Mitigation of environmental impact from shipping

Applying Marine Spatial Planning methodology in the Baltic Sea

Erika Norén

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Internal supervisor: Maria Hansson, Center for Environmental and Climate Research, Lund University

External supervisor: Jonas Pålsson, World Maritime University

Abstract

In April 2014, the European Parliament endorsed a new Directive on Maritime Spatial Planning, a way to analyse and organize marine areas in an economically efficient and sustainable way. The Spatial planning includes mapping of all marine activities, such as aquaculture, shipping, nature conservation, military and wind turbines. Many interests are competing for the same geographical areas, and the conflict is often between economic and environmental interests. One dispute is between shipping and protected areas. Dynamic route planning is a way for vessels to adjust the shipping routes to various aspects, such as ecological sensitive areas.

The focus of this study is to collect basic information and to mark on maps where protected areas with sensitive species exist in the Baltic Sea, with rough estimates of critical seasons that can be used in dynamic route planning for shipping. It will include recommendations for possible restrictions in various sensitive areas.

This study shows that the environmental values most exposed to shipping in the Baltic Sea are birds, seals and porpoises. Oil spills are the greatest threat to sea-bird populations, since a high density of the species population can occur in the same geographical area during some seasons. Seals are especially vulnerable during winter when they rest and breed on the ice, where ships might cross and disturb or harm the populations. Passing vessels can physically injure porpoises, and the noise from the engines and sonar can disrupt their communication and scare them away from areas that might be important for their breeding and feeding.

The main conclusions and recommendations are that the most important areas for porpoises should have a speed limit. The seal areas should have restricted shipping routes during winter ice conditions in the Gulf of Finland. Some of the sea-bird areas should be avoided completely during the seasons when a high density of the species population occurs there.

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1 Introduction

Marine Spatial Planning, MSP, was recently introduced on the EU Agenda as a method for a more economically efficient and sustainable way of managing the marine resources (Douvere, 2008). A new directive (COM/2013/133/FINAL) has been endorsed by the European parliament, suggesting that a marine spatial planning process should be implemented in all member states. This way of planning geographical areas and activities has existed on land for a long time, but is a bit different in the marine environment, and also between the different European regional seas (Douvere, 2008). One of the European marine areas is the Baltic Sea, an enclosed sea area with a limited water exchange with the Atlantic (BalticSea2020, 2013). The brackish water gives a special environment with a very unique and sensitive flora and fauna. Both marine and freshwater species exists but are very easily affected by environmental changes, as many species live in a level of water salinity they can hardly survive in (Havs- och vattenmyndigheten, 2013). Despite all marine species, it is an important breeding and wintering area for many European waterbird populations (Larsson, 2012). The whole Baltic Sea Area has been designated as a "Particularly Sensitive Sea Area" by the United Nations International Maritime Organization, IMO, which means that it is particularly sensitive to maritime activities and needs special protection due to ecological, socio-economical or scientific reasons (IMO, 2014). Certain measures can be applied in these areas regarding the maritime activities taking place, such as route planning or strict applications of ship equipment. Shipping is increasing steadily in the Baltic Sea that today has some of the busiest shipping routes in the world. There is a high risk for accidents due to a large number of islands, narrow passages and partly ice cover during winter (BalticSea2020, 2013). Many parts in the Baltic Sea are therefor difficult to navigate due to these circumstances (Mäkinen et al., 2003).

In 2007, The Helsinki Commission, HELCOM, adopted the Baltic Sea Action Plan with the aim to improve and restore the current ecological conditions in the Baltic Sea by year 2021 (HELCOM, 2007). The plan aims at providing a basis with the current scientific knowledge and management method and further on the instruments to implement this in a strategic way to achieve these goals of an undisturbed sustainable ecological environment (HELCOM, 2009). The EU Marine Strategy Framework Directive, MSFD (2008/56/EC) is currently under implementation in Baltic EU member states. In July 2015, EU member states will present their programme of measures for an ecosystem-based approach of the marine environment. One of the descriptor to achieve Good Environmental Status, GES, for the marine environment is "underwater noise" that might be harmful to marine mammals. Measures to control underwater noise are a part that is supposed to be presented and implemented after year 2015.

More regulations and legal frameworks for the marine areas might still be needed to achieve the environmental goals for the Baltic Sea. The new EU directive regarding Marine Spatial Planning is a step towards a more structured way of managing our marine environment. In this process, all member states need to map out the marine activities taking place in their national waters. This will help to organize the marine space in a more economically efficient and sustainable way, and it could also help in the conflict resolution between different interests. One big conflict is between economic and environmental interests, now that protected areas are more included in the spatial planning process. One factor that has a huge impact on these areas and protected values is shipping. The risk of oil spills, air emissions, dumping of solid waste, noise from engines and sonar, minor oil leaks etc. have a direct impact on the surrounding environment.

Data regarding protected areas and species have never been collected and compiled with the purpose of being used for navigation before. This report should be seen as a first step trying to collect and transfer relevant, basic data of marine protected areas in the Baltic Sea in a format that can be used for shipping. Risk assessments of areas sensitive for oil accidents have been done before, e.g. in the HELCOM project (Admiral Danish Fleet HQ, 2012), but here the different species have been merged together in categories with a ranking stating the protective values as a whole. In this report the focus will be on if areas with different species are affected differently and therefor needs different restrictions and regulations. There is no

available technique to clean up oil spills from seas with ice-cover, like the Arctic Sea. This fact is also relevant for the Baltic Sea, which is partly covered with ice during winter (WWF, 2007).

1.1 Marine Spatial Planning and Shipping

The European Union have recently endorsed a directive about *Maritime Spatial Planning* (COM/2013/133/FINAL), a tool to help member states coordinate their activities in marine and coastal areas. Due to the rapidly increasing demand for maritime space for new activities, such as a growing interest in renewable energy and food production, there is a need for a structured way of managing and coordinating the marine areas in a sustainable and efficient way (Douvere, 2008). With the variety and amount of marine activities taking place today, conflicts in areas often arise. Fishing grounds, aquaculture farms, marine protected areas, wind power stations, underwater infrastructure of pipelines and cables, shipping lanes for transport of oil, gas and cargo sometimes have interests in the same geographical space. The new directive on Maritime Spatial Planning is also a tool for avoiding and solving these conflicts. The minimum requirement of the directive is to draw up all national maritime plans, including all human activities and the most efficient possible way of managing them. Implementing maritime spatial planning in the member states is one possible way to increase the international co-operation in the Baltic Sea.

Shipping is the main marine activity that crosses international borders, and the marine traffic has a huge impact on the surrounding and global environment (Fuglestvedt et al., 2009). A big part of the global greenhouse gas emissions are from ships, oil spills and solid waste is dumped and noise from the vessels might affect sensitive areas close to the busiest routes. A part of the big work of managing our marine areas would be dynamic route planning, a way to plan shipping routes while taking into account parameters affecting the speed such as winds and water currents, improve the passage planning and the impact on sensitive or protected areas (Larsson, 2012). Summarized, an increased exchange of information that vessels can take into account while planning there routes to use as little fuel as possible and avoid areas that are more sensitive to disturbance or potential risks of accidents.

There are many risk factors when it comes to shipping. The most devastating one is the risk of major oil spills and accidents. It is hard to create risk assessments of which areas that might be more vulnerable to this, since we are lacking the knowledge of how it might impact all different areas in the Baltic Sea. The contaminants from oil, PAH (polycyclic aromatic hydrocarbons) in particular, are toxic to marine life (Michel, 1992). When an accident has already occurred, it is also very difficult to clean up depending on which season it occurs (WWF, 2007). In the Baltic Sea, the water can freeze in some areas, and there are no available techniques for cleaning those areas under ice conditions. The toxins from oil can last for several years in the sediments as well. It's one of the main problems for water bird populations, where hundreds of thousands of birds can get killed by the same accident. It's also very common that oil leaks continuously from the engine and mix with water in the bilge, so minor oil spills occur on a daily basis. Solid waste also gets dumped in the ocean due to lack of facilities to take care of and recycle this when at sea and in big ports. Greywater and blackwater from the sewage and cleaning is also a major reason for pollution from ships (Herz & Davis, 2002). This can contain various bacteria, viruses, parasites and nutrients. Ballast water taken on by ships in large tankers and bulk cargo in one port are often discharged in the next port when reloading cargo. This water can include species and foreign biological material and invasive species to the area where it is released, which can damage the marine ecosystems. Both the noise from and the physical presence from vessels can harm marine species, or animals relying on sound for communication (Mortensen et al., 2011).

The mechanical effects of maritime traffic are the waves, streams, suction and pressure caused by vessels, which can erode shoreline areas. Increased traffic causes more noise and emissions that may have an impact on life forms in the area. Increased marine traffic also leads to an increase in the risk for accidents (Ministry of Agriculture and Forestry, 2007).

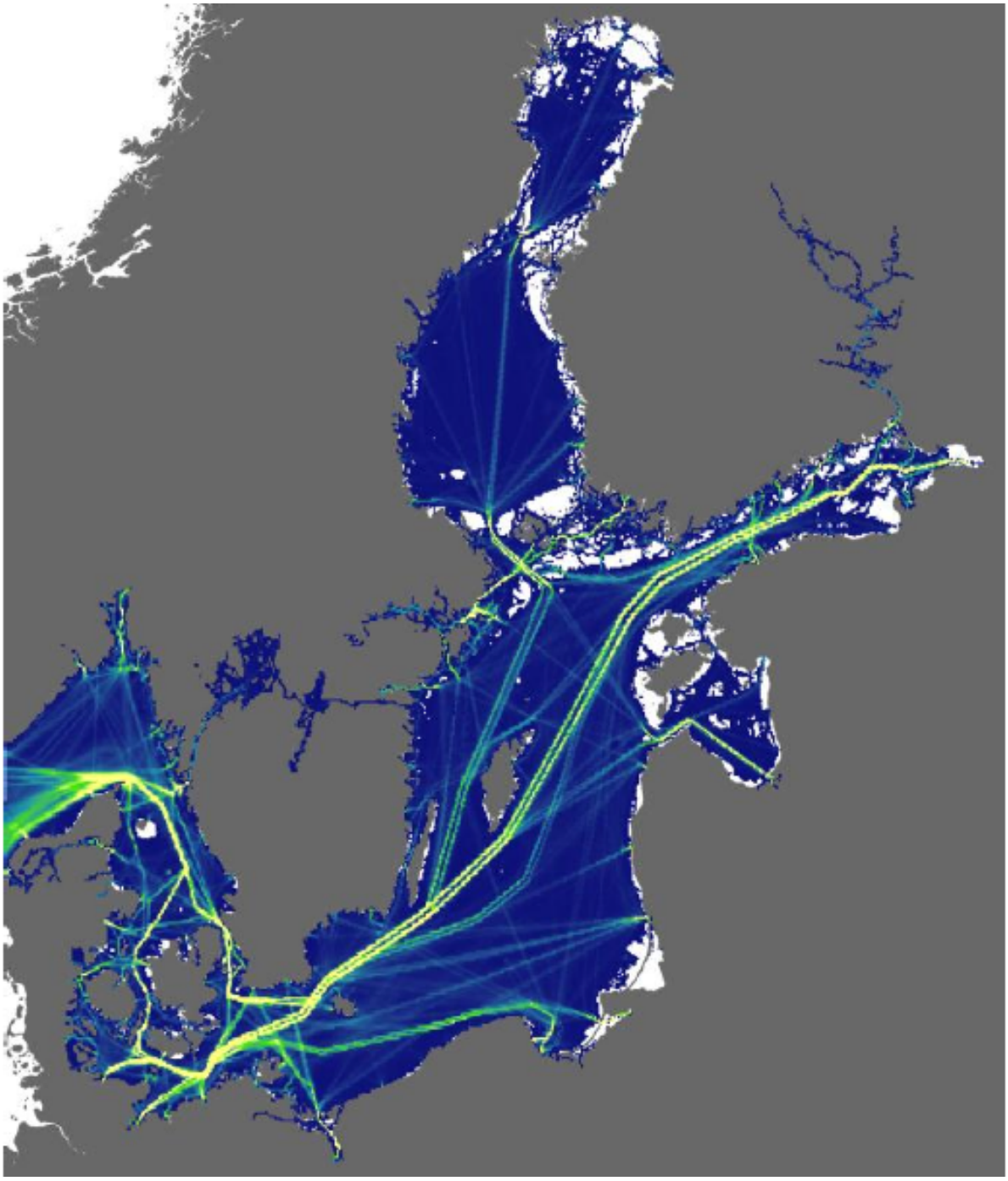

Figure 1. Shipping routes in the Baltic Sea, based on the average monthly density during 2011.
The highlighted yellow lanes represents the busiest routes. Map retrieved from the publication *"Report on shippng accidents in the Baltic Sea during 2011",* HELCOM. 2011. Available online http://www.helcom.fi/Lists/Publications/Shipping_accidents_2011.pdf

1.2 Marine Protected Areas in the Baltic Sea

Natura 2000 is a network of protected areas that are designated for various bio-geographical regions. It is based on the Birds Directive (Directive 2009/147/EC) adopted in 1979 and amended in 2009 and also the Habitats Directive (Directive 92/43/EEC) adopted in 1992. The network applies to bird sites and habitat sites both on land and in marine areas and is a part of the EU nature and biodiversity policy. The network provides legal protection to all the appointed sites. Natura 2000 areas are not strict nature reserves that prohibit human activities; restrictions are made for each specific case if needed. The protection status is primarily to ensure a sustainable management of the areas in the future.

The Helsinki Commission, HELCOM, have created another network of Baltic Sea Protected Areas (BSPA). It focuses on the marine and coastal areas in the Baltic Sea and most of the designated areas existing today are also Natura 2000 sites, but many times with slightly different geographical shapes and limits. Only the marine and coastal parts of them are included in the BSPA network. The BSPA provides a specific management plan focusing on marine activities and threats, on top of the Natura 2000 management plan. In year 2013, 64% of the Natura 2000 areas in the Baltic Sea region were designated as BSPAs. The BSPA designation does not offer the same protection status and regulation as the Natura 2000 sites, which EU member states have a responsibility to ensure management and conservation of (European Commission, 2014). BSPAs and Natura 2000 sites that overlap often have different geographical coordinates, since Natura 2000 areas may cover inland areas as well, while BSPAs are restricted to the coastal zone and marine area. Natura 2000 network protects certain natural habitats and species at EU level, whereas the BSPAs network aims to protect marine and coastal habitats and species specific to the Baltic Sea environment (HELCOM, 2013).

Marine protected areas are one of the marine activities to be included as one of the marine activities that have to be marked on the maps in Marine Spatial Planning. Today, the Baltic Sea Protected Area Status does not prohibit any other activities within these areas, and there is no legal support if marine activities should harm these protective values in any way. There are management plants for the areas, adopted on national political level that should be implemented on Baltic level. The Natura 2000 network has special regulations for each area, appointed by the country that designated the area. The only sensitive areas marked on nautical maps today are the areas appointed by IMO as Areas To Be Avoided, ATBA. Unfortunately, the geographical boundaries of these three different area classifications do not match each other (HELCOM, 2013, Larsson, 2012).

The main threats in all BSPAs were listed and presented by HELCOM in 2013. The marine activities stated as main potential threats in the future were oil pollution, alien species and pollution from shipping (see Figure 2, page 5) (HELCOM, 2013). Unfortunately, the management plans and regulations within these areas do not match the actual threats. Even if the threats that were most frequently mentioned to have a main impact in these areas in the future, e.g. shipping, is one of the least restricted activities within these areas according to the same report (see Figure 3, page 6).

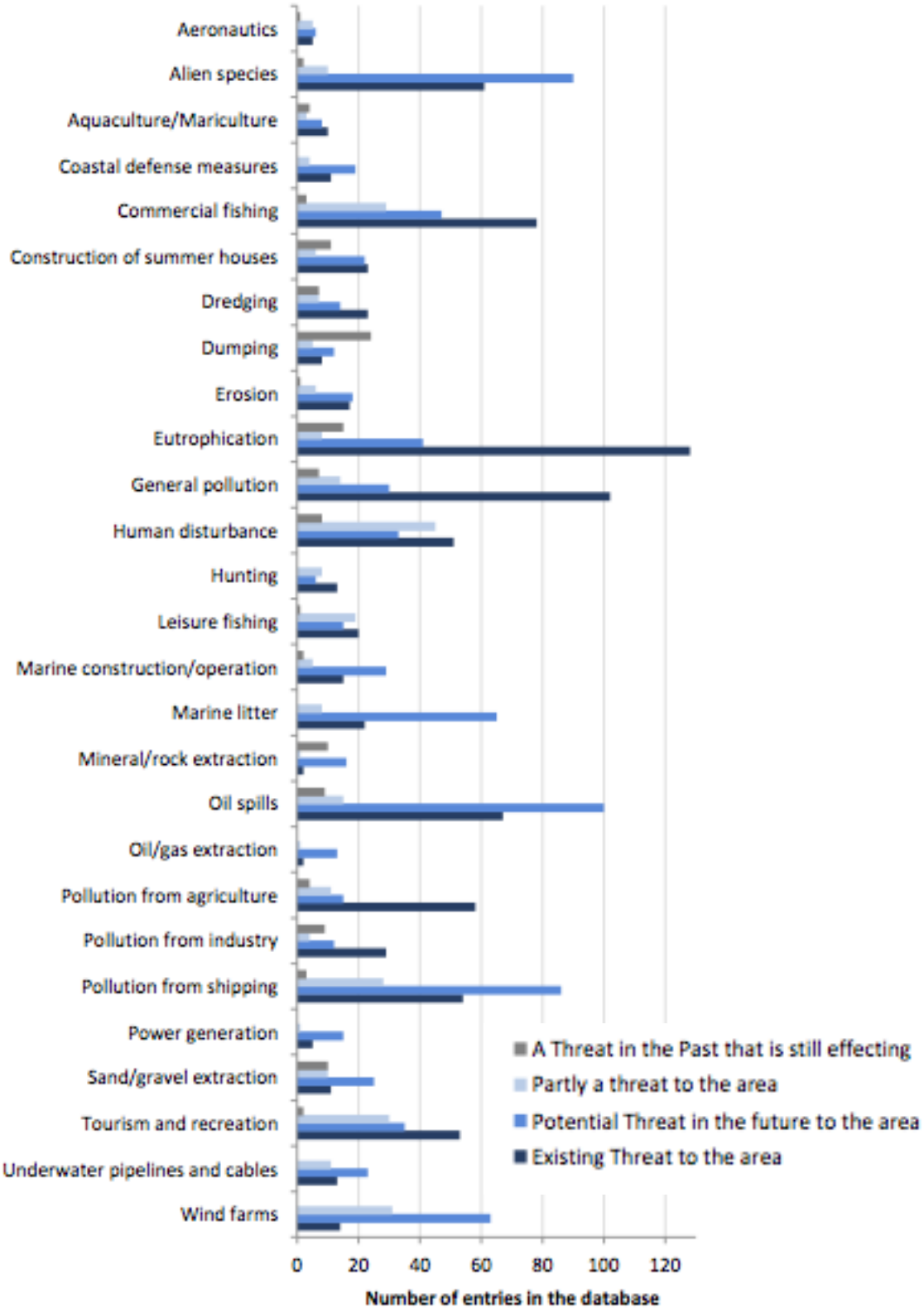

Figure 2. Negative environmental impacts and threats in the Baltic Sea Protected Areas.
The environmental threats are divided into four categories described above depending on if it's already existing, have existed in the past, only partly a threat or if it's a potential threat in the future. Each BSPA have a description of possible threats with these categories. Retrieved from *HELCOM 2013. HELCOM PROTECT- Overview of the status of the network of Baltic Sea marine protected areas. 31 pp.*

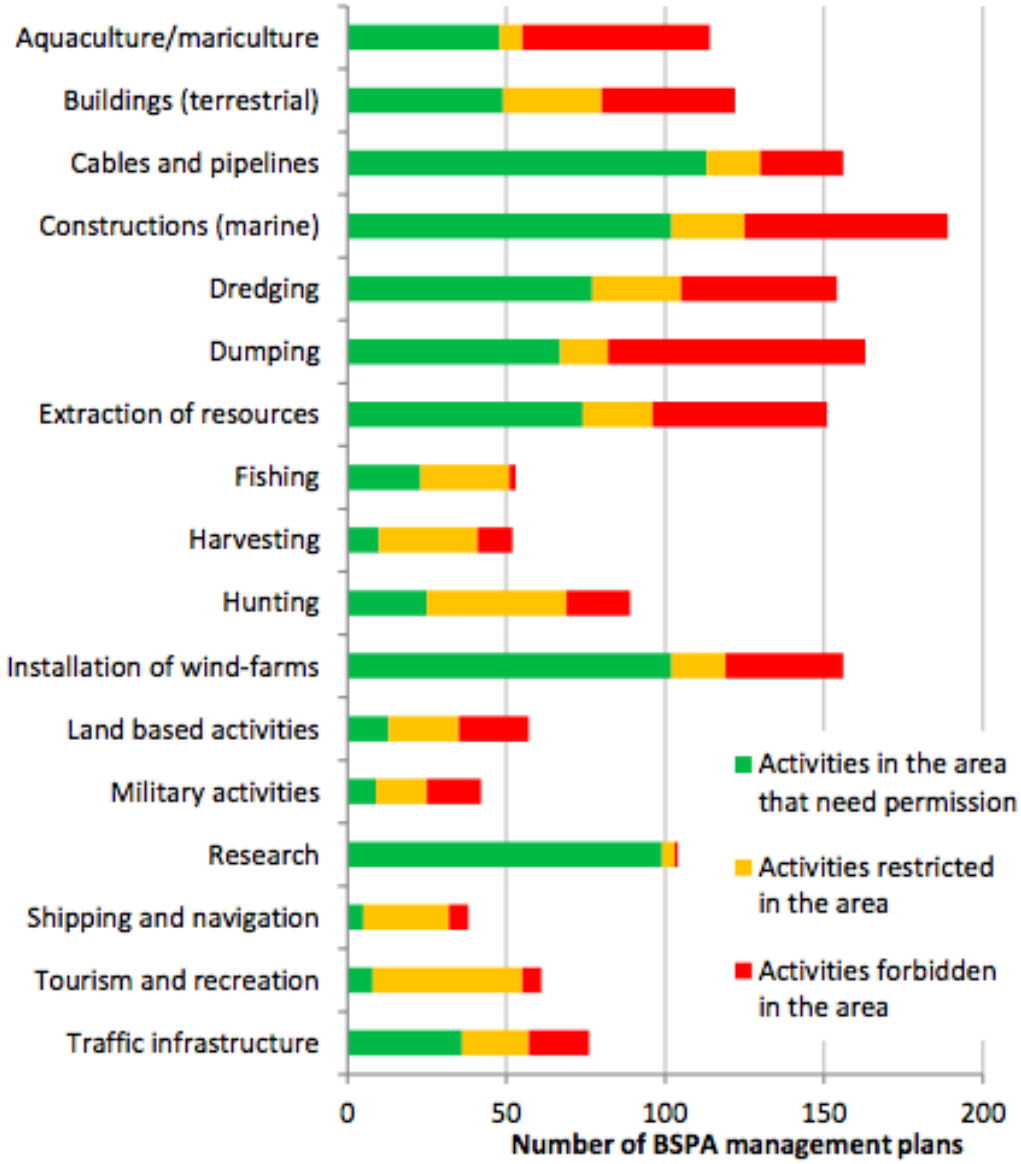

Figure 3. Management plans and restricted activities within all BSPA areas.
Current marine activities in the Baltic Sea that either needs permission, are forbidden or restricted within BSPAs. The chart is based on the number of management plans for designated BSPAs and in how many of these areas each activity is regulated. Retrieved from *HELCOM 2013. HELCOM PROTECT- Overview of the status of the network of Baltic Sea marine protected areas. 31 pp.*

1.3 Aim of study

The aim of this study is to give basic recommendation of how to mitigate the negative impact from shipping on sensitive areas and species in the Baltic Sea with a Marine Spatial Planning approach. The recommendations are based on data collected through current available literature presented as simplified GIS-maps. The information collected and presented is a study of and a first attempt to collect and translate data that will fit the template for dynamic route planning and to be used by shipping. By collecting environmental data in maps it is a possible way to include marine protected areas in the marine spatial planning for shipping routes in the Baltic Sea. There is currently an on-going project in EU developing a new system for the coordination of shipping. The aim is to create an electronic communication central with all spatial data and maps available for ships to use and download when arriving in ports, as a part of the Marine Spatial Planning process. It will compile and provide nautical charts with all information that might be relevant for optimizing sustainable and efficient shipping routes, including weather forecasts, geospatial and port information and sensitive areas. Currently, no electronic nautical charts are used for shipping and marine

protected areas are not marked in the charts used today. This study will mainly focus on the direct impact of shipping on sensitive species in the marine protected areas and how this might be avoided or reduced by giving certain recommendations to ships of how to adjust to these aspects.

The following research questions were formulated:

- *Which protective values and sensitive species exist in the Baltic Sea Protected Areas and how can they be included in Marine Spatial Planning?*
- *How may shipping have a negative local environmental impact on these areas and species?*
- *How can these species be taken into account and how should shipping adjust to those in a dynamic route planning process?*

1.4 Environmental scientific applicability

Shipping is a topic that is not mentioned very often in environmental discussions or education, even though it has a huge negative impact on the environment, both on a global and local scale. It contributes to the global greenhouse gas emissions, but it also has a direct impact on the local environment and the marine wildlife and ecology with oil spills. It's important to highlight the environmental impact of shipping on the marine environment, since it's a topic often forgotten and not mentioned. Protected areas, such as Natura 2000 or Baltic Sea Protected Areas, are not marked on nautical charts. This geographical and ecological information is not included or translated into media that can be used in shipping, and the effects of shipping on different species are not understood or examined well enough to make restrictions or proper planning for it. There is not enough dialogue between the conservation and maritime activities today, which is an important aspect, if conservation issues should be integrated in the maritime spatial planning in the future.

2 Methodology

2.1 Literature review and case studies

A literature review was conducted to find information related to shipping and it's negative impact on the local environment and sensitive areas. The databases Google Scholar and LUBSearch were used to find research articles, risk assessments, publications and information related to how different species and protective values can be threatened by shipping. The categories birds, seals and whales were selected as species threatened by shipping. A research was done on all Baltic Sea Protected Areas in the BSPA-database from HELCOM and the corresponding Natura 2000 fact sheets, available online, to see which of the species existed within these areas, and where. Detailed information of the protection status and the most important species within each site was retrieved. All Baltic Sea Protected Areas were then listed in Excel format (see Appendix I) and categorized based on the species groups existing within each area. The categories were separated by species due to the notion that they are affected differently by shipping. A few different sea-bird species evaluated as most threatened by shipping were chosen as the main study area within the bird category, based on estimations by Kjell Larsson, retrieved through personal communication, and relevant publications (Larsson 2014 personal communication, Larsson, 2012). Information on selected species of birds, whales and seals in the Baltic Sea were collected from publications and research reports. This information was then transferred into quantifiable measures and was compiled in tables in Excel (see Appendix I). The BSPAs of special significance for each species were defined by research publications and personal communication with ornithologists., e.g. Swedish Ornithological Association. The selection of important areas were based on the information in fact sheets, that sometimes stated areas as especially important for some species because of the density of the species population occurring within the areas or external ecological factors that makes the species dependent on those specific areas. Using the information of occurring bird species and populations found in the BSPA-database and the Natura 2000-database, the seasons for bird seasons in the areas were estimated based on the report Skov, H. et al *"Waterbirds and Populations and Pressures in the Baltic Sea",* 2011 and personal communication with Kjell Larsson. Other reports regarding marine protected areas were also used as guidelines for creating possible recommendations and restrictions of areas that are threatened by shipping.

A limited case study was conducted to look at similar cases of management of marine protected areas or threatened species in other geographical areas or with similar species. Publications with observed effects on each chosen species group were studied to see what the main threats of shipping are to these species groups, since it might determine how to adjust shipping differently in the categorized areas.

2.2 Spatial data and GIS

To achieve data that can be used for navigation and planning of shipping routes the information retrieved from the literature study were transferred and visualized as geospatial data in maps. Geospatial data on all Baltic Sea Protected Areas was collected using the Data & Map Service from the HELCOM website, and imported into Quantum GIS 1.8. The data and information found through the literature review and processed in Excel were then transferred to geospatial data in GIS. The different categories based on species occurrence within each area were translated as different shape layers in GIS. The areas identified as of special significance for each species were highlighted in the corresponding GIS-layer, to distinguish the areas that are particularly vulnerable. The quantifiable data were presented in the maps for each area as temporal and spatial, and not in relation to the different species. For the areas for birds, the layer with the species with the

longest period of stay was chosen to be front layer, based on that it will also include species with shorter season in the same area.

2.3 Analysis of data

The findings were used to distinguish the protected areas most vulnerable to shipping, and also comparing the created GIS layers with critical areas to the shipping routes that exist today. cases and management were compared and partly transferred as recommendations for the Baltic Area with possible restrictions in some of these areas to partly reduce the negative impact of shipping to the most common and threatened species groups. The results of the case studies were applied to some similar areas within the Baltic Sea and in the created GIS-maps, and these were used to make similar guidelines and recommendations of restrictions in some of the marine protected areas in the Baltic Sea. All data from literature reviews and geospatial information were compiled in an attempt to create data for dynamic route planning for shipping, or to include protected areas in a marine spatial planning process for the Baltic Sea.

2.4 Limitations

This research is delimited to Baltic Sea Protected Areas (BSPA). Since 64% of all Natura 2000 areas in the Baltic Sea are also included in the BSPA-network it covers many protected areas. The BSPA-areas are restricted to coastal zone and marine area, and therefore more suitable for this study. It is also limited to three main species groups, due to the limited amount of time and required structure of the report. Important to notice is that many other areas important for the species mentioned are not included, it's only the ones within the network of Baltic Sea Protected Areas that are presented in this study.

3 Results & analysis

3.1 Literature review and case studies

The species mentioned as most threatened by shipping in current published research are sea-bird populations, the endangered harbour porpoise, seals and spawning grounds for fish. (Mäkinen, 2003) Sea-bird populations, harbour porpoise and seals were chosen as the three main species groups in this study. Spawning grounds were not included in this report due to the limited amount of time and structure of this study.

Sea-Bird Populations
The main threats for bird populations are oil spills and shipping accidents that usually affects all sea-bird individuals within the same geographical area (Larsson, 2012). They get smothered and lose their insulation and often die of hypothermia, or by drowning. During wintering and breeding seasons a high population density occur in the same small geographical area, mostly on the offshore banks in the Southern Baltic Sea (Skov et al., 2011). The breeding season is during the summer and occurs on small islands in the Archipelago of Sweden and Finland and in the Gulf of Finland (Herrmann et al., 2013). Sea ducks are the most common birds spending the non-breeding season in marine environment. The offshore banks have their most important food source, bivalves. Most common ducks found in the Baltic Sea are Common and Steller's Eider, Long-tailed Duck, Common and Velvet Scoter. Their breeding areas and habitats are different, but they all depend on offshore waters and the benthic invertebrates (bivalves) as food source during wintering season. The Common Eider and Velvet Scoter are the species that both breed and winter in the area (Bellebaum et al., 2011). The Baltic Sea is the most important site for wintering sea ducks and migratory sea birds in the world (Bellebaum et al., 2011). During winter time 90 % of the European sea-duck populations can be found within an area less than 5% of the Baltic Sea, which makes these areas very vulnerable (Larsson, 2012). The Baltic Sea coast is an important breeding and wintering ground for both species Common Eider and Velvet Scoter (Skov et al., 2000). Two major surveys of wintering sea-birds in the entire Baltic have been conducted, the first in year 1992 - 1993, and the second repeated in the same areas with similar methods in 2007-2009 (Skov et al., 2011). In this period, the numbers of wintering birds from the five sea duck species declined altogether by more than 4.2 million birds, or by about 60%. There are several speculated reasons for this, but one of the main threats is oil pollution from continuous illegal discharges from ships, or oil spills from accidents. Ship traffic can impact the marine habitats with consequences of permanently displacing sea ducks from favoured feeding grounds. Some of the major shipping routes in the Baltic sea still cross or pass very close to the most important wintering sites of Long-tailed Ducks, and the shipping in the Baltic Sea area is predicted to increase (Larsson 2012).

Whales
The harbour porpoise (*Phocoena phocoena*) is a small whale species, and the only cetacean species existing in the Baltic Sea (Nabe-Nielsen et al., 2014). The status of the harbour porpoise in the Baltic Sea is a subject of concern. This has been concluded from substantial incidental catches in bottom set gillnets, from indications of declines in several parts of the Baltic and from the possibility that contaminants can affect the long-term viability of the stock. There is a growing concern regarding the status and viability of harbour porpoise stocks in certain areas of their distributional range. Studies have shown that ships have a significant negative impact on a Danish population of harbour porpoise in the inner Danish waters of the Baltic Sea. Among the many threats for porpoise are environmental contaminants and disturbance by noise and boat traffic.

There has been an increasing concern about possible negative effects of man-made underwater noise on marine ecosystems, yet there are very few studies available that can establish a connection between this noise and the distribution of marine species. Shipping is one of the most significant sources causing underwater noise. The Baltic Sea is one of the most frequented marine areas with shipping in the world, and at the same time home to a significant population of harbour porpoises. As the harbour porpoise is generally considered to be sensitive to acoustic disturbance a study has been conducted in the Great Belt area in Denmark in order to monitor possible effects of ship traffic on the fine-scale distribution of porpoises. The highest levels of underwater noise exists within shipping lanes, mostly low frequencies and seems to mostly have an impact on a very close range (Mortensen et al., 2011).

If this noise would occur synergistically with multiple stress-factors it could prevent animals from moving through the last remaining areas or corridors that leads to important foraging areas, for instance. This could have an adverse effect on the population. Little is known about how porpoises react on noise disturbance from shipping lanes, but studies have shown that they avoid passing vessels (Nabe-Nielsen et al., 2014).

In other parts of the world there are cases when whales have been physically struck, leading to injuries and even death, by passing vessels. There is no such case recorded regarding porpoises in Baltic waters. Ships travelling with a speed of 15 knots colliding with a whale have an 80% risk of a deadly outcome (Vanderlaan, & Tagart, 2006). In the United States of America a speed limit of 10 knots have been introduced in areas where whales occur. This regulation has statistically been confirmed to contribute to less whale strikes and accidents (NOAA, 2013).

Seals

Three seal species live in the Baltic Sea areas, on the southern coasts of Sweden and in the Gulf of Finland. The species occurring are harbour seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*). The harbour seal mainly occur in the south of the Baltic Sea, in Swedish and Danish waters, while the other two species are found further up north due to their dependent on areas with ice during winter where they give birth to their pups (Finland Ministry of Agriculture and Forestry, 2007). The main negative impact on seals from human activities are by hunting, professional fishing and maritime traffic (Mäkinen et al., 2003). Legislation and measures could influence the use of the marine environment to mitigate this negative impact. There are several established Finnish seal conservation areas, based on the requirements of the EU Habitats directive. The aim is to prevent seals from being disturbed and to safeguard their habitats, mainly the protection of grey seals (Finland Ministry of Agriculture and Forestry, 2007). Growing tanker traffic has a huge impact on Baltic seals, and oil hitting breeding areas during winter would be severe. The Baltic Sea is probably the only marine area where seals give birth and nurse their young on ice in areas with heavy maritime winter traffic. The largest harbours in the Bothnian Bay have been kept open for traffic through the winter since long ago. Vessels passing through the ice could destroy the lairs of ringed seals and also kill pups that are lying on the ice. Although this is not a significant threat to the seal populations since they avoid settling down close to shipping lanes.

3.2 Geospatial data and GIS

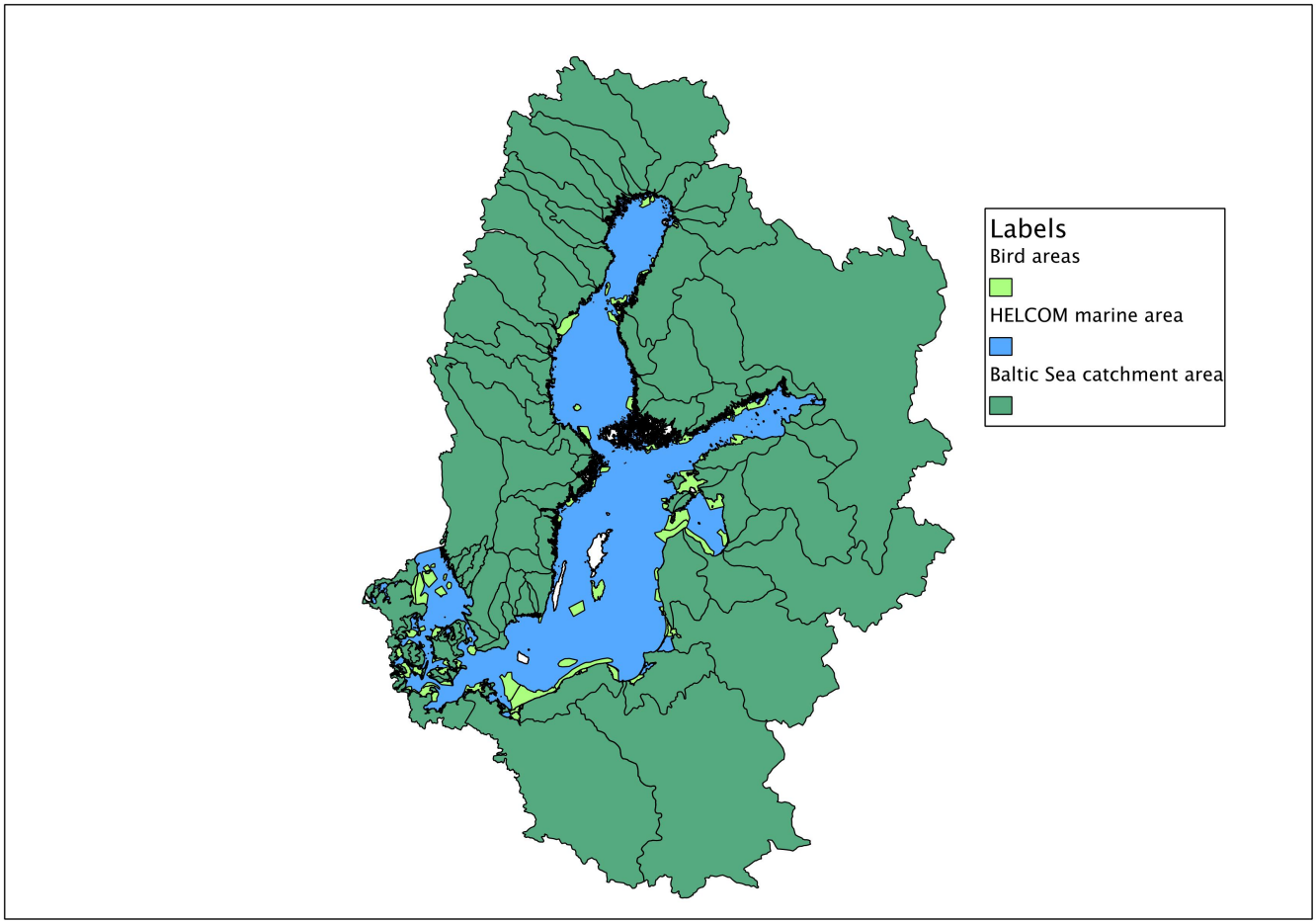

Figure 4. Map with Baltic Sea Protected Areas where birds occur.
Basic GIS-data of Baltic Sea Protected Areas collected from HELCOM's Data & Map Services accessed online http://maps.helcom.fi/website/mapservice/index.html. *Important note:* only the areas designated with the BSPA-status are included. There might be several other important bird areas that are not included in this map.

Figure 4 shows all the Baltic Sea Protected Areas that, according to the factsheets on BSPA-areas and Natura 2000-sites, that are protected partly because of the occuring bird species. The other Baltic Sea Protected Areas that are not containing protected bird species are not visualized in this map. To see the list with all BSPA-areas, see Annex I. Many different bird species are included in this map, and it differs how many individuals occuring within each area and what seasons they occur. This map only shows all areas that are of some significance to any bird species in this region.

Table 1. List of threatened wintering sea-bird populations in the Baltic Sea.
Data based on the report Skov, H. et al, "Waterbird populations and pressures in the Baltic Sea", 2011.

Bird species	Red listed*	Pop density	Pop decline 1993-2003	Wintering Season
Long-tailed duck (*Clangula hyemalis*)	x	31,50%	-65,30%	October - April
Common Eider (*Somateria mollissima*)		28,30%	-50,80%	October - March
Velvet Scoter (*Melanitta fusca*)	x	37%	-60%	October - March
Common Scoter (*Melanitta negra*)		26%	-47,50%	October - May
Steller's Eider (*Polysticta stelleri*)	x	-	-66%	November - May

- *According to the IUCN Red list of threatened species, found online at:* ***http://www.iucnredlist.org/***

Table 1 shows a list of selected species of wintering sea-bird populations in the Baltic Sea. Due to their population density during certain seasons and the declining trend of the population during the last decades they are in this study estimated to be particularly vulnerable against maritime activities and shipping, especially oil spills or accidents. The selection of species to include in this first mapping was based on recommendations from Kjell Larsson, professor in Ecology at Gotland University and the amount of current existing quantifiable data from reports (Larsson, personal communication 21 May 2014).

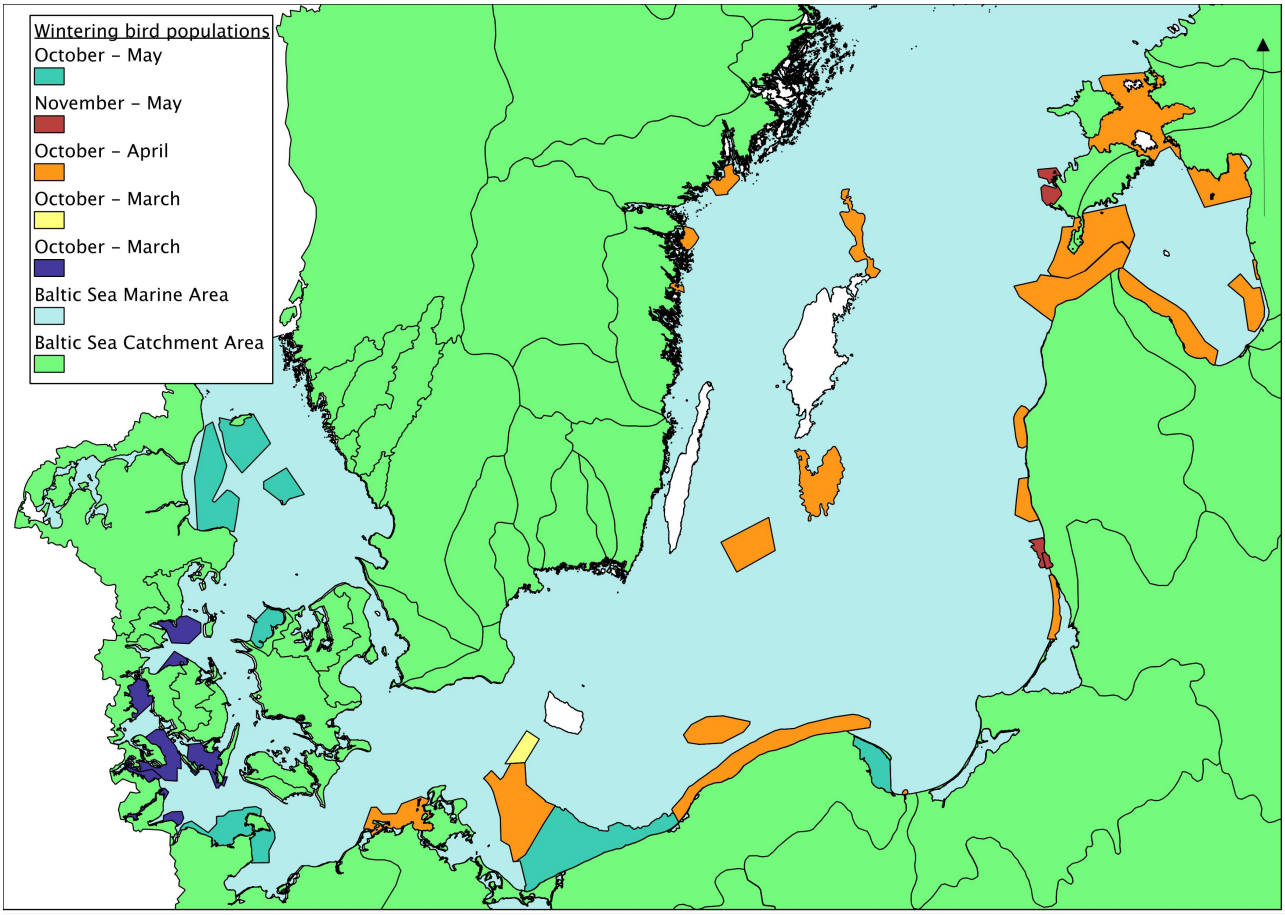

Figure 5. Baltic Sea Protected Areas with wintering sea-bird populations.
Only areas with at least 10 000 breeding numbers of sea-birds and above were included in the map. The areas marked on the map are based on the the species from Table 1 with the stated season when a high population density occur in the selected areas.

Figure 5 shows the Baltic Sea Protected Areas with wintering sea-bird populations, mostly sea-duck species. The species included in the figure are the ones from Table 1. The map in Figure 4 is categorized in quantifiable data as seasons instead of species, to visualize the data as information that can be used in dynamic route planning for ships. The seasons are based on the species occurrence. All species from Table 1 and their areas are included in the map in Figure 5 as different shape-file layers. The shapefile-layer with the species that is present the longest season is put as the front layer in the map. The areas in the front-layer may also cover and include areas where other species that are present a shorter season also occur. The purpose of this is a precautionary measure, that the longest season should determine the possible restrictions within the area. This map only shows the areas with a very high density of the bird populations during winter season. As can be seen, it's mostly in the southern part of the Baltic Sea that birds occur during winter since the northern parts are partly covered with ice.

Table 2. List of threatened sea-bird populations breeding in the Baltic Sea.
Data retrieved from EBCC Atlas of European Breeding Birds, 1997, Accessed online http://s1.sovon.nl/ebcc/eoa/

Breeding species	Red listed	Breeding numbers	Season
Common Murre (*Uria aalge*)		10 000 - 100 000	May - July
Common Eider (*Somateria mollissima*)		10 000 - 100 000	May - September
Razorbill (*Alca torda*)		10 000 - 100 000	May - July
Velvet Scoter (*Melanitta fusca*)	x	10 000 - 100 000	May - September

Table 2 shows a list of breeding sea-bird populations in the Baltic Sea area during summer. The breeding areas are different from the wintering areas, so the sensitive areas change with the seasons. Wintering and breeding season are when the population density is very high in limited areas, and also when the species are most vulnerable. The breeding species were chosen by recommendations from Kjell Larsson, professor in Ecology at Gotland University, and since most of the species are bound to and dependent on very specific geographical areas which makes the population particularly vulnerable.

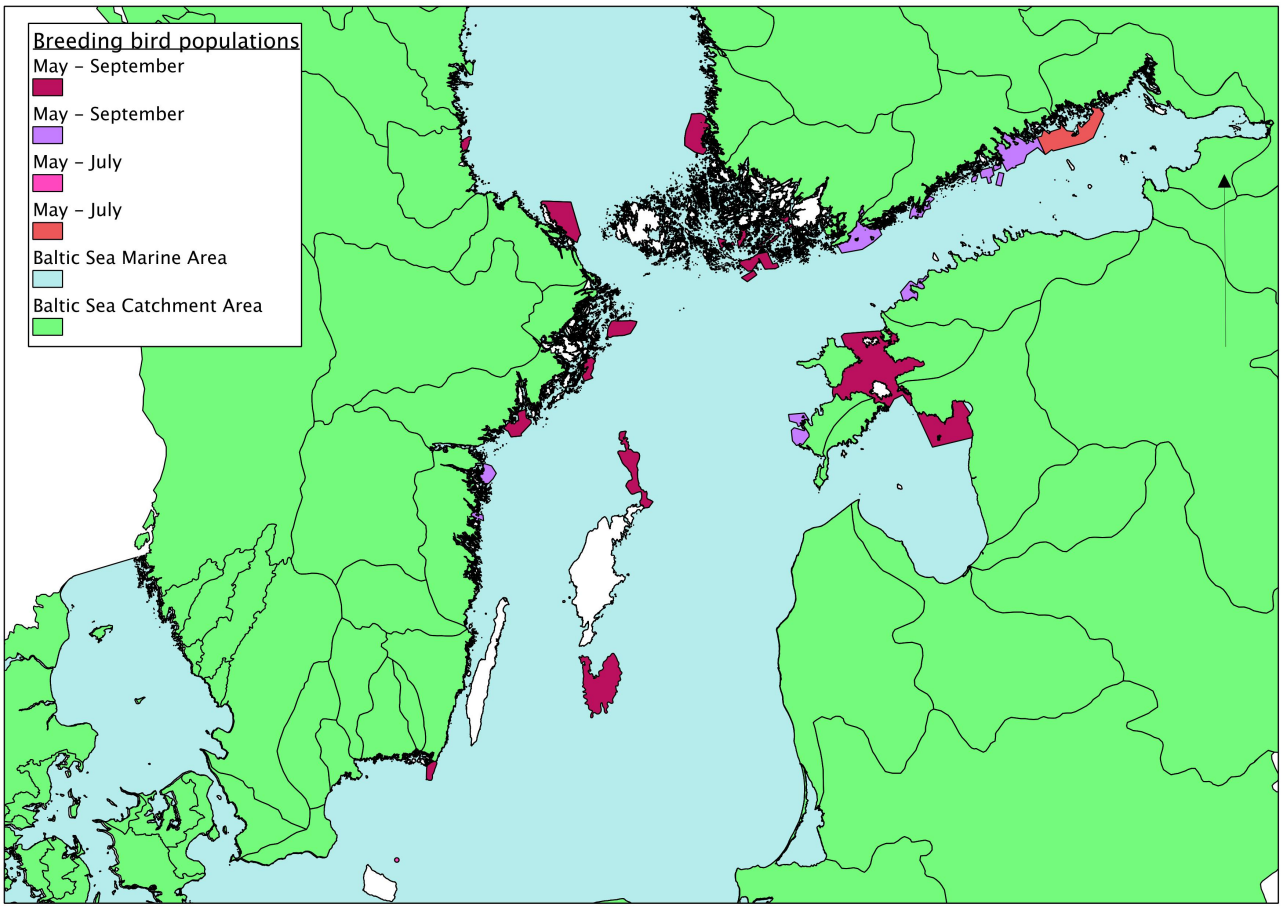

Figure 6. Baltic Sea Protected Areas with breeding sea-bird populations, summer season.
Only areas with at least 10 000 breeding numbers of sea-birds and above were included in the map. The breeding areas were chosen based on the EBCC Atlas of European Breeding Birds online at http://s1.sovon.nl/ebcc/eoa/. Basic GIS-data of Baltic Sea Protected Areas collected from HELCOM's Data & Map Services at http://maps.helcom.fi/website/mapservice/index.html

Figure 6 shows the Baltic Sea Protected Areas with breeding sea-bird populations. The species included in the figure are the ones from Table 1. The map in Figure 6 is categorized in quantifiable data as seasons instead of species, to visualize the data as information that can be used in dynamic route planning for ships. The seasons are based on the species occurrence. All species from Table 2 and their areas are included in the

map in Figure 6 as different shape-file layers. The order of the layers was chosen to show the longest period in front, which may also cover and include areas where other species with a shorter season occur as well as in Figure 6. The purpose of this is a precautionary measure, that the longest season should determine the possible restrictions within the area. The species Common Eider and Velvet Scoter are included both in Figure 5 and Figure 6, since they stay in the Baltic Sea both during wintering season and the breeding season in summer. Different geographical areas are significant for these species during the different seasons, as can be visualized when comparing Figure 5 and Figure 6. As can be seen, it's not the southern areas that are important in the breeding season in summer but the areas in the archipelago that are of significance.

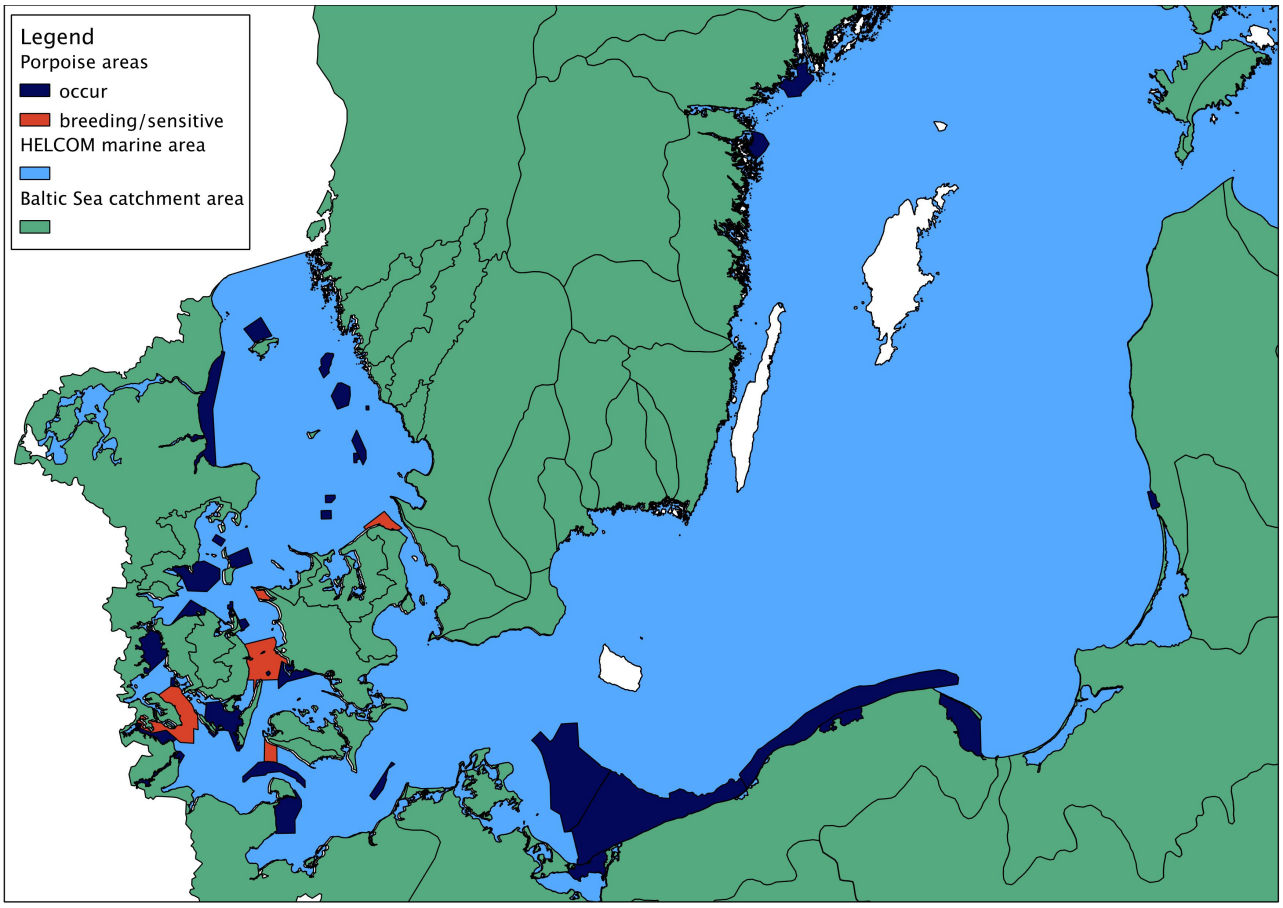

Figure 7. Map showing all Baltic Sea Protected Areas where harbour porpoise occur
Areas marked dark blue show where they may occur, the red marked areas shows the most sensitive and important areas, such as areas for breeding or important passages. Basic GIS-data of Baltic Sea Protected Areas collected from HELCOM's Data & Map Services at http://maps.helcom.fi/website/mapservice/index.html

Figure 7 shows all Baltic Sea Protected Areas where harbour porpoise (*Phocoena phocoena*) occur. The species is moving a lot and probably individuals are distributed on a much larger area in the southern Baltic Sea, which does not make this map very significant or representative of the porpoise distribution in general. For information of total distribution, see Appendix III (Amundin, 2014). It mainly occurs in the Danish waters, and it is also there the areas of greater significance are marked out (red areas in Figure 7). These areas are directly important for breeding, or passages leading to important areas.

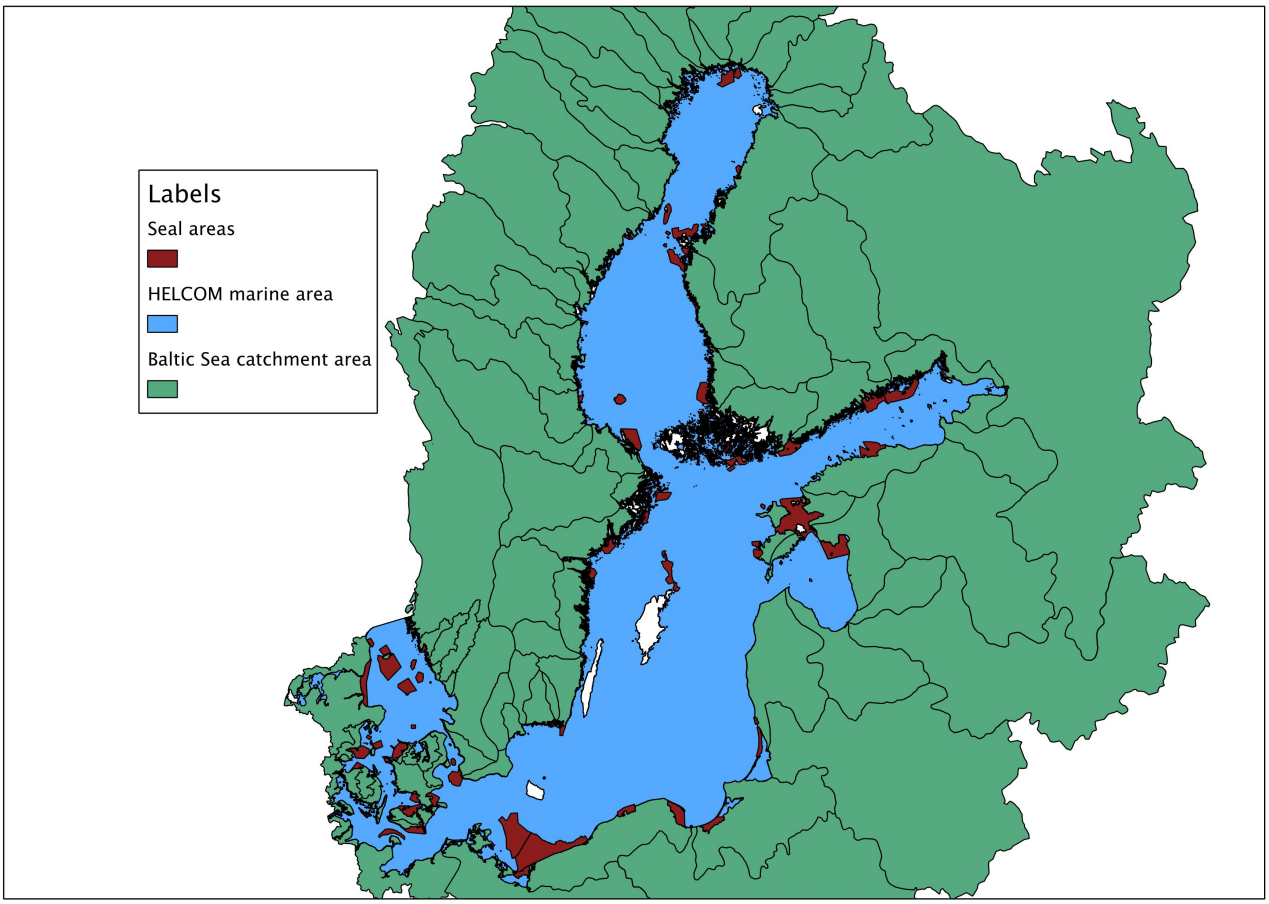

Figure 8. Map showing all Baltic Sea Protected Areas where seals occur.
The map includes the species Harbour seal, Grey seal and Ringed seal. The areas are not distinguished for the different species. Basic GIS-data of Baltic Sea Protected Areas collected from HELCOM's Data & Map Services at http://maps.helcom.fi/website/mapservice/index.html

Figure 8 shows all Baltic Sea Protected Areas where different seal species occur, in this case Harbour seal, Grey seal and Ringed seal. Since different species of seal exist in the same areas, and are much more similar in how they might be affected by environmental impact of shipping than e.g. different bird species, no distinction was made between the different species areas.

4 Discussion

The study shows that the main species of concern (sea-bird populations, harbour porpoise and seals) have different aspects to take into consideration while adjusting shipping routes to the protective values. They should therefor be studied separately, and the areas should have different restrictions. The study shows that the current available data is not sufficient to create a sustainable spatial planning where marine protected areas are included. It has also been found that the current networks that include marine protected areas (e.g.BSPA, Natura 2000, ATB) are not consistent with each other, and that designated areas with the same name can have different geographical coordinates. All these issues is related to how to find, collect and translate this information so it becomes sufficient for the activities that might have a negative impact on these areas, in this case shipping. If comparing Figure 1 and Figure 4-8, it is clear that many of the BSPAs are close to, or in the middle of, the most frequented shipping lanes, showing that further regulations are needed.

4.1 How to include Baltic Sea Protected Areas in Marine Spatial Planning

The main species groups mentioned as threatened by shipping in current published research were sea-bird populations, harbour porpoise and seals. As can be seen in the results, very different parameters are important for the different species. When it comes to birds, the occurrence and significance of certain areas are linked to seasonal patterns and behaviour. The migration of birds is also an important factor to include if the aim is a more dynamic planning process. The areas that are important for birds during winter are not the same geographical areas that are important for birds during the breeding season in summer, as shown in Figure 5 and Figure 6. The significance partly depends on the population density occurring, the ecological dependency on specific areas, the breeding season when they are more vulnerable and if the species are internationally threatened or red-listed. Information used in marine spatial planning and dynamic routes should be based on this notion when it comes to areas where birds are the most threatened species. Even though birds occur in many of the BSPAs (see Figure 4), a large number of the population density might actually be in a very limited geographical area during both seasons. These specific geographical sites might need increased protective measures and regulations due to their significance. When it comes to bird populations, the main factors that should be taken into account when an area is assigned special regulations are the species dependency on certain geographical areas. During winter, that would be the offshore banks that are important as feeding grounds for all sea ducks. Data on bird seasons and sensitive areas are rarely presented in a way that can be used as data for marine spatial planning and dynamic shipping routes. To collect all this data and visualize it geographically is very difficult, but important if it should be included in spatial planning processes at all. Shipping uses nautical charts and can only adjust to information presented on maps. It is important that the data and spatial information regarding the areas of consideration is clear and presented in a way that the restrictions and recommendations can be adjusted to the areas. One possible way would be the one presented in Figure 5 and Figure 6, where the most critical areas and months are presented to know when they should be avoided.

Harbour porpoise is the only cetacean existing in Baltic waters, and it's also endangered according to the IUCN Red list. A decline in a population might have a huge impact on the total population density. The Porpoise is a very small species and is unlikely to be physically injured by passing vessels, compared to other cases with large whale species in the United States of America mentioned in the results (NOAA, 2013). What might have a bigger negative impact is the noise in heavily trafficked shipping lanes (Nabe-Nielsen et al., 2014). Most of the Baltic porpoise population are distributed in the southern parts and the Danish waters

around the many islands and narrow passages. Since this area is also more critical for navigation, without much open water, it might be an idea to introduce restrictions of avoiding the area, or speed limits within the most significant areas for breeding (see Figure 7). Since studies have shown that porpoises avoid vessels and shipping lanes, and therefor the most important areas should have restrictions for shipping since they might affect their breeding which could lead to a decrease in population size (Mortensen, et al., 2011).

There are several species of seals in the Baltic Sea but they are ecologically similar when it comes to living requirements and how they would be affected by shipping. The Gulf of Finland and Bothnian Bay both have heavy shipping traffic during winter, even under ice conditions. During winter, both the grey and ringed seal are dependent on these areas for breeding and could become victims of passing vessels (Finnish Ministry of Agriculture and Forestry, 2007). With this taken into consideration it would be favourable to create as few shipping lanes in the ice-covered areas as possible, since seal populations probably stay away from the busiest shipping routes. If too many breeding populations become victims it might have an impact on the population density. Oil spills and accidents are a major threat to both sea-bird and seal populations. A risk assessment of areas sensitive for oil accidents should include both these species groups.

Protected areas are usually categorized based on the protective values that exist within each area. The Natura 2000 sites are based on the EU Habitat Directive and the Birds Directive, based on sites important for birds and specific habitats important for various species. When included in the Marine Spatial Planning process, this information and protective measures have to be translated in a way that can be used by other marine activities, including information of which areas are sensitive to the different activities taking place, and during what time of the year. Since various Baltic species are affected differently and at different seasons, there has to be separated requirements for different sites. As can be seen in Figure 4 – 8, different spatial and temporal parameters are important to include depending on what economic sector is going to use this information, in this case the shipping sector.

A possible solution to the problem could be an international standard for classifying marine protected areas, also with the aim of including them in marine spatial planning. It is difficult to know which protected areas to include when the different conservation networks designate areas that differ in geographical coordinates and shape. It's difficult to include the Natura 2000 areas, since some of them are both land- and sea-based areas. The designation is based on parameters related to species habitats or important bird areas, and are not described by the risk for them to be affected by e.g. pollution from shipping or other environmental threats. There should be clear criteria when deciding which nature protected areas to include in a marine spatial planning process. Not even the BSPAs cover all the areas that are critical for shipping, since many of the main breeding areas for birds are not included. For instance, neither Öland, Stora Karlsö (west of Gotland) or Laholmbukten are covered in the BSPAs even though these areas are of major importance for some bird populations (Hagemeijer & Blair, 1997). When it comes to seals, Kalmarsund and Måkläppen are some are not included either (Finland Ministry of Agriculture and Forestry, 2007). Porpoises also have a wider distribution in the Danish waters than the map presented here in Figure 7 (see Annex II). Many of the marine protected areas (BSPA/Natura 2000) in the Baltic Sea where porpoises usually occur are localized close to their breeding areas. This might be good to take into account when planning routes to reduce the negative impact of shipping on the Baltic harbour porpoise, since the breeding areas are significant for maintaining the size of the population.

There is no conservation-network that covers all areas that would be significant in a marine spatial planning process, and we are still discovering new areas that might be of nature conservation value. First of all, more research related to this issue needs to be carried out, since there's not enough available data to designate all appropriate sites yet.

4.2 Mitigation of the negative impact on BSPA from shipping

As can be seen in Figure 1 and Figure 2, environmental risks associated with shipping are the main threats in the future in a majority of the Baltic Sea Protected Areas. Still, shipping is one of the least restricted and regulated marine activities within these areas. One of the most restricted activities are wind power stations, that in some aspects contribute to the same environmental problems as shipping when it comes to noise. Wind power stations are quite new activities within these sensitive areas, which makes it easier to take

precautionary measures for regulations that might mitigate the impact on sensitive areas. Shipping is an activity that has already existed within these areas for a very long time, and the regulations within protected areas are developed later, which is much more difficult. Also, the main problem with shipping on the local environment is the risk for oil accidents, and it's very difficult to anticipate when and where it's going to happen and which areas that are more sensitive to oil spills than others. What we do know is that some species are dependent on certain, rare areas as food resources and will not move away even if there are heavy traffic routes passing nearby. If comparing areas important to waterbird populations and areas important to porpoises, the porpoises are much more movable and can avoid areas with heavy disturbing marine traffic. If the negative impact of shipping should be reduced within these areas, it's important to create this priority for each area. Risk assessments have been done before in the BRISK-project, but then the different species were not studied separately. Instead the areas were categorised with all species together as a protective value (Admiral Danish Fleet HQ, 2012). To retrieve significant data, these areas have to be looked at in detail and the information collected from researches within each area.

The Natura 2000 network is well respected and has a strong protection status by law within the European countries. The Baltic Sea Protected Areas does not have the same status yet. The first step is to get the Natura 2000 included in maritime negotiations, hopefully through Marine Spatial Planning and dynamic route planning for shipping. In general, the problem seem to be the lack of dialogue between different sectors, mostly economic and ecological interests that are both included in the concept of sustainability. It is also important to note that to ensure that any regulations or restrictions are being followed it must include incentives for the shipping sector to comply with these rules.

4.3 Environmental scientific applicability

A big part of the problem when it comes to environmental issues is the lack of dialogue between the different sectors. All the data on negative environmental impact are collected and presented for other environmental researchers or organizations to read. Increased collaboration between different sectors is necessary if environmental matters are to be included in all other planning processes, in this case between the shipping sector and the nature conservation sector. Currently, there is not enough available data to establish a functional marine spatial planning process that includes protected areas and assures a sustainable management of our marine resources. It is also important that the dialogue between the sectors needs to be continuous, since the ecological information itself is dynamic and will change over time. Species populations will decrease or increase and move from different areas, which means that the regulations and restrictions have to change as well. The research activities need to be more diverse and the aim adapted to the other sectors that are willing to integrate this information in their activity.

5 Conclusions

- The current busiest shipping routes in the Baltic Sea pass through sensitive areas significant for sea-bird-, porpoise- and seal-populations. There is much evidence that these species are at large risk or might be harmed by intense maritime activities in these areas, such as shipping.
- Shipping is one of the least regulated marine activities in the marine protected areas in the Baltic Sea, even though it is predicted to be one of the major potential environmental threats in the future.
- The species in marine areas appointed as most sensitive to, or threatened by, marine activities need to be studied and regulated separately, since they are affected by shipping in different ways. The regulations need to be based on this information and adjusted to the different protective values.
- Current available biological and geographical data for sensitive areas is not sufficient to establish a marine spatial planning that includes marine protected areas or a sustainable management plan for those. More research is needed to draw conclusions on what restrictions and regulations that are necessary for shipping to reduce the negative impact.
- Regulations for marine shipping activities need to be up to date with current research, since ecological parameters are dynamic and can change from different seasons and years. A dialogue between ecological research and the shipping sector, e.g. via IMO, is necessary to achieve the environmental goals agreed for the Baltic Sea, e.g. in the HELCOM Baltic Sea Action Plan.
- The current situation with different networks of protected areas does not represent ecological or geographical coherent information and data. Criteria for establishing a coherent network of marine protected areas would favour the process of integrating sensitive sea areas in the spatial planning process, and for shipping sector to reduce their negative impact within these areas.

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Council Directive 92/43/EEC of May 1992 on the conservation of natural habitats and of wild fauna and flora

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Personal communication

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Appendix I

Excel table with all Baltic Sea Protected Areas and categories based on species occurence.

Name	Country	Birds	Porpoise	Seals
Ostoja Slowinska	Poland	x	x	x
Zalew Wislany i Mierzeja Wislana	Poland	x		x
Ujscie Odry i Zalew Szczecinski	Poland	x		
Wolin i Uznam	Poland	x	x	x
Zatoka Pomorska	Poland	x	x	x
Przybrzezne Wody Baltyku	Poland	x	x (rare)	
Zatoka Pucka	Poland	x	x	x
Ujscie Wisly	Poland	x		x
Begtrup Vig og kystområder ved Helgenæs	Denmark			
Fyns Hoved, Lillegrund og Lillestrand	Denmark		x	
Æbelø og havet syd for og Nærå	Denmark	x	x	x
Havet mellem Romsø og Hindsholm samt Romsø	Denmark	x	x	
Odense Fjord	Denmark	x		
Lillebælt	Denmark	x	x (some)	
Bøjden Nor	Denmark	x		
Maden på Helnæs og havet vest for	Denmark	x	x	
Vestlige del af Avernakø	Denmark			
Stenrev sydøst for Langeland	Denmark			
Sydfynske Øhav	Denmark	x	x	
Roskilde Fjord og Jægerspris Nordskov	Denmark	x		
Vestamager og havet syd for	Denmark	x		
Ølsemagle Strand og Staunings Ø	Denmark	x		
Havet og kysten mellem Hundested og Rørvig	Denmark	x		
Sejerø Bugt og Saltbæk Vig	Denmark	x		x
Udby Vig	Denmark			
Hov Vig	Denmark	x		
Havet og kysten mellem Præstø Fjord og Grønsund	Denmark	x		x
Klinteskov Kalkgrund	Denmark			
Nakskov Fjord og Inderfjord	Denmark	x		
Stege Nor	Denmark			
Ryggen	Denmark			
Hatter Barn	Denmark			
Broen	Denmark		x	
Munkegrunde	Denmark			
Stevns Rev	Denmark			
Bøchers Grund	Denmark			
Hvideodde Rev	Denmark			

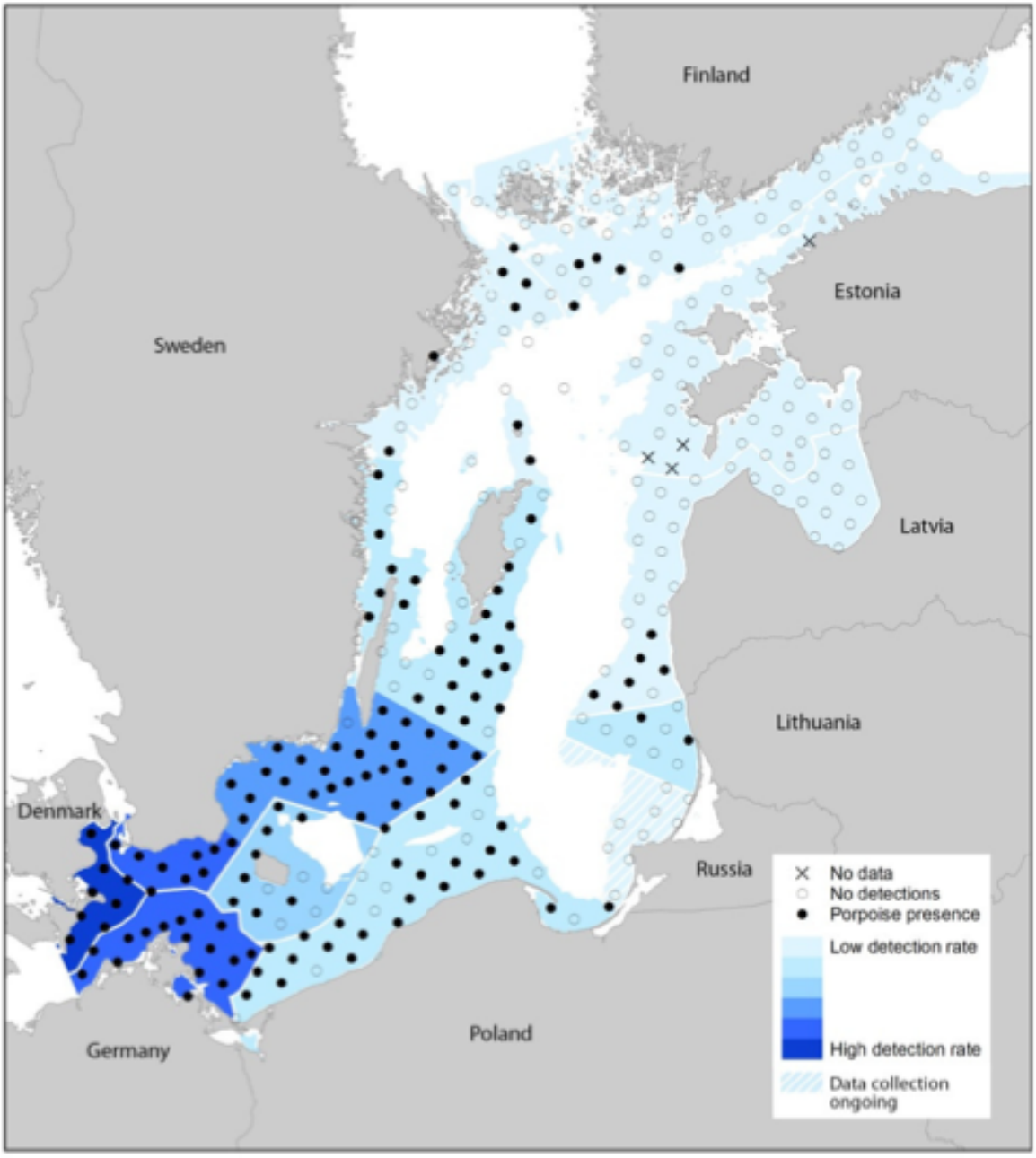
Bakkebrædt og Bakkeground	Denmark			
Mols Bjerge med kystvande	Denmark			
Kaløskovene og Kaløvig	Denmark			x
Kobberhage kystarealer	Denmark			
Jægerspris Skydeterræn	Denmark			
Thurø Rev	Denmark			
Ålborg Bugt, østlige del	Denmark	x		
Mejl Flak	Denmark	x	x	x
Adler Grund og Rønne Banke	Denmark			
Kims Top og den Kinesiske Mur	Denmark			
Horsens Fjord, havet øst for og Endelave	Denmark	x	x	x
Lysegrund	Denmark		x	
Røsnæs, Røsnæs Rev og Kalundborg Fjord	Denmark	x	x (winter)	x
Femern Bælt	Denmark		x (important)	
Gilleleje Flak og Tragten	Denmark		x (summer)	
Schultz og Hastens Grund samt Briseis Flak	Denmark			
Flensborg Fjord, Bredgrund og farvandet omkring Als	Denmark	x	x (breeding!)	
Ebbeløkke Rev	Denmark			
Kyndby Kyst	Denmark			
Northern Midsjöbanken	Sweden	x		
Morups Bank	Sweden		x	x
Stora Middelgrund och Röde Bank	Sweden		x	
Finngrundet-Östra Banken	Sweden	x		x
Vänta Litets Grund	Sweden			
Marakallen	Sweden			
Kvädöfjärden med Torrö	Sweden	x		
Kura Kurk	Estonia	x		
Pärnu lahe	Estonia	x		x
Pakri	Estonia	x		
Jasmund National Park	Germany			
West-Pommeranian Lagoon National Park	Germany	x		
Lahemaa	Estonia	x		x
Hiiu Madala	Estonia	x		x
Vilsandi	Estonia	x		x
Haparanda Archipelago	Sweden	x		x
Holmö Islands	Sweden	x		x
High Coast	Sweden	x		
Gräsö/Singö Archipelago	Sweden	x		x
Stora Nassa-Sv. Högarna	Sweden	x		x
Fifång-Askö-Hartsö	Sweden	x	x	x
St. Anna/Missjö Archipelago	Sweden	x	x	x
Kopparstenarna/Gotska Sandön/Salvorev Area	Sweden			x
Torhamns Archipelago	Sweden	x		x
Falsterbo Peninsula with Måkläppen	Sweden	x		x
Kullaberg-Skälderviken	Sweden	x		

Kungsbackafjorden	Sweden	x		x
Hoburgs Bank	Sweden	x		
Fladen	Sweden	x	x	x
Lilla Middelgrund	Sweden	x	x	x
Curonian Spit National Park	Lithuania	x		x
Pajuris Regional Park	Lithuania	x	x	x
Nemunas Delta Regional Park	Lithuania	x		
The state Baltic sea marine reserve	Lithuania	x		
Bornholm: Davids Banke	Denmark			
Skælskør Fjord og havet og kysten mellem Agersø og Glænø	Denmark	x	x	
Saltholm og omliggende hav	Denmark	x		x
Stavns Fjord, Samsø Østerflak og Nordby Hede	Denmark	x	x	x
Hesselø med omliggende stenrev	Denmark		x	x
Ålborg Bugt, Randers Fjord and Mariager Fjord, Birdprotection sites	Denmark	x	x	x
Herthas Flak	Denmark			
Bothnian Bay National Park	Finland	x		x
Outer Bothnian Threshold Archipelago (The Quark)	Finland	x		x
Oura Archipelago	Finland	x		
Uusikaupunki Archipelago	Finland	x		x
Archipelago Sea	Finland	x		x
Tammisaari and Hanko Archipelago-and Pojo Bay marine proteciton area	Finland	x		x
Eastern Gulf of Finland Archipelago and waters	Finland	x		x
Hailuoto northshore	Finland	x		
Kirkkosalmi	Finland	x		
Isomatala-Maasyvänlahti	Finland	x		
Liminka Bay	Finland	x		
Rahja Archipelago	Finland	x		x
Kokkola Archipelago	Finland	x		
Luoto Archipelago	Finland	x		
Uusikaarlepyy Archipelago	Finland	x		
Närpiö Archipelago	Finland	x		
Kristiinankaupunki Archipelago	Finland	x		x
Tulliniemi bird protection area	Finland	x		
Kirkkonummi Archipelago	Finland	x		
Söderskär and Långören Archipelago	Finland	x		
Porvoonjoki estuary-Stensböle	Finland	x		
Pernajabay and Pernaja Archipelago marine protection areas	Finland	x		x
Walkyriengrund	Germany			
Pommersche Bucht-Rönnebank	Germany	x	x	x
Küstenbereiche Flensburger Förde von Flensburg bis Geltinger Birk, Flengurger Förde	Germany	x	x	
Schlei incl. Schleimünde und vorgelagerter Flachgründe	Germany	x	x	
Eckernförder Bucht mit Flachgründen, Südküste der Eckernförder Bucht und vorgelagerte Flachgründe	Germany	x		
Küstenlandschaft Bottsand - Marzkamp u. vorgelagerte Flachgründe, Östlichen Kieler Bucht	Germany	x	x	
Staberhuk, Großenbrode Meeresbereiche, Wagrien, Sagas-Bank	Germany	x	x	

Ostseeküste am Brodtener Ufer	Germany	x		
Fehmarnbelt	Germany	x	x	x
Kadetrinne	Germany		x	
Bornholm: Ertholmene	Denmark	x		x
Kirkegrund	Denmark			
Havet og kysten mellem Karrebæk Fjord og Knudshoved Odde	Denmark	x		x
Smålandsfarvandet nord for Lolland, Guldborg Sund, Bøtø Nor og Hyllekrog-Rødsand	Denmark	x		x
Kronören	Sweden	x		x
Axmar	Sweden	x		x
Bullerö-Bytta	Sweden	x		x
Värnanäs Archipelago	Sweden			
Lundåkrabukten	Sweden	x		
Hallands Väderö	Sweden	x		x
Väinameri	Estonia	x		x
Havet omkring Nordre Rønner	Denmark	x	x	x
Læsø Trindel og Tønneberg Banke	Denmark	x		
Store Middelgrund	Denmark		x	
Hirsholmene, havet vest herfor og Ellinge Å's udløb	Denmark			x
Strandenge på Læsø og havet syd herfor	Denmark	x		x
Ainazi-Salacgriva	Latvia			
Akmensrags	Latvia	x		
Irbes saurums	Latvia	x		
Nida-Perkone	Latvia	x		
Selga uz rietumiem no Tujas	Latvia	x		
Vitrupe-Tuja	Latvia	x		
Rigas lica rietumu piekraste	Latvia	x		
Lawica Slupska	Poland	x		
Anholt og havet nord for	Denmark	x		x
Centrale Storebælt og Vresen	Denmark		x (breeding)	
Kursiu Marios Biosphere Polygon	Lithuania	x		

Appendix II

Map of distribution of harbour porpoise in the Baltic Sea based on the latest research from the EU LIFE+ SAMBAH-project, lead by Mats Amundin.



LUNDS UNIVERSITET

Miljövetenskaplig utbildning

Centrum för klimat- och
miljöforskning

Ekologihuset

22362 Lund