HELCOM Actions to Eliminate Illegal and Accidental Oil Pollution from Ships in the Baltic Sea

Anne Christine Brusendorff, Samuli Korpinen, Laura Meski, and Monika Stankiewicz

Abstract The Baltic Sea countries have been quite successful in preventing major pollution spills from shipping, and establishing a system to monitor ship traffic and detect illegal oil spills using aerial and satellite surveillance. The regional cooperation is carried out in the framework of HELCOM, an intergovernmental organization of the nine coastal states and the European Union. Ships operating in the Baltic Sea have to follow strict global and regional anti-discharge regulations, and the number of illegal, deliberate oil discharges has decreased since 1980s substantially. While the risk of large accidental spills is constantly present, requiring that sufficient response capacities are available in the region, smaller oil discharges also pose a threat to, and have an impact on the marine environment of the Baltic Sea.

Keywords Baltic Sea, HELCOM, Impact of oil, Response to oil spills, Shipping accidents

Contents

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1 Introduction to HELCOM

For close to four decades the Baltic Marine Environment Protection Commission (the Helsinki Commission/HELCOM) has acted as the main environmental policy maker for the Baltic Sea area by developing specific measures to protect and conserve the unique Baltic marine environment, taking into account its sensitivity and the impacts of different pressures.

The work is based on the Convention on the Protection of the Marine Environment of the Baltic Sea Area [1], made up in 1974 and revised in 1992, following political changes and developments in international law. All countries surrounding the Baltic Sea as well as the European Union (EU) are parties to the HELCOM work.

The Convention takes a comprehensive approach to the protection of the Baltic marine environment in addressing all sources of marine pollution, be it from land, at sea, or in the air, and also includes the cooperation to improve response to accidents at sea.

This work is prepared and carried out in expert subsidiary groups, assisted by the HELCOM Secretariat, and political and strategic decisions are taken by high-level representatives of the ten Contracting Parties on an annual basis by the governing body, HELCOM. On a regular basis HELCOM meets at ministerial level, to get guidance and input on its further work from environmental ministers as well as ministers of other sectors.

Decisions are taken unanimously, meaning that all countries and the EU have to agree in order to further proceed with an issue.

In 2007 HELCOM, at a ministerial meeting in Krakow, Poland, adopted the HELCOM Baltic Sea Action Plan (BSAP), embracing an ecosystem approach to management of human activities impacting the marine environment. Within an overall vision of a healthy Baltic Sea, the ministers and the EU representative decided on goals for the main environmental challenges to the marine environment, on indicators for how to measure the progress in reaching these goals as well as importantly, on actions to be implemented on a Baltic wide scale in order to reach the goals.

Acknowledging the steadily growing maritime transportation and the thus growing environmental risks, a goal to achieve an environmentally sound maritime transportation in the Baltic was established. And two of the decided indicators were “No illegal discharges” as well as “Safe maritime traffic without accidental pollution”.

Prevention of pollution from maritime traffic has been a major item for the Baltic coastal countries since the beginning of their environmental cooperation in the 1970s. To ensure maritime safety in the Baltic Sea region, which is well-known for its narrow straits, shallow waters, archipelago areas, and ice coverage during winter time, HELCOM has decided on a great number of measures over the last more than 35 years.

HELCOM, working through intergovernmental cooperation between all nine coastal countries and the European Union, has produced many environmental gains. These gains validate the belief that the deterioration of one of the most polluted seas in the world can be arrested and the state of the marine environment improved.

2 International Regulations for Shipping

The international character of shipping strongly influences the elaboration of regulatory measures. This is firstly due to the fact that the regulations have to be applicable to the whole of the Baltic Sea, including internal waters, the territorial seas, and the exclusive economic zones, and secondly, due to the fact that the regulations have to be applicable to all ships entering and leaving the Baltic Sea, and not only those sailing under the flag of one of the Baltic Sea States.

The legal regime to be followed is laid down in the United Nations Convention on the Law of the Sea, 1982, the UNCLOS Convention [2], which balances the rights and duties between flag, coastal, and port states. With the granting of the overall right of freedom of navigation, including transit passage in international straits and the right of innocent passage through the territorial seas, the UNCLOS Convention correspondingly states the obligation of the flag state to, as a minimum, adopt laws and regulations, established by the International Maritime Organization (IMO), and to ensure, through enforcement, that its ships are complying with relevant rules.

The right of the coastal/port states to adopt rules to reduce and control pollution to the marine environment from ships is limited by the above rights of the flag state. Thus, in the territorial seas the right of the coastal state to adopt laws and regulations is restricted by the right of ships to innocent passage and these may in any case not apply to the design, construction, manning, or equipment other than giving effect to generally accepted international rules or standards. In international straits the right of the coastal state is generally limited to giving effect to the applicable/generally accepted international regulations. In the Exclusive Economic Zone, apart from particularly and clearly defined areas, the right of the coastal state is restricted to generally accepted international rules and standards established by IMO.

The right of the coastal state to enforce infringements of pollution prevention control measures depends on the spatial zone where the infringement took place as well as the gravity of the offence. These measures include physical inspection, at first limited to examination of certificates required to be carried by generally accepted international rules and standards, and only in case of substantial non-correspondence, or need of additional information to verify a suspected violation enlarged to a further physical examination. In case of violations having taken place in the Exclusive Economic Zone, the measures are restricted to requiring the vessel to give information, *inter alia,* regarding the last and next port of call.

Only in case of casualties where there are grounds to expect they might result in major harmful consequences, is the coastal state entitled to take and enforce measures even beyond the territorial seas. As a general rule, however, proceedings in respect of violations beyond the territorial seas have to be suspended in case the flag state institutes proceedings within six months.

Therefore, the IMO is the most appropriate international forum to seek regulations on environmental protection and safety measures for ships, including ensuring their harmonized implementation in the Baltic Sea area. The above overview also emphasizes the importance of the cooperation between the Baltic Coastal States in promoting and reaching decisions at the international level in the interest of the protection of the Baltic Sea environment.

Also within the EU a large number of pollution prevention and maritime safety measures have been adopted covering the key aspects of the IMO Conventions, thereby ensuring a harmonized and effective implementation within the EU. In 2002 the EU established the European Maritime Safety Agency (EMSA) as a major source of support to the European Commission and the EU Member States in the field of maritime safety and prevention of pollution from ships, with its mandate further refined and enlarged to cover assisting the Commission in monitoring the implementation of the EU legislation, developing maritime information capabilities at the EU level and establishing marine pollution preparedness, detection, and response capabilities. Regarding the latter one, EMSA has established a European network of stand-by oil spill response vessels, to top-up the existing national resources, as well as established a European satellite oil spill monitoring service (CleanSeaNet).

When it comes to response to pollution incidents at sea and the national and trans-national response to such incidents, this issue needs to be dealt with at the regional level. This is due to the fact that there is a need to consider the national capability as a precondition to be able to cooperate at the trans-national level in case of bigger accidents. For this reason HELCOM measures (see Sect. 5.2) have been put in place:

- To establish the national response capacity;
- To guide the trans-national cooperation (HELCOM Response Manual);
- To practice the cooperation in real-time, including both aerial surveillance operations and response exercises.

The work of HELCOM in the field of pollution prevention and safety of navigation as well as response to incidents at sea is carried out in accordance with these principles and has paved the way for a very effective and close regional coordination.

Such cooperation in the Baltic Sea is especially needed due to the intense shipping and the steadily increasing oil transportation, which raises the risk of a large oil spill, caused by grounding or a collision. Ensuring maritime safety and preventing pollution from ships is an aim which can only be achieved by a continuous process of improvement.

3 Oil Spills in the Baltic Sea

3.1 Shipping Activities

The Baltic Sea has always played an important role to people living in the surrounding countries. The sea is used for a multitude of maritime activities like commercial fishing, leisure boating, and extraction of sea-floor resources. For the future there are also extensive plans for offshore wind parks and gas pipelines in the area. Additionally and most importantly, the Baltic Sea is a very busy traffic route for shipment of goods and passenger traffic.

Due to its narrow straits, winding passages, shallow waters, and vast labyrinths of skerries and islands, the Baltic Sea is a difficult area for ships to navigate. Winter conditions in the northern Baltic Sea, where waters freeze up every winter, make navigation even more challenging. The busy waters where shipping lanes cross, and many fishing vessels operate, also result in increasing risks of major pollution accidents, which could have a devastating impact on the marine environment, especially in the coastal waters.

During the last decade shipping has steadily increased in the Baltic Sea, reflecting intensifying international cooperation and economic prosperity. Since mid-2005 the Baltic Sea countries are able to monitor maritime traffic with the use of the Automatic Identification System (AIS), invented for the exchange of information between ships, and between ships and shore-based stations. The data derived from this monitoring system provides for annual reports and statistics on ships' traffic in the Baltic Sea area as well as trends compared to earlier years.

At any time around 2,000 sizeable ships are normally at sea in the Baltic and each month around 3,500–5,000 ships ply the waters of the Baltic. In 2010, vessels entered or left the Baltic Sea via Skaw 56,564 times (Fig. 1). This figure has increased by more than 10% since 2006 (51,628 crossings). Approximately, 19% of those ships were tankers, 44% other cargo ships, and 4% passenger ships. Additionally, 31,933 ships passed through the 98-kilometer long Kiel Canal (in 2010).

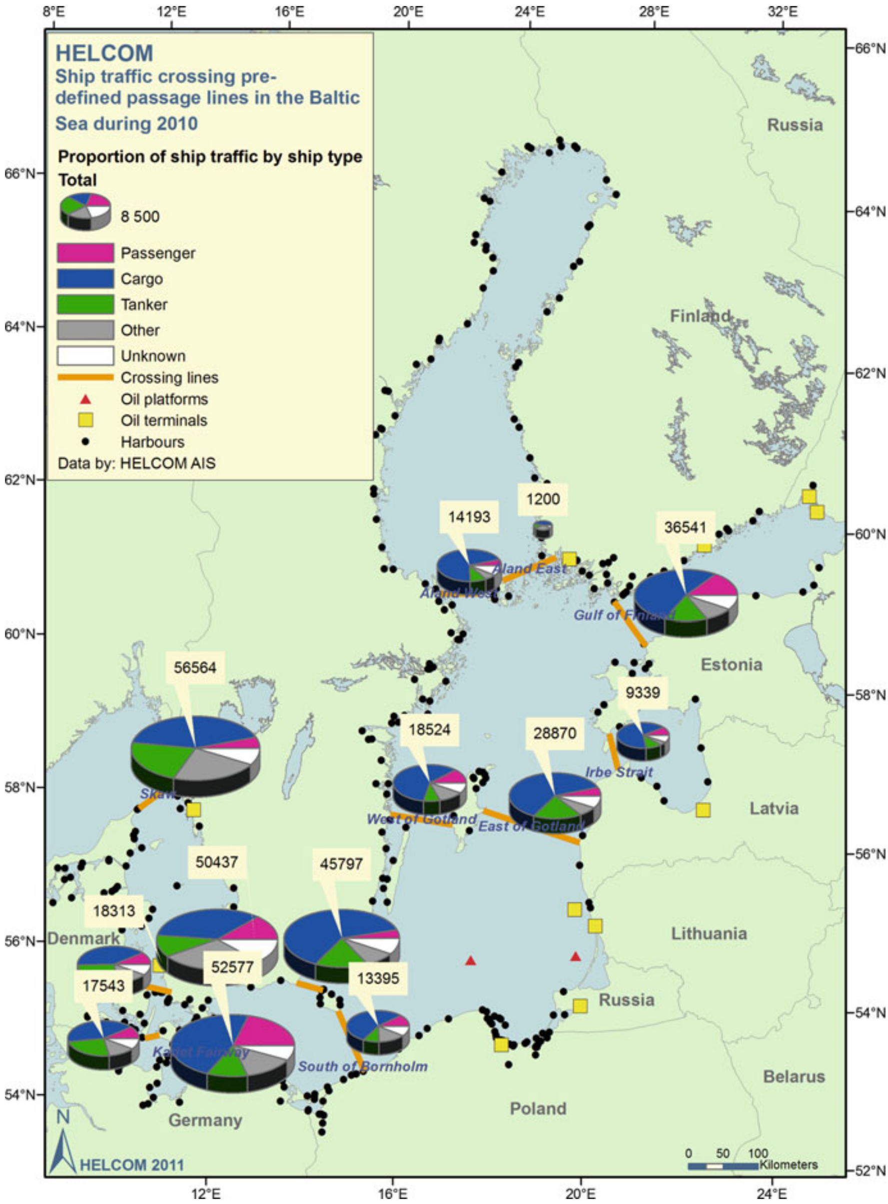


Fig. 1 Number of ships crossing Automatic Identification System (AIS) fixed lines in the Baltic Sea according to the type of the vessels, 2010

Following the increase between 2006 and 2008, an overall traffic in the Baltic Sea has declined in recent years (Fig. 2), which is related to the economic downturn in the region.

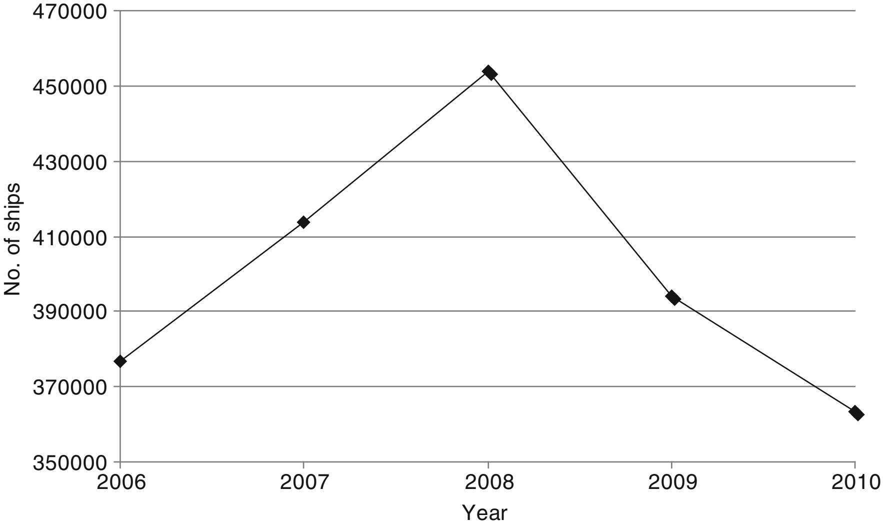


Fig. 2 Overall traffic in the Baltic Sea, 2006–2010, based on HELCOM AIS data

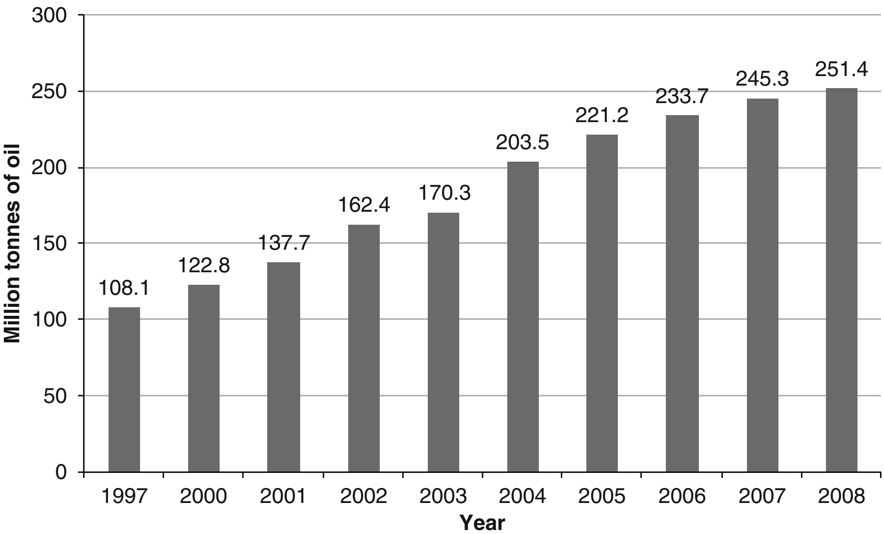


Fig. 3 Amount of oil transported via the 16 largest oil terminals in the Baltic Sea area during 1997, and 2000–2008. Data source: HELCOM MARIS

The Baltic Sea accounts for around 9% of total cargo and 11% of oil transportation in world traffic. The amount of cargo shipped on the Baltic in 2008 was 822.4 million tonnes, with the fastest annual growth taking place in Russia [3]. In 2008, over 251 million tonnes of oil were shipped on the Baltic, more than double of the shipment in 2000 (Fig. 3). The use of much bigger tankers is also expected, meaning that there will be more tankers in the Baltic carrying 100,000–150,000 tonnes of oil.

3.2 Shipping Accidents

Maritime transportation is generally one of the most environmentally friendly ways of transporting goods, but there are also potential negative impacts like ship-generated wastes, air pollution, releases of alien species in ballast water, accidental, and illegal pollution. A number of shipping accidents, of which groundings and collisions are the most common, occur every year in the Baltic. Only a few of these incidents have so far resulted in serious pollution. The last major oil spill (more than 100 tonnes of oil) in the Baltic Sea happened in 2003 as a result of the bulk carrier "Fu Shan Hai" colliding with the container ship off Bornholm Island in Denmark.

Overall, there is a slightly decreasing trend in the number of shipping accidents in the Baltic Sea (Fig. 4) [4]. A more profound decreasing trend is observed in busy waters of the Gulf of Finland for groundings and collisions, and in the southwestern part of the Baltic Sea, including Danish straits, for groundings. On average there are about 130 accidents per year in the Baltic Sea, mostly occurring very close to shore or in harbors.

The number of shipping accidents in the Baltic Sea resulting in some kind of pollution, usually containing not more than 0.1–1 tonnes of oil, ranges from zero to 13 annually (Fig. 4). Although most of the shipping accidents in the Baltic Sea do

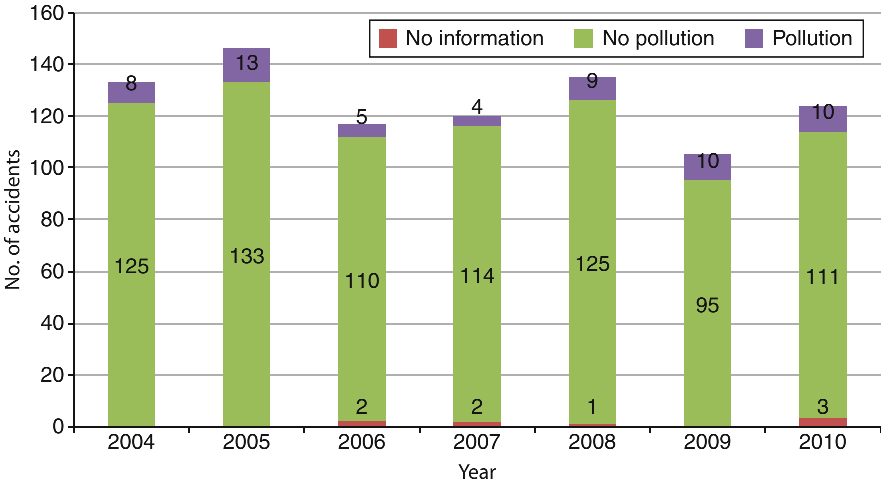


Fig. 4 Number of reported shipping accidents in the Baltic Sea during the period 2004–2010, with and without causing pollution

not result in any pollution, the risk of a major spillage of oil or hazardous substances is profoundly present due to heavy traffic and the large amount of tankers in the Baltic Sea.

Overall, the launch of HELCOM AIS, the traffic separation schemes and the ship reporting systems introduced in the Baltic, e.g., the Gulf of Finland Reporting System (GOFREP), have had a positive effect on the safety of navigation and have contributed to the reduced number of accidents over the recent years.

3.3 Assessment of Risk of Major Oil Pollution

One way of dealing with risks of shipping activities is to conduct a formal safety assessment (FSA), an IMO process which assesses the risks and evaluates the costs and benefits of different risk control options. A region-wide risk assessment, with a character of FSA has been carried out within an EU-funded project called BRISK (Subregional risk of spill of oil and hazardous substances in the Baltic Sea), with the main purpose to optimize the coastal countries' resources to respond to pollution at sea.

The BRISK assessment indicates hot spots for accidents and spills as well as estimates the so-called return period – expected intervals between spill events. According to BRISK, the total number of accidents in the Baltic Sea corresponds to approximately 44 groundings and 4 collisions with ships of 300 gross tonnage and above per year. Based on the estimated risks of accidents, the risk of spills has been analyzed, covering all size classes of spills, up to 150,000 tonnes.

The spills of 5,000 tonnes of oil and above are estimated to occur once every 26 years for the whole Baltic Sea, whereas the spills of 300–5,000 tonnes are expected once every four years. According to the assessment, the risk of spills of up to 300 tonnes is dominated by illegal discharges, and accidental small spills play a minor role in this size category.

There are also substantial differences in the intervals between possible spills in the two biggest size ranges in different subregions of the Baltic Sea area (Table 1).

Table 1 Estimates of expected intervals between spill events

Subregion	Large accidents: 300–500 tonnes spilt (years)	Exceptional accidents: 5,000 tonnes and more (years)
1. Gulf of Bothnia	36	600
2. Gulf of Finland	39	255
3. Northern Part of the Baltic Proper	30	175
4. Southeastern Baltic Proper	140	1,060
5. Southwestern Baltic Proper	17	97
6. Sound and Kattegat	11	65
Entire Baltic Sea	4	25

These intervals are the shortest in the Sound and the Kattegat, closely followed by the southwestern Baltic Sea, and the longest in southeastern Baltic Proper. Spills are expected to be also less frequent, in the Gulf of Finland and Gulf of Bothnia (more than four times) and northern part of the Baltic Proper (almost three times), than in the Sound and Kattegat.

3.4 *Illegal Oil Discharges*

Deliberate, illegal discharges from ships are observed each year by national surveillance aircrafts and satellites over the Baltic Sea area. The number of detected oil spills in the Baltic Sea has been decreasing over the past years, even though the density of shipping has grown and aerial surveillance in sea by the countries has increased. In 2010 a total of 149 illicit oil spills were detected (Fig. 5), which is one third of the spills observed a decade earlier [5].

The size of slicks is also declining, the majority being smaller than a cubic meter, or even less than 100 L. Of the total 149 oil discharges detected in 2010, 136 (91%) were smaller than 1 m^3, and of these oil spills as much as 97 were even smaller than 0.1 m^3 or 100 L. Two oil spills were over 10 m^3 in size and the total estimated volume of oil spills observed in 2010 amounted to 49 m^3. The share of each size category of oil spills is presented in Fig. 6. The trend of the spill sizes for the years 1998–2010 is presented in Fig. 7. Figure 8 further illustrates the trend in total

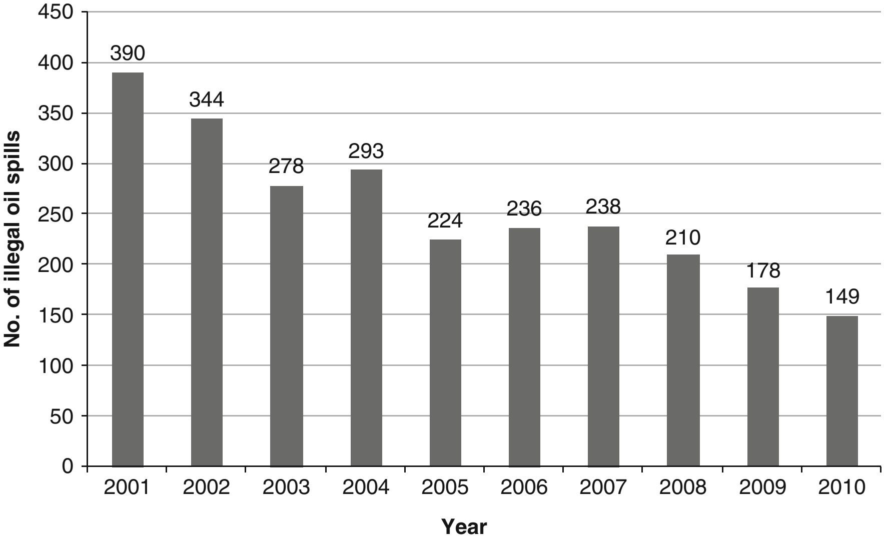


Fig. 5 Number of detected illegal oil spills in the Baltic Sea area, 2001–2010

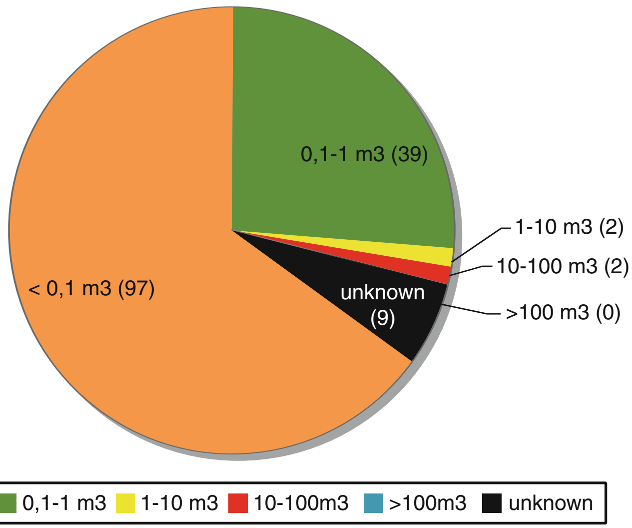
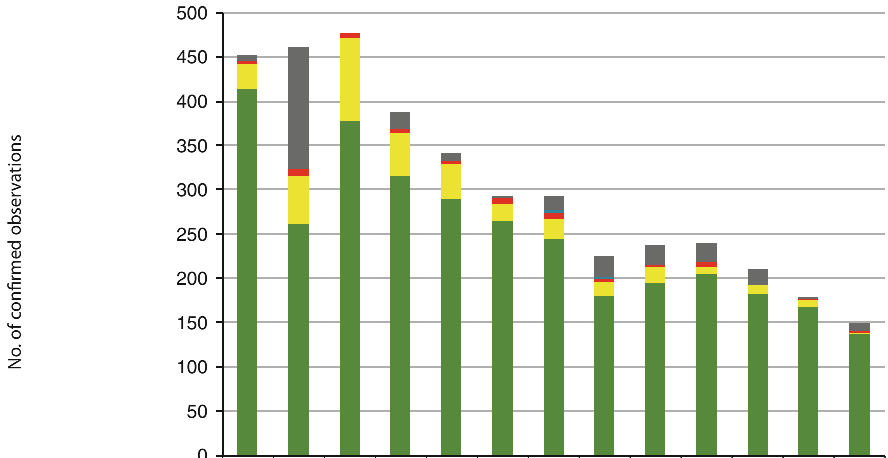


Fig. 6 Illegal oil discharges detected in the Baltic Sea during aerial surveillance in 2010 according to size of spill



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
unknown	7	138	0	19	9	2	17	23	21	21	18	2	9
>100 m3	0	0	0	0	0	0	2	2	1	0	0	0	0
10-100 m3	3	8	6	5	4	6	8	4	2	4	0	1	2
1-10 m3	28	54	93	50	40	20	22	16	18	9	10	7	2
< 1 m3 (incl. < 0,1 m3)	414	261	377	314	288	264	244	179	194	204	182	168	136

Fig. 7 Illegal oil discharges by spill size observed during aerial surveillance in the Baltic Sea, 1998–2010

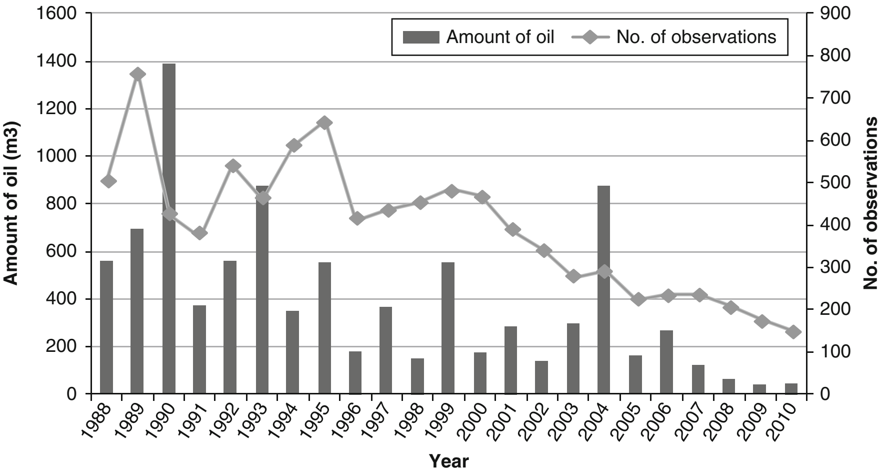


Fig. 8 Total estimated amount of oil detected versus number of observations, 1988–2010

amount of oil detected and the number of spills observed in 1988–2010. Most illegal oil discharges are detected along major shipping routes (Fig. 9).

Regular aerial surveillance flights (see Sect. 5.3) have contributed significantly to the decrease in illegal discharges because ships are aware that their illicit polluting activities can be detected.

4 Impact of Oil on Marine Environment and Its Assessment in the Context of Good Environmental Status

Maritime traffic inflicts multiple pressures on the Baltic Sea biodiversity including noise, release of nutrients, coastal erosion, disturbance of seabed, oil spills, and spreading of alien species. Impacts of this array of pressures on the marine ecosystem are wide, affecting not only species but also quality of habitats and the marine environment in general. One of the major oil accidents globally – the Prestige oil spill in the Atlantic coast of Spain in 2002 – caused significant short-term reduction in phyto- and zooplankton biomass [6], reduced abundance and species richness of littoral invertebrates [7] and severely affected fish reproduction [8]. It killed or harmed about 200,000 birds [9], caused stranding of marine mammals and turtles [10] and significant egg and adult mortality of peregrine falcons [9]. Long-term chronic effects of such large-scale environmental catastrophes are well known from the tens of studies after the Exxon Valdez oil spill in Alaska in 1989 (e.g., [11]).

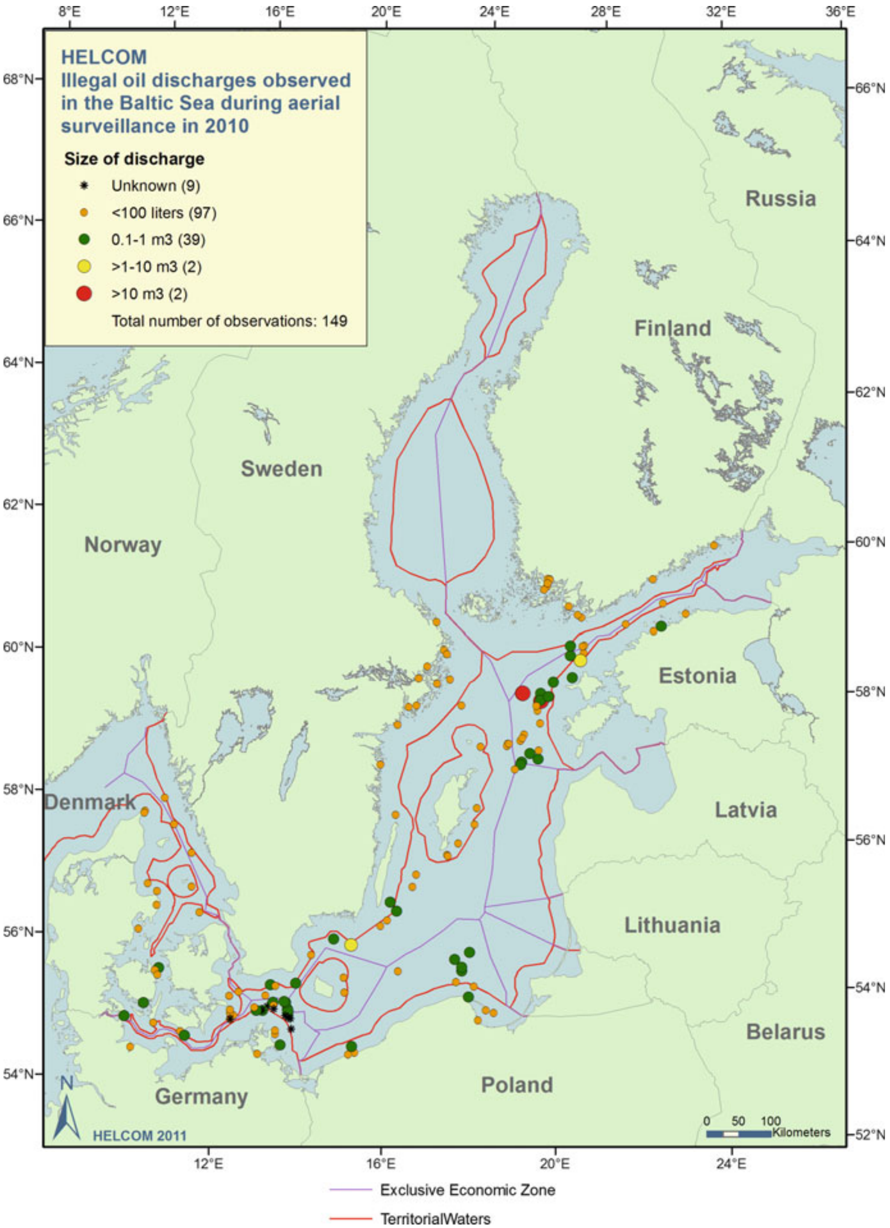


Fig. 9 Spatial distribution of illegal oil discharges in the Baltic Sea during aerial surveillance in 2010

The Baltic Sea has avoided a large-scale oil spill despite the high volume of the transported oil and the shallow and narrow navigation routes. There have, however, been small oil spills in the sea, which show – in addition to the experience from other sea areas and experimental science – the impacts of oil spills in the Baltic Sea.

4.1 Impacts on Lower Trophic Levels

Species in the lower end of the trophic chain, such as plants (phytoplankton, periphyton, and macrophytes) and invertebrate fauna (zooplankton and zoobenthos), form the basis of the functioning marine ecosystem. Increased mortality or intoxication of these species cause not only decreased food availability to higher trophic levels but also biomagnification of several hazardous substances from the oil in sea birds and marine mammals and degradation of habitat quality and several crucial ecosystem services, which are operated by the organisms at the lower trophic levels [12, 13].

The exposure of molluscs to crude oil in vitro has been shown to cause mainly sublethal effects [14]. The clam *Macoma balthica* buries deeper to sediment as a response to oil exposure and the mussel *Mytilus edulis* detaches from hard substrata. The gastropod *Theodoxus fluviatilis*, which is an abundant epiphytic grazer in the littoral zone, was shown to slow its crawling, ending to total immobilization after 2 h of exposure time [14]. A dominating littoral crustacean *Gammarus oceanicus* was shown to suffer from impaired swimming performance, reduced egg production, and increased mortality after experimental exposure to crude oil and refined oil [15]. In the studies outside the Baltic Sea, soft-bottom amphipod species have been suggested to be particularly sensitive to impacts of oil spills [16].

Field sampling after the Tsesis oil spill in October 1977 on the Swedish east coast (Baltic Proper) revealed that the abundance of amphipods (*Pontoporeia femorata*) and polychaetes (*Bylgides sarsi*) was reduced to less than 5% of their pre-spill abundance and the meiofauna species (ostracods, harpacticoids, Turbellaria, and kinorhynchs) showed clear reductions in abundance [17]. Indirect impacts of the Tsesis oil spill were seen for example as a high frequency of malformed embryos of *P. femorata*. Reproduction rate of the affected species returned to normal levels after two years of the spill, but the authors estimated that the full recovery of the local ecosystem may take a decade. The Tsesis oil spill was only 1,000 tonnes, but it happened within an archipelago area, which increased its impacts on the littoral zone. Similar effects were seen after the Antonio Gramsci oil spill in 1979 with 5,000–6,000 tonnes of crude oil spilled in the eastern Baltic Proper [18]. In the studies after the Antonio Gramsci oil spill, it was also noticed that the zone of the perennial alga *Fucus vesiculosus* was impacted more severely than the hydrolittoral zone of ephemeral seaweeds [18].

4.2 Oil Spills Destroy Fish Larvae

Light oil and crude oil have been shown to cause malformations and death to hatched larvae of Baltic herring in laboratory conditions [19]. Likewise, exposure of the Pacific herring to low concentrations of polynuclear aromatic hydrocarbons (PAHs, 0.7 ppb) caused malformations, genetic damage, mortality, and decreased size and inhibited swimming [20]. PAH concentrations as low as 0.4 ppb caused sublethal responses such as yolk sac edema and immaturity consistent with premature hatching. Field estimates of the effect of the Exxon Valdez accident on the mortality of herring larvae in the Prince William Sound (Alaska) reached a loss of 52% of larvae.

4.3 Seabirds Are Sensitive to Small Oil Spills

Seabirds are very sensitive to the effects of oil in the sea. Even small amounts of oil on the sea surface absorbs to the plumage causing hypothermia. Oiled birds suffer also from intoxication. Especially, wintering populations in the offshore areas have been shown to be heavily affected by the oil spills [21]. Annually, 100,000–500,000 ducks, guillemots, and other bird species are estimated to die due to small oil spills in the Baltic Sea [22]. Long-tailed Duck (*Clangula hyemalis*) is a species of worldwide concern for which the Baltic is of special importance. The species has been the most numerous bird wintering in the Baltic Sea, but is now most likely rapidly decreasing in numbers, because of chronic oiling [23]. An important shipping route from the southern Baltic Sea to the Gulf of Finland with approximately 22,000 ship passages per year passes through the Natura 2000 site Hoburgs Bank (south of Gotland). Around 150–200 oil spills, most of them less than 1 tonne, are registered along the route each year. Weekly winter surveys of oiled birds at southern Gotland between 1996/1997 and 2006/2007 have shown that several tens of thousands of Long-tailed Ducks are annually killed by oil in the central Baltic Sea [24, 25]. Furthermore, analyses of Long-tailed Ducks drowned in fishing gear at Hoburgs Bank showed that a large proportion, about 12% of the birds, had oil in the plumage [25]. Encouragingly, oil spills seem to have decreased during the recent years, possibly due to better enforcement.

The oil spills have also intoxicating impacts on sea birds. In the northwestern Spain, embryos and adults of peregrine falcon died due to toxic concentrations of PAHs from the Prestige accident [9]. In Alaska, the hepatic activity in Harlequin ducks was significantly higher in the oil area than elsewhere [26]. In contrast, heavy metal concentrations in sea birds in the northwestern Spain, some years after the Prestige oil spill, were not higher than in other areas of the North Atlantic coast [27].

4.4 Marine Mammals Accumulate Hazardous Substances from Oiled Prey

Marine mammals do not seem to suffer from the acute effects of oil exposure [28], except in the case of very large oil spills such as the Exxon Valdez [29]. However, in a review paper of the effects of the oil on grey seal Jenssen [28] suggested that chronic effects as a result of bioaccumulating of organochlorines (PCBs and DDTs) from the oil may cause greater concern than the exposure to the oil itself. The concentrations of organochlorines are high in the marine mammals in the Baltic Sea, but the main source of the compounds has been judged to be pulp industry [30].

4.5 Ecosystem Effects

The impact of a large oil spill on the Baltic marine and coastal ecosystem is difficult to predict because of the differences between the Baltic Sea and the oceanic ecosystems which have experienced large oil spills. The Baltic food web consists of fewer species than oceanic ecosystems, being probably less intricate as regards the interspecific relationships but, on the other hand, risking the loss of all food sources for a predatory species. The cascading effects of the decreased abundance of a prey species are well documented in the Baltic Sea [31, 32].

The degradation of habitats in the water column, seabed or shore is a serious consequence of oil pollution. In the Prince William Sound, Day et al. [33] noticed a clear initial decrease in the habitat suitability of oiled breeding habitats for 42 species of birds. Coastal habitats are breeding and feeding areas of many terrestrial and marine species that spend most of their life cycle in the open sea. Hence, the effects of oil pollution – either degraded habitat quality or increased exposure to hazardous substances – spread further than the oiled area.

4.6 How to Measure the Good Environmental Status as Regards the Oil Pollution?

Maritime traffic is addressed by one of the four main segments of the BSAP. A number of management objectives have been set in order to point out the main areas of concern (see [34]). The management objectives represent normative definitions to reduce anthropogenic pressures to reach the Good Environmental Status (GES). There are two BSAP management objectives for the oil spills: “No illegal discharges” and “Safe maritime traffic without accidental pollution,” which both are clearly more linked to the human activities than the environmental status or even impacts of the pressures. A step closer to the status objectives would be to define an objective for the *impacts* of the oil spills, such as “No oiled sea birds” or

"No petrogenic PAHs in mussels," which could be used indirectly to estimate GES in an area.

Objectives more directly linked to GES should define the *status* of the environment and not the pressures or their impacts. In the case of the impacts of the oil spills, an objective for the environmental status could be "Viable sea bird populations" or "Reproduction of predatory birds at natural levels." The European Marine Strategy Framework Directive (MSFD) sets clear normative objectives for GES [35]. The 11 objectives are called qualitative descriptors for GES and they define the status of the marine environment as regards its biological diversity, eutrophication, hazardous substances, condition of seabed and hydrography, and introduction of noise and litter. Assessment of GES as regards the impacts of oil spills can be linked directly or indirectly to at least five GES descriptors:

D1: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic, and climatic conditions.
D4: All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
D6: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
D8: Concentrations of contaminants are at levels not giving rise to pollution effects.
D9: Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.

The EU MSFD requires the Member States to assess each of the GES descriptors by the use of associated criteria and indicators [36]. The criteria and indicators for each of the descriptors are given in Table 2. The descriptors 1 (distribution, abundance and condition of populations, habitats, and the functioning of the ecosystem), 4 (functioning of the food web), and 6 (sea-floor integrity) are status objectives for biodiversity, whereas the descriptors 8 and 9 (hazardous substances) are status objectives for water quality and contamination. Pressure indicators can be used indirectly to measure the status objectives or directly the impact of management measures. Thus, the assessment of GES in the MSFD is not done solely on the basis of status objectives (i.e., measuring the actual status), but also by measuring pressures (i.e., measuring the progress toward the good status).

The GES criteria and indicators in the EU MSFD are indicative in the sense that more specific indicators can be used to assess the state of the ecosystem. For example, the impacts of oil spills can be seen in the polychaete/amphipod ratio in soft-bottom communities, in the nematode/copepod ratio in the meiobenthos [16], in the extent of oiled habitats or abundance of oiled sea birds, or by specific measurements of petrogenic contaminants in organisms. The tendency in the marine assessments is currently, however, not in separate assessments, but in the development of methods to integrate indicators, which measure GES from different aspects [23, 30, 37, 38], and in holistic assessments [38], which include not only status indicators but also indicators for impacts, pressures, drivers, and management responses.

Table 2 Descriptors, criteria and indicators for good environmental status in the EU Marine Strategy Framework Directive related to impacts of oil spills

Criteria	GES indicator
Descriptor 1.	
1.1 Species distribution	1.1.1 Distributional range
	1.1.2 Distribution pattern within the latter
	1.1.3 Area covered by the species (for sessile/benthic species)
1.2 Population size	1.2.1 Abundance and/or biomass
1.3 Population condition	1.3.1 Population demographic characteristics: (body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)
	1.3.2 Population genetic structure
1.4 Habitat distribution	1.4.1 Distributional range
	1.4.2 Distributional pattern
1.5 Habitat extent	1.5.1 Habitat area
	1.5.2 Habitat volume
1.6 Habitat condition	1.6.1 Condition of the typical species and communities
	1.6.2 Relative abundance and/or biomass
	1.6.3 Physical, hydrological and chemical conditions
1.7 Ecosystem structure	1.7.1 Composition and relative proportions of ecosystem components
Descriptor 4.	
4.1 Productivity of key species or trophic groups	4.1.1 Performance of key predator species using their production per unit biomass
4.2 Proportion of selected species at the top of food webs	4.2.1 Large fish (by weight)
4.3 Abundance/distribution of key trophic groups and species	4.3.1 Abundance trends of functionally important selected groups/species
Descriptor 6.	
6.1 Physical damage, having regard to substrate characteristics	6.1.1 Type, abundance, biomass and areal extent of relevant biogenic substrate
	6.1.2 Extent of the seabed significantly affected by human activities for the different substrate types
	6.2.1 Presence of particularly sensitive and/or tolerant species
6.2 Condition of the benthic community	6.2.1 Presence of particularly sensitive and/or tolerant species
	6.2.2 Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species
	6.2.3 Proportion of biomass or number of individuals in the macrobenthos above some specified length/size
	6.2.4 Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community

(continued)

Table 2 (continued)

Criteria	GES indicator
Descriptor 8.	
8.1 Concentration of contaminants	8.1.1 Concentration of the contaminants mentioned above, measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC
8.2 Effects of contaminants	8.2.1 Levels of pollution effects on the ecosystem components concerned, having regard to the selected biological processes and taxonomic groups where a cause/effect relationship has been established and needs to be monitored
	8.2.2 Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil and oil products) and their impact on biota physically affected by this pollution
Descriptor 9.	
9.1 Levels, number and frequency of contaminants	9.1.1 Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels
	9.1.2 Frequency of regulatory levels being exceeded

5 Regional Work to Prevent and Combat Oil Spills

5.1 Safety of Navigation

While recognizing that the IMO is a global regulator of shipping, also regional measures to increase the safety of navigation are undertaken by the Baltic Sea countries. The most voluminous set of such measures were adopted by the ministers of the environment and of transport in the form of the Copenhagen Declaration [39], covering new and improved routing measures, improved hydrographic services, AIS, phasing out the use of single hull tankers, port State control, places of refuge, safety of winter navigation, and adequate response capacities. The ministers also agreed to investigate the benefits from designating parts of the Baltic Sea as a Particularly Sensitive Sea Area (PSSA).

PSSA is an area that needs special protection through action by the IMO because of its significance for recognized ecological, socio-economic or scientific reasons and because it may be vulnerable to damage by international shipping. The Baltic Sea is such an area with the special attributes, like unique biodiversity, which are at risk of damage arising from the heavy and increasing international shipping activities. Following a proposal in 2002, the Baltic Sea area, except for the waters of the Russian Federation, has been decided in 2005 to become a PSSA.

The PSSA is linked to associated protective measures (APM) by the IMO to prevent, reduce, or eliminate risks from shipping activities. The available APM include:

– To designate an area as a Special Area and/or as an Emission Control Area under MARPOL Annexes [40] or application of special discharge restrictions to ships operating in a PSSA;
– To adopt ships' routing and reporting systems near or in the area, under the SOLAS Convention [41];
– To develop other measures, such as a compulsory pilotage schemes or vessel traffic management systems.

Until now numerous ship routing systems have been established in the Baltic Sea area, including a number of traffic separation schemes and deep water routes, ship reporting, recommended pilotage, measures related to safety of winter navigation. Mariners' Routeing Guide for the Baltic Sea has been prepared and is available in a form of a chart serving as a single source of navigational information for ships sailing in the Baltic Sea. Web-based version of the Mariners' Routeing Guide for the Baltic Sea has also been produced.

The Baltic Sea has also been designated, among others, as a Special Area under MARPOL Annex I prohibiting the discharge of oil from ships.

5.2 Response to Oil Pollution

To ensure the safety of navigation, various measures have been adopted at the global level by the IMO, at the regional level by HELCOM, and at the national level by the Baltic Sea States. But even though all safety of navigation measures would be in place and as long as ships ply the waters of the Baltic Sea, the risk of oil spills exists.

The cooperation in combatting spillages of oil in the Baltic Sea area is based on the Helsinki Convention and HELCOM Recommendations on combatting matters, adopted by the Helsinki Commission.

Regional principles and procedures for international response operations in the Baltic Sea have been laid down in the HELCOM Response Manual. The Manual is a framework guiding the nine nations how to act in case of major oil pollution, starting from alerting the neighboring countries and exchanging the details on an accident to requesting foreign assistance and solving the related financial matters.

HELCOM Recommendations determine the required minimum national ability to respond to pollution incidents threatening the marine environment of the Baltic Sea, including adequate equipment, ships, and manpower prepared for operations in coastal waters as well as high seas.

Likewise, HELCOM has agreed on guidelines for how to designate places of refuge, in case of accidents, on an overall Baltic scale, irrespective of in whose waters the accident has occurred (HELCOM Recommendation 31E/5).

Overall, the national resources to respond to pollution at sea are substantial, with more than 70 oil combatting vessels on stand-by located around the Baltic Sea. Six new oil combatting ships will become operational within the next three years. Additionally, three oil spill recovery vessels are chartered by the EMSA in the Baltic Sea to top-up the HELCOM response resources. These vessels are in principle able to reach any place in the region within some hours of being notified of an oil spill accident.

An important aspect of maintaining the readiness to respond to pollution is exercising. Several kinds of exercises are conducted under the HELCOM flag, including the annual BALEX DELTA exercises, which test the alarm procedures and response capability of the coastal countries in case of a major accident. The general objective of the BALEX DELTA exercises is to ensure that every Contracting Party is able to lead a major response operation.

5.3 Enforcement of Anti-discharge Regulations

One of the tools to enforce the existing anti-discharge regulations is aerial surveillance for illegal oil spills from ships.

According to the Helsinki Convention and the HELCOM Response Manual, the Baltic Sea countries shall develop and ply individually or in cooperation, surveillance activities covering the Baltic Sea area in order to spot and monitor oil and other substances released to the sea, using, *inter alia*, airborne surveillance equipped with remote sensing systems.

The purpose of aerial surveillance is to detect spills of oil and other harmful substances which can threaten the marine environment of the Baltic Sea area. These spills caused by accidents or made in contravention of international Conventions will be registered and, if possible, sampled from both the sea surface and on board the suspected offender.

The aerial surveillance is complemented by satellite surveillance to enable bigger area coverage and optimization of flight effectiveness.

Within the framework of the Helsinki Convention close cooperation on airborne surveillance has been established through:

- Regular National Flights;
- Setting up special flights such as CEPCO Flights (Coordinated Extended Pollution Control Operation Flights);
- Standardization of reporting formats and exchange of information;
- Working together in improving existing systems and developing new techniques to enhance the information obtained.

The Baltic Sea countries have conducted national airborne surveillance since late 1980s. The HELCOM states aerial surveillance fleet comprises more than 25 aircrafts and helicopters, the majority of which are equipped with remote sensing

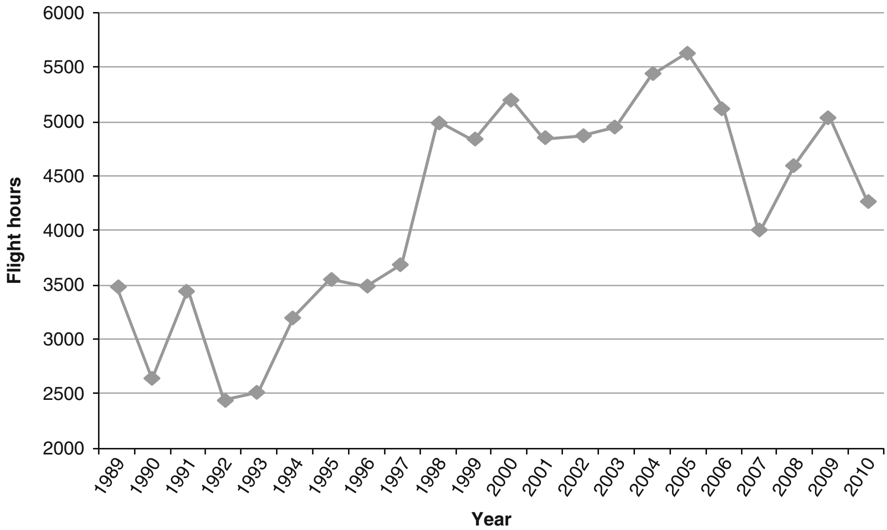


Fig. 10 Total number of flight hours in the Baltic Sea area during aerial surveillance, 1988–2010

equipment such as side-looking airborne radar (SLAR), infrared (IR) and ultraviolet (UV) cameras, and photo and video equipment.

In 2010, a total of 4,279 surveillance flight hours were carried out by the Baltic Sea countries, which is 23% more than in 1989 when the surveillance started (Fig. 10). A certain flight proportion is ensured for detections in darkness, when deliberate discharges are more likely to occur. In 2010, 12% of all flight hours were at night [5].

Apart from regular national surveillance, twice per year the Baltic Sea countries jointly undertake CEPCO flights to monitor main shipping routes for 24 h or more. The first Baltic SuperCEPCO, where aircrafts from several countries maintained continued surveillance for several days, was held in 2009 and the second Baltic SuperCEPCO was arranged in 2011.

In addition to the aerial surveillance the Baltic Sea countries utilize satellite images to detect illegal discharges of oil. Satellite surveillance in the Baltic Sea area has been intensified since 2007 thanks to the CleanSeaNet satellite surveillance service, provided by the EMSA. The satellite images are delivered in near real time to provide first indication of possible oil slicks to be checked by aircraft on a spot.

Altogether, EMSA provided 647 satellite scenes for the users of CleanSeaNet in the Baltic Sea in 2010 (608 in 2009), indicating 186 possible detections (280 in 2009). In the HELCOM area, 44% (82) of the spill indications were checked and out of these 15% (12) were confirmed to be mineral oil (21% in 2009) (Table 3).

These activities by the coastal states have proved to be effective and have led to a decreasing number of illegal oil spills in the Baltic Sea, which can be demonstrated

Table 3 Satellite detections of oil spills in HELCOM countries waters provided by European Maritime Safety Agency (EMSA), including verified detections in 2010

Country waters	Satellite detections	Verified satellite detections					Not checked
		Confirmed mineral oil	Confirmed other oil, chemical, sewage or garbage	Confirmed natural phenomena	Unknown substance	Nothing foumd	
Denmark	40	4	0	6	1	9	20
Estonia	18	2	1	3	0	0	12
Finland	13	3	1	0	1	4	4
Germany	15	1	0	2	2	7	3
Latvia	3	1	0	0	0	0	2
Lithuania	0	0	0	0	0	0	0
Poland	47	0	6	3	1	12	25
Russia	3	0	0	0	0	0	3
Sweden	47	1	0	1	4	6	35
Total	186	12	8	15	9	38	104

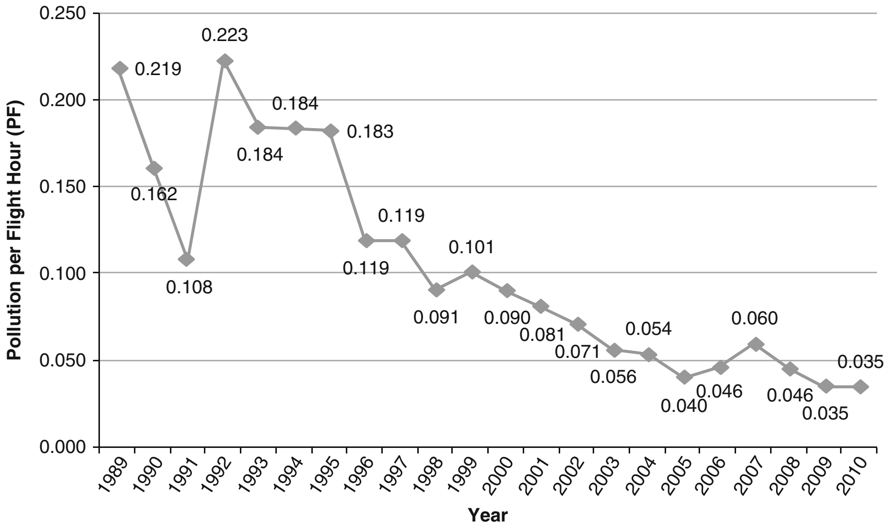


Fig. 11 Pollution per Flight Hour (PF) Index for the Baltic Sea, 1989–2010

by a Pollution per Flight Hour (PF) Index, comparing the total number of observed oil spills to the total number of flight hours (Fig. 11). A decreasing PF Index over the years indicates less oil spills or/and increased surveillance activity. The PF Index for the whole Baltic Sea in 2009 and 2010 was 0.035, the lowest recorded so far.

6 Conclusions

The dense shipping and the rapidly rising amounts of oil being transported by the Baltic Sea mean that the risk of an accident involving serious oil pollution increases correspondingly, unless counteractive measures are implemented. The Baltic Sea region can serve as a model for cooperation on increasing the safety of navigation whereby new risk reduction measures are discussed, coordinated, proposed to the IMO, and applied jointly by several neighboring or all Baltic Sea countries. Likewise, the cooperation among the HELCOM countries to build capacities to respond to major accidental pollution by oil, has led to the high level of preparedness in the region and clear operational routines in place to follow when conducting an international response operation.

Enforcement of existing anti-discharge regulations is crucial for preventing illegal oil discharges from ships, and the monitoring and enforcement system implemented in the Baltic Sea region, consisting of both aerial and satellite surveillance, proves to be efficient, resulting in decreasing number and size of illicit discharges.

References

1. Anon. (1992) Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992. Helsinki Commission. Available at: http://www.helcom.fi/Convention/en_GB/text/
2. Anon. (1982) The United Nations Convention on the Law of the Sea. Available at: http://www.un.org/depts/los/index.htm
3. Särkijärvi J, Stenberg J, Tuormarmäki H, Saurama A (2009) Baltic Port List 2008. Annual cargo statistics of ports in the Baltic sea Region. Centre for Maritime Studies, University of Turku, 158 pp
4. HELCOM (2010) Report on shipping accidents in the Baltic Sea area for the year 2010. Available at http://www.helcom.fi/stc/files/shipping/shipping_accidents_2009.pdf
5. HELCOM (2011) Annual 2010 HELCOM report on illegal discharges observed during aerial surveillance. Available at http://www.helcom.fi/stc/files/shipping/shipping_accidents_2010.pdf
6. Mendes JC, Johns DG, Richardson AJ (2005) Impact of the Prestige oil spill on plankton communities. VERTIMAR 2005: Symposium of Marine Accidental Oil Spills, Vigo, Spain. Available at: http://otvm.uvigo.es/vertimar2005/orales.html
7. ICES (2007) Report of the Benthos Ecology Working Group (BEWG). Available at http://www.ices.dk/reports/MHC/2007/BEWG07.pdf
8. Dominguez R, Saborido-Rey F (2005) Reproductive ecology of European hake (*Merluccius merluccius*) and its relation with the *Prestige* oil spill. VERTIMAR 2005: Symposium of Marine Accidental Oil Spills, Vigo, Spain. Available at: http://otvm.uvigo.es/vertimar2005/orales.html
9. Zuberogoitia I, Martínez JA, Iraeta A, Azkona A, Zabala J, Jiménez B, Merino R, Gómez G (2006) Short-term effects of the prestige oil spill on the peregrine falcon (*Falco peregrinus*). Mar Pollut Bull 52:1176–1181
10. López A, Llavona A, Alonso JM, Mtnez-Cedeira JA, Caldas M, Valeiras X, Covelo P (2005) Effects of the Prestige oil spill in aquatic mammals and sea turtles of the Galician coast (NW Spain). VERTIMAR 2005: Symposium of Marine Accidental Oil Spills, Vigo, Spain. 13–16 July 2005. Available at: http://otvm.uvigo.es/vertimar2005/poster.html

11. Peterson CH, Rice SD, Short JW, Esler D, Bodkin JL, Ballachey BE, Irons DB (2003) Long-term ecosystem response to the Exxon Valdez oil spill. Science 302:2082–2086
12. MEA (Millennium Ecosystem Assessment) (2005) Ecosystems and human well-being Synthesis. A report of the Millennium Ecosystem Assessment. Island press, Washington, DC
13. SEPA (2009) What’s in the sea for me – ecosystem services provided by the Baltic Sea and Skagerrak. SEPA Report 5872. The Swedish Environmental Protection Agency, ISBN 978-91-620-5872-2. Stockholm, Sweden
14. Linden O (1977) Sublethal effects of oil on mollusc species from the Baltic Sea. Water Air Soil Pollut 8:305–313
15. Linden O (1970) Effects of oil on the amphipod *Gammarus oceanicus*. Environ Pollut 10:239–250
16. Gómez Gesteira JL, Dauvin J-C (2000) Amphipods are good bioindicators of the impact of oil spills on soft-bottom macrobenthic communities. Mar Pollut Bull 40:1017–1027
17. Elmgren R, Hansson S, Larsson U, Sundelin B, Boehm PD (1983) The “Tsesis” oil spill: acute and long-term impact on the benthos. Mar Biol 73:51–65
18. Bonsdorff E (1981) The *Antonio Gramsci* oil spill impact on the littoral and benthic ecosystems. Mar Pollut Bull 12:301–305
19. Linden O (1978) Biological effects of oil on early development of the Baltic herring *Clupea harengus membras*. Mar Biol 45:273–283
20. Carls MG, Rice SD, Hose JE (1999) Sensitivity of fish embryos to weathered crude oil: Part I. Low-level exposure during incubation causes malformations, genetic damage, and mortality in larval pacific herring (*Clupea pallasi*). Environ Toxicol Chem 18:481–493
21. Votier SC, Hatchwell BJ, Beckerman A, McCleery RH, Hunter FM, Pellatt J, Trinder M, Birkhead TR (2005) Oil pollution and climate have wide-scale impacts on seabird demographics. Ecol Lett 8:1157–1164
22. BirdLife International (2007) Baltic Sea Action Plan overlooks oil pollution. Available at: http://www.birdlife.org/news/news/2007/11/baltic_sea_action_plan.html
23. HELCOM (2009) Biodiversity in the Baltic Sea – an integrated thematic assessment on biodiversity and nature conservation in the Baltic Sea. Baltic Sea Environment Proceedings 116B. Available at: www.helcom.fi/publications
24. Larsson K (2007) Inventeringar av oljeskadad alfågel längs Gotlands sydkust under perioden 1996/97 till 2006/07. Report. Gotland University (in Swedish)
25. Larsson K, Tydén L (2005) Effects of oil spills on wintering Long-tailed Ducks *Clangula hyemalis* at Hoburgs bank in central Baltic Sea between 1996/1997 and 2003/2004. Ornis Svecica 15:161–171
26. Trust KA, Esler D, Woodin BR, Stegeman JJ (2000) Cytochrome P450 1A induction in Sea Ducks Inhabiting Nearshore Areas of Prince William Sound, Alaska. Mar Pollut Bull 40:397–403
27. Pérez-López M, Cid F, Lourdes Oropesa A, Eusebio FL, López BA, Soler F (2006) Heavy metal and arsenic content in seabirds affected by the Prestige oil spill on the Galician coast (NW Spain). Sci Total Environ 359:209–220
28. Jenssen BM (1996) An overview of exposure to, and effects of, petroleum oil and organochlorine pollution in Grey seals (*Halichoerus grypus*). Sci Total Environ 186:109–118
29. Loughlin TR, Ballachey BE, Wright BA (1996) Overview of studies to determine injury caused by the Exxon Valdez oil spill to marine mammals. Proceedings of The Exxon Valdez Oil Spill Symposium. American Fisheries Society Symposium 18:798–808
30. HELCOM (2010) Hazardous substances in the Baltic Sea – an integrated thematic assessment of hazardous substances in the Baltic Sea. Baltic Sea Environment Proceedings 120B. Available at www.helcom.fi/publications
31. Casini M, Lövgren J, Hjelm J, Cardinale M, Moinero J-C, Kornilovs G (2008) Multi-level trophic cascades in a heavily exploited open marine ecosystem. Proc R Soc B 275:1793–1801

32. Eriksson BK, Ljungberg L, Sandström A, Johansson G, Mattila J, Rubach A, Råberg S, Snickars M (2009) Declines in predatory fish promote bloom-forming macroalgae. Ecol Appl 19:1975–1988
33. Day RH, Murphy SM, Wiens JA, Hayward GD, Harner EJ, Smith LN (1997) Effects of the Exxon Valdez oil spill on habitat use by birds in Prince William Sound, Alaska. Ecol Appl 7:593–613
34. HELCOM (2007) The HELCOM Baltic Sea Action Plan. Helsinki Commission. Available at www.helcom.fi
35. Anon (2008) Directive 2008/56/EC of the European Parliament and the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union, L 164/19, 25.06.2008
36. Anon (2010) Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU). Official Journal of the European Union L 232
37. HELCOM (2009) Eutrophication in the Baltic Sea – an integrated thematic assessment of the effects of nutrient enrichment in the Baltic Sea region. Baltic Sea Environment Proceedings 115B. Available at: www.helcom.fi/publications
38. HELCOM (2010) Ecosystem health of the Baltic Sea 2003–2007: HELCOM Initial Holistic Assessment. Balt. Sea Environ. Proc. No. 122. Available at www.helcom.fi/publications
39. HELCOM (2001) Declaration on the safety of navigation and emergency capacity in the Baltic Sea area. Available at http://www.helcom.fi/stc/files/MinisterialDeclarations/Copenhagen2001.pdf
40. Anon. (1973) International Convention for the Prevention of Pollution from Ships (MARPOL). Available at: http://www.imo.org/about/conventions/listofconventions/pages/international-convention-for-the-prevention-of-pollution-from-ships-(marpol).aspx
41. Anon (1974) International Convention for the Safety of Life at Sea (SOLAS), 1974. Available at: http://www.imo.org/about/conventions/listofconventions/pages/international-convention-for-the-safety-of-life-at-sea-(solas),-1974.aspx

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