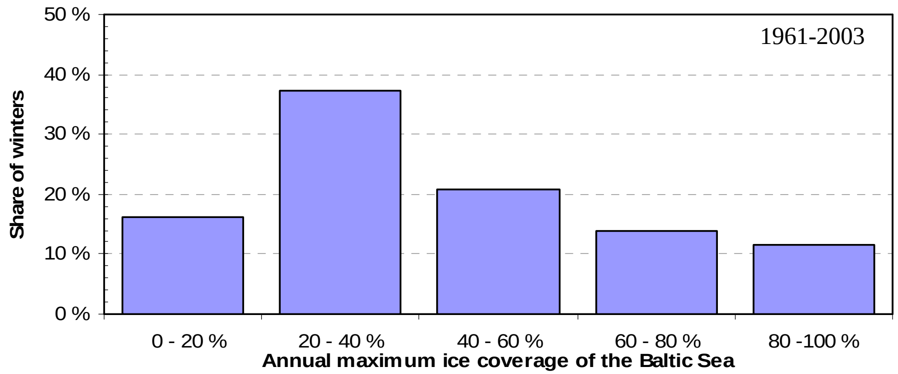
5) A case study: Collisions in winter navigation

H. Ramsay, 1947: I kamp med Östersjöns isar

Introduction:

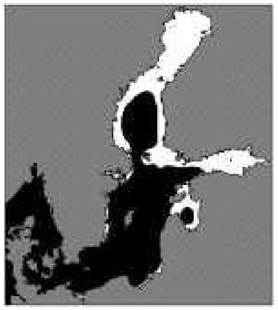
Ice cover affects winter navigation

The area covered by ice varies a lot

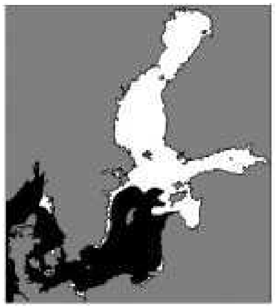


The histogram above presents the frequencies in five relative max. ice coverage classes in the Baltic in the years 1961-2003:

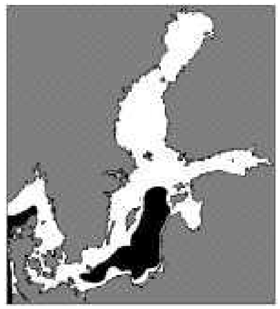
The three figures below represent the maximum area of ice cover in the Baltic sea during a mild winter (1991), a normal winter (1994) and a hard winter (1986)



FIMR/Ice service



FIMR/Ice service



FIMR/Ice service

Introduction:

MARINE ACCIDENTS related to winter navigation, but excluding hull ice damages, in Finnish waters in 1970-1990 & 1991-2003:

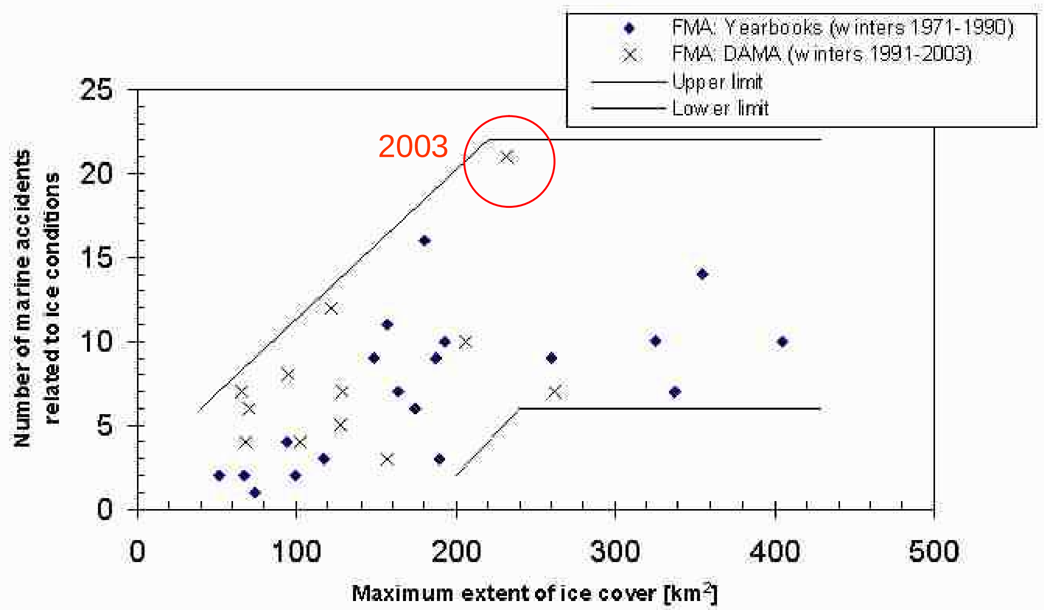


Figure 69 The number of marine accidents caused by severe ice conditions or otherwise connected to the environmental conditions of winter in Finnish waters vs. the maximum extent of ice cover in the Baltic Sea in years 1971-1990 (source: (FMA 1971-1990)) and in years 1991-2003 (source: FMA/ DAMA database). Note! Hull ice damage cases are not included in either series.

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Hazard identification:

What can go wrong? ⇨ **The answer is a list of hazards**

List of initiating events, problems or deviations related to winter navigation hazards (1)

=> Difficulties in keeping the ship moving, speed loss, unexpected loss of speed
=> Difficulties in manoeuvring, unexpected motions of the ship, unexpected restrictions of movements
=> Deviations from the originally planned route
=> Ice impacts due to ship speed & ship motion
=> Noise & vibrations increase
=> Increased time needed for: voyage, taking pilot, berthing, getting ship ready for cargo handling
=> Increased time and restrictions to rescue units arrival on accident site
=> Difficulties in finding objects or substances (oil) that are submerged below ice cover or under ice floe(s)
=> Difficulties to find shoreline from radar based information
=> Abrasive effects on ship hull painting => increased rate of rusting
=> Damage or other effects (e.g. change of location) to the aids to navigation
=> Compressive ice: ice loads due to ice movement & pressure
=> Ship stuck in ice / Ship movement with ice
=> Anchoring not possible due to ice
=> Movement of newly broken channel / old channel from its original location
=> Ice accumulation on the deck of the ship, on the side of the ship etc.
=> etc.

The list developed is too long to be presented here in it's full length !

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HAZARD IDENTIFICATION

IMO's taxonomy of initial events in marine casualties:

Collision
Stranding / Grounding
Contact
Fire / Explosion
Hull failure / failure of watertight doors / ports, etc.
Machinery damage
Damages to ship or equipment
Capsizing / Listing
Missing: assumed lost
Accidents with life-saving appliances
Other

All the initial events in the list above can be caused by ice as a contributory factor

How? A case study regarding collision incidents and accidents in ice follows

Risk assessment:

- A quantitative risk model, supported by historical data, was developed for winter navigation

- In this case the risk (in most sub-categories of the risk of winter navigation) was assumed to be proportional to
  - total number of port visits in ice conditions
  - distance traveled in ice and
  - ice thickness
- The approach included all ships in the ice-covered area, not just one generic ship
- Main focus was laid on collisions, groundings and hull ice damage

Risk assessment:

ICE DAMAGE

Hull ice damage:

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

Propeller damage:

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

Rudder damage

Machinery damage

- e.g. problems with sufficient supply of cooling water from sea chest due to ice accumulation

Collision: Note that a significant portion of the collisions occur with an icebreaker

- bow damage: collision to the stern of icebreaker, bow/bow collision collision bow to bow
- bow/stern collision
- other collision types: bow/side, side/side

Grounding:

- powered grounding
- drift grounding

Icing

Risk assessment:

The risk analysis was focused on three main accident types:

Hull ice damage:

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

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Propeller damage:

- propeller blade(s) lost
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- bow thruster damage

Rudder damage

Machinery damage

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Grounding:

- powered grounding
- drift grounding

Accident Investigation Board Finland

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 assessment:

- 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 20 - 33 x 10^{-6} cases of hull ice damage / (nm x m)

- However, if the effects of various ice classes are taken into account, the probability/ frequency range for structural hull damage* due to ice load is much wider:

  - 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

Note! Hull damages may range from slight permanent dents to large deflections, fractures of the side structure of the ship

Note! The frequency/probability data of ice damages presented above is based on the preliminary risk analysis of the available data. It should be noted that these values include uncertainty due to the size of the database in use and the particular conditions in which all individual ice damages occured. Therefore, the author takes no liability of any further use of this data.

Risk assessment: 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

Thus, the following results were obtained:

Procedures of the same kind were carried out for collisions and groundings.

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.

Note! See the note on the previous page.

Risk assessement: Results

The following results were obtained, when the consequences for hull ice damage, collisions and groundings were combined:

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

* Note! It is assumed here that one fatality is equivalent to 10 injuries

Note! It should be pointed out that the risk estimates presented above include an unknown amount of uncertainty. They are presented for the whole fleet of vessels (of an assumed size) operating in the Baltic Sea in the period of winter navigation, and may include even some vessels, that do not fully fullfill all the requirements of the maritime authorities and classification societies.

Note! See the note on the previous page.

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

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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 navigation
- etc.

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Technical   Operational

Risk control options: Efficiency assessment

Risk control option:

- **Ice class**: ice strengthening (hull strength & machinery power etc.)

Probability of ice damages in winter 2002-2003 [Hänninen, 2003]:

	Probability	
Ice class IASuper or ice class IA:	0.007	some kind of ice damage/voyage
Ice class IC or no ice class:	0.060	some kind of ice damage/voyage

Note! The calculation of the costs and savings for a risk control option is not always an easy task:

Should we limit the calculations to the ship and the shipping company or should we also take into account the effects on the cargo owner or even the national economy?

The method how to measure the efficiency should be agreed on

Cost/benefit analysis is one method for assessing the efficiency, but it is not the only one

The work with risks (and ice loads on ship hull) continues in the EU-funded **SAFEICE - research project (2004-2007)**, 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),

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.

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!

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