Baltic LINes

Coherent Linear Infrastructures in Baltic Maritime Spatial Plans

SHIPPING IN THE BALTIC SEA

Past, present and future developments relevant for Maritime Spatial Planning

Interreg Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Foreword

Although Maritime Spatial Planning (MSP) is a national competence, member states need to ensure coherence of plans across sea basins in the coming years. This is prescribed by the EU MSP Directive (2014) and also required in terms of spatial efficiency and connectivity. As a minimum, issues that are transnational by nature, i.e. shipping routes, energy infrastructure and ecosystem considerations need to be coordinated.

The Interreg project Baltic LINes (2016-2019) seeks to increase transnational coherence of shipping routes and energy corridors in Maritime Spatial Plans to prevent cross-border mismatches and secure transnational connectivity as well as efficient and sustainable use of Baltic Sea space.

This report was developed under Work Package (WP) 2.1. Screen and analyse available information, data and maps related to shipping in the Baltic Sea. It represents a first synthesis of available literature on the topic of shipping in the Baltic Sea and related past, present and future developments relevant for MSP. The report concentrates on the following key questions:

- What are the unique characteristics of the Baltic Sea with regard to shipping?
- Which economic, environmental and technological developments will influence shipping in the coming years and what are their spatial implications?
- What plans/ guidelines are existent for the coordination of shipping traffic in the Baltic Sea?

The report serves as a working document for further project activities and does not claim to be complete in one or the other way. By collecting available information and providing it to all project partners in concentrated form it aims to enable in-depth discussions on common planning criteria for shipping, to develop likely future scenarios and to consult stakeholders in a comprehensive manner.

Hamburg, 20.12.2016
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Federal Maritime and Hydrographic Agency (BSH)

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1. Introduction

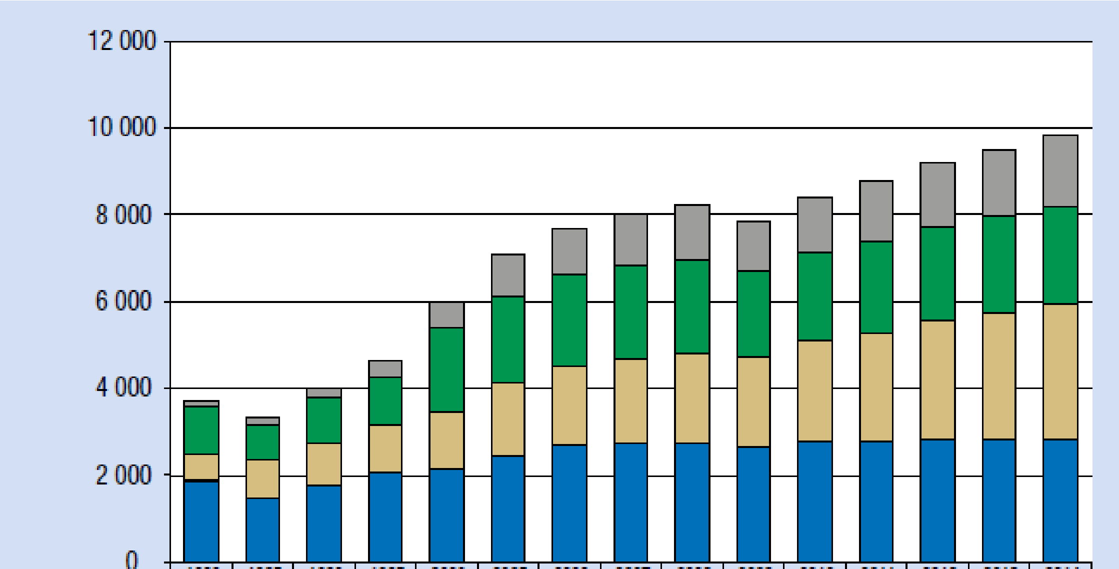
Up to 15% of the world's cargo traffic is handled in the Baltic Sea making it to one of the busiest maritime places on earth (Madjidian et al. 2013). By the same time, the Baltic Sea has been known as difficult area for shipping for a long time as narrow straits, multiple islands and shallow waters do not leave a lot of space for navigation. Dependent on season shipping also has to deal with rough weather conditions (intensive storms during autumn, strong currents in the straits and icy waters during winter). In addition to these natural restrictions to shipping, new interests have arisen in the past decades. Most relevantly is the vast need for space for offshore wind farms (OWFs), and the concurrent desire to designate additional marine protection areas (MPAs).

To coordinate these different interests and maintain the necessary safety standards it is of essential need to define commonly consistent transnational shipping traffic corridors. These corridors should regulate todays' traffic but also account for economic, environmental and technological future developments and their spatial implications on the shipping sector. Different political and legal systems complicate common maritime spatial planning on a basin-scale. National interests and priorities divide from each other and the status of the national maritime spatial plans as well as time-scales for their development vary considerably. Therefore, it is unrealistic to develop one joint plan of shipping corridors for the Baltic Sea. A more practical way to assure consistent MSP is to define gates for shipping where two countries border. Although this task is much less complicated it is important to take care that these gates are defined in a similar way (e.g. based on agreed widths and safety distances). A summary of the recommendations from the Baltic SCOPE project for practical approaches in transboundary shipping in the Baltic Sea can be found in Annex II.

KEY MESSAGES
There is limited space for shipping due to the physiographical shape of the sea bed of the Baltic Sea.
Concurrent uses by other sectors narrow down the available space, especially the most recent growth of the offshore wind energy sector.
The designation of coherent shipping corridors is most feasible via the definition of common gates at country borders.

2. Economic developments relevant for shipping in the Baltic Sea Region

According to the International Maritime Organization (IMO) 90% of the world trade is accomplished via transport overseas. In the past 30 years the total amount of cargo transported by ships has almost doubled with an accelerated increase since 2010. Especially the container market has grown considerably (Fig. 1, UNCTAD 2015).



	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Container	102	152	234	371	598	969	1 076	1 193	1 249	1 127	1 280	1 393	1 464	1 544	1631
Other dry cargo	1 123	819	1 031	1 125	1 928	2 009	2 112	2 141	2 173	2 004	2 022	2 112	2 150	2 218	2272
Five major bulks	608	900	988	1 105	1 295	1 709	1 814	1 953	2 065	2 085	2 335	2 486	2 742	2 923	3112
Oil and gas	1 871	1 459	1 755	2 050	2 163	2 422	2 698	2 747	2 742	2 642	2 772	2 794	2 841	2 829	2 826

Fig. 1: International seaborne trade, selected years (millions of tons) (UNCTAD 2015)

However, the global shipping sector is highly dependent on the large-scale economic development in the world. Changes in the economic development have a direct effect on the transport demand and, thus, on the well-being of the commercial shipping market. So-called “random shocks”, often triggered by wars or severe financial crisis, may suddenly destabilize a regional or even the global economic system. Economic recession usually causes reduced demands for the shipping market, most recently to observe in 2008 (Boteler et al. 2015). Regional developments are not always in line with global trends and the severity the shipping industry is affected is also dependent on its resilience and adaptive capacity towards sudden changes. In the Baltic region the recession 2008 caused an intermediate fall of the shipping industry in some of the countries while others remained stable (Fig. 2). By 2010 most of the European ports experienced a clear recovery from the decline in production, trade and shipping activities and continued to grow. In 2012, the maritime transport sector accounted for about 69,000 jobs in the Baltic Sea region with an average turnover of 60,023 million EUR (Boteler et al. 2005).

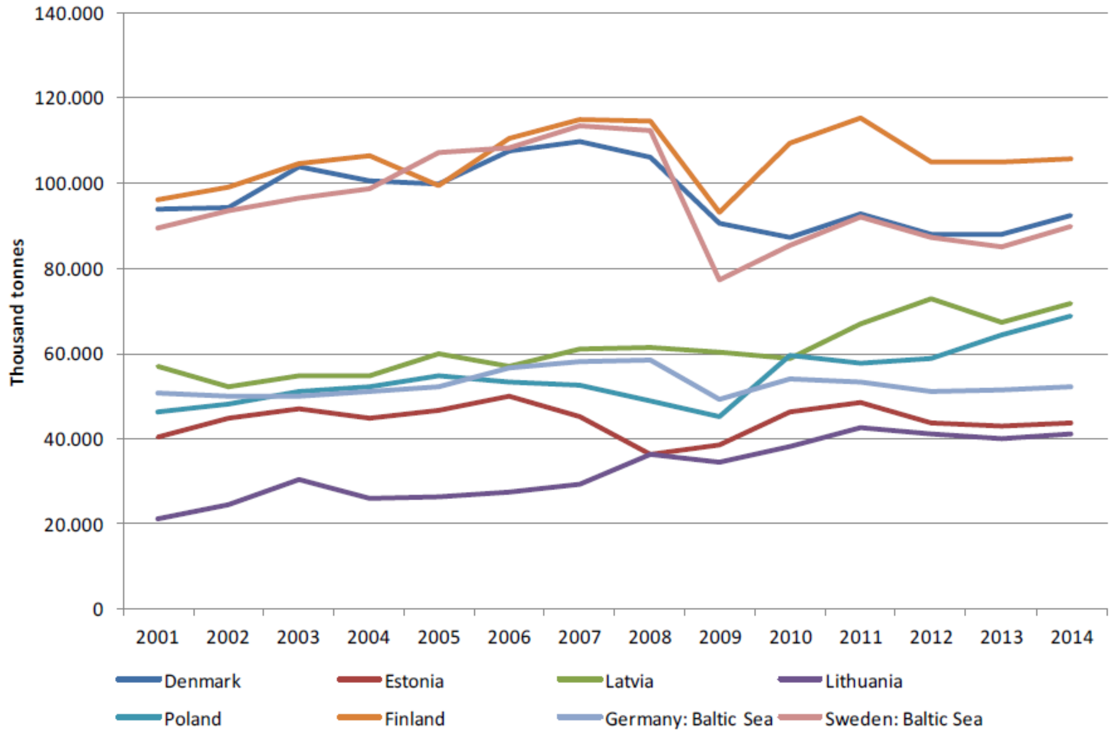


Fig. 2: Maritime transport goods in Baltic Sea countries between 2001 and 2014 (gross weight) (data: Eurostat; Boteler et al. 2015)

With regard to the long-term development the transport of cargo increased by around 18% from 2004 to 2013. This growth can be mainly attributed to an increased turnover in ports in the eastern Baltic Sea region, especially Russia (Parsmo et al. 2016). The strongest growth is to observe for the transport of crude oil and fuels after completing the construction of deep-water oil terminals in Primorsk and Ust-Luga as of 2015 (Parsmo et al. 2016).

In 2014 all Baltic Sea countries (including Russia) controlled about 7000 ships with gross tonnage > 1,000, representing 13% of the world fleet and 35% of the EU-controlled fleet (Boteler et al. 2015). The EU-controlled fleet (including Norway) has expanded by more than 70% in the Baltic Sea region in the period 2005 to 2014 (both in GT and DWT). However, the total number of vessels decreased by 31% for the same period indicating a trend towards larger ship sizes, especially for the cargo transport (Fig. 3).

There are about 2000 ships in the Baltic marine area at any given moment and about 3500–5500 ships navigate through the Baltic Sea per month (Stankiewicz et al. 2010, Madjidian et al. 2013). More than 50% of the ships are general cargo ships. Approximately 20% of the ships in the Baltic Sea are tankers carrying over 200 million tons of oil, about 11% are passenger ships operating about 50 million passengers (Stankiewicz et al. 2010, Meski and Kaitaranta 2014, Parsmo et al. 2016).

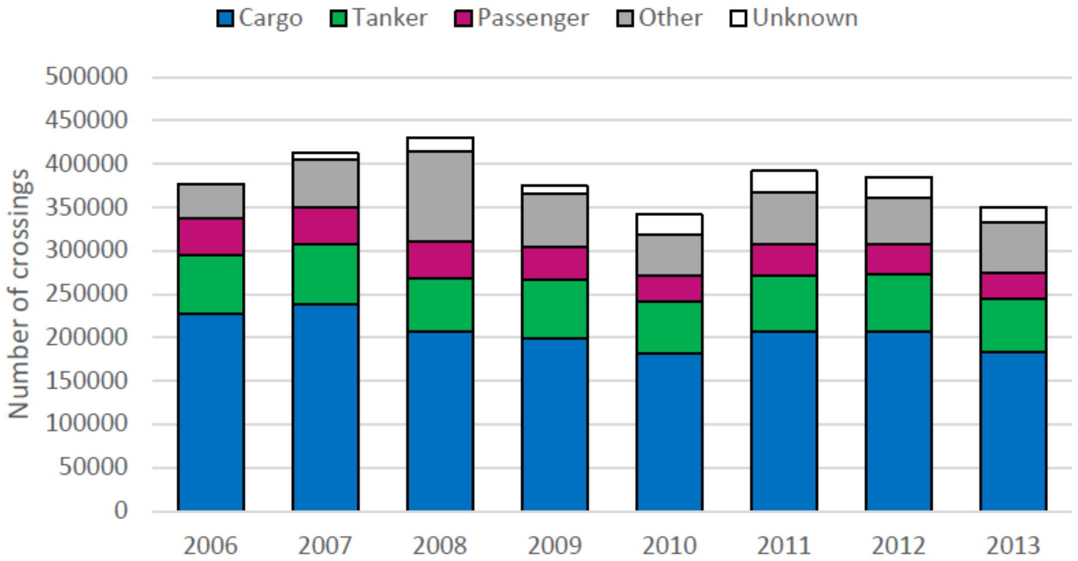


Fig. 3: Total annual crossings at fixed AIS lines in the Baltic Sea during 2006-2013 grouped by ship type (Meski and Kaitaranta 2014)

Cargo ships in the Baltic Sea are still often packed with break bulk (e.g. forestry, metal or steel products). Most of these ships stay inside the Baltic Sea and Northern Europe, and export rates among Baltic States are generally high (Fig. 4). Especially the trade between the EU and Russia has grown considerably, reaching a peak in 2012. In 2013 a total of 0.6 billion tons of cargo was handled from which approximately 25% was attributed to Russia, serving about 70% of the bulk cargo market in the Baltic Sea. Also the ten largest ports handled containers of 7.8 million TEU, which was about 3% more compared to 2012 (Parsmo et al. 2016)

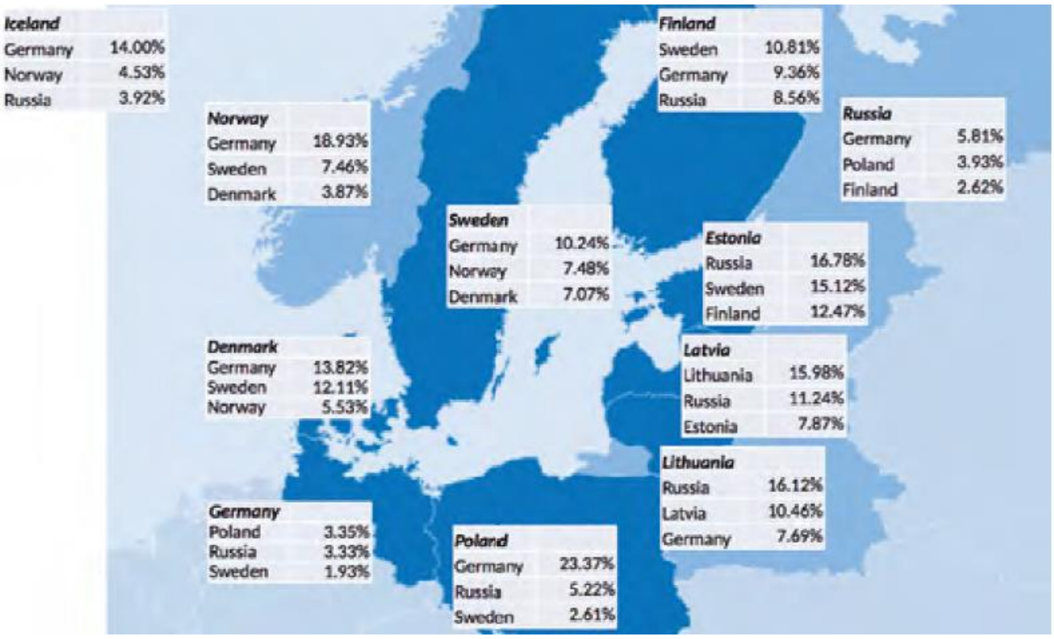


Fig. 4: Share of exports to top three countries in the Baltic Sea Region (Ketels & Pedersen 2015)

In the past two decades a downwards trend of maritime passenger transport is to observe. This is mainly related to declining ferry services resulting from competition with inexpensive commercial flights and high speed rail links. On the other hand, the cruise ship sector is due to an upwards trend, with Europe as one of the key markets for the global cruise ship industry. Current plans show that between 2015 and 2021 34 of the 36 new cruise ships to be constructed can be attributed to European yards. Five of the European main destinations are located in the Baltic Sea region, namely St. Petersburg, Copenhagen, Tallinn, Helsinki and Stockholm (Parsmo et al. 2016).

Fishing in the Baltic Sea is subject to a number of different policies, regulations and strategies that are mainly related to the Common Fisheries Policy (CFP). The fishing industry of the Baltic Sea has declined since 2005. Especially larger trawlers and beam trawlers have reduced considerably. As of 2013 around 6250 vessels were active in the Baltic Sea, in total providing about 9,300 jobs (Tab. 1, Boteler et al. 2015).

Tab. 1: Overview of Baltic Sea fishing fleet (data: STECF 2015; Boteler et al. 2015)

Country	No. of Vessels	Days at sea in region (days)	Vessel power (KW)	Vessels tonnage (tonne)	Estimated employed (FTE)
Germany	897	71,799	34,896	5,809	880
Denmark	619	36,142	49,881	12,168	406
Estonia	1,336	3,315	29,631	5,951	2,046
Finland	1,733	138,458	104,330	12,251	1,817
Lithuania	91	8,452	9,251	3,967	405
Latvia	267	19,364	20,673	7,681	680
Poland	752	70,515	64,203	15,584	2,213
Sweden	561	39,343	76,623	14,117	840
Total	**6,256**	**387,388**	**389,488**	**77,528**	**9,287**

IMO regulations require an AIS-transponder for all ships larger than 300 GT and 500 GT on international and non-international voyages respectively, as well as passenger ships irrespective of size. Consequently the shipping traffic flow can be recognized by collecting data from Automatic Identification Systems (AIS) at any moment. Main routes can be identified by summarizing data on an annual basis (Fig. 5). The number of cargo ships is highest in the Western part of the Baltic Sea (Grimvall 2014). Changes in global shipping routes, e.g. the opening of north-west and north-east passages due to climate warming, will also have an effect on the traffic pattern in the Baltic Sea as larger ships may entry without reloading to smaller vessels in preceding European ports. Ports in the Baltic will need to cope with by dismounting sufficient infrastructure to handle this development (Parsmo et al. 2016).

HELCOM data suggests that the number of ports stay the same in the BSR but existing medium and large ports are likely to grow by more than 50% in the next ten years. Especially northern ports could benefit from anticipated climate warming and related ice-free conditions during the winter months (WWF 2010).

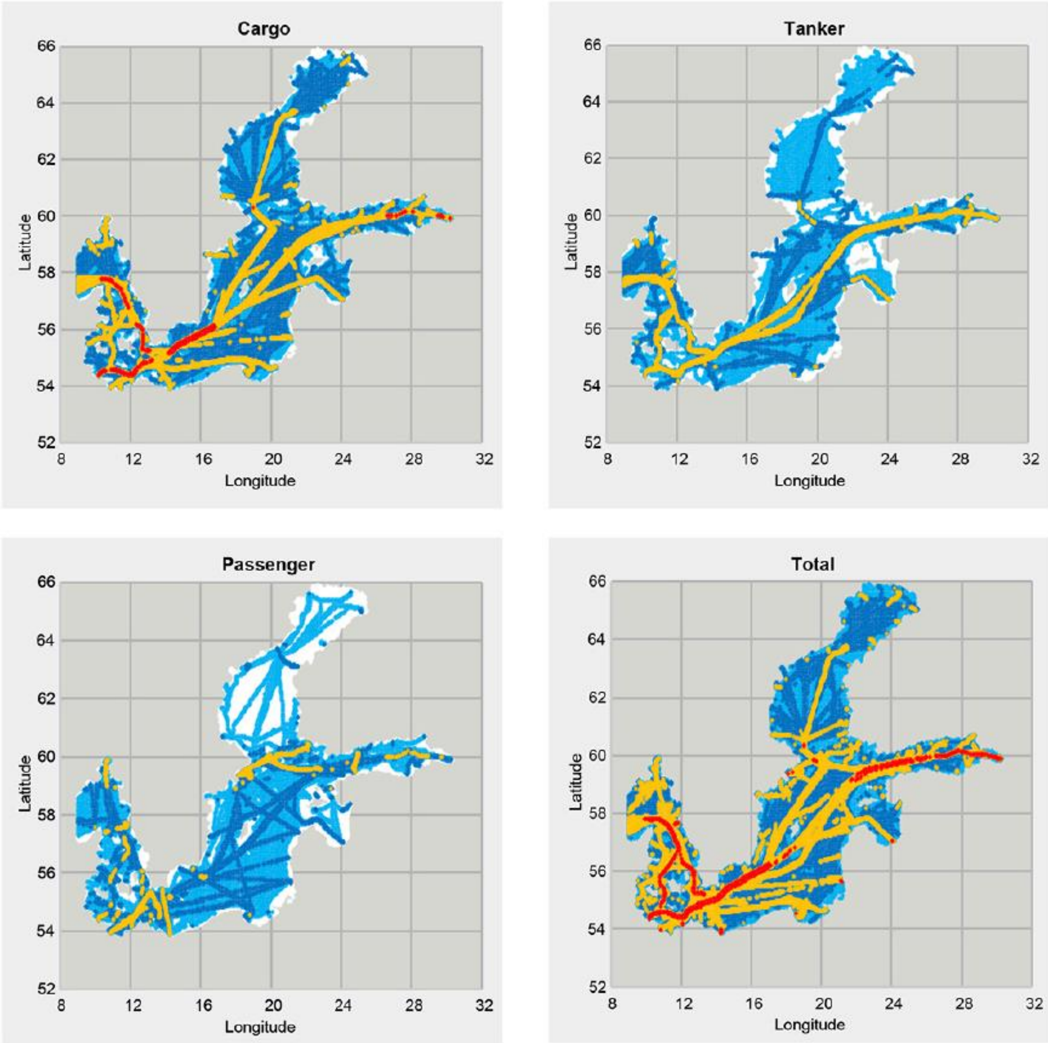


Fig. 5: Shipping intensity and routes in the Baltic Sea in 2013; color coding: white = no vessels, light blue = 1-99 vessels, dark blue = 100-999 vessels, orange = 1000-9999 vessels, red = >10000 vessels (Grimvall 2014)

Annex I contains more detailed shipping density maps per category for the year 2014. For cargo ships and tankers it is easy to identify clear common main routes and even traffic separation is observable at open sea. Passenger ships show a similar traffic pattern over longer distances, but, by the very nature of this transport category, visiting much more small and medium ports than ships executing freight transport. In contrast fishing and service ships show a very different spatial pattern. There is a high density of fishing vessels observable close to ports especially in the south east Baltic Sea (at the coasts of Poland, Lithuania and Latvia) but no distinct routes can be spotted. Service ships operating the construction of offshore installations show strong local patterns and seem to move on defined routes. However, service traffic is always temporary and shifts with construction site.

Short-term predictions regarding the future development of the global shipping industry are usually quite general as individual developments are highly dependent on the capacity of a region to adapt to economic changes. Forecasting long-term development is even harder, as these developments are not only highly dependent on the fossil fuel market, but also on the development of new technologies and changes in the national and international legislation (Parsmo et al. 2016).

Despite these uncertainties some trends can be expected. First, ship traffic is likely to increase on an intra- as well as on an extra-European scale due to global population growth, economic growth and effects of increasing globalization (Fig. 6).

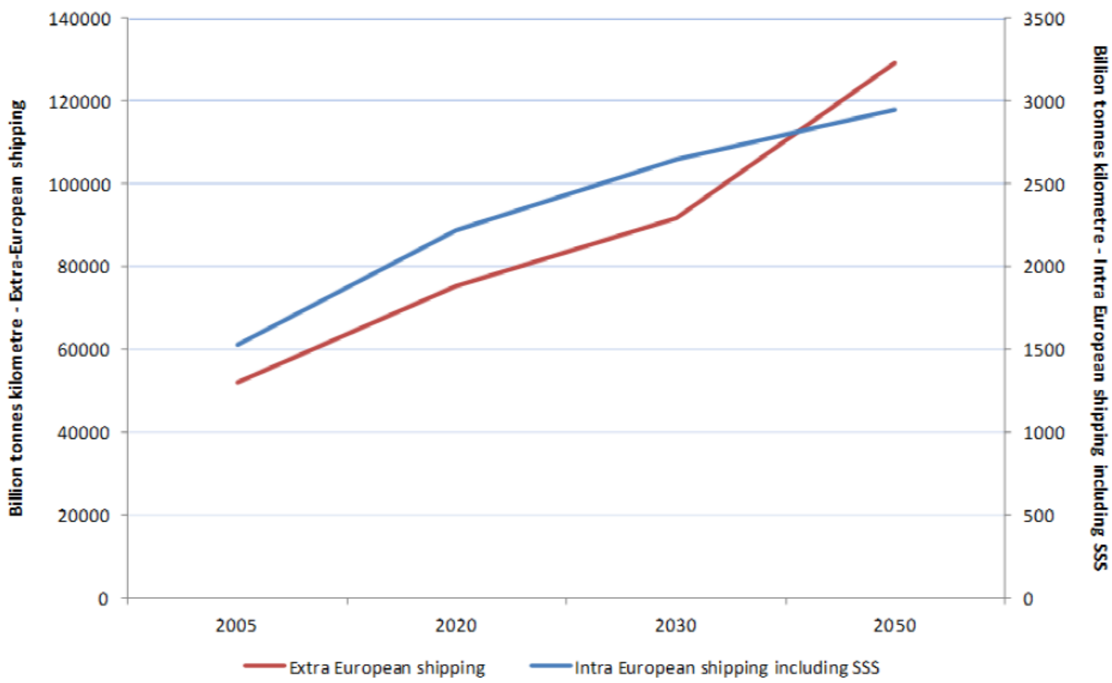


Fig. 6: Expected maritime transport growth for the EU until 2050 (data: MRAG, Poseidon and IFM 2009, Boteler et al. 2015)

Second, it is expected that a modal shift of transport from road to sea will take place in Europe. This trend goes back to the White Paper “Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system” published by the European Commission in 2011. The superior goal specified in the paper is to reduce greenhouse gas emissions from the transport sector by 20% until 2030 (compared to 2008) and 60% until 2050 (compared to 1990). To achieve this goal it is aimed to move 30% of road freight over 300 km to other modes (rail and waterborne) by 2030 and more than 50% by 2050. The Baltic Sea favours waterborne transport over shorter distances because of the high density of harbors. Here Short Sea Shipping often reduces the total distances compared to road freight transport (Boteler et al. 2015). The development towards a raise of road-, bridge-, and tunnel taxes in several EU countries favours this shift from road to sea. However, the shipping industry remarks that also shipping becomes more expensive due to stricter regulations (Parsmo et al. 2016).

Third, it is expected that vessel size will increase to enable more efficient and cost-saving freight transport. However, larger ships are not efficient during times of economic depression as they may be only partly loaded. Shipping companies may account for this risk in having a mixed fleet consisting of ships of different size and react to overcapacity with slow steaming (i.e. going at reduced speed to save fuel costs) (Parsmo et al. 2016). Larger ships with deep draught represent a major challenge especially for routes crossing shallow areas of the Baltic Sea as well as for the port development as channels need to be deeper and wider.

KEY MESSAGES

The shipping market is highly dependent on the global and regional economic development.

Globally transport overseas has increased over the last decades. In the Baltic Sea economic growth of commercial shipping can be mainly attributed to increasing trade volumes of Russia.

Despite increasing trade volumes the number of ships navigating through the Baltic Sea has decreased highlighting a trend towards larger vessel sizes.

Passenger transport related to ferry services has declined while the European cruise ship industry shows a strong upwards trend. The Baltic fishing market declined over the past decade.

Ports in the Baltic Sea have to prepare for larger ships and provide access as well as appropriate infrastructure for loading/ unloading.

Climate warming can have a strong impact on shipping traffic as well as port development in the Baltic Sea.

The shipping market is expected to grow. The European Commissions' ambition to shift transport from road to sea supports this development.

3. Environmental developments relevant for shipping in the Baltic Sea Region

As one of the world's largest reservoirs of brackish water the Baltic Sea is ecologically unique. However, during the last ~100 years, the Baltic Sea has changed from an oligotrophic clear-water sea into a eutrophic marine environment (Madjidian et al. 2013). The high shipping traffic density is one of the main factors for this negative development by causing air and water pollution. Pollution mainly results from ships using heavy-fuel oil or marine diesel oil and exhausting pollutants such as nitrogen oxide (NO_x), sulphur oxide (SO_x) and particulate matter (PM). Addressing these issues IMO adopted the International Convention for the Prevention of Pollution from Ships (MARPOL) which defines important regulations regarding environmental performance standards (Boteler et al. 2015). The Baltic Sea is designated as an Emission Controlled Area (ECA) and as a Particularly Sensitive Sea Area (PSSA) for which apply much stricter regulations. As of 2015 the Sulphur limits for ECAs are reduced considerably down to 0.1% (Boteler et al. 2015).

Figure 7 gives an overview over shipping emissions in the Baltic Sea in the period from 2006 to 2014. While the transport work increases most of the pollutants decrease over time indicating the change to alternative fuels or the introduction of exhaust gas cleaning (scrubbers). Unlike emissions from other pollutants, carbon emissions are still on the same level as in the beginning of the period.

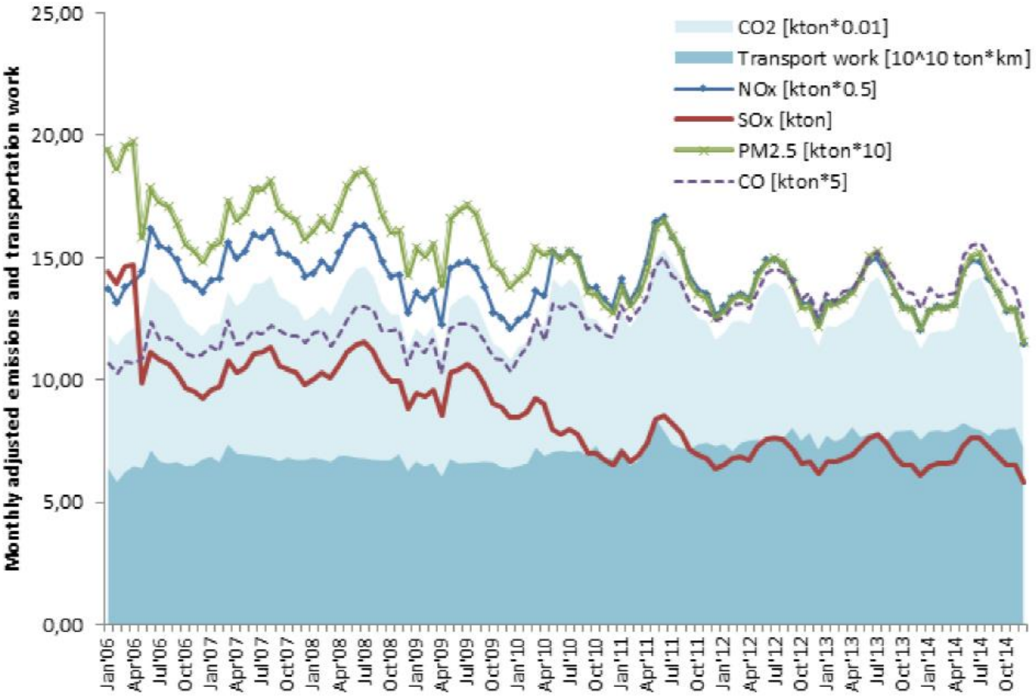


Fig. 7: Emissions from shipping in the Baltic Sea, 2006-2014 (data: Johansson and Jalkanen 2015, Boteler et al. 2015)

In 2011, the European Commission set the target of cutting carbon emissions in transport by 60% by 2050, including at least 40% cut in shipping emissions. Also there is the long-term objective of “zero-waste, zero-emission” released by the EU’s maritime transport policy. These goals are ambitious as projections show that shipping may increase its annual CO_2 emissions from 800 million tons in 2010 to 2000 million tons by 2050 if no measures are taken (Parsmo et al. 2016).

The discharge of waste at sea is prohibited through MARPOL since 1988, however, illegal discharge continued in the decades after as it represented the cheapest and most convenient solution. To reinforce ship owners to discharge their waste in ports voluntarily the countries of the Baltic Sea agreed on introducing the No Special Fee (NSF) principle, a 100% indirect fee system with no additional costs, applicable to all vessels and independent from the amount of waste discharged (Boteler et al. 2015).

For reasons of stabilization many cargo ships transport ballast water when they are not fully loaded. This ballast water often transfers sediments and organisms from one location to another. Organisms that are new to the other locations environment are so-called alien species. In 2010, a total of 100 non-native aquatic species have been recorded in the Baltic, of which the major portion established reproducing populations (Stankiewicz et al. 2010). About 50% of all introduced species result from shipping traffic (Fig. 8, Ruiz and Backer 2014).

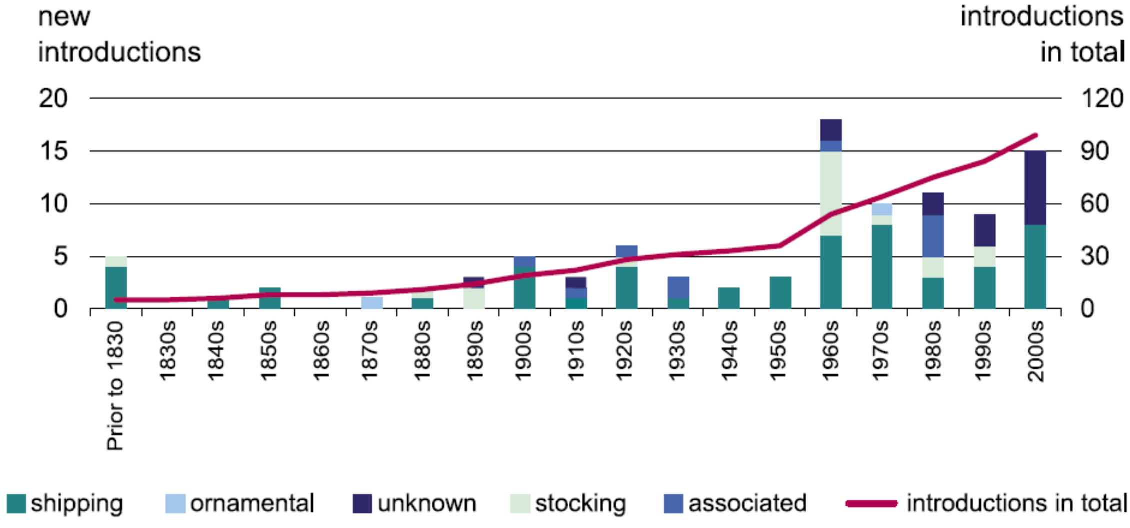


Fig. 8: Alien and cryptogenic species in the Baltic Sea based on the HELCOM list 2008 (Ruiz and Backer 2014)

With the International Convention for Control and Management of Ships’ Ballast Water and Sediments (BWMC) the IMO aims to act as a global regulator for the management of ballast water. The regulations indicate that ballast water exchange (BWE) has to take place at least 200 nm from the nearest land and in water at least 200 meters in depth. If these requirements cannot be met – BWE needs to take place at least 50 nm from the nearest land and in water at least 200 meters in depth. None of these requirements work for the Baltic Sea and it was agreed that BWE was not a suitable option within the Baltic Sea at all. In cooperation between the Barcelona Convention, the OSPAR Commission, and HELCOM it was decided that vessels transiting the Atlantic or entering the North-East Atlantic from routes passing the West African Coast are requested to conduct, on a voluntary basis, BWE before passing through the OSPAR area and heading to the Baltic Sea (Ruiz and Backer 2014). BWE for ships only transiting within the Baltic Sea region is also regulated by BMWC and less strict (Ruiz and Backer 2014).

With regard to future perspectives the EU Marine Strategy Framework Directive (MSFD) is of importance as it has the aim to achieve good environmental status by 2021. Indicators for a good environmental status, including the avoidance of underwater noise, are listed in Figure 9. Following the MSFD all EU member states are required to develop a marine strategy which includes an initial assessment of the state of environment and a clear description of monitoring programs (Boteler et al. 2015).

1. Biodiversity is maintained
2. Non-indigenous species do not adversely alter the ecosystem
3. The population of commercial fish species is healthy
4. Elements of food webs ensure long-term abundance and reproduction
5. Eutrophication is minimised
6. The sea floor integrity ensures functioning of the ecosystem
7. Permanent alteration of hydrographical conditions does not adversely affect the ecosystem
8. Concentrations of contaminants give no effects
9. Contaminants in seafood are below safe levels
10. Marine litter does not cause harm
11. Introduction of energy (including underwater noise) does not adversely affect the ecosystem

Fig. 9: List of descriptors to achieve good environmental status of the MSFD (Boteler et al. 2015)

On a regional scale HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area. With regard to regulations concerning the environment the Baltic Sea Action Plan (BSAP), adopted 2007, is the key instrument for future conservation as it aims to restore good ecological status of the Baltic Sea by 2021. Main goals refer to stop eutrophication, avoid hazardous substances, ensure biodiversity and conduct maritime activities in an environment friendly way (Fig. 10, Boteler et al. 2015).

Eutrophication	Biodiversity
∴ Concentrations of nutrients close to natural levels ∴ Clear water ∴ Natural level of algal blooms ∴ Natural distribution and occurrence of plants and animals ∴ Natural oxygen levels	∴ Natural marine and coastal landscapes ∴ Thriving and balanced communities of plants and animals ∴ Viable populations of species
Hazardous Substances	**Maritime Activities**
∴ Concentrations of hazardous substances close to natural levels ∴ All fish are safe to eat ∴ Healthy wildlife ∴ Radioactivity at the pre-Chernobyl level	∴ Enforcement of international regulations – no illegal discharges ∴ Safe maritime traffic without accidental pollution ∴ Efficient emergency and response capabilities ∴ Minimum sewage pollution from ships ∴ No introductions of alien species from ships ∴ Minimum air pollution from ships ∴ Zero discharges from offshore platforms ∴ Minimum threats from offshore installations

Fig. 10: Objectives of Baltic Sea Action Plan (Boteler et al. 2015)

In addition to the aim to achieve good environmental status the Convention of Biological Diversity (CBD) set the target to protect a minimum of 10% of each habitat in the Baltic Sea region. Since 2004 the area of marine protected areas (MPAs) increased threefold. Today about 12% of the Baltic Sea is already covered by the 163 MPAs, either as part of the Natura 2000 network or as HELCOM Baltic Sea protected area (HELCOM 2014). Even though a total of more than 10% of the area is protected already this is not the case for the sub-basins of the Baltic Sea. Therefore HELCOM aims to designate more MPAs in areas where the coverage is rather low. This applies mainly to areas at open sea, implicating that the focus will lay on the protection of areas which are also interesting for the offshore energy sector (Fig. 11).

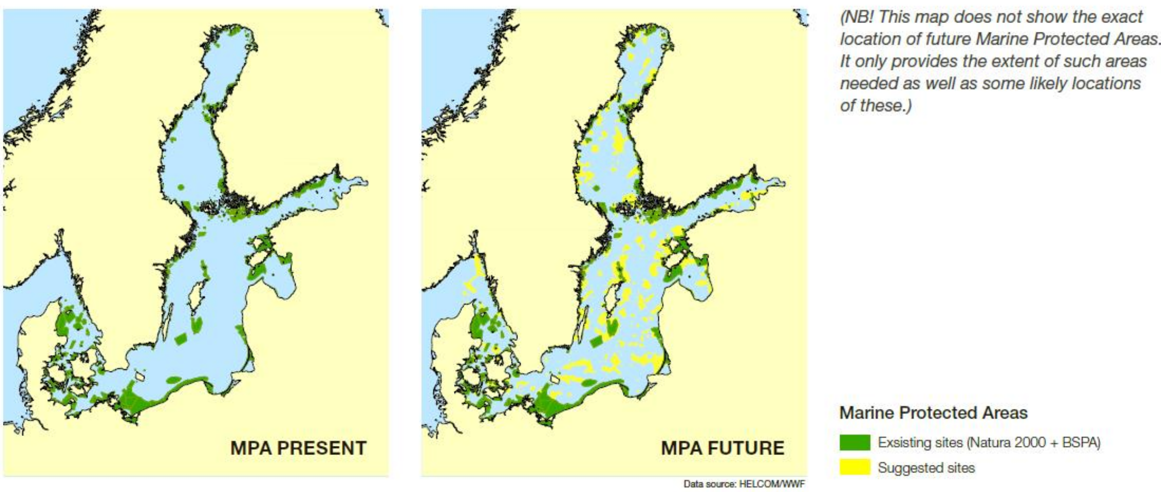


Fig. 11: Marine protected areas, existing and suggested sites (WWF 2010)

KEY MESSAGES

Despite of increased transport work the emissions of most pollutants could be reduced to a lower level than a decade ago. Only carbon emissions remained unchanged in the Baltic Sea.

MARPOL and BWMC provide guidelines and set standards regarding emission control, discharge of waste at sea and ballast water exchange in the Baltic Sea.

Specific solutions such as the “No Special Fee” system in ports and the avoidance of ballast water exchange of international voyages are mainly based on agreements between transnational maritime organizations and the Baltic Sea countries (especially the port authorities).

Both, the MSFD and HELCOM, request Baltic Sea countries to present a marine strategy ensuring a good environmental status of the Baltic Sea by 2020/2021.

HELCOM aims for additional MPAs, especially in offshore areas that have a lower protection coverage than the rest of the Baltic Sea.

4. Technological developments relevant for shipping in the Baltic Sea Region[1]

There is considerable pressure to look for an alternative to fossil fuels, both with regard to environmental issues and to become economic independent from the oil market. In a workshop related to the SHEBA project (Sustainable Shipping and Environment of the Baltic Sea region) stakeholders stated that they believe that in the long-term the shipping sector will shift towards hybrid propulsion systems (e.g. combining diesel electric with wind and solar). This shift would solve environmental problems and act as noise mitigation measure. Unfortunately the technology is not fully developed yet. Short- and medium-term solutions will rather focus on LNG technology as soon as the necessary port infrastructure is available. The EU-driven LNG Rotterdam Gothenburg initiative aims to set up a complete LNG supply for the Baltic Sea. Also the first LNG-fuelled cruise ferry Viking Grace started to operate the Turku-Stockholm route recently (Parsmo et al. 2016).

Since a number of years automation is on the agenda for all operative and technical processes of maritime shipping. The unmanned machinery space is already reality on board of many seagoing vessels. In this concept the engine room and its control room is only manned during normal day time working hours, while it is unmanned overnight. Yet, the concept for the navigational bridge of a ship is different. It is still manned at any time when the ship is underway. The manning level, however, has been significantly reduced with often only the watch keeping officer being on the bridge when the ship is in open waters. To facilitate such a reduced manning level several automated navigational systems have been introduced during the past years. Today, an advance voyage planning is carried out on the electronic chart display and information system (ECDIS). Together with an automatic track control, including autonomous course alterations and continuous track monitoring, to avoid undesired deviations from the pre-planned track, a ship could safely pass all known navigational hazards in a reasonable distance without running into danger of grounding on a well charted shoal or colliding with men made installation.

One of the main reasons to keep the navigational bridge of a ship manned at any time is collision avoidance with other ships or uncharted floating objects such as drifting cargo lost from another ship. The radar systems on board have become more sophisticated over the years. An automatic radar tracking function is a standard feature on modern seagoing vessels today. The detection of small targets, however, remains a significant challenge as the so-called clutter impairs the target detection in heavy sea or rain. Therefore, to supplement the radar based traffic surveillance and collision alerts, additional bridge equipment like the automatic identification system (AIS) has been introduced to assist the watch keeping officer in collision avoidance. However, an important precondition for all these on-board technics to unfold their effectiveness is

[1] With contributions from the BSH shipping division

spatial designations for ships traffic in congested and busy waters. This task is addressed by the acknowledged system of traffic separation schemes (TSS) and other ships routeing and reporting systems through the International Maritime Organization (IMO) as the competent United Nations' specialized agency dealing with maritime matters. For highly frequented sea areas like the German Bight or the Kadetrenden in the Baltic Sea the dedicated traffic lanes facilitate the separation of the main traffic directions. The ship reporting systems enable the vessel traffic service (VTS) centres to better monitor and manage the traffic. Both measures, therefore, provide for a significant reduction of the risk of a collision.

Presently the safe navigation of a ship, at least in near coastal, congested or busy areas, results from the cooperation between the ship's bridge team and the shore based supervision of the overall traffic situation. The e-navigation strategy of the IMO already targets at a significant shift. Modern broadband communication promises a future routeing and navigation that is more driven by information provided from the shore to the ship side. First simulated trials have been undertaken to proof the concept of transmission of the most safe and, therefore, also most efficient route from shore to ship. The optimised geometry of this track, however, might not follow the route taken traditionally. Future MSP should reflect this.

This sort of optimisation yet remains based on cooperation between humans at sea and ashore. But autonomous operation is already all around these days. Scientists, following examples from the industry for vehicles, trains or planes, are at the forefront to take the next step forward also for ships' navigation. First studies supporting the idea of unmanned ships have been presented. The EU funded Munin (Maritime Unmanned Navigation through Intelligence in Networks) project (http://www.unmanned-ship.org/munin) is just one example that the concept of unmanned ships is more than just reverie. Industry has already started different projects to test the operation of unmanned ships in practice. Although, these first attempts are presently limited to near coastal voyages.

If the concept of unmanned ships is to become reality, MSP could play a crucial role in its implementation. Today, traffic separation schemes and other ship routing systems of the IMO have been established in most of the major congested shipping areas of the world. MSP goes beyond these measures by providing space not only for shipping but for all the intended uses of a certain sea area. Tomorrow, with unmanned ships eventually sailing across the oceans, either autonomously or with the routeing and navigation controlled and executed from ashore, cross border, or even global, MSP would significantly enhance the safety at sea. For this type of remotely controlled or fully autonomous navigation MSP could prescribe the applicable special conditions in terms of safety margins or crossing prohibitions and put significant restrictions for other maritime stakeholders. Fixed corridors to be used mandatorily by ships, as for aircraft in aviation, could become a prerequisite for the concept of unmanned shipping together with reasonable safety distances to other spaces dedicated to e.g. fishery, military operations or deep sea mining. As a first step a comprehensive, and cross border, spatial planning for all near coastal areas could already today enhance safety of navigation as it clearly allocates space to different users. In this respect, sea areas like the Baltic Sea are prominent for a comprehensive MSP. For the future, global MSP could cater for the necessary separation between the various activities to take place at sea. The notion of MSP to anticipate future claims and requests for the expected uptake of remotely controlled or fully autonomous operation should, already today, evenly apply to the collaborative approach under the e-navigation strategy of the IMO.

The professional operations at sea might be easily covered by MSP. The recreational activities, however, could pose a challenge; mainly in near coastal areas or the semi-enclosed Baltic Sea, but also on the high sea, albeit to a much smaller extent. Spatial planning could allocate dedicated areas for recreational use. But the status of leisure craft, and therefore their required behaviour, while in transit to and from the allocated spaces would need to be defined. The same requirement for a clear definition applies to those ships still sailing with crew on the bridge. The conduct of vessels and the applicable rules for collision avoidance between manned and unmanned ships needs to be determined. Or, as one possible alternative, different traffic lanes could be allocated through MSP to avoid any undesired interference.

KEY MESSAGES

Short-term development focuses on facilitating the LNG technology to be able to shift to alternative fuels. In the long-term hybrid-propulsion systems are regarded as the most convenient solution.

Modern broadband communication promises a traffic information-based navigation which might not follow traditional shipping routes.

Autonomous operation of unmanned ships is still under scientific investigation but represents a real future option for commercial shipping.

The increasing level of automatization requires the designation of fixed shipping routes and consistent safety distances, as well as strict spatial rules for the recreational use of leisure crafts.

5. Shipping safety and security concerns in the Baltic Sea Region

To monitor shipping safety and maintain the safety at sea HELCOM annually compiles a report on shipping accidents in the Baltic Sea. Here all accidents in the territorial sea and the EEZ are reported that involve tankers > 150 GT and/or other ships > 400 GT. Accident types cover groundings, collisions, contacts with fixed or floating objects, pollution and on-board accidents (like fires, explosions or machinery damage). In 2013 150 of such accidents were reported. This was the highest number of accidents within the past ten years and an increase of 15% since 2010 (Fig. 12, Meski and Kaitaranta 2014).

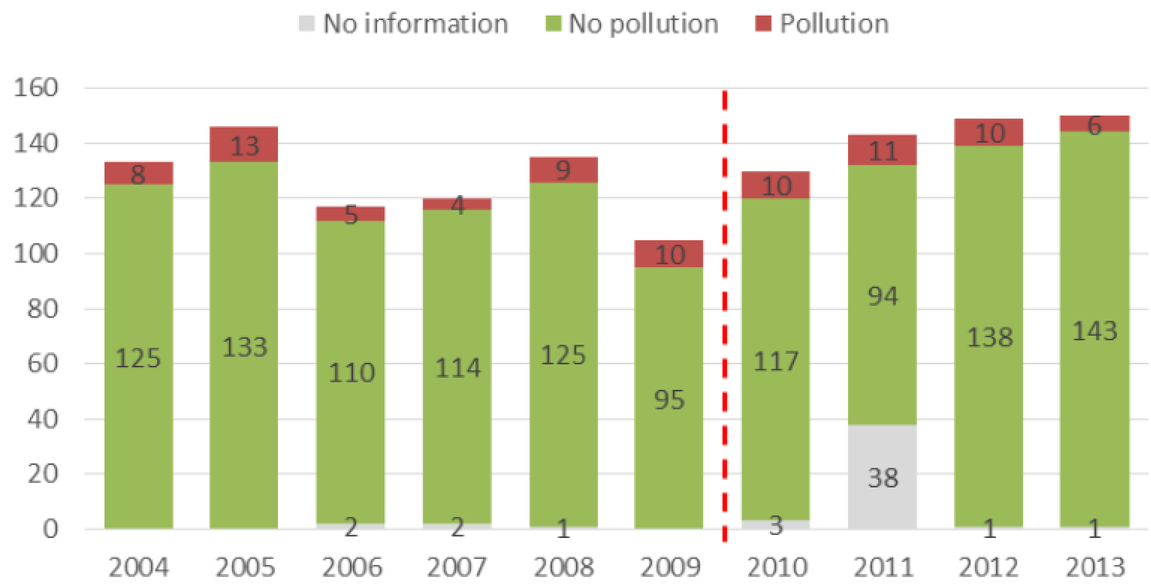


Fig. 12: Number of reported ship accidents in the period 2004 to 2013 (Meski and Kaitaranta 2014)

About half of the accidents happened to cargo ships corresponding well with the total number of cargo ships navigating the Baltic Sea. The number of passenger ships involved in ship accidents (25%) is somewhat higher than the portion of ships dedicated to passenger transport (11%) while the number of tanker accidents (10%) is smaller than the overall share of tankers in the Baltic Sea (20%) (Fig. 13, left).

For a large portion of accidents the initial cause remains unknown or is not reported to HELCOM (Fig. 13, right). However, the largest number of reported accident causes refers to human error (28%) followed by technical failures (19%). Of all the cases where humans failed most of them acted by mistake (62%) or unintentionally (16%). Nevertheless, an alarming portion of accidents occurred after intentional decisions to act against rules or plans (17%).

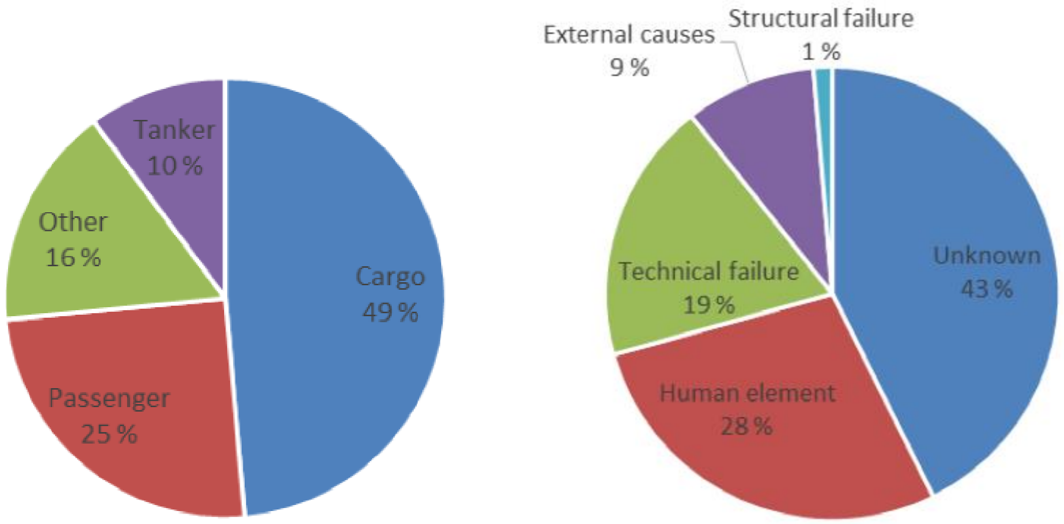


Fig. 13: Type of ships involved in accidents (left) and their causes (right) in the Baltic Sea, 2013 (Meski and Kaitaranta 2014)

Almost half of the accidents took place when ships were within ports or approached them. About 34% of the ship accidents occurred at open sea. Groundings accounted for 29% and were the most common type of accident (Fig. 14) although a decreasing trend compared to the previous years (36% in the period 2004-2013) is to observe. Still, due to its shallowness groundings occur more often in the Baltic Sea than elsewhere (Stankiewicz et al. 2010). Most of the groundings (37%) happened to ships with draught sizes < 7 m without pilotage on board. More than 60% of the ships in the Baltic Sea are smaller vessels of this size, less than 5% have a draught of 11 m or more. No groundings were recorded for ships > 15 m draught size (Meski and Kaitaranta 2014).

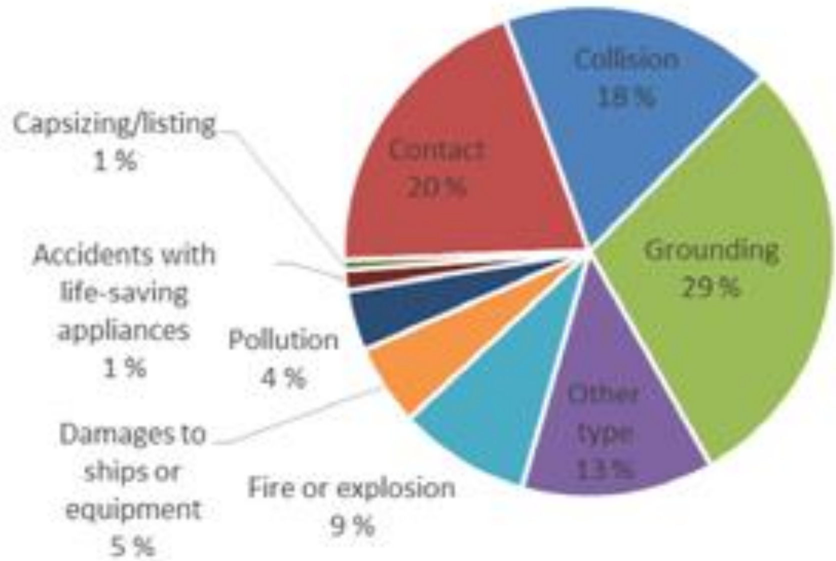


Fig. 14: Types of ship accidents in the Baltic Sea, 2013 (Meski and Kaitaranta 2014)

Combining the numbers for collisions with other vessels and contacts with fixed or floating objects, and comparing them to available average numbers of contact/collisions for the period 2004-2013 reveals an increasing trend from 35% to 38% respectively (Meski and Kaitaranta 2014).

Especially in the southwestern Baltic Sea the number of collisions has increased considerably in the recent years and represents more than 50% of all recorded ship accidents in 2013 (Fig. 15). The narrow areas in and around ports are traditionally the main hot spots. In other areas such as the Gulf of Finland the number of collision accidents has decreased over the same time.

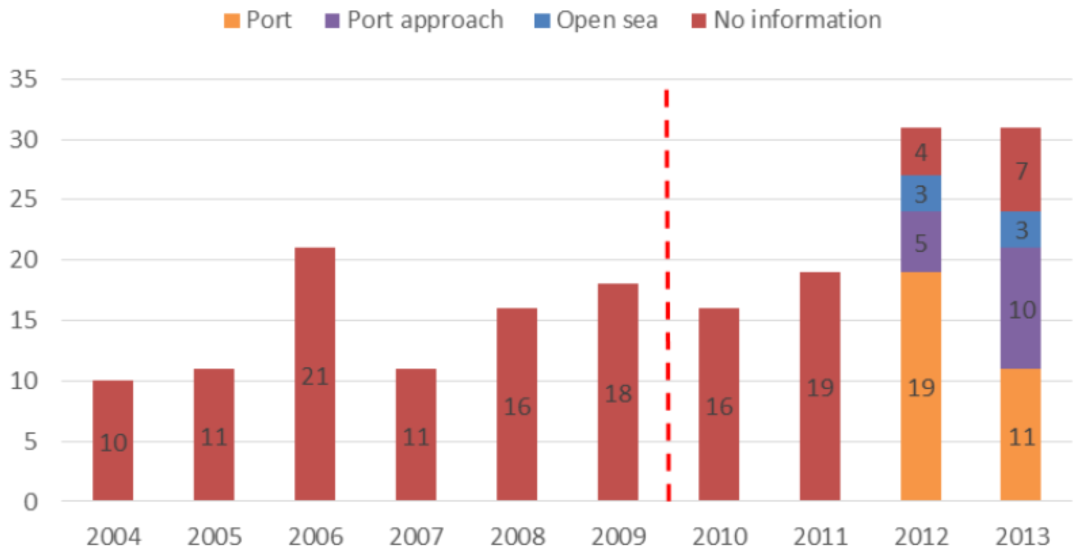


Fig. 15: Number of collision accidents in the southwestern Baltic Sea, 2004-2013 (Meski and Kaitaranta 2014)

The increasing number of collisions and the high portion of accidents related to contacts with fixed or floating objects can be related to the higher number of objects associated with the construction of offshore wind farms. HELCOM data from 2010 suggests that by 2030 about 2500 km² will be needed to accommodate all planned wind farms without yet including the usual safety distance recommended by UNCLOS of 500 m around each wind farm (WWF 2010). Besides the offshore installations themselves (like converter platforms and turbines) there is also a lot of service traffic in place (see Annex 1). In addition, subsea electricity cables need be laid and require additional sea space especially during the construction phase. To reduce the risk of cable damage due to emergency anchoring it is therefore also highly recommended to establish a cable protection zone for electricity cables and gas pipelines.

There is also a growing amount of leisure crafts in the Baltic Sea Region especially in the Scandinavian region (Tab. 2). About 3.5 million leisure boats are active in the Baltic Sea, mainly close to the coastal areas for recreational boating. It is likely that the number of boats will increase significantly in the coming years as the recreational boating market in Europe is expected to grow faster than the one in North America (Boteler et al. 2015). Any safety distances related to shipping must therefore also account for leisure traffic.

Tab. 2. National recreational boat ownership for some Baltic Sea countries (data: Plan Bleau 2011, Boteler et al. 2015)

Country	Population	Recreational boats per 1000 inhabitants	Total fleet	Sailboats	Inboard motor boats	Outboard motor boats and other rigid boats	Inflatable boats >2.5 m and >20 kg
Finland	5,300,000	143	734,100	19,000	93,000	620,000	2,100
Germany	82,438,000	5	441,530	120,475	88,932	232,123	n.a.
Poland	37,000,000	2	68,000	64,000	n.a.	n.a.	n.a.
Sweden	9,182,927	83	778,100	97,100	90,800	552,200	38,000

Important regulations for the safety at sea are stipulated in the Convention on the International Regulations for Preventing Collisions at Sea (COLREG), and the International Convention for the Safety of Life at Sea (SOLAS). In addition, the IMO has highlighted the Baltic Sea as a particularly sensitive marine area within which certain specific measures are to be taken, including traffic management (Kopti et al. 2016).

Multiple measures are undertaken to avoid groundings and collisions in the Baltic Sea Region. Different (mandatory) ship reporting systems for larger ships in the Baltic Sea that transmit data to the Vessel Traffic System (VTS) Centre to keep track of shipping traffic in the region. The use of pilotage systems is recommended by IMO for loaded oil and chemical tankers, gas carriers and ships loaded with nuclear fuels of high-level radioactive wastes (INF cargoes) (Stankiewicz 2010).

There exists a transit route (Route T) for deep draught ships passing through the shallow entrances of Kattegat, the Great Belt and Western Baltic (with a maximal depth of ~17m). Smaller additional deep water routes are also available and constantly maintained to enable larger cargo ships to safely navigate through the Baltic Sea. Additionally there are a number of traffic separation schemes established and adopted by IMO in the Baltic Sea (Fig. 16). These are commonly in areas difficult to navigate where corridors for shipping are narrow and bending.

To ensure safety of winter navigation two websites (www.baltice.org, www.bsis-ice.de) are available that inform about ice conditions, traffic restrictions, icebreakers and other information relevant for navigation (Stankiewicz 2010).

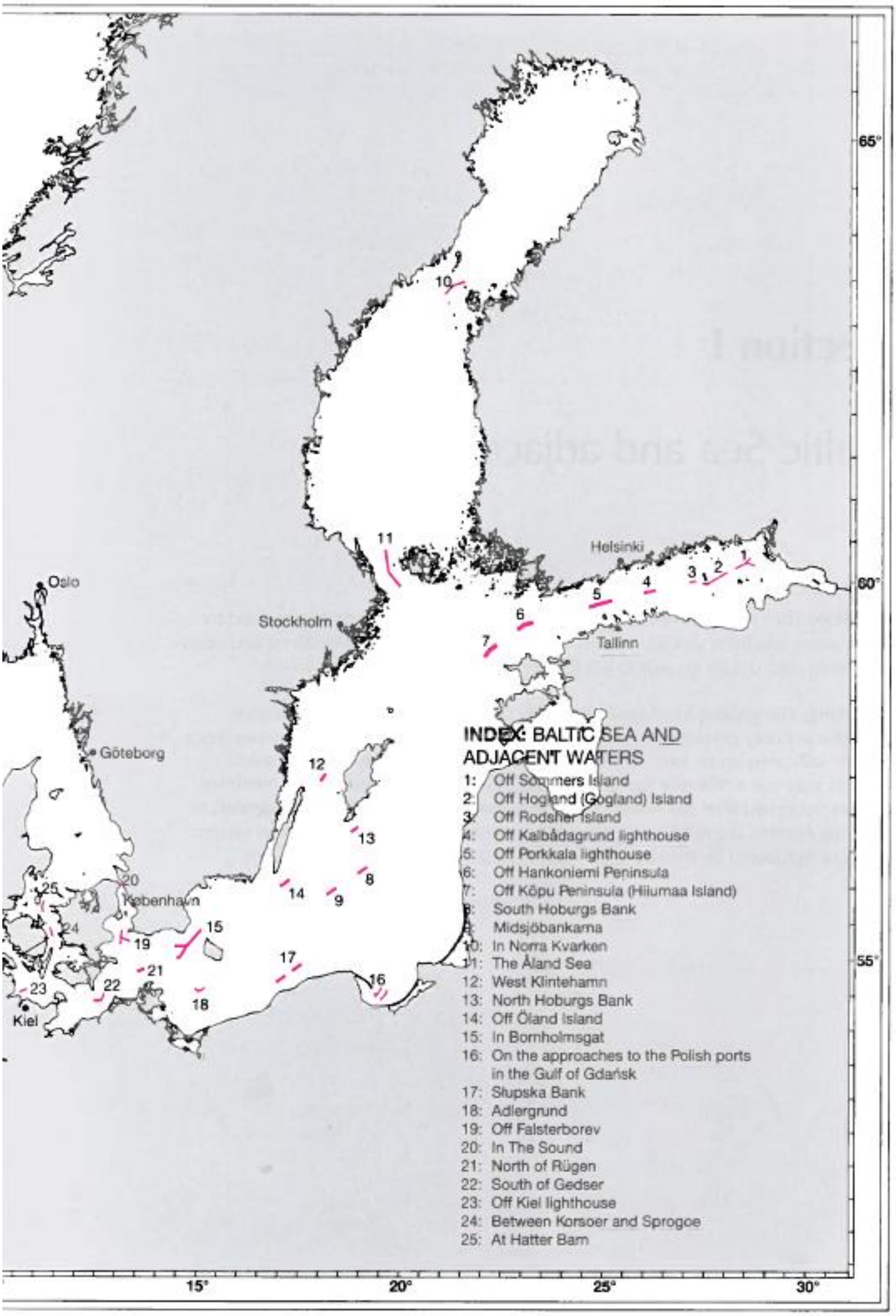


Fig. 16: Traffic separation schemes in the Baltic Sea (IMO 2015)

KEY MESSAGES

The number of shipping accidents increased over the past years, with cargo ships most frequently involved followed by passenger ships and tankers.

Human error is the main cause for accidents and is mainly related to unintentional action. However, 17% of the accidents occurred after intentional decisions against common rules and plans.

Groundings account for 29% of all accidents and mainly involve small vessels with minor draught sizes that lack on-board pilotage systems.

The number of collisions with other vessels and contacts to fixed or floating objects has increased over the past years and account for 38% of all accidents in 2013. The southwestern Baltic Sea is the main hotspot for these types of accidents.

The offshore wind energy sector will have high spatial demands in the future especially when ample safety distances are assigned to all components and additional space is reserved for the related service traffic.

The expected increase in leisure traffic will also demand more space which should be possible dedicated to an expansion of safety distances to keep the commercial shipping traffic undisturbed.

IMO, COLREG and SOLAS are important authorities for traffic management in the Baltic Sea and the designation of deep water routes and traffic separation schemes accordingly.

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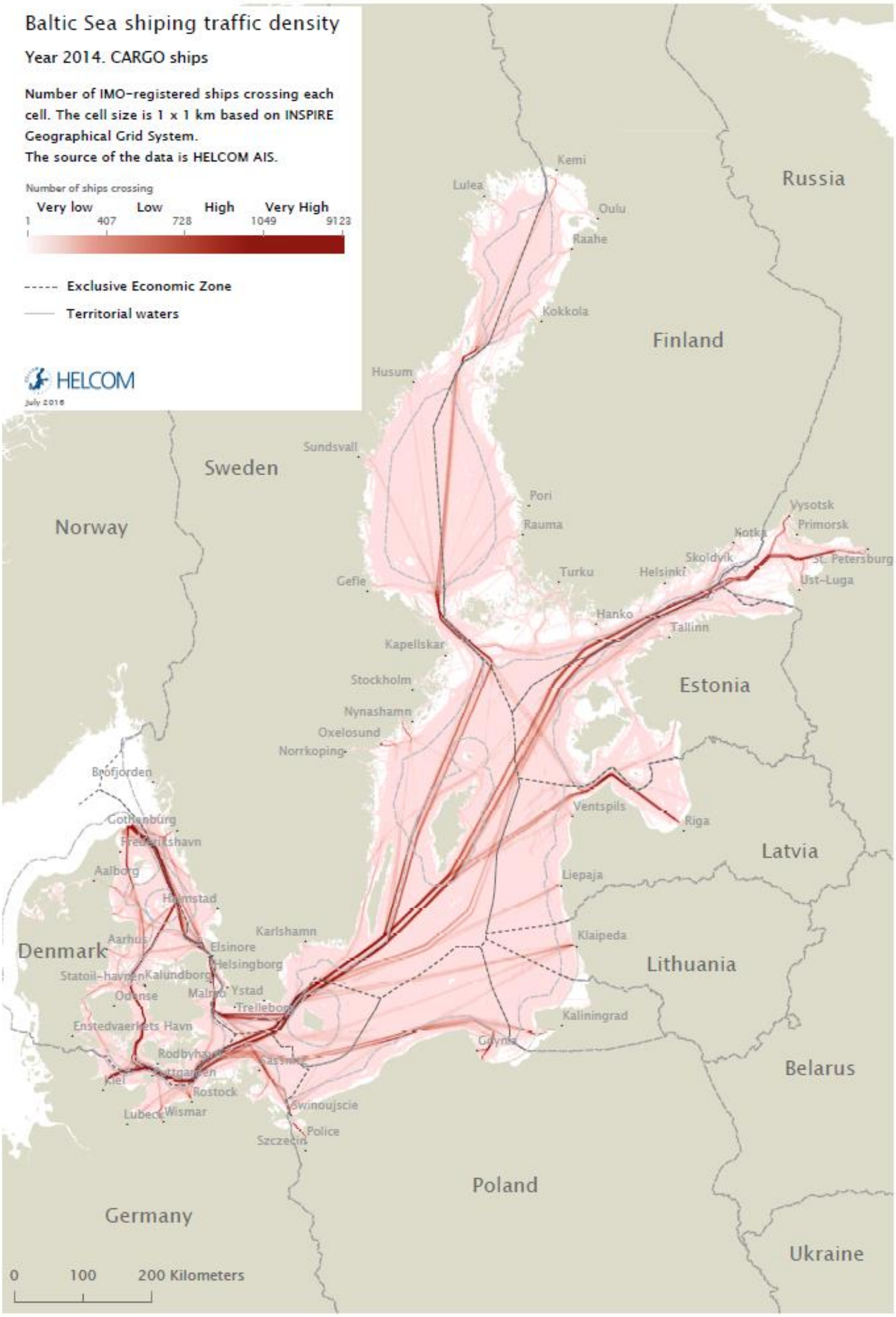
Annex I


Baltic Sea shiping traffic density
Year 2014. CARGO ships
Number of IMO-registered ships crossing each cell. The cell size is 1 x 1 km based on INSPIRE Geographical Grid System.
The source of the data is HELCOM AIS.
Number of ships crossing
Very low
Low
High
Very High
1
407
728
1049
9123
Exclusive Economic Zone
Territorial waters
HELCOM
Russia
Finland
Sweden
Norway
Estonia
Latvia
Lithuania
Denmark
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Poland
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Sundsvall
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Oxelosund
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Klaipeda
Aarhus
Elsinore
Helsingborg
Kalundborg
Odense
Malmo
Ystad
Trelleborg
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Police
Szczecin
Lubeck
Wismar
Kiel
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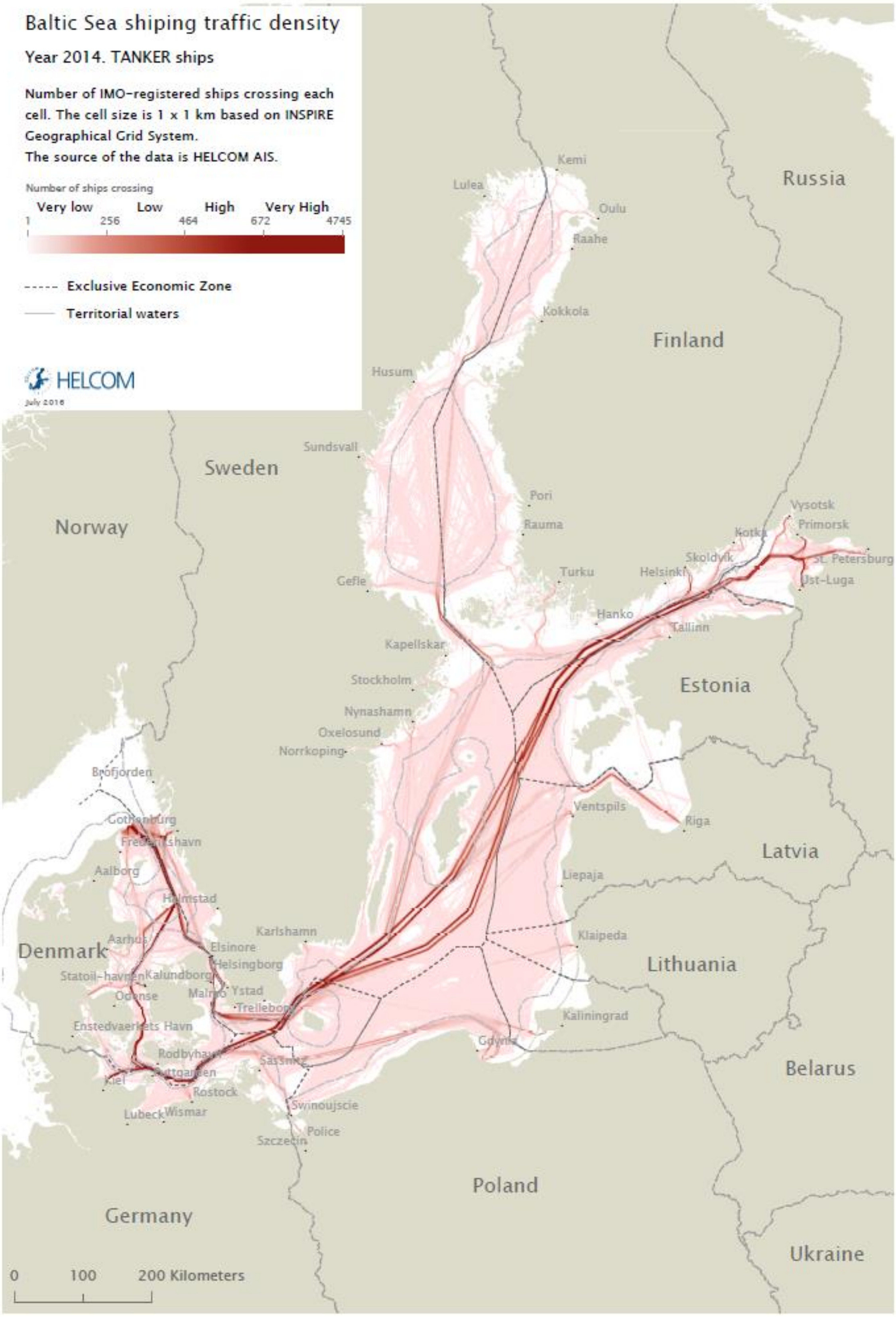
100
200 Kilometers


Baltic Sea shiping traffic density
Year 2014. TANKER ships
Number of IMO-registered ships crossing each cell. The cell size is 1 x 1 km based on INSPIRE Geographical Grid System.
The source of the data is HELCOM AIS.
Number of ships crossing
Very low
Low
High
Very High
1
256
464
672
4745
Exclusive Economic Zone
Territorial waters
HELCOM
July 2016
Russia
Finland
Sweden
Norway
Estonia
Latvia
Lithuania
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Ukraine
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Enstedvaerkets Havn
Kaliningrad
Gdynia
Rodbyhavn
Sassnitz
Puttgarden
Kiel
Rostock
Lubeck
Wismar
Swinoujscie
Police
Szczecin
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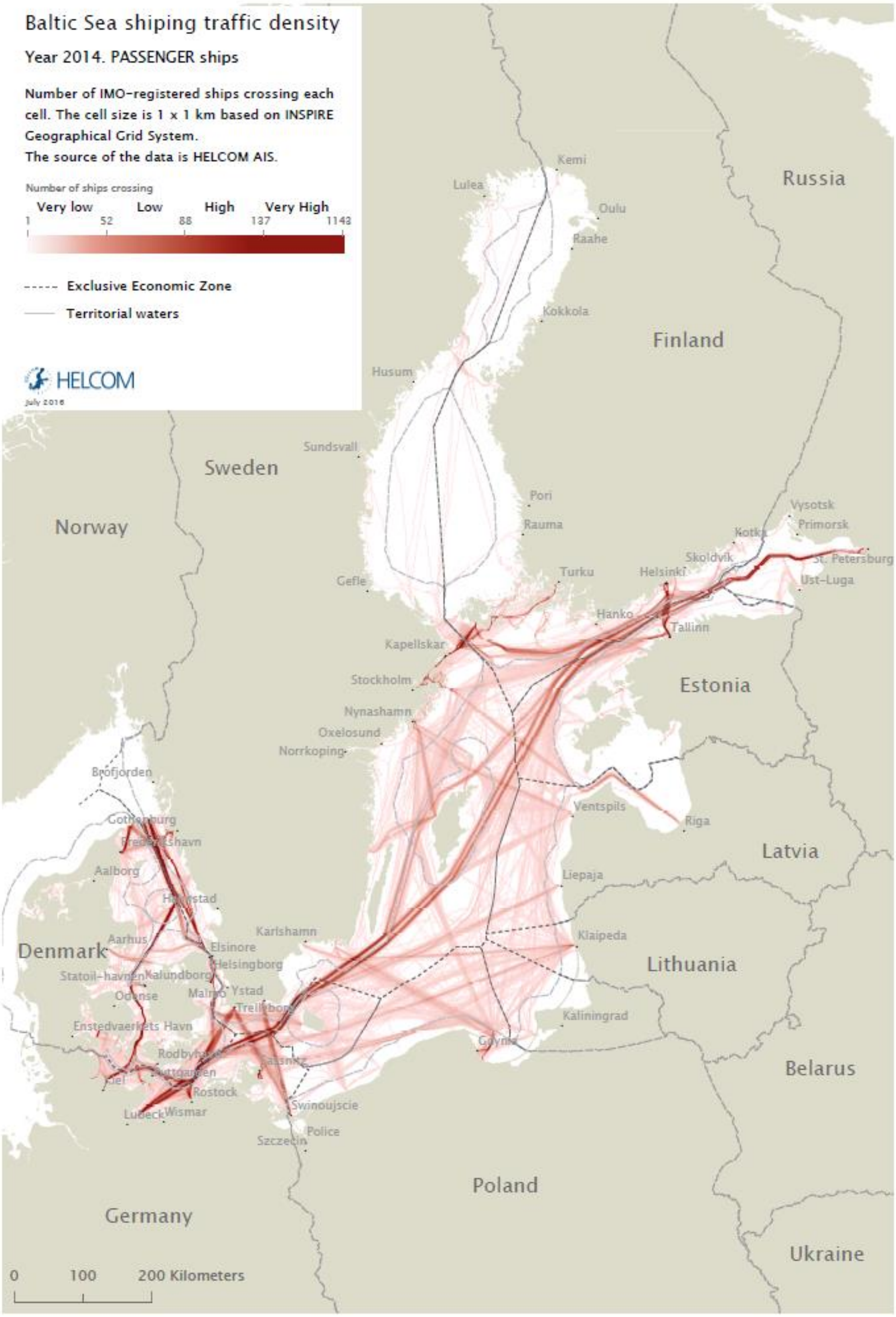
200 Kilometers


Baltic Sea shiping traffic density
Year 2014. PASSENGER ships
Number of IMO-registered ships crossing each cell. The cell size is 1 x 1 km based on INSPIRE Geographical Grid System.
The source of the data is HELCOM AIS.
Number of ships crossing
Very low
Low
High
Very High
1
52
88
137
1143
Exclusive Economic Zone
Territorial waters
HELCOM
July 2016
Russia
Finland
Sweden
Norway
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Police
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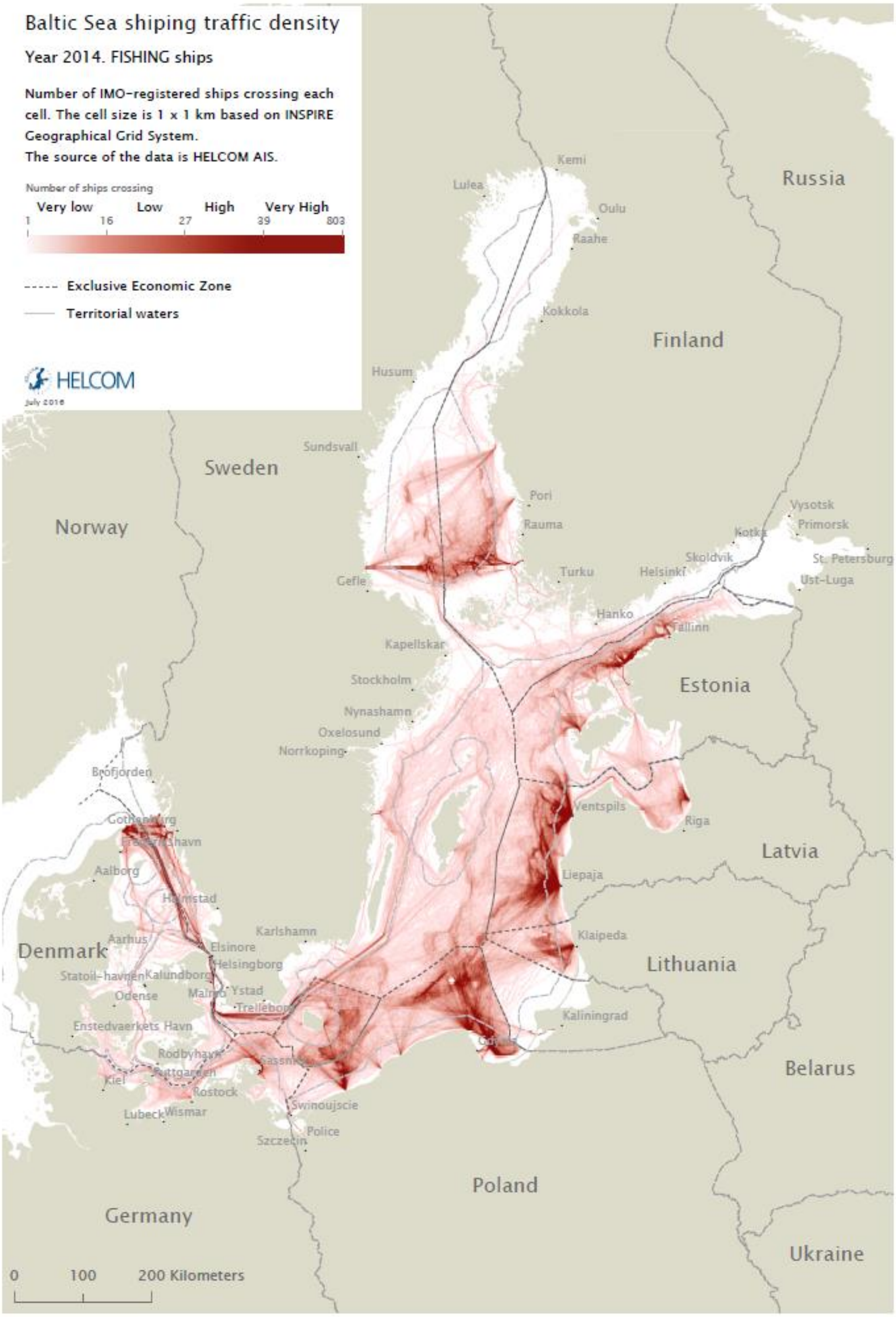
Baltic Sea shiping traffic density
Year 2014. FISHING ships
Number of IMO-registered ships crossing each cell. The cell size is 1 x 1 km based on INSPIRE Geographical Grid System.
The source of the data is HELCOM AIS.
Number of ships crossing
Very low
Low
High
Very High
1
16
27
39
803
Exclusive Economic Zone
Territorial waters
HELCOM
July 2016
Russia
Finland
Sweden
Norway
Estonia
Latvia
Lithuania
Denmark
Belarus
Poland
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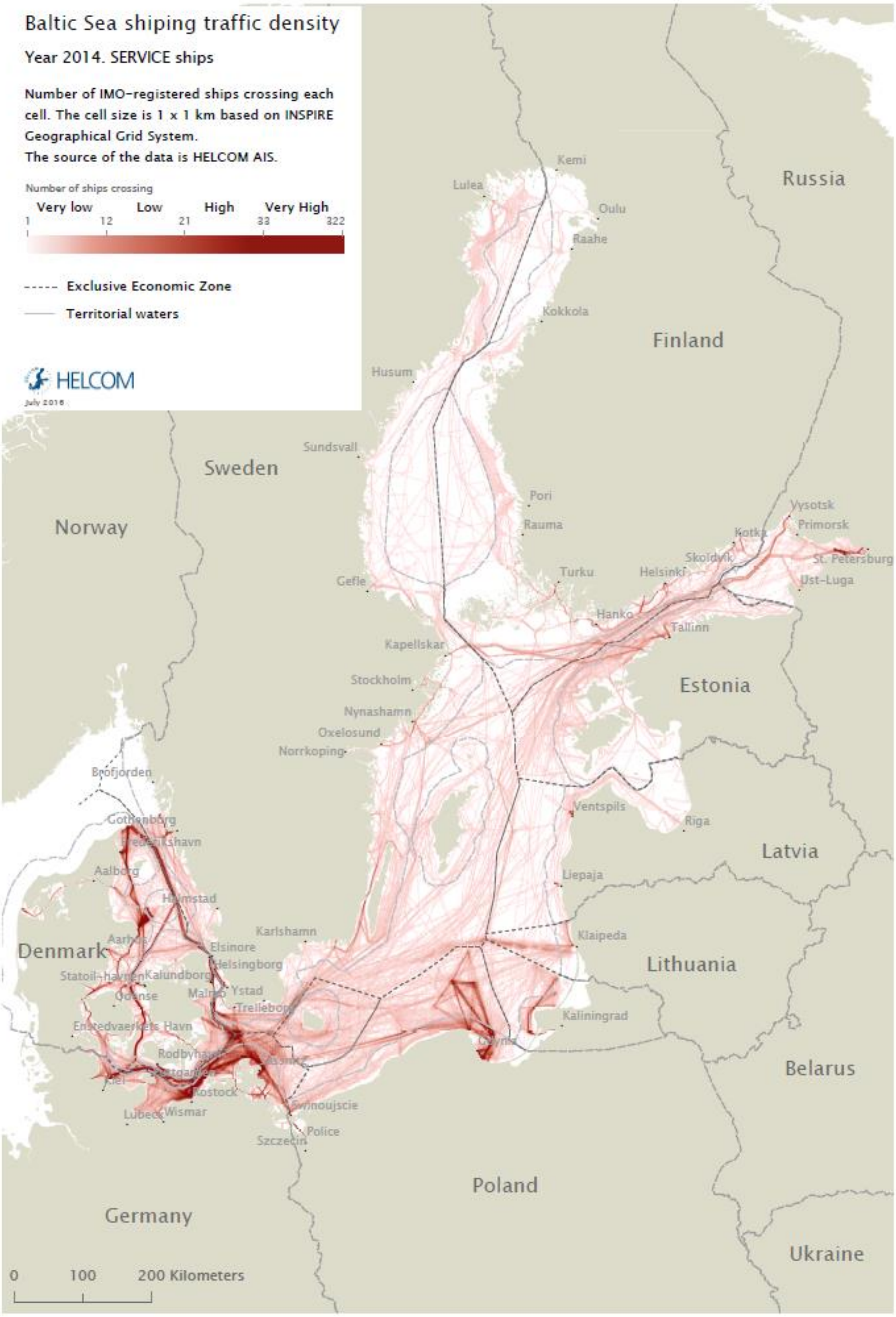
Baltic Sea shiping traffic density
Year 2014. SERVICE ships
Number of IMO-registered ships crossing each cell. The cell size is 1 x 1 km based on INSPIRE Geographical Grid System.
The source of the data is HELCOM AIS.
Number of ships crossing
Very low
Low
High
Very High
1
12
21
33
322
Exclusive Economic Zone
Territorial waters
HELCOM
Russia
Finland
Sweden
Norway
Estonia
Latvia
Lithuania
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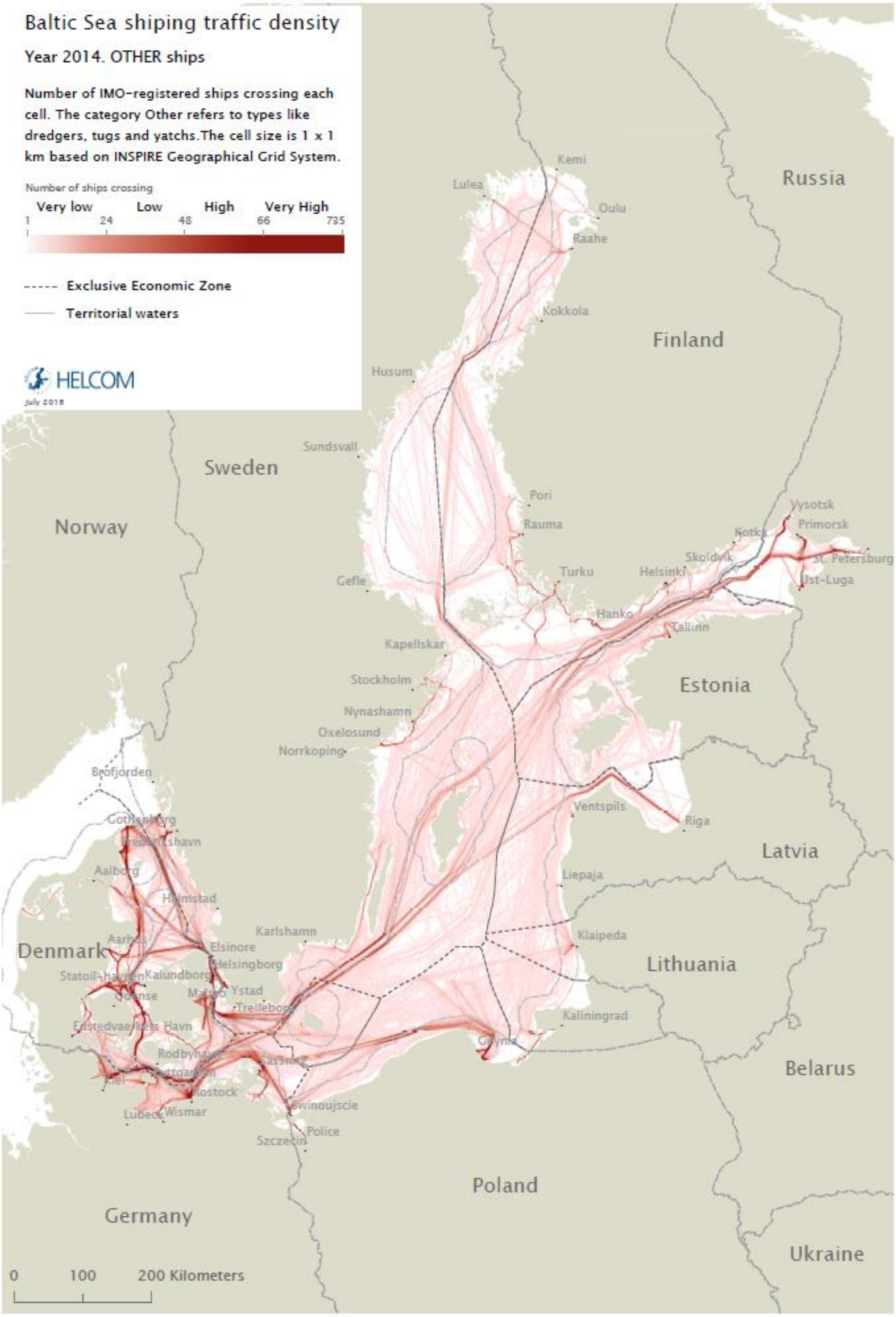
Baltic Sea shiping traffic density
Year 2014. OTHER ships
Number of IMO-registered ships crossing each cell. The category Other refers to types like dredgers, tugs and yatchs.The cell size is 1 x 1 km based on INSPIRE Geographical Grid System.
Number of ships crossing
Very low
Low
High
Very High
1
24
48
66
735
Exclusive Economic Zone
Territorial waters
HELCOM
July 2016
Russia
Finland
Sweden
Norway
Estonia
Latvia
Lithuania
Denmark
Belarus
Poland
Germany
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Annex II

Baltic SCOPE recommendations regarding shipping on transboundary level

Summary of relevant recommendations for MSP with regard to shipping in the Baltic Sea (Baltic SCOPE 2015, Kopti et al. 2016)

- Address sea and navigation requirements already during preparation and planning of offshore installations
- Avoid rerouting of existing main routes and in and/or adjacent to existing TSSs
- Potential changes of international main routes can only be carried out through IMO
- Establish a safety distance to fairways, routes, and TSSSs
- Mark offshore facilities consistently, e.g. by following IALA O-139
- Consider separation of sea traffic if there is conflict between commercial vessels and leisure craft, e.g. the safety distances must include space for leisure craft
- Perform risk assessment for major hazards following Guideline 1018 and recognised risk assessment methods, e.g. the IALA risk management toolbox or the IMO adopted Formal Safety Assessment methodology (FSA)
- New routing systems, or amendments of existing ones, must be evaluated by IMO's Sub-Committee on Navigation, Communication and Search and Rescue (NCSR), and adopted by MSC
- Align corridors/areas of shipping coherent across the borders and avoid connection caps
- Involve more international organizations/stakeholders (IMO, HELCOM, etc.) to ensure a harmonized representation of shipping data
- Take into account trends of shipping intensity, different types of shipping, countries strategical development plans in terms of connections, shipping in different weather conditions, when assigning new shipping corridors
- Enhance transboundary communication between equal levels of organizations
- Keep in mind planning is done for the decision makers and shipping data in marine space should be simplified during the planning process

Annex III

Definitions

Priority areas (for shipping): Other uses (than shipping) are prohibited in such areas unless they are compatible with the priority uses. The designation of areas (for shipping) takes account of the principle of international law attributing priority to these uses; recognized shipping routes that are indispensable for international shipping constitute the framework of the overall planning concept (BSH definition)

Reservation areas (for shipping): Designated areas (for shipping) that are considered particularly important as compared to spatially significant competing uses (BSH definition)

Recommended route (shipping route): A route of undefined width, for the convenience of ships in transit, which is often marked by centreline buoys (IMO definition)

Deep-water route: A route within defined limits which has been accurately surveyed for clearance of sea bottom and submerged articles (IMO definition)

Ship traffic lane: An area within defined limits in which one-way traffic is established. natural obstacles, including those forming separation zones, may constitute a boundary (IMO definition)

Traffic Separation Scheme (TSS): A routing measure aimed at the separation of opposing streams of traffic by appropriate means and by the establishment of traffic lanes (IMO definition)

Area to be avoided: An area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or by certain classes of ships (IMO definition)

Shipping corridor: Refers to all (defined) areas designated for shipping in maritime spatial plans (project definition)

Ship traffic gate: At the intersection of two maritime spatial plans a defined section where two shipping corridors meet (project definition)

Sources

IMO - http://www.imo.org/en/OurWork/safety/navigation/pages/shipsrouteing.aspx
BSH - http://www.bsh.de/en/Marine_uses/Spatial_Planning_in_the_German_EEZ/documents2/ordinance_baltic_sea.pdf

EUROPEAN UNION

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Mecklenburg Vorpommern
Ministry of Energy, Infrastructure and State Development

Liikennevirasto
Finnish Transport Agency

Swedish Agency for Marine and Water Management

NHTV Breda University of Applied Sciences

SYKE

Vides aizsardzības un reģionālās attīstības ministrija

Aalborg University – Breaking New Ground

Maritime Institute in Gdańsk

VASAB
VISION & STRATEGIES AROUND THE BALTIC SEA

Urząd Morski w Gdyni

Tartu Ülikool – Universitas Tartuensis 1632