POPCORN
Preventing Oil and Plastics Contamination of Ocean Regions of the North

Northern Periphery and Arctic Programme 2014–2020

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Best technological and operational practices for OSR in Arctic and icy conditions

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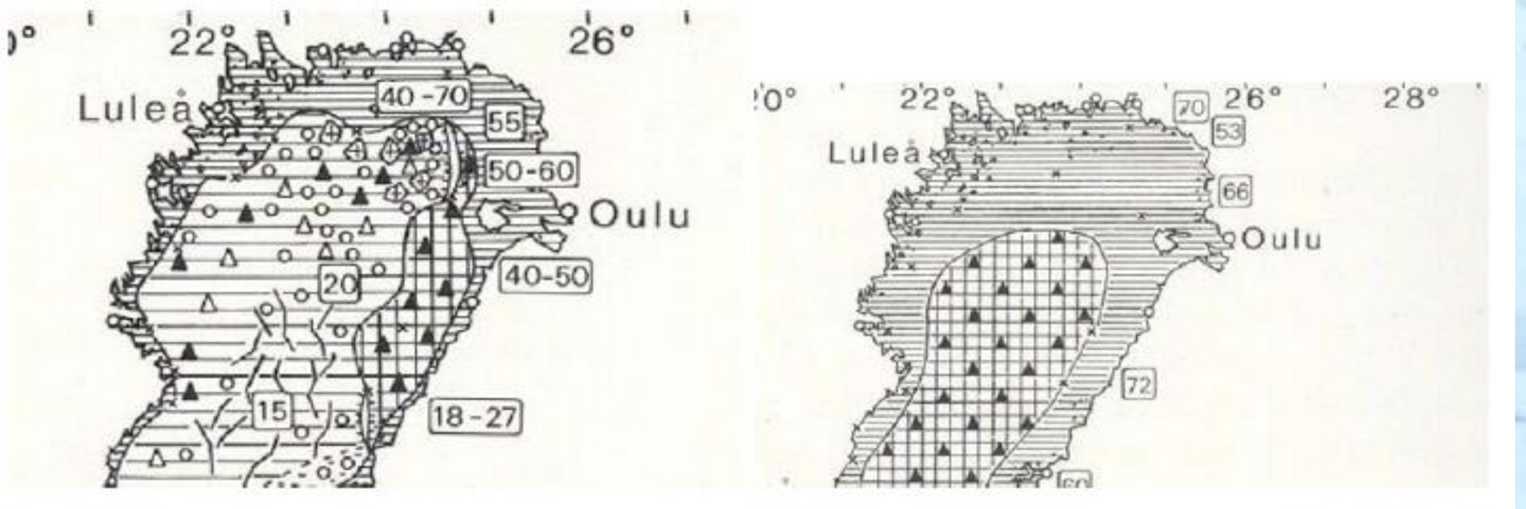
Basic Features of the Arctic

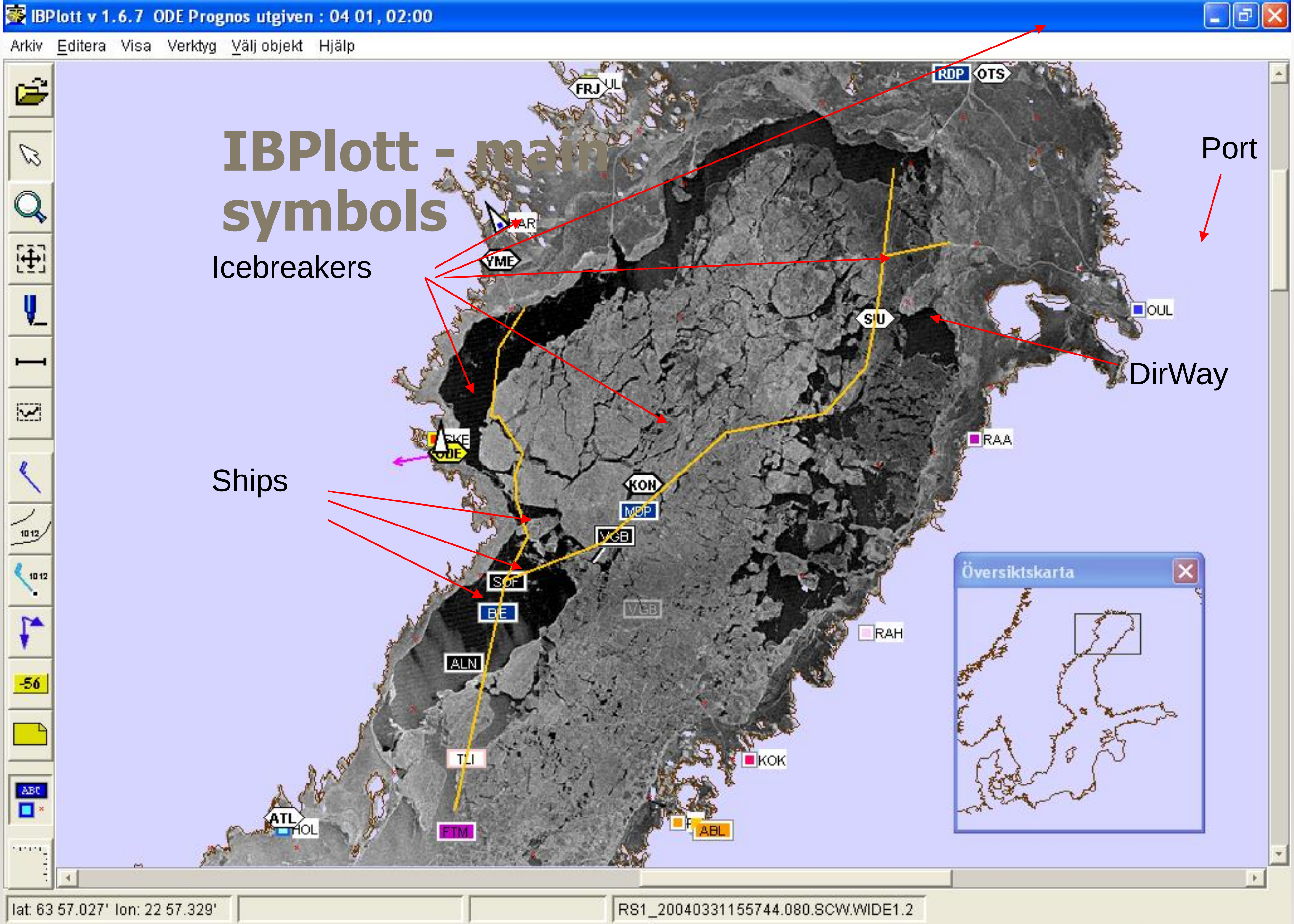
- The Arctic area is a very large area with different geological formations, islands and rocks and deep-water basins.
- There are numerous types of shorelines, which greatly affects oil recovery options or coastal protection operations against drifting oil slick.
- Oceanographic and coastal seasonal variations have significant impact on nature and the air temperature variations and winds create rapidly changing conditions where all operations could be difficult and time consuming.
- Varying ice conditions – global warming impact ?
- Logistic challenges – remoteness – preparedness – communication means – monitoring…….

Ice conditions in mild(left) and severe(right) winter

source: Leppäranta, M. 2011. Siikajoen Tuulivoimapuiston vaikutukset jääeroosioon



IBPlott - main symbols



Fate of Oil in Ice Infested Waters

- Oil type – oil characteristics
- Oil in open water
- Oil among ice
  - Oil on ice
  - Oil under ice
  - Oil mixed and inside the ice
- Oil weathering
  - Evaporation, emulsification, sinking, liquefaction, degradation….
- Oil drifting (sea currents, wind and moving ice)

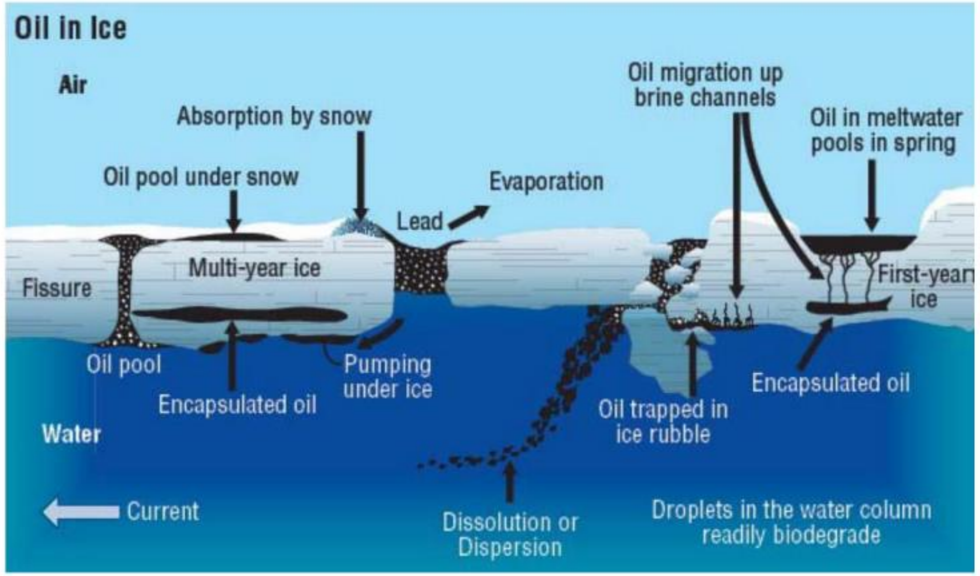


Figure 1. Illustration of oil and ice processes (adapted from Bobra, A.M. and Fingas, M. 1986
(Source: ExxonMobil).

Some Arctic Pollution Prevention Challenges

- **Oil recovery in ice**
- **Oil recovery in high seas – significant wave height**
- **Darkness, bad visibility, remote surveillance**
- **Viscous or weathered oils**
- **Emulsions and sinking oils**
- **Leaking wrecks**
- **Shore cleaning and shallow areas**
- **Strategy & tactics**

Winter recovery

Difficulties:

- **Location of the oil.**
- **Freesing ambient.**
- **Darkness.**
- **Specialized skimmers and ice going vessels needed.**
- **High viscosity, difficult skimming and pumping.**

Advantages:

- **The window of opportunity may be larger than in open waters –there is more time for response before oil reaches the shore.**
- **Ice prevents the oil from spreading over large distances; it acts as a physical barrier.**
- **Normally no waves.**

Mechanical Recovery

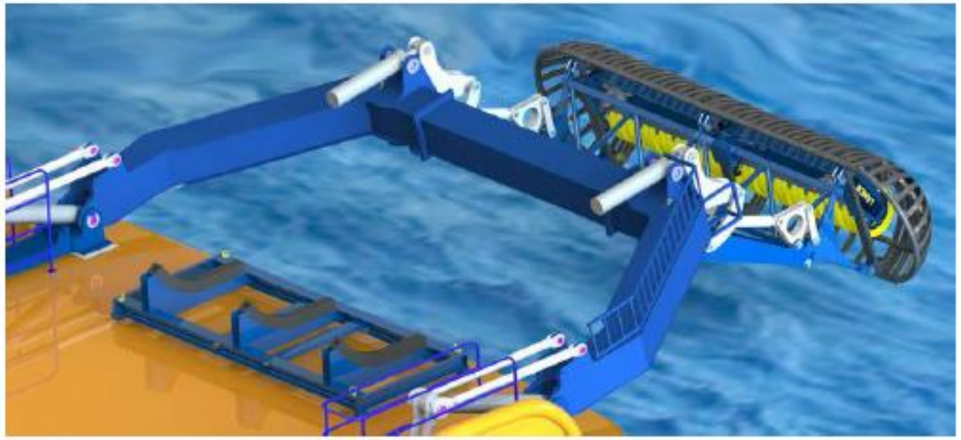
- Mechanical recovery has been understood as a method to contain and collect oil from the water’s surface for disposal.
- This approach requires storage of recovered fluids until they can be properly managed.
    - mechanical recovery with two vessels with a boom;
    - mechanical recovery with a single vessel with an outrigger (sweeping arms and inbuilt oil lifting system to the recovery tank);
    - three vessels with Vessel of Opportunity (VOO) with boom and - single vessel in ice.

OIL RECOVERY IN ICE CONDITIONS
In a bigger scale some new devices at sea

Jorma Rytkönen, SYKE

LOUHI with 4 oil recovery brushes for ice conditions – new set up with three brush units

Kemin Karhu and Sternmax 29



In-Situ Burning

- ISB is one of the countermeasures available for responding to oil spills in marine but also in ice and snow conditions. Actually, ISB in oil spill response has been utilized since the 1960s and it is one of the oldest response method !
- The window of opportunity for ISB is a function of oil weathering

Burning of oil in a melt pool (Source: D Dickins; in Buist I.A et al. 2013).

Dispersants

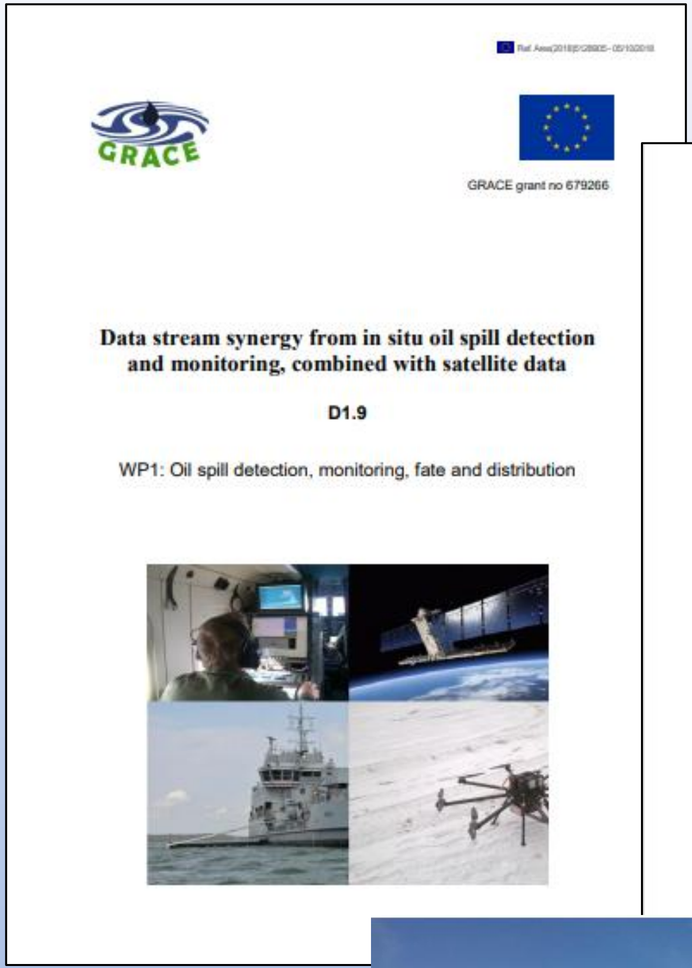
- Chemical dispersants enhance natural dispersion by reducing the surface tension at the oil/water interface, making it easier for waves to create small oil droplets that remain in suspension for long periods and are rapidly diluted in the water column.
- The main reason to use dispersants is to reduce the amount of oil drifting to shorelines in the case of a very large oil spill.
- In addition, the aim is to reduce the exposure of birds and mammals to oil on the water surface

HELCOM recommendation 22/2

- **mechanical means are the preferred response measures**
- **chemical agents may be used only in exceptional cases and after authorization, in each individual case, by the appropriate national authority**
- **sinking agents are not used at all**
- **absorbents are used only when sufficient recovery devices ensure the timely removal of the absorbed oil from the sea surface**

Monitoring

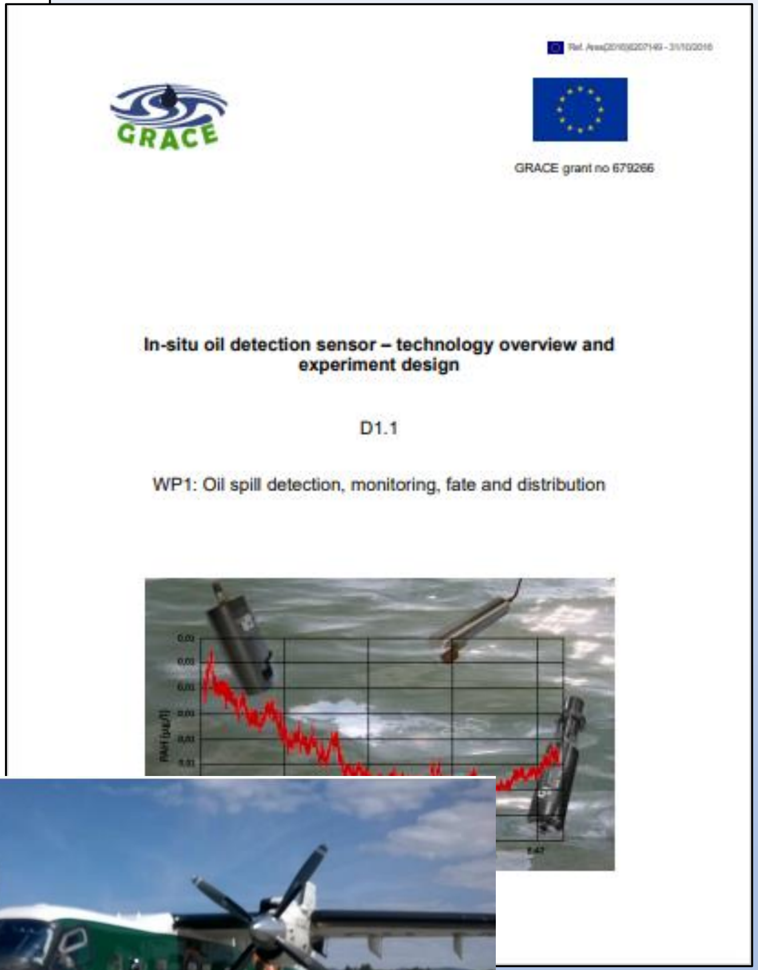
- There is a large set of sensors and tools available for oil spill detection and tracking.
- The usual way to initiate countermeasures against detected oil spill is based on the first alert made by the ship(s) in distress, some other party close the accident or a third party getting data based on remote-controlled means.
- Typical remote-controlled party is a surveillance aircraft or helicopter flying over the oil spill and detecting a spill and giving the first warning to authorities.
- Another option is to get an alert via satellite images, for example as a part of the EMSA's CleanSeaNet service.
- Drones


GRACE grant no 679266

Data stream synergy from in situ oil spill detection and monitoring, combined with satellite data

D1.9

WP1: Oil spill detection, monitoring, fate and distribution


GRACE grant no 679266

In-situ oil detection sensor – technology overview and experiment design

D1.1

WP1: Oil spill detection, monitoring, fate and distribution

Lessons learned with ice problems in the Baltic area

All major oil releases in ice conditions have taken place in northern Baltic, mainly in Finnish and Swedish response zones.

- Grounding of M/T Raphael 16.11.1969 in Gulf of Finland near Porvoo, Finland.
  - Release of **200 tons of crude oil**.
  - 85 % burned, small part collected mechanically among ice.
  - 80 km shoreline polluted.

Main Baltic oil accidents cont.

Collision between T/T Katelysia and M/T Otello 20.3.1970 in the Stockholm archipelago, Sweden.

- **150 to 200 tons of heavy fuel** oil leaked from Otello.
- The archipelago was covered **with thick ice**.
- The major part of the oil was collected at sea.
- The methods used were burning, (dredger) grabs, vacuum pumps, dispersants, and picking up by hand.
- The most effective means was lifting the oil with the grabs of dredgers, and manual collecting.

Main Baltic oil accidents cont.

- Grounding of M/T Antonio Gramsci, first incident 28.2.1979 near the harbour of Ventspils, Latvia
  - Release was about 5,000 tons of crude oil.
  - Heavy weather conditions, **recovery was impossible** and the oil drifted to the open sea.
  - **The oil and oily ice blocks stopped when they reached the solid ice**.
  - About 2,500 seabirds were killed.
  - A part of the Swedish coastline was affected and oil also reached the Finnish archipelago.
  - Oil was mainly collected from the shoreline by hundreds of volunteers.

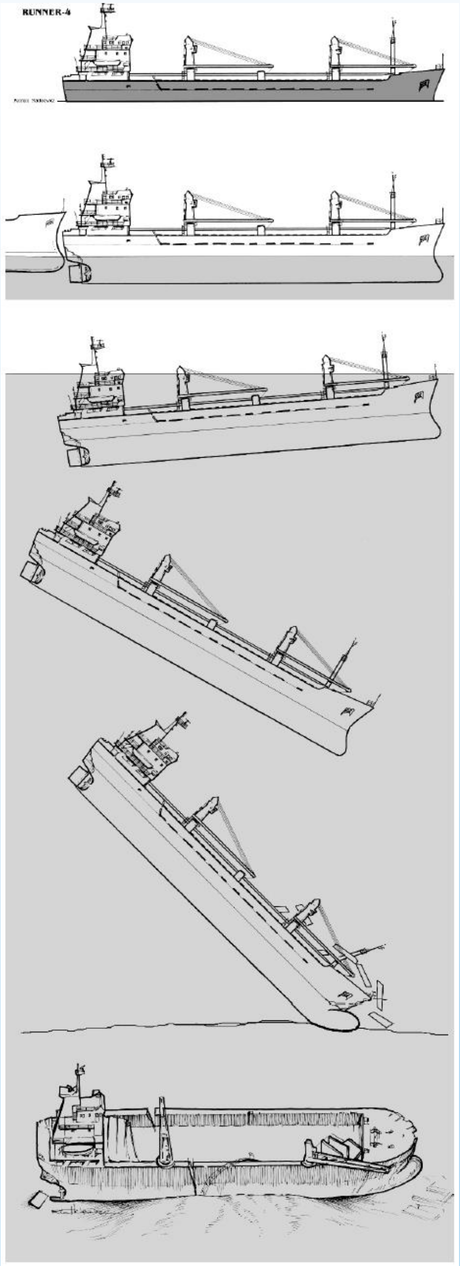
Main Baltic oil accidents cont.

- Grounding of M/T Thuntank 5, 21.12.1986 near the city of Gävle in the Gulf of Bothnia, Sweden.
  - Release was **200 tons heavy fuel**.
  - A significant part of the **oil sank to the bottom**.
  - The main response methods were excavator shovels and the use of different types of vessels, bowls by hand by divers.
  - The main difficulties were the location of the oil in different depths of the water column and on the bottom as well as the difficult weather conditions.

Main Baltic oil accidents cont.

- Grounding of M/T Antonio Gramsci, second incident 6.2.1987 near Porvoo in the Gulf of Finland, Finland.
  - Release of 570…600 tons of crude oil.
  - 100 tons collected mechanically from sea, 10 tons from shoreline, 186 tons evaporated.
  - Rest mixed with water column and few tons sedimented and dissolved to the water.
  - Response operation cost was about USD 5 million.

Runner 4 case



Sank 5.3.2006 due collision in Estonian waters in convoy in ice channel on the way from St. Petersburg.

- Spilled oil between 30 – 50 t.
- Joint Estonian – Finnish operation.
- Collected in March about 15 t. with several bucket brush skimmers.
- The wreck was emptied autumn 2006, about 110 t.
- The lifting of the aluminum cargo was lifted spring 2008.

Different response methods versus ice coverage

		Ice coverage									
Response method	Open water	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %
Mechanical recovery:											
- Traditional configuration (boom and skimmer)											
- Use of skimmer from icebreaker											
- Newly developed concepts (Vibrating unit; MORICE)											
In-situ burning:											
- Use of fireproof booms											
- In-situ burning in dense ice											
Dispersants:											
- Fixed-wing aircraft											
- Helicopter											
- Boat spraying arms											
- Boat "spraying gun"											

Conclusions

- Mainly three OSR methods has been seen as suitable in the Arctic area:
    - mechanical response,
    - in-situ burning and
    - the use of dispersants.

Natural oil biodegradation – attenuation – has also some potential in OSR work, but is seen here as a “support tool”.

The interested persons are encouraged to seek out more detailed data from the reports of the Arctic Councils AMAP (Arctic Monitoring and Assessment Programme) Working Group (https://www.amap.no/). The latest data of the Council’s Emergency Prevention, Preparedness and Response (EPPR) form also a solid data bank for evaluating best OSR practices in the Arctic area.

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