Finnish Experience in Oil Spill Prevention and Response in The Baltic Sea

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1. The Purpose of Report

This report provides a summary of the current state of knowledge, technologies and experience in responding to oil spills accidents in open sea water and in icy conditions, accumulated in Finland during the last 30 years. This report provides information about the structures of the Finnish Environmental Institute and other Baltic Sea environmental organizations. It also shows the level of preparedness of the Finnish authorities to major oil spill accidents in the Baltic Sea.

The report presents a review of SYKE's (Suomen ympäristökeskus – Finnish Environment Institute) oil spill reports published during the last two years, highlights of Finnish and other Baltic Sea countries' conferences records, as well as analysis of different practices and experiences, based on tests and exercises performed in the Baltic Sea area.

The intention of this report is to present how Finland and all the countries, which have access to the Baltic Sea, are responding in case of oil spill accidents, what methods are usually used and why are they used. Additionally, this report will describe the latest developments in terms of communication and actions coordination between the Finnish authorities and the Baltic Sea countries in the state of an oil spill accident occurrence in the Baltic Sea region. The general conclusions are made considering the conditions of the Baltic Sea and commonly accepted regulations based on HELCOM's (Baltic Marine Environment Protection Commission) references.

This study has been compiled as part of Kolarctic ENPI CBC project KO437, Enhancement of Oil Spill Response System by Establishing Oil Database. This project aims to improve the prerequisites to prevent and to response to potential oil spills in the Barents Sea.

2. Introduction

The increase of naval traffic in the Baltic Sea in the last decade has changed the needs for response preparedness for a major oil spill accident in this region. The increased amount of oil transportation and the usage of bigger tankers have also increased the risk factors in the Baltic region. (Figure 1)

There are now 17 large oil harbors on shores of the Baltic Sea. The annual oil transport has already exceeded 250 million tons per year and the amount is expected to grow. Under the Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM), the Baltic coastal states are committed to cooperate effectively in respond to any oil spills by collecting the oil with vessels specially equipped for this purpose.

Therefore, the need for new, effective oil spill methods and technologies and high level of international cooperation is growing every year. At the same time, Finland is very concern about preservation of the Baltic Sea's fragile environment. That is why all new developments should be environment-friendly.

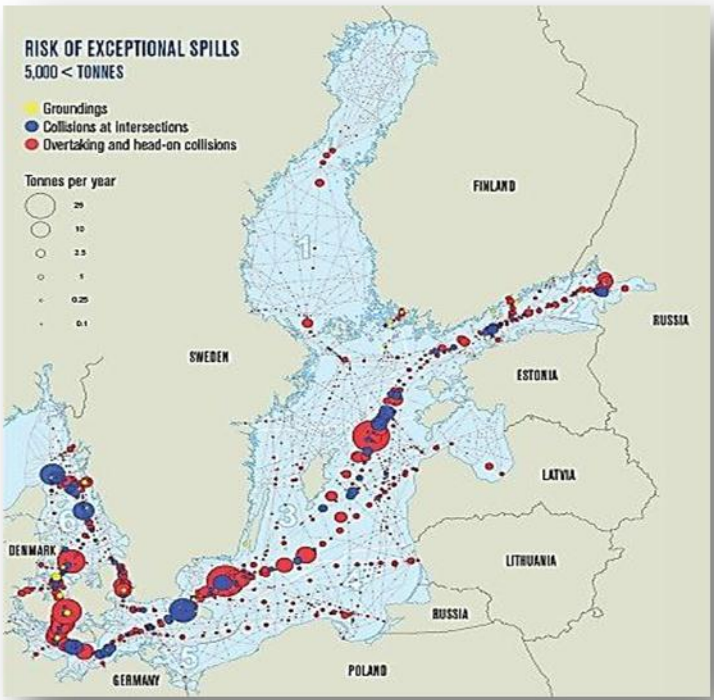

Figure 1. *Map of risk hotspots in the Baltic Sea. (Source: HELCOM)*

Dot size indicating risk of collision. Color indicating the type of accident

3. Main Finnish Authorities and Commissions

3.1. Environmental Emergency Response in Finland (SYKE)

SYKE

The Finnish Environment Institute (SYKE) is the competent governmental pollution response authority in Finland. It is in charge of measures against pollution incidents in the open sea, whenever severity of an incident necessitates so. SYKE is also the nationally appointed competent authority that is empowered to request and give international assistance in response to marine pollution caused by oil or other harmful substances. If there is a pollution risk situation, SYKE may give an order to undertake recovering activities – both within the Finnish territorial waters or even outside the territorial waters, which are intended to avoid or limit the pollution risk.

A risk of pollution in the Finnish response region of the Baltic Sea sends the Finnish oil recovery vessels to the seas 5 to 10 times in a year. This decision is done by the Finnish Environment Institute. In most of these cases, there is a threat of pollution, but oil or other harmful substance is not always released to the sea in large quantities from a ship in distress. The harmful material can be transferred to another vessel or the leakages are repaired by divers at the site of accident. In some cases, the response vessels are there to secure that no pollution enters the sea during the towing of damaged object. Since 1990, there have been four accidents in the Finnish pollution response zone that have led to an oil spill larger than 30 m^3.

Finland implements the "Polluter-Pays Principle". In cases, if the polluter cannot be identified, the National Oil Pollution Compensation Fund can cover the costs for oil pollution response. The National Fund can finance also the authorities' equipment purchases that are made to enhance the national oil pollution response preparedness.

The environmental pollution protection infrastructure has been developed in Finland over the years. (Figure 2.) In order to succeed and effectively prevent oil spill accidents all participants of the infrastructure, presented below, are working together.

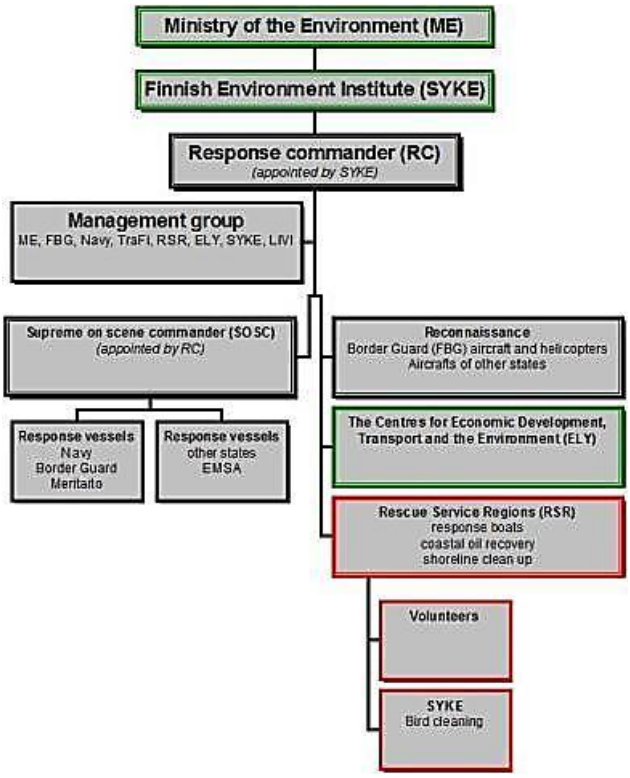

Figure 2. *Finnish environmental pollution protection infrustructure (SYKE)*

3.1.1. Responsibilities in Pollution Response

The **Ministry of Environment** has the supreme responsibility for the management and supervision of the response against pollution caused by oil and other harmful substances.

The **Finnish Environment Institute** (SYKE), operating under the Ministry, is the competent governmental authority combatting marine pollution. SYKE is also responsible for purchase and development of governmental oil combatting equipment.

The **Regional Centers for Economic Development, Transport and the Environment** (ELY) advice and supervise the local municipalities and certain commercial companies in arranging the pollution preparedness and response.

The **Response Service Regions** have the obligation take care of oil pollution preparedness and response on their own area.

The **owners** of different kind of facilities handling big amounts of oil shall have a limited oil combatting ability of their own.

Other authorities are obliged to assist in combating oil and chemical spills within their abilities.

3.2. HELCOM as the Baltic Sea Protector

One of the oldest and most respected organizations working in the Baltic Sea area is HELCOM. It is the governing body of the "Convention on the Protection of the Marine Environment of the Baltic Sea Area," commonly known as the Helsinki Convention of 1974 and 1992, the first regional convention to address the Baltic Sea (HELCOM, 2010).

HELCOM works not only as an environmental policy-maker for issues related to the Baltic Sea, but also as the main organization which coordinates and supervises the implementation by the Contracting Parties. In addition to that, HELCOM provides information about the environmental status and trends in the Baltic Sea area, the measures and their efficiency. HELCOM’s members are all the nine Baltic coastal nations: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden, as well as the EU.

3.2.1. History

In 1974, there were seven states bordering the Baltic Sea. The Helsinki Convention which was signed in 1974 was the first agreement taking into account all the sources of pollution to the Baltic Sea at once. It entered into force on 3 May 1980.

Due to the changes in the political situation and developments in international environmental and maritime law, a new convention was signed in 1992. The European Community completed the membership of all bordering states now (except Russia). After ratification the Convention entered into force on 17 January 2000. It covers not only the Sea area itself, but also inland waters in the catchment areas and the Sea bed. Therefore, also land-based pollution as one important source for pollution to the Sea is subject to management by HELCOM. **In 2009, HELCOM received the award for its Baltic Sea Action Plan.**

3.2.2. Organization

The Commission meets annually and decides unanimously what recommendations should be given to all members in particular year in order to improve the marine environment. Each Contracting party is given 1 vote in the Commission. The EU may vote for its member states if these do comply or are not present. These recommendations are then put into law by all respective countries of the Contracting Parties. Extraordinary meetings of the Commission are enforced after request from one Contracting Party and the endorsement of another one.
In addition, ministerial meetings are also held at least every 3 years, leading to the Ministerial Declarations.

While the chairmanship rotates between the countries every two years (in the alphabetical order in English), the secretariat has a constant address in Helsinki, Finland. Currently there are 13 people, including one Executive secretary, employed at headquarters of HELCOM. The Secretariat supports the working structure of HELCOM, which is shown in Figure 3.

Besides the meetings of the Contracting Parties, there is an extra board of the Heads of Delegation and the five main working groups of HELCOM as subsidiary bodies of the Commission:

1) The Monitoring and Assessment Group (HELCOM MONAS)
2) The Land-based Pollution Group (HELCOM LAND)
3) The Nature Protection and Biodiversity Group (HELCOM HABITAT)
4) The Maritime Group (HELCOM MARITIME)
5) The Response Group (HELCOM RESPONSE)

Figure 3. *HELCOM Structure (Source: HELCOM)*

These five groups implement the policies and strategies in the different aspects of HELCOM´s work and in return propose issues to discuss at the Heads of Delegation meetings. At these meetings, which are held at least twice a year, the proposals of the groups have to be approved before they are passed on to the Commission.

The general tasks of the Heads of Delegations meetings are to:

1) Supervise implementation of Commission policy
2) Make policy and strategy proposals to the Commission

3) Provide guidance to and support the Executive Secretary in program development and management
4) Carry out all other tasks which they may be given by the Commission

3.2.3. The Baltic Sea Action Plan

The HELCOM Baltic Sea Action Plan is an ambitious program to restore the good ecological status of the Baltic marine environment by 2021. It applies the Ecosystem Approach to the management of human activities (HELCOM Baltic Sea Action Plan, 2007).

HELCOM's Priorities:

1) Eutrophication, especially the contribution of agriculture
2) Hazardous substances
3) Land transport sector
4) Maritime transport sector, including carrying out the Baltic Strategy
5) Environmental impacts of fishery management and practices
6) Protection and conservation of marine and coastal biodiversity
7) Implementation of the Joint Comprehensive Environmental Action Program and HELCOM Recommendations

3.2.4. Other International Environmental Treaties and Laws

The International Convention for the Prevention of Pollution from Ships, 1973/1978, or **MARPOL**, is the international treaty covering the prevention of operational or accidental pollution of the marine environment by ships. It is a combination of two treaties and updated by amendments through the years. The 98 percent of the world's tonnage is signatory to MARPOL Annex I and II (IMO, 2002).

UNCLOS is the United Nations Convention of the Law of the Sea of 1982 and is widely recognized as the constitution of the oceans. UNCLOS has been ratified by a majority of the UN's member states. The treaty deals with a multitude of issues in maritime and marine affairs, including accidents resulting in discharges of hazardous substances into the oceans (UN, 2010).

The European Union has recently approved their **Baltic Sea Strategy**, which outlines acomprehensive strategy for the economic development and environmental protection of the Baltic Sea area. The aim is to improve the economy in a sustainable way, while improving the environment (EU, 2010a).

3.2.5. HELCOM Actions and Recommendations in Case of Oil Spill Accident

Decisions taken by the Helsinki Commission are regarded as recommendations to the governments concerned. These HELCOM Recommendations are to be incorporated into the national legislation of the member countries (HELCOM Baltic Sea Action Plan, 2007).

Due to the HELCOM's recommendations, development of oil response methods in the Baltic Sea States has almost exclusively concentrated on the ability of mechanically collecting oil from the sea, even in winter conditions.

The main recommendations which deal with oil combating are as follows:

1) **RECOMMENDATION 22/2.** Restricted use of chemical agents and other non-mechanical means in oil combating operations in the Baltic Sea area
2) **RECOMMENDATION 31/1.** Development of national ability to respond to spillages of oil and other harmful substances

4. Natural and Geographical Basis for Oil Spill Response Methods Usage

4.1. Special Characteristics of the Baltic Sea Area

The Baltic Sea is a unique and complex ecosystem. It has special characteristics that affect the response methods in case of an oil spill accident.

1) The Baltic Sea is an area of salty water but the salinity of its water is only about 10% of ocean water´s salinity
2) Small water volume - the sea is very shallow in most of the areas
3) Restricted connection to the ocean seasonality
4) Average temperature are low during the year
5) There is ice cover every year at least in the northern Baltic

Photo 1. *Coast o of Baltic Sea. Photo by NorTech Oulu*

The above conditions make the Baltic Sea very vulnerable to the effects of oil spills. Unfortunately, the Baltic Sea is already heavily polluted and due to the shallow and narrow Danish straits, which are the only connection to the Atlantic Ocean, it takes 25 to 30 years to change out the water from the whole basin.

Because of the low salinity of the Baltic Sea´s water, the Baltic ice is predominantly rather solid, without significant brine channels. Therefore, the oil adheres to the ice blocks rather weakly, so most oil can be removed from the ice with only a small amount of energy, which aids to the process of cleaning the oily ice blocks. On the other hand, the low salinity means that heavier oils sometimes have a tendency to sink, which makes response to such oil difficult, especially if the oil is under the ice. Low-oxygen conditions and the lack of oil-degrading microbes enable oil to remain in the ecosystem for a longtime. Indeed, in 2005 the

International Maritime Organization IMO designated the Baltic Sea as a Particularly Sensitive Sea Area (PSSA) along with 15 other seas around the globe (Lampela Kari, 2012).

From geographical and economical point of view The Baltic Sea is also one of the busiest shipping routes of the world. Nine countries are bordering the Baltic Sea and there are more than 2000 ships sailing along the Baltic Sea waters on average at any given time. Among all the transported goods the share of oil transportations is the biggest, mainly due to the Russian new oil terminals in the eastern part of the Gulf of Finland: the volume of oil products transported through the main terminals in the Gulf of Finland was over 150 million tons already in 2010. Moreover, due to the start-up phase of the oil terminal in the new Ust-Luga port of Russia, the oil transportation is expected to exceed 200 million tons by the end of this year, and reach 230 million tons by 2015. (Figure 4). This presents a great challenge for oil spill prevention and response as large oil tankers will be operating in these waters during winter time, pointing out of the necessity for mechanical oil recovery systems for ice conditions

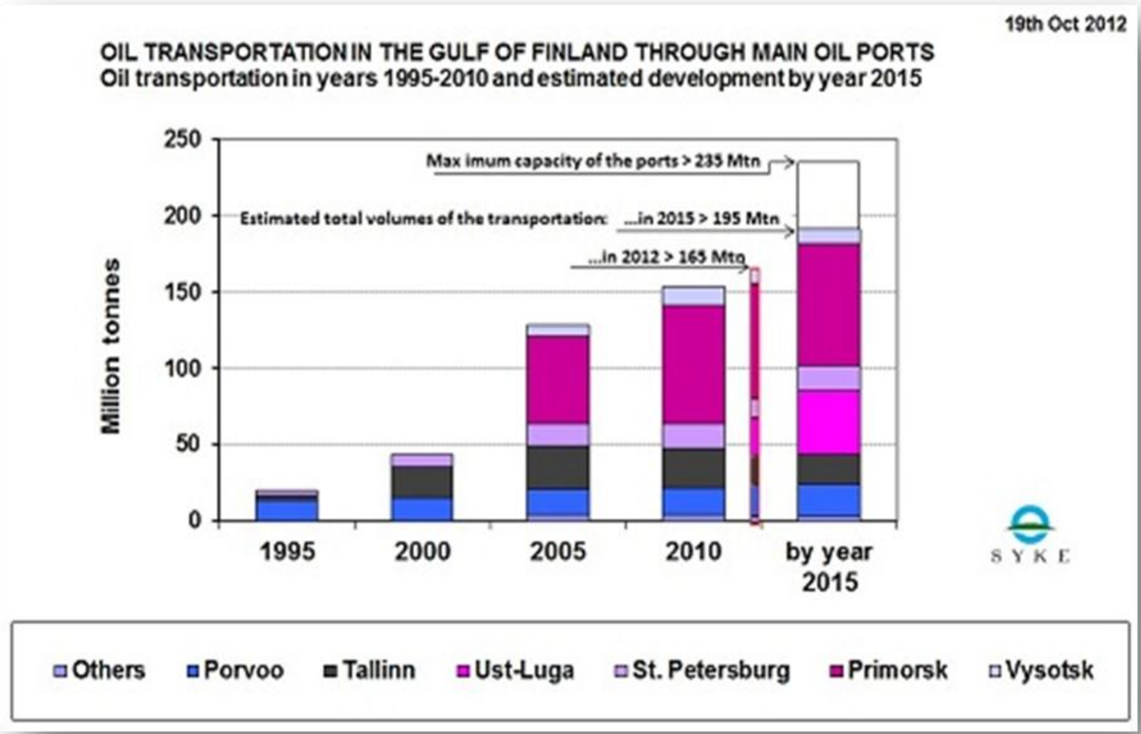

Figure 4. *Development of oil transportations in the Gulf of Finland area (Source:SYKE).*

The increase of maritime transportation in the Baltic Sea area in total is expected to grow by 30 percent between 2010 and 2030 (McDaniel and Kyster-Hansen, 2011). This corresponds closely to 250 million tons of increment of cargo, most part of which will be due to the container and RORO traffic. The cargo increment will lead to the increase of number of the ships which in turn means higher traffic density in certain areas and increase risks of collisions and oil spill accidents.

5. Oil Behavior in the Baltic Sea

The behavior of oils spilled at sea depends highly on the prevailing conditions (e.g. temperature, sea-state, release conditions) and on the physical and chemical compositions of the oil. Not all oils need to be cleaned up. Some lighter products like kerosene tend to evaporate quickly and it will "disappear". On the other hand, many crude oils are so persistent that they require a quick clean up response.

When oil is spilled at open sea, it will break up and degrade into the environment over time. Sea water will change the properties and behavior of the oil. Due to chemical processes this degradation called oil-weathering. Some of these processes are:

1) Evaporation of the lighter products
2) Emulsification which is incorporation of water droplets into the oil
3) Dispersion which is oil droplets mixed into the water column. This is a natural process which can be increased by using dispersants.
4) Dissolution fractions of the oil will be dissolved in the water

Other processes are spreading, photo oxidation, biodegradation, drift of the oil and sedimentation. (Figure 5)

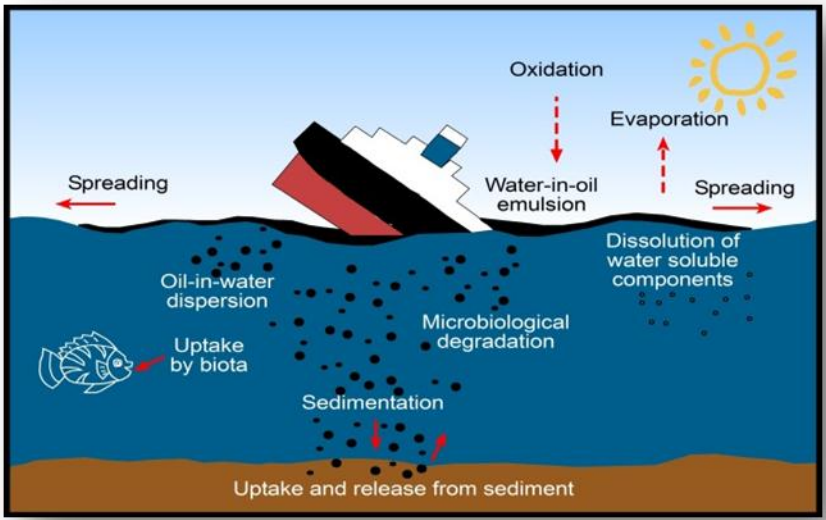

Figure 5. *Oil-weathring process in open sea water (Source: SINTEF)*

The dissipation of oil does not happen suddenly. The time it takes depends on the type of spilled oil, the weather conditions and if the oil remains at open sea or if it is washed ashore.

If a big oil spill accident should ever happen in the Baltic Sea, the level of harmful substances would stay on a high level for a long time because of the small water capacity, low water turnover, the layering of the water and cold water temperature. There are also a lot of sheltered and shallow bays in the Baltic that are especially vulnerable to the effects of the oil.

5.1 Oil Spill Types and Its Impact in the Baltic Sea

5.1.1 Impacts Depend on the Type of Oil Spil

The consequences of an oil spill at sea vary considerably according to the type of oil spilt. Oil tankers may carry crude oil, light fuel oil or heavy fuel oil. Large ships themselves use mostly heavy fuel oil, and almost all vessels at sea contain varying quantities of oils of lighter grades.

5.1.2. Crude Oil Behavior

The composition and properties of crude oil vary considerably. Crude oil is refined to produce lighter petrochemicals such as petrol and diesel fuels, leaving heavy fuel oil as a residual distillate.

When spilt into the sea, crude oil spreads rapidly over the surface, and its lighter constituent chemicals immediately begin to evaporate. Crude oil is described as persistent oil, since after its lighter constituents have evaporated the remaining oil does not significantly evaporate or disperse through the sea water. Since crude oil contains the constituent petrochemicals of both light and heavy fuel oils, its impacts on the marine environment include the effects of both these oil grades.

Crude oil often forms an emulsion, consisting of tiny droplets of oil mixed in with the seawater. The volume of such an emulsified oil slick can be as much as four times greater than that of the original oil spill.

5.1.3. Heavy Fuel Oil Is Slow to Decompose

Heavy fuel oils are residual products of the refining of lighter petrochemicals from crude oil. They are widely used as fuels in power plants and ships. In ships, such fuels are also known as "bunker oil". Heavy fuel oil is black; and since it is very viscose in cold conditions, but runny when warm, it is usually warmed for transportation and storage.

Heavy fuel oil spilt into the sea congeals and does not evaporate. Its characteristics vary considerably. Some varieties are denser than water, meaning that they float beneath the surface, and are more difficult to observe. The wind will not directly affect any such spills, which tend to drift according to the prevailing water currents.

Collecting oil from underwater is a difficult task, since booms can only contain the spread of oil relatively near the surface. A lot of the other equipment on oil pollution control vessels can similarly only be used to collect oil near the surface. Heavy fuel oil often forms congealed slicks of oil extending beneath the surface for tens of centimeters. Such sticky and inflexible slicks of heavy fuel oil are very difficult to clean up. Due to this the recovery equipment including pipes and hoses must be heated to ensure the congealed oil does not block them.

Heavy fuel oil is very persistent in the marine environment, and some of its constituent petrochemicals will not decompose at all. On the land, heavy fuel oil and other dense petrochemicals do not percolate into the ground.

5.1.4. Light Petrochemicals Evaporation

Lighter petrochemicals such as petrol, diesel, and light fuel oils are used for heating, to fuel motors, and as lubricants. Spills of lighter petrochemicals in the sea evaporate at varying rates according to the oil grade and factors such as the wind, wave and temperature conditions. They will evaporate from the surface of the sea within 24 hours, or sometimes even just in few hours of the spill. Light petrochemicals however have the most serious toxic effects on marine life. On the land, if light petrochemicals are spilt in areas with penetrable soils, they will rapidly saturate into the ground.

6. Specifics of Winter Oil Spill Response in Finland

The sea area of Finland covers a significant part of The Baltic Sea, the northern side of the Gulf of Finland, the northern part of the Baltic Sea Proper and the eastern side of the Gulf of Bothnia. The total length of the Finnish coastline without taking into account islands, capes and bays, is about 1 200 km. Due to the thousands of islands and broken shoreline, the total length of shoreline which could be affected in case of oil spills is about 16 000 km. Also significant to Finnish waters are the narrow fairways, which make navigation difficult especially in winter time and high sea conditions. About 80 percent of the Finnish exports and imports are carried by marine transport and all the Finnish harbors can freeze in winter.

The Gulf of Finland is also a major oil route since the Russian oil harbors in the eastern part of the Gulf are the biggest export harbors of Russian crude oil. The total amount of transported oil via the Gulf of Finland in 2010 was about 155 million tons and is expected to increase to 235 million tons by 2015 (SYKE 2012). Therefore, as safe as possible navigation in ice conditions and an adequate capability to combat oil in connection of marine accidents in winter time is a necessity for Finnish authorities.

In a normal winter, the northern part of the Gulf of Bothnia gets ice cover in November which lasts about 5 months. The Gulf of Finland is normally covered with ice for a 3 months period and in the eastern part of the Gulf ice conditions can be very difficult even in spring due to pack ice caused by prevalent westerly winds. The maximum solid ice thickness is normally from 0.4 to 1.0 m, but the main navigational difficulties are caused by pack ice, which can be several meters thick.

6.1. Main Obstacles and Differences in Winter Response

The main differences and **difficulties** with response to oil in winter and in icy conditions are as follows:

1) The freezing environment: Temperatures in the Baltic can reach -20 to -30 degrees Celsius, which can render methods and equipment designed for use in open water and at temperatures above the freezing point useless.
2) Darkness in winter.
3) Remoteness.

4) Viscous oils: Quite a few types of oil transported on the Baltic have a high viscosity. In addition to this, many oils that are easy to collect in warmer conditions are viscous in freezing temperatures and therefore impossible to collect with skimmers designed for lighter oils.
5) Poor buoyancy: In the brackish, low-salinity water of the Baltic Sea, oil loses some of its buoyancy. Because of this, some types of oil have a tendency to sink and the oil under the surface in the water column or at the bottom is difficult to find and to collect.
6) Ice pressure: The response tools used in icy conditions must be designed to withstand the pressure of the drifting ice blocks.
7) The need for ice processing: The oil that has become stuck to ice or is under, between, or on blocks of ice must be separated from the ice blocks, and this ice processing procedure requires special methods and equipment.
8) However, ice often provides **benefits**, including the following:
9) The window of opportunity may be larger than in open waters –there is more time for response before oil reaches the shore.
10) Ice prevents the oil from spreading over large distances; it acts as a physical barrier (Lampela Kari, 2011).

Photo 2. *Oil spill on ice. Photo by Finnish Environment Institute SYKE*

6.2. The Fate and Behavior of Oil in Ice - Some Key Points

1) Ice concentrations of over 60% can naturally contain oil in relatively thick films (one millimeter or more).
2) Freeze-up oil/ice interactions are controlled by grease and ice slush.
3) Encapsulation of under-ice spills stops weathering but limits access.

4) Under-ice currents are rarely strong enough to move oil over any distance under the ice in The Baltic Sea conditions.
5) The ice drift rate controls the thickness of the oil layer that can accumulate on the surface with an extended release.
6) Spring migration through porous ice exposes fresh oil naturally.
7) Most weathering processes are substantially reduced, but evaporation is still significant even with snow cover. Ice acts as a physical barrier (drift ice) or retardant (grease ice); oil does not spread or disperse as far and ends up in a thicker layer.
8) Evaporation is slower where oil spills are thickened.
9) The total water uptake and rate of uptake may be reduced through dampening of wave activity by the presence of ice. (Figure 6.)

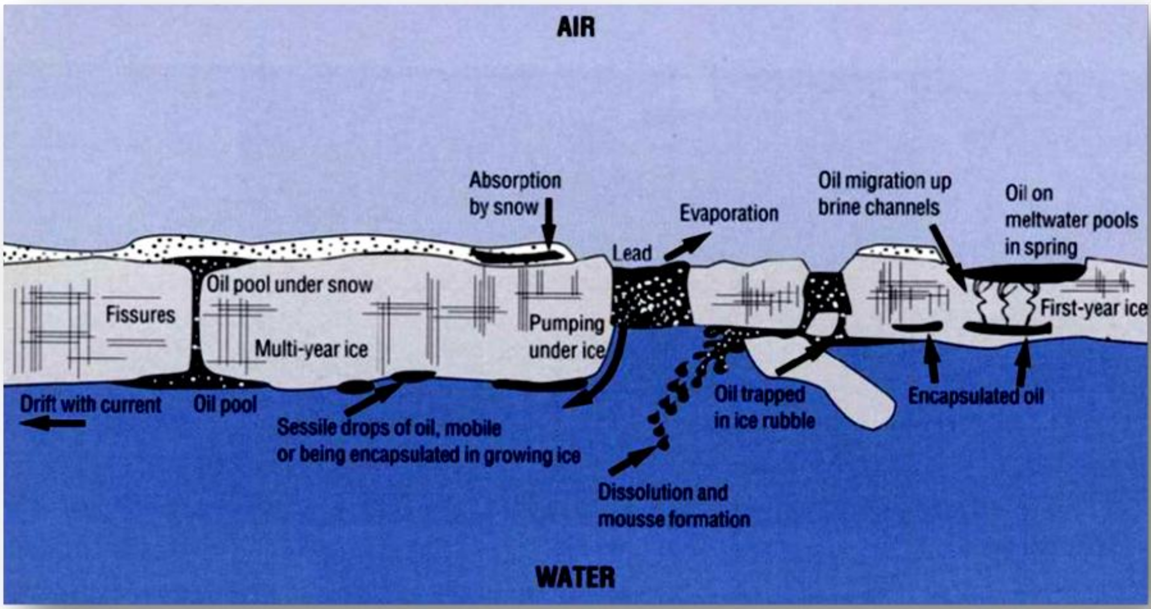

Figure 6. *Fate and behavior of oil spilled on ice (Source: SYKE: State of the Art Report)*

7. Detection

Over the last decade, due to the increasing risk from oil spill accidents, a variety of efforts have been made to improve the techniques for detecting, monitoring, modeling, and combating oil spills in both open water and icy water conditions.These will be addressed in this chapter.

7.1 Open Water Oil Spill Detection

Open water spill detection is mostly done by the aircrafts of the **Finnish Border Guard** during the environmental monitoring flights. Of these spills on average, 70 % detected using aircraft and 30% using helicopters. Aerial surveillance plays also an important role in guiding the recovery vessel into the thickest part of the slick so that the oil can be recovered as quickly and efficiently as possible, and its drifting to the shore can thus be prevented. It is impossible to visually estimate from the vessel where the thickest parts of the slick are, but the infrared camera in the aircraft can detect them easily. In addition to the Finnish Boarder Guard flights, the satellite image service of **the European Maritime Safety Agency** (EMSA) contributes significantly to the control of marine oil spills. Reports from citizens are a welcome complement to the observations made by the authorities.

Photo 3. *The Finnish Border Guard. Aircraft Dornier on an environmental monitoring flight*

7.1.1. Aerial and Vessel Surveillance of Oil Discharges

Finland has two Dornier aircraft, which are used to monitor oil discharges from ships within Finnish EEZ - which is also the Finnish pollution response zone. Finnish Environment Institute (SYKE) is responsible for the surveillance of oil discharges together with the Finnish Border Guard.

SYKE has equipped the Dornier 228 surveillance aircraft of the Finnish Border Guard with SLAR and IR/UV scanner. The surveillance equipment enables the crew to have, even in darkness or in bad visibility, a real-time view of Finnish waters and possible foreign substances floating on water surface. When the Border Guard is carrying out border patrol flights, they also survey for illegal oil discharges. In addition, oil observations are reported by the vessels of the Navy and the Border Guard, as well as by merchant vessels. Finland is using also EMSA's CleanSeaNet satellite based monitoring service to detect oil pollution at sea (Tahvonen Kati. 2008).

7.1.2. The Results of Aerial Surveillance

During year 2011, the Finnish surveillance aircraft detected altogether 18 oil spills. In addition, the Border Guard helicopters reported 8 oil spills (Figure 7).

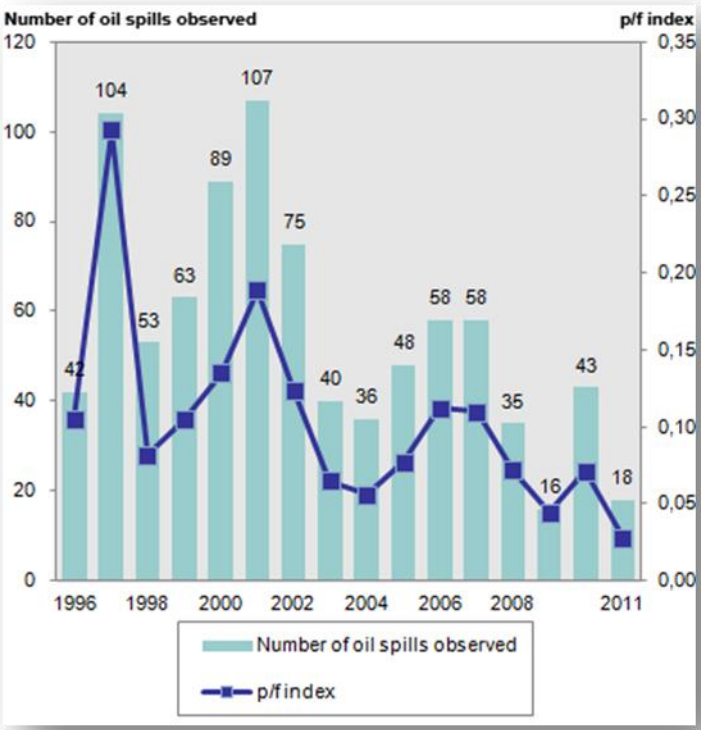

Figure 7. *Oil spills detected by Finnish surveillance planes in years 1996–2011 (SYKE)*

On April 1st 2006, the new legislation allowing the Border Guard to issue an administrative fee to ships discharging oil in the waters under Finnish jurisdiction entered to force. The amount of the imposed fee is connected to the amount of discharged oil and the size of the vessel. The law does not define an upper limit to the fee.

Every year, the aerial surveillance efforts of the Baltic Sea coastal states have resulted in detection of 200 to 800 spillages. However, this number does not represent the number of actual spills, because all Baltic Sea states do not have yet aircraft equipped for oil spill monitoring. Those countries, who have the means to do this, cannot conduct surveillance duties around the clock.

HELCOM estimates the average volume of bilge discharge to be about 0.5 to 1 m^3. It has to be noted, that during the last couple of years the average estimated volume of detected oil spills has diminished significantly. (HELCOM, 2010)

7.1.3. The Effectiveness of Finnish Monitoring and Detecting Actions in 2012

In 2012, the Finnish authorities detected 54 oil spills in the Baltic Sea, 47 of which were observed in the Finnish sea area, six in Estonia and one in Sweden. (Figure 8) In addition to these, the Estonian authorities reported three oil spills in the Finnish sea area. As in previous years, most of the spills in the Finnish area were observed either in the ports or by the shoreline. Surveillance aircraft detected several spills by the major shipping lanes.

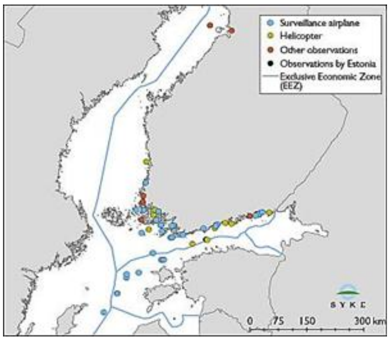

Figure 8. *Oil spills reported in 2012(SYKE)*

The number of spills detected by the authorities has dropped by 50 per cent in six years, and the size of the spills has also reduced markedly (Figure 9). In 2012, the average volume of an oil spill was estimated at 25 liters compared to that of 170 liters in 2008.

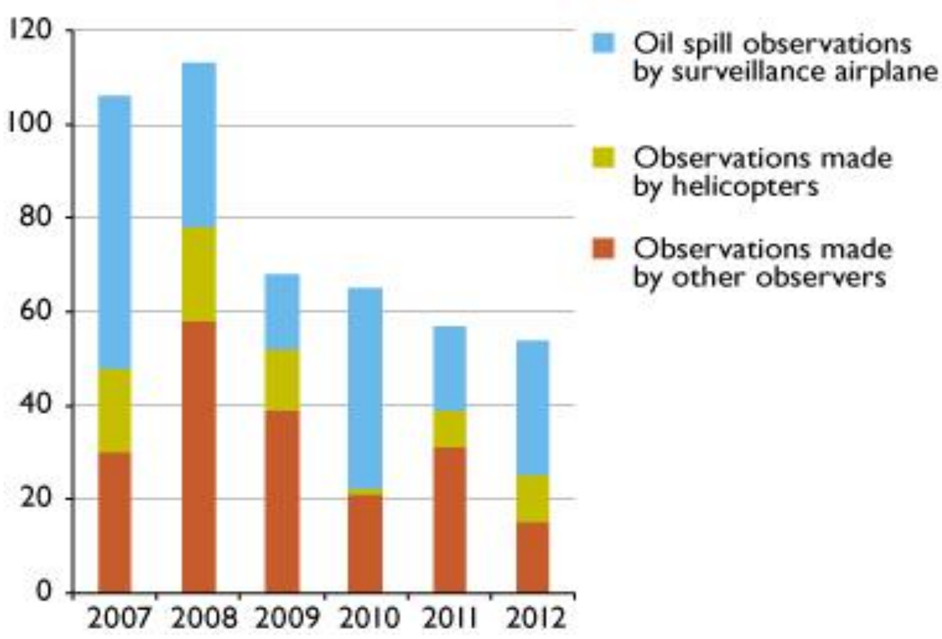

Figure 9. *Number of oil spills reported by Finland(SYKE)*

7.1.4. Oil Spills Prevention Through Effective Surveillance and Legislation

One of the likely reasons for the reduction in oil spills was a new law, which entered into force in 2006. This law enabled faster imposition of administrative oil pollution fees on shipping companies or private individuals found guilty of the oil spill offences than the normal criminal procedure. The amount of the fee depends on the volume of the spill and the size of the vessel. In 2012, the Finnish Border Guard investigated two oil spill incidents, which was eleven cases less than in 2007. The amount of a single oil pollution fee has been approximately EUR 10,000 over the last six years, and it seems that the fees have acted as a deterrent in Finland.

The number of detected spills is in decline also elsewhere in the Baltic Sea. The effective aircraft surveillance, which has been carried out in cooperation with Finland's neighboring countries, has played a key role in reducing the number of spills. Regular surveillance flights have been carried out since the 1980’s with aircraft equipped with environmental monitoring systems. Finland purchased its surveillance aircraft in mid-1990s. Despite the decline in spills, much remains to be done, as the Baltic Marine Environment Protection Commission (HELCOM, 2010) seeks to put a stop to oil spills in the Baltic Sea by 2021.

7.2. Icy and Cold Water Oil Spill Detection

The difficulties in detecting oil in or under ice are numerous. Ice is never a homogeneous material; on the contrary, it includes air, sediment, salt, and water, many of which may present false oil-in-ice signals to detection mechanisms. In addition, snow on top of the ice, or even incorporated into the ice, adds complications. During freeze-up and thaw in the spring, there may not be distinct layers of water and ice. There are many types of ice and different ice crystalline orientations.

7.2.1. Remote Sensing

The multispectral airborne remote sensing – supplemented by visual observations by trained observers – has proven to be the most effective method for identifying and mapping the presence of oil on water. A flexible combination of sensors operating from aircraft, helicopters, vessels and satellites can be used for oil detection also in ice conditions. The most useful remote sensors and systems applicable to spills on ice are:

1) Side-Looking Airborne Radar (SLAR)
2) Satellite-based Synthetic Aperture Radar (SAR)
3) Aircraft and vessel-based Forward Looking Infrared (FLIR)

7.2.2. Laser Fluorosensors

The laser fluorosensors are active sensors that take advantage of the fact that certain compounds in petroleum oils absorb ultraviolet light and become electronically excited. The laser fluorosensors have significant potential for detecting oil spills as they may be the only means to distinguish between oiled and unoiled weeds and between sediment and oil on ice, and to detect oil on different types of beaches. The fluorosensors are also the only reliable means of detecting oil in certain ice and snow situations and is a powerful tool for a variety of oil spill applications (Brown Carl, 2003).

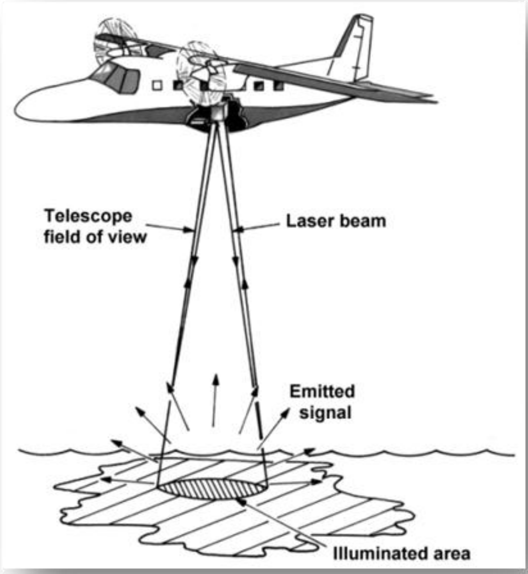

Figure 10. *SEOS, Marine Pollution Measuring principle of the laser fluorosensor, analysis of an oil spill at sea.*

7.2.3. Ground Penetrating Radar (GPR)

The Ground Penetrating Radar has been found to be an effective system for detecting oil under ice. A series of tank tests and field experiments demonstrated that surface-based ground-penetrating radar (GPR) can clearly detect and map the presence of oil films as thin as 1-3 cm underneath the ice and trapped as layers within the ice. Modeling indicated that the same system operating at low altitude from a helicopter should be able to detect thin oil layers under cold ice in mid-winter, as well as oil on the ice surface buried under snow (JIP report, 2006)

7.2.4. Conclusions

The technology for detecting oil in or under ice is still evolving. The state-of-the-art technology for the detection of oil on ice is more advanced than that for oil under ice. The oil mixed with ice detection optical technologies may work with limitations.

The laser fluorosensors show the greatest potential for detection of oil when the oil is exposed to the surface. The fluorosensors are also the only reliable means of detecting oil in certain ice and show situations.

There are also new technologies like acoustic, radar based (Ground Penetrating Radar) and electronic gas sensors, “sniffers”. Some of these methods have shown potential to track oil also under ice and snow, but they still need further development and testing. Trained dogs are also able to reliably detect very small volumes of oil and to map oil boundaries on solid ice and in sediments on Arctic shorelines under cold conditions (JIP report, 2006). Often the best operational method is the simplest; use of divers and ROV to find oil under ice (Kari Lampela 2012).

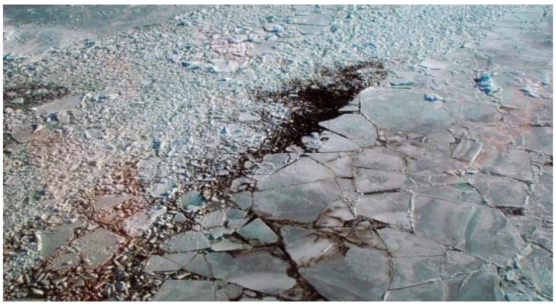

Photo 4. *Aerial photo about an oil spill in winter. Photo by Finnish Environment Institute SYKE*

8. Oil Pollution Response Methods

Due to the fragile and sensitive ecology of the Baltic Sea, it has been internationally agreed in the Helsinki Convention that the oil **combatting policy of the Baltic Sea countries must be based on mechanical combatting and recovery of oil**. The agreement also restricts (***HELCOM Recommendation 22/2***) the use of chemicals – so called dispersants – which lower the surface tension at the oil-water interface and dissolve the oil slick into tiny droplets that are diluted into the sea water. ***Because of these agreements dispersants are not used in Finland*** (Helcom Baltic Plan Action, 2007).

All the government-owned oil recovery vessels in Finland are capable of independent oil recovery, i.e. they are permanently fitted with built-in oil recovery systems. The principal strategy is to skim the oil from the water surface as quickly and completely as possible, so the oil can be reused or destroyed in an appropriate manner.

Aerial surveillance plays an important role in guiding the recovery vessel into the thickest part of the slick so that the oil can be recovered as quickly and efficiently as possible, and its drifting to the shore can thus be prevented. Ice-covered waters present additional challenges for oil spill response when compared to open waters, such as the remoteness of the area, the low temperatures, and seasonal darkness, along with the presence of ice. Finland together with other northern countries, Norway, Canada and the USA has developed special response techniques for cold and icy conditions (SYKE, 2012).

8.1. Response Vessels in Finland

The response vessels in the Baltic Sea States are all multipurpose vessels. They are normally used as patrol vessels, tugboats, ice breakers, navy supply vessels and tankers, for fairway maintenance, for water policy duties, etc. Many of them have oil spill response equipment constantly on board so they can start response operations immediately when reaching the accident site.

The recovery capacity depends, among other things, on the thickness and viscosity of the oil layer and of the recovery vessel's speed. When recovering oil from the sea surface the vessels' speed is usually 1-2 knots. If the oil layer is on average 0.5 mm thick and the recovery vessels operate with speed of 2 knots, then the Finnish oil recovery fleet is able to collect total of about 830 m^3/hour.

Ship's name	owner	Length [m]	Tank capacity [m^3]	Sweeping width [m]
Halli	Navy	60	1400	40
Hylje	Navy	54	800	35
Kummeli	Meritaito	28	70	25
Letto	Meritaito	43	43	30
Linja	Meritaito	35	77	23
Louhi	Navy	71	1200	42
Merikarhu	Border Guard	58	40	32
Oili I	Meritaito	24	80	21
Oili II	Meritaito	24	80	21
Oili III	Meritaito	24	80	21
Oili IV	Meritaito	19	30	19
Sektori	Meritaito	33	108	25
Seili	Meritaito	50	198	30
Svärtan	Åland government	24	52	30
Tursas	Border Guard	61	100	30
Uisko	Border Guard	61	100	30

The Finnish Environment Institute got a new multipurpose vessel in 2011. It is operated by the Finnish Navy and is also equipped for both oil and chemical spills. Picture below shows Louhi vessel during ice tests.

Photo 5. *Louhi undergoing ice tests. Photo by: SYKE*

The Louhi vessel represents the state-of-the-art technology in responding to marine oil and chemical spills. It is able to collect oil from the sea in open waters in higher waves than is allowed to Finland's other response vessels. It is able to operate in ice conditions with the aid of its special equipment. Louhi is designed to combat also chemical spills. It can collect harmful substances and operate in a chemical cloud without exposing the crew. The vessel can also be used for emergency towing of vessels, fire-fighting and other rescue operations.

Recently, a Finnish ship design company specializing in arctic shipping, Aker Arctic Technology Inc, has designed an oblique ice breaker, which can be also equipped for oil spill response in ice conditions. Depending on the ice conditions, the vessel can move forward or sideways thus enabling to break wider channel in ice. First vessel of this type is under construction with delivery expected to take place in **December 2013 to a Russian customer**. She will have oil response equipment both for open recovery and for recovery in ice conditions and will be operated in the Gulf of Finland area (Lampela Kari, 2012)

Photo 6. *Picture of the ice breaker currently under construction by Aker Arctic Technology INC for a Russian customer. Photo by Aker Arctic Technology INC*

8.2. Mechanical Recovery in Cold Water and Icy Conditions

From the environmental point of view, the mechanical recovery is usually considered as the most favorable oil spill combating method. Because of HELCOM recommendations and the fact that the Baltic Sea is already heavily polluted, mechanical removal of released oil is the most frequently used response method in the Baltic Sea states.

Depending on the ice coverage, different methods can be used:

1) If the ice coverage is 0–30 percent, normal open-sea skimmers can be used. However, the risk of damage to the skimmer due to the pressure of moving ice has to be taken into account. Also, even in favorable conditions, 100 percent recovery cannot be expected.
2) If the ice coverage is between 30 and 70 percent, special iced skimmers are needed. If self-floating skimmers are used, they must be specially built to withstand the ice pressure. In order to facilitate movement among ice blocks, these skimmers should have their own propulsion system or the possibility to enhance movements by the crane of a supporting vessel
3) If ice coverage is 70 percent or more, specialized, robust ice skimmers are needed. They must be operated by ice going response vessels or integrated directly to the vessel. Often there is also a need for special cranes or excavators on board the vessel to be operated effectively. Some skimmers can be used also from a vessel of opportunity thus enlarging the usable response vessel fleet.

When skimmers are used in ice and in cold conditions, the skimmer must be modified for these special circumstances. Heating of the skimmer and recovered oil with steam, hot water, etc. is often needed, and the pumps used must be able to pump heavy, viscous oil. The Nordic nations have studied how the skimmers and pumps used in these countries behave in cold conditions.

The developed methods and techniques are based mainly on the brush technology. Several devices have been developed and then tested at laboratory scale and in real-world conditions over the years. Many Nordic manufacturers of response equipment have developed special skimmers for response in icy conditions, such as self-floating ice skimmers and hanging rope mop skimmers. These are usable when the ice concentration is clearly less than 100 percent, but can be rather difficult and ineffective in cases of a high ice concentration. In very light ice conditions, also skimmers designed for open water can be used effectively.

8.3. Mechanical Recovery, Finnish Developments

Finland, being one of the Baltic Sea States, is strongly dependent on marine transport. About 80 percent of Finnish exports and imports are carried by maritime transport. Since one of the main routes of Russian oil export goes along the southern coastline of Finland (155 million metric ton year 2010) (SYKE, 2010) and Finland is the only country in the world, where all harbors can freeze in the winter, it has been essential to develop adequate ability to respond oil spills also in ice. Another reason for developing special equipment is due to the low salinity of the Baltic Sea as the Baltic Sea ice is rather solid and without significant brine channels. Therefore, spilled oil attaches rather slightly to sea ice blocks, and oil can mostly be removed (loosened) using just a small amount of energy which eases the cleaning process (Liukkonen, S. 1996). On the other hand, due to this low salinity, heavier oils can sometimes have a tendency to sink, which makes oil difficult to recover, especially if the oil is under the ice.

The national oil spill response authority, the Finnish Environment Institute (SYKE), has worked together with private companies and research institutes for over 20 years, both in Finland and abroad, to develop mechanical recovery methods to combat oil in icy conditions (SYKE, 2012).

Mechanical recovery is preferred due to recommendations of the Baltic Marine Environment Protection Commission (HELCOM), where chemical agents and in situ burning can be used only in special, restricted circumstances (HELCOM Recommendations).

Following, are descriptions of a few skimmers, which have been developed by the Finnish Environment Institute (Lampela, Kari 2011) in co-operation with the Finnish manufacturers.

8.3.1. Lori Ice Cleaner

The Lori Ice Cleaner, a specialized skimmer bow, is designed to operate in broken ice at sea, lake, river, and port locations. Its recovery process is carried out by a two-stage brushing and water pumping system. First, high-pressure water jets loosen oil from ice blocks, and the robust brush chains under the bow complete the cleaning of the ice blocks. Then loose oil is separated from water with conventional oil-collecting brush chains. The principle of operation of the Lori Ice Cleaner is shown below. (Figure 10) The maximum thickness of ice blocks, for which the unit can be used, is about 0.5 meters. This ice-cleaner is a removable unit and can be attached to the bow of a tugboat, or an icebreaker.

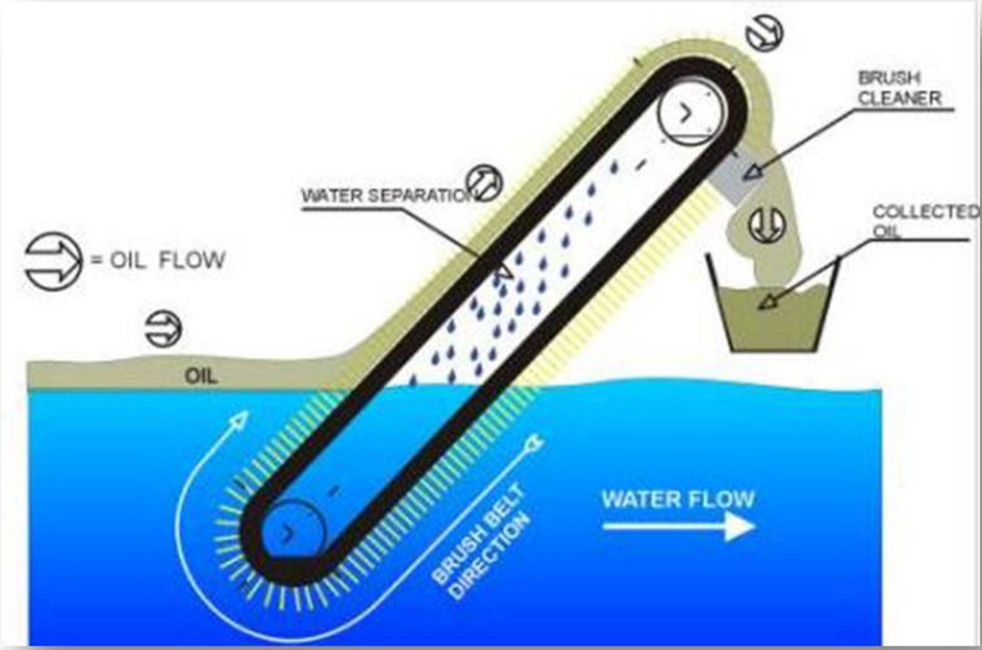

Figure 10. *Principle of operation of the Lori Ice Cleaner*

8.3.2. Oil Ice Separator – LOIS

The LOIS system consists of removable oil-in-ice separator units, which can be installed on an oil recovery vessel with special fittings when needed. The idea of this specialized ice skimmer is to use a vibrating grid connected to the sides of a response vessel to force the ice blocks submerged under the recovery unit to move upside down when the vessel is going forward and possibly rotate the ice by moving the grid. By increasing the relative movement between the oil-covered ice blocks and water, the skimmer washes spilled oil from the ice blocks. Oil rises through the grates to the water’s surface, which is inside the body of the LOIS. The oily water is then pumped through a conventional brush chain system in the companion response vessel, where the oil is then separated from the water. Any small pieces of ice that enter the brush system are transferred back to the sea by a conveyor. Figure 11 (Lamor Corporation Report, 2012).

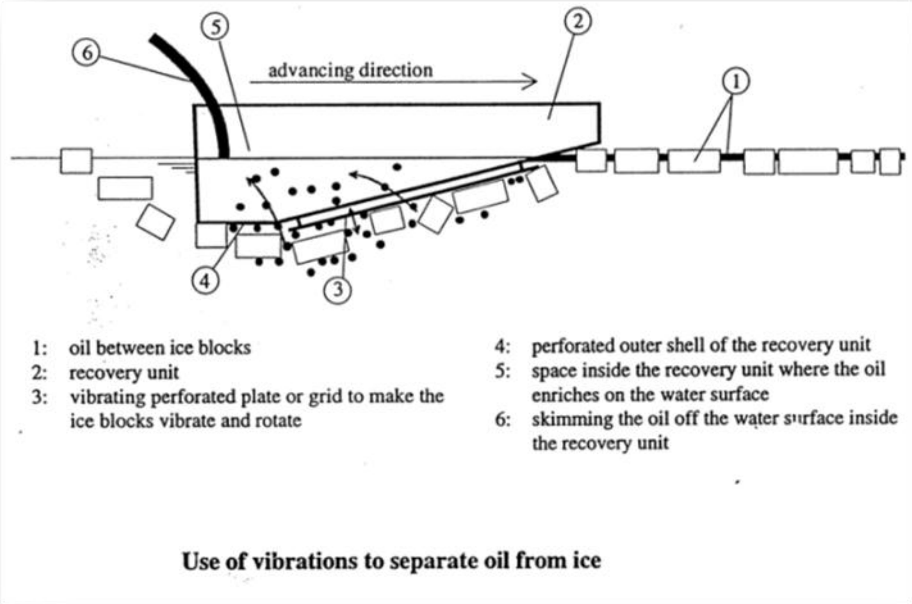

Figure 11. *Principle of operation of the Oil Ice Separator*

Photo 7. *LOIS unit installed on a fair service vessel. Photo by SYKE.*

Note: *SYKE owns the patent of the Oil Ice Separator. A Finnish company,* ***LAMOR Corporation,*** *has the manufacturing rights and is marketing the device worldwide. The commercial name of the device is Oil Ice Separator*

8.3.3. Oil Recovery Bucket

The principle of the oil recovery bucket is that the oil adheres to stiff, rotating brushes of the equipment. As the drum rotates, oil is swept from the brushes and enters the bucket. A screw pump transfers the oil to recovery tanks. Three sizes of oil recovery bucket exist. The smallest device has a sweeping width of 60 cm, the medium size's sweeping width is 1.6 m, and the largest has a sweeping width of 3 m. The diameter of the brush wheel has been 800 mm. The two largest oil recovery buckets can be connected to and operated by a hydraulic crane or hydraulic excavator. The largest bucket has been developed to be operated by a large oil recovery vessel's crane. The pictures below shows the oil recovery bucket during tank tests and the largest recovery bucket connected to response vessel´s crane. The oil recovery bucket has been the standard equipment in Finland for cases of small spills in ice, and it is also used in some other Baltic Sea states.

The smallest oil recovery bucket was originally developed to clean oil from areas with soft soil – for example, in shoreline-cleaning. For this purpose, the device can be connected to a modified, remotely controlled forest work vehicle (Lamor Corporation Report, 2012).

Photos 8-10. *Finnish Oil recovery bucket installed on a new Swedish response vessel. Photos by Lamor*

8.3.4. Ship-Mounted Ice-Cleaning Brush Wheels

The brush unit consists of a large brush wheel with a 1.8 m diameter and a length of 4.0 m, which is connected to a special crane. The wheel, which has stiff (steel) brushes among normal collection brushes, rotates and cleans the oiled ice block. Normally, a response vessel will be moving backwards and the units are installed on the aft deck with container fastenings. There will be four brush units in the new Finnish multipurpose vessel Louhi, so the total sweeping width in ice will be about 16 m.

Figure 12. *Principle of the installation of the units to the new multipurpose vessel (Source: Lamor)*

8.4. Other Response Methods and Equipment Widely Used in the Nordic Countries

Many Nordic manufacturers of response equipment have developed special skimmers for response in icy conditions, such as self-floating ice skimmers and hanging rope mop skimmers. These are usable when the ice concentration is clearly less than 100 percent but can be rather difficult and ineffective in cases of a high ice concentration. In very light ice conditions, also skimmers designed for open water can be used effectively.

Most of the equipment is designed to be used in connection with specialized response vessels, but some can be used also from a vessel of opportunity thus enlarging the usable response vessel fleet. Brush technology is the most common response method in ice condition in the Baltic Sea states: mechanically separating oil from water and from ice, provided that the oil is floating on the water's surface or is stuck to the ice.

8.4.1. Rope Mop Skimmers

Rope mop systems are adhesion skimmers. The rope principle has demonstrated its effectiveness in removing medium – viscosity oils in low wave conditions, at relative velocities as high as several knots, and in debris (including ice). Vertically oriented rope mops driven by a driver/wringer unit suspended from a crane represent an appealing technology for removing in-ice oil, as selective positioning is possible and there is no need for actively processing ice encountered by the recovery unit. In freezing ambient conditions, the rope has a tendency to freeze, thus greatly reducing the recovery capacity. Heating with warm water has been included in some rope mop skimmers, to improve their utility in temperatures below freezing.

8.4.2. Arctic Skimmer

The Arctic skimmer is a crane-operated system to be deployed vertically for recovering oil in broken ice. The skimmer incorporates static ice deflection pipes and rotating brush wheels for oil separation and collection. Recovered oil and small ice pieces are delivered into a collection hopper with screw conveyors that feed the material into an Archimedes screw pump for transfer to storage (Lamor Corporation Report, 2012). The idea is that moving the skimmer in between blocks of ice allows the ice surfaces to be cleaned and oil floating between the ice blocks then can be recovered. The skimmer is equipped with a warm-water heating system to improve recovery in Arctic conditions. The Arctic skimmer is normally deployed by a crane, but can also be used as a free-floating skimmer utilizing its optional floats when required.

Photo 11. *Arctic skimmer. Photo by Lamor.*

8.4.3. Polar Bear Skimmer

The Polar Bear skimmer consists of six brush drums, in hexagonal configuration. The results from tests indicate that it can be effective in collecting flowing oil when positioned in oil of varying slick thickness (several millimeters to several centimeters) among ice chunks. Cohesive oil slicks can be effectively drawn into the brushes if the drum speed is not too high and the sump lip remains above the sea surface. The skimmer works best in the presence of low concentrations of smaller ice pieces and slush ice (< 50–70%) and might also have potential for application alongside larger ice floes (JIP report, 2006).

Photo 12. *Desmi Polar Bear skimmer*. Photo *by SINTEF,*

8.4.4. Polaris Ice Skimmer

The brush drum ice skimmer (Polaris Ice Skimmer) developed by Frank Mohn Flatøy AS is

triangular and features two brush drums on each side angled towards a bow flotation chamber. The skimmer is self-propelled through the use of two thrusters. It was concluded that a skimmer with thrusters that utilizes this technology would be a useful mechanical recovery device for oil spills in ice. As a result of the flow created under the brush drum and rotating augers, the skimmer exhibited good small ice processing capabilities. The triangular shape with use of thrusters was a successful combination and allowed the skimmer to move effectively in ice. The skimmer is expected to ultimately have the potential to recover oil in ice concentrations up to 70 percent (JIP report, 2006).

Figure 13. *Frank Mohn Framo, Polaris Ice Skimmer*

8.5. Conclusion

In spite of all attempts, laboratory and field tests to find adequately and efficient solutions to combat spilled oil in ice and cold conditions, the progress has been slow. Finland is still in a stage of developing new techniques and equipment, which can be successfully used if big spill on the Baltic Sea ice happens. Finland now has the capacity to combat small and medium spillages in ice conditions but in cases of a big spill, we sometimes must wait until the ice melts and then recover oil with the aid of open-sea techniques. Normally, under operations in ice conditions several different response methods are needed because the circumstances can vary often during long operations (Lampela Kari, 2011). The responders need techniques to collect oil in heavy ice conditions and in almost open sea conditions. The main limitations and recommendations, looking from the viewpoint of the Finnish authorities, are therefore as follows:

1) Finland has techniques and methods for small spills in ice, but much work is still needed to develop real operative response methods for large spills in ice
2) To succeed, responders must have many alternative methods
3) Locating spilled oil under snow covered ice is a problem
4) If the spilled oil sinks, it will be very difficult to find and collect
5) Fully reliable, operational oil/ice drift models do not exist yet

9. The Baltic Sea Oil Combating Co-operation

The co-operation within oil spill response among the Baltic States is regulated by several agreements. There are bilateral and trilateral agreements between different states on co-operation in oil and chemical spill response. One of the basic agreements is the Copenhagen Agreement between all Nordic States including Norway and Iceland. The main body in the Baltic Sea area is the Helsinki Commission (Baltic Marine Environment Protection Commission), also known as HELCOM. The present Contracting Parties to HELCOM are Denmark, Estonia, European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. Decisions taken by the Helsinki Commission are regarded as recommendations to the governments concerned (Pålsson Jonas, 2009).

9.1. International Agreements

Finland has signed following oil and HNS response agreements:

1) Helsinki Convention
2) Copenhagen agreement
3) Finnish-Russian agreement
4) Finnish-Estonian agreement

Each of these has clauses on information exchange, as well as on alerting, requesting and providing assistance. Within each of these agreements there will be annual exercise, which include alerting and at sea exercise. If a large oil accident happens, then the assistance and cooperation of neighboring countries is needed. That is why the Baltic Sea states organise annually a Balex Delta exercise, which is held by a different country every year. In addition to this, Finland has obligation to inform the EU Monitoring and Information Centre about marine pollution accidents.

9.2. Balex Delta Exercise 2012

The Balex Delta operational response exercise is the largest maritime emergency and counter-pollution drill of its kind in the Baltic Sea area and one of the largest worldwide. The goal is to learn about the readiness of the Baltic coastal countries to jointly respond to oil at sea. The annual exercise also tests the alarm procedures and response capability of the HELCOM Contracting States (all nine Baltic Sea coastal states) in case of a major accident and an international response operation (Jorma Rytkönen, 2012).

HELCOM BALEX DELTA HELSINKI 2012

In 2012, Balex Delta was hosted by Finland and was exceptionally large: 22 specially equipped oil response vessels from all the nine Baltic coastal countries, over 50 other ships, boats and aircraft took part in the exercise. The 2012 Balex Delta lasted for 4 days, from 27th to 30th of August, and included the following sub excercises:

1) Day 1, Accident and alerts
2) Day 2, National exercise – both onshore and offshore operations
3) Day 3, International HELCOM exercise – both onshore and international offshore operations
4) Day 4, International seminar, onshore training and equipment storage and disassembling, open door event

The following scenario was performed for the exercise:

> *"On 27th of August 2012, two vessels collide in the Gulf of Finland. The accident happens in the Finnish response zone at the open sea at location of N59°48' E024°47', i.e. between Helsinki and Tallinn. The accident location is 21 NM from Helsinki mainland and about 14 NM from the first islands of the Helsinki archipelago. Shortest distance to Finnish mainland is 14 NM - the same as to Estonian mainland. The wind and currents are moving the oil slick towards Helsinki."*

Based on the Exercise scenario countermeasures against 15 000 ton of crude oil endangering the coastline were taken. These consisted of alert procedures, onshore and offshore pollution response operations and use of modern management and communication tools. During the four days of Exercise around 1000 persons took part in the exercise on 19 recovery vessels, 50 small crafts and on other support vessels. Three helicopters were also used. More than 130 experts participated in the seminar, where highlights of the event, lessons learned and other related topics of exercise were discussed (HELCOM HOD, 2012).

The exercise was arranged and coordinated by the Finnish Environment Institute together with the national Core Group and a set of other Exercise players. All participating bodies gave their comments and feedback in the expert meetings and debriefing sessions after the Exercise. Moreover, two expert evaluation teams (HELCOM and EU Civil Protection) made comments on the Exercise and made some recommendations for further development (SYKE Report, 2012)

Photos 14–16. *Balex Delta 2012. Photoes by SYKE.*

9.3 Situation Awareness System for Environmental Emergency Response (BORIS 2)

9.3.1. Project Background

Geographical Information Systems (GIS) have had a major role in environmental emergency response already for several years. With the help of GIS it has become easier to combat oil spills, as the overall picture of the incident is better known. Response methods can be put into use so that majority of the spill is taken care at the source and sensitive sites can be protected, avoiding the most expensive and most harmful damages.

Since 2006, all national oil spill response authorities have had access to **BORIS** GIS system, which is hosted by SYKE. However, BORIS has not fully responded to the needs of the users outside the Finnish environmental administration. Also, the internet map services have developed greatly in recent years, making BORIS already obsolete. Because of this, an updated version – BORIS 2 – has been created (Tahvonen Kati, 2012).

9.3.2. Project Objectives and the Features of the System

The purpose of the project is to produce an Internet-based GIS for the Finnish oil spill response authorities. With the help of this system it is possible to support the preparedness planning for oil spills, cost-effective and well-targeted spill response and information services during operations, as well as archive data for relevant compensation negotiations.

The new system will enable the Response Commander of oil spill operation to see the different datasets in a single map view, which are necessary for the response planning. These include the locations of the resources, high priority protected targets, traffic networks, harbors etc. The satellite and aerial surveillance imagery can be loaded into the map view to estimate the extent of the spill. The system is connected to real time weather datasets and predictions and it enables the user to calculate a forecast of the oil drifting. The reports received from shore reconnaissance units are included in the system too. Based on all of these different datasets the leading authority can plan the operations in the map view and distribute the plans through the system to all users.

As the response operation progresses, new information and new plans are continuously fed into the system, providing the users with an up-to-date view of the current situation. This view can be utilized by the leaders of the operations as well as other involved parties. In addition to actual response operations, the system will also support other duties related to the oil spill response. It can be used in assessing and enhancing the preparedness for future spill response, in training and as a source of information for compensation cases. The system functions as an archive from which information can be easily retrieved later on.

9.3.3. Boris 2 Involvement During the Balex Delta 2012 Exercise

A BORIS2-round training – directed at the authorities who took part in the testing Balex DELTA 2012-drill – was organized before the actual exercise took place. The following contents of Boris 2 were used during Balex Delta 2012:

1) Background maps and datasets
2) Surveillance information
3) Satellite images and the identified spills
4) Data from aerial surveillance and shoreline reconnaissance
5) Oil drift forecasts
6) Real time weather and forecasts
7) Maritime traffic image
8) Tools for planning the oil response measures

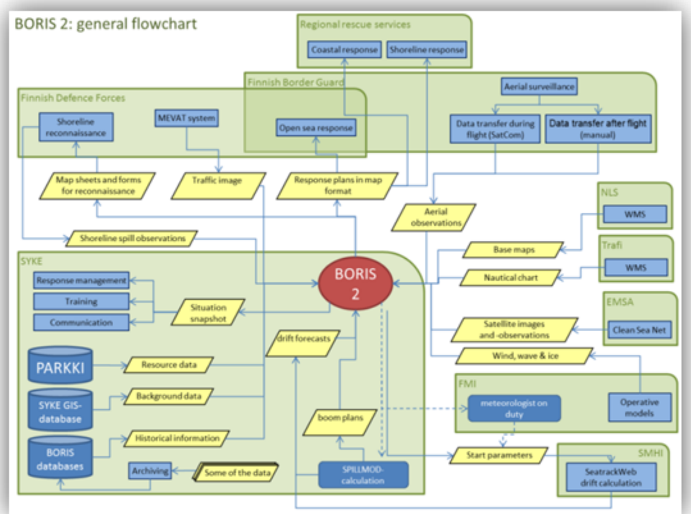

Figure 14. *Plan of Boris 2. Source: SYKE*

The participating units were able to feed information to the database, and to get supporting real time data from it. This made it possible to have an overall picture of the accident as a whole and manage the response activities better. The Boris 2 system will be officially taken to service in 2013 after some proposed changes have been made to the system. Boris 2 is expected to become an effective tool for the oil spill countermeasure management in the future (Tahvonen Kati, 2012).

10. General Conclusions

As marine traffic in the Baltic Sea increases every year, the risk of oils spills grows. Finland is reasonably well prepared for oil spills on the open sea, but there are still limitations in the coastal regions and in icy conditions. Some major investments, which address these deficiencies, must be made in the nearest future.

The Finnish Environmental Institute (SYKE) is the main government marine combating authority. SYKE is in charge of response to major incidents within its response zone of the Baltic Sea.

Finland takes the following actions in terms of Oil spill protection:

1) Monitoring marine traffic in and evaluating risks of vessel accidents:
   - Finland is using also EMSA's CleanSeaNet satellite based monitoring service to detect oil pollution at the Baltic Sea
2) Improving disaster response capacity and technology for both icy and open sea conditions:
   - Finland has the best and most efficient fleet of oil and chemical spill response multipurpose vessels on the Baltic Sea. They are capable of taking part in environmental protection tasks besides their everyday duties, such as coastguard work, service assignments, shipping lane construction and icebreaking.
3) Developing new technologies for combating oil spills in both icy and open sea conditions:
   - SYKE together with the National Rescue Service Regions is also responsible for purchasing and developing new oil combating equipment. SYKE and Finnish oil recovery equipment manufacturers work closely on this together.
4) Testing readiness to respond in case of oil spills:
   - The BALEX DELTA operational response exercises have been held annually since 1989.
   - The 2012 Balex Delta exercise was organized by Finland, SYKE

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