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INTERPRETATIONS OF, AND AMENDMENTS TO, MARPOL AND RELATED INSTRUMENTS

Information on the proposal to designate the Baltic Sea as a Special Area under MARPOL Annex IV

Submitted by Denmark, Estonia, Finland, Germany, Lithuania, Latvia, Poland, the Russian Federation and Sweden

SUMMARY

Executive summary:	This document contains background information for the proposal to amend MARPOL Annex IV with regard to nutrient discharges from the sewage of passenger ships sailing in the Baltic Sea. The document contains the information required by the Guidelines for the Designation of Special Areas under MARPOL 73/78 (Assembly resolution A.927(22)). The Committee is invited to take this document into account when considering the proposal of the Baltic Sea States to designate the Baltic Sea as a Special Area of MARPOL Annex IV (document MEPC 60/6/2).
Strategic direction:	7.1
High-level action:	7.1.2
Planned output:	7.1.2.1
Action to be taken:	Paragraph 8.1
Related documents:	MEPC 60/6/2, MEPC 60/6/3 and resolution A. 927(22)

1 INTRODUCTION

1.1 This document contains background information for the proposal to amend MARPOL Annex IV with regard to nutrient discharges from the sewage of passenger ships sailing in the Baltic Sea. Due to its biogeographical characteristics and decades of anthropogenic nutrient input, the Baltic Sea suffers from a severe eutrophication problem. Amending MARPOL Annex IV to take into account this sea area's sensitivity to nutrients is therefore necessary. It is proposed that more stringent discharge regulations would be applied for passenger ships sailing in the Baltic Sea area. This document contains the information required by the Guidelines for the Designation of Special Areas under MARPOL 73/78 (resolution A.927(22)).

2 DEFINITION OF THE AREA

2.1 The proposed MARPOL Annex IV special area, the Baltic Sea area, comprises the Baltic Proper with the Gulf of Bothnia, the Gulf of Finland and the entrance to the Baltic Sea bounded by the parallel of the Skaw in the Skagerrak at 57°44.8′ N, as defined in regulation 1.11.2 of MARPOL Annex I (Figure 1).

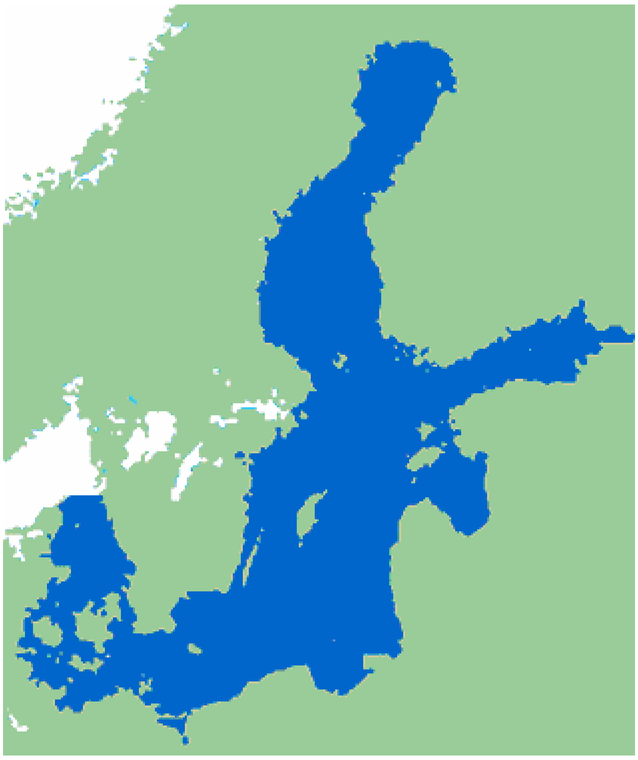

Figure 1. Map of the proposed Special Area (in blue).

2.2 The Baltic Sea area can further be divided into the Kattegat, the Belts and the Sound, the Baltic Proper, the Gulf of Riga, the Gulf of Finland, the Bothnian Sea and the Bothnian Bay. These areas are described in greater detail in annex 1 to this document.

3 THE TYPE OF SPECIAL AREA

3.1 It is proposed to amend MARPOL Annex IV by designating the Baltic Sea as a Special Area with new discharge regulations for nutrients in the sewage of passenger ships.

4 A GENERAL DESCRIPTION OF THE AREA

Oceanography

4.1 The Baltic Sea can be characterized as a semi-enclosed ecosystem, with slow water exchange, giving the Baltic water a residence time of 25-35 years. The catchment area of the Baltic Sea, 1.7 million km^2, is four times larger than the area of the basin of 415,000 km^2. There are no tides in the Baltic, except for the Kattegat area; however, seasonal variation in the water level can be more than 1.5 m due to the changes in atmospheric pressure and winds. The cold bottom water, periodically forced into the Baltic Sea, follows the deeper parts of the Arkona, Bornholm and Gotland basins in an anti-clockwise main northern current along the eastern side of the Baltic Sea. Both the surface and bottom currents run anti-clockwise around the Baltic Sea following the western part of the sea back southwards.

4.2 The Baltic Sea, being a comparatively cold sea, has a mean temperature of 5ºC. Large parts are normally ice-covered during the winter, and the ice conditions are strongly related to the severity of the winters. In the northern parts, the average duration of the ice cover is four to six months, whereas in the southern part the ice cover may be less than a month. The actual ice conditions in the Baltic Sea vary rather substantially. The Bothnian Bay and the eastern Gulf of Finland freeze almost every year. Ice starts forming in the bayheads of the Bothnian Bay and the Gulf of Finland during November. Once a decade there might be a winter where only a small area in the Southern Baltic remains ice-free. At its widest, the annual ice cover ranges from 52,000 km^2 to 415,000 km^2, which is equivalent to 12-100% of the surface area of the Baltic Sea, the Kattegat and Skagerrak. On average, a 218,000 km^2 area is covered by ice. The annual ice cover is at its most extensive between January and March, usually in late February, early March. The break-up of the ice starts in the south and progresses to the north. The northern Baltic Sea first opens at the beginning of April. By the beginning of May, ice exists only in the Bothnian Bay, where the last ice melts during the first half of June at the latest. See annex 2.

Ecological characteristics

Uniqueness or rarity

4.3 The Baltic Sea area is a globally unique and sensitive northern brackish-water ecosystem with extraordinary environmental conditions. It is geologically young, semi-enclosed and shallow with a mean depth of 53 m. The salinity in the surface water ranges from 8 practical salinity units (psu) in the Southern Baltic proper to 5 in the Gulf of Finland and the Bothnian Sea and close to zero at the far ends of the Gulf of Finland and the Bothnian Bay. In the Kattegat salinities are near Atlantic levels. The bottom salinity ranges from 16 psu in the Southern Baltic Proper to 10-12.5 psu in the Gotland deep and only 6.5-7 psu in the Bothnian Sea. The present salinity range has existed for a few thousand years and only a small number of marine and freshwater species have been able to adapt to its brackish water. These few species entered the area from the Atlantic during early history and are still trying to adapt to the low salinity and show signs of stress through slower growth, smaller size and greater sensitivity to other types of stress. Together with a small number of freshwater species and even fewer truly brackish-water species they form an ecosystem which is less diverse than that of the North Sea but the Baltic Sea is unique in its biodiversity.

4.4 The exchange of water with the North Sea is, due to geomorphological and climatological reasons, limited and slow resulting in a long residence time of the water, in some parts of the Baltic Sea area up to 25 to 35 years. Nutrients and other pollutants therefore accumulate easily in the Baltic Sea. The water is vertically stratified with two distinct layers. The upper water body with low salinity reaches down to 20-70 m and receives oxygen from the air. The lower, more saline oxygen-rich North Sea water that enters only episodically through the Danish straits and the Sound is denser and hence heavier and forms the deeper waterbody. The interval between such episodes may be several years and their ecological implications are significant. The permanent stratification combined with a high nutrient input frequently causes oxygen depletion in the deep waterbody. In summer, there is typically also thermoclinic stratification at a depth of 15-20 m, caused by differences in temperature between surface and deeper waters. The climate ranges from sub-arctic to temperate and large parts of the Baltic Sea can annually be ice-covered. See annex 2.

4.5 Due to the ice age, land uplift is still an on-going, unique process along the coastal areas of the northern Baltic Sea (about 10 mm per year in the northern part and 4-5 mm per year in the Stockholm Archipelago and the Finnish Archipelago Sea). This continuous land uplift process has formed globally unique coastal land forms and biotopes, e.g., coastal meadows, shallow "glolakes" and "fladas" (flada and glo-lake are different succession stages in the process of a lagoon being separated from the sea by land uplift). Furthermore, the land uplift has created large archipelago areas with several tens of thousands of islands in the Baltic Sea which have no parallel in other areas of the world. Other specific coastal biotopes that are not found outside the Baltic Sea area are the esker islands with sandy, rocky and shingle beach vegetation, boreal Baltic islets and Baltic narrow inlets, specific brackish water influenced coastal meadows and Southern Baltic (brackish water) reed stands. These biotopes are all identified in the EU NATURA 2000 network.

Critical Habitats

4.6 Some of the species in the Baltic Sea are so-called habitat-forming species, i.e. key-species. They have an indisputable importance by creating a life-supporting environment for other species and that is why their occurrence is most important. Typically habitat forming species are plants such as the bladder wrack (*Fucus vesiculosus*), the red alga black carrageen (*Furcellaria lumbricalis*) and eelgrass (*Zostera marina*). A few animals have a habitat-forming role, e.g., the common mussel (*Mytilus edulis*) forms mussel banks that are inhabited by other animals. As much as 90% of the marine and coastal biotopes around the Baltic Sea are to some degree threatened today and many of these areas are important habitats for rare or endangered species. During the last decades, the occurrence of both bladder wrack and eelgrass has declined dramatically mainly due to the effects of eutrophication: decreasing water transparency, increasing sedimentation and increasing amounts of fast growing filamentous algae.

4.7 A functional and healthy marine ecosystem is highly dependent on its coastal areas. In this sense, Baltic lagoons and wetlands are very important for biological reproduction and for the biodiversity of the Baltic Sea as a whole. The shallow bottom areas along the coasts are highly productive, especially in the archipelago areas, and they provide nursery, breeding, spreading and resting grounds for many different Baltic Sea species. This shallow integrated land-water zone receives nutrients and suspended matter from the surrounding land mass and the atmosphere. Such coastal shallow water areas and lagoons can act as filter for nutrients and pollutants. Many of the coastal habitats in the archipelagos are threatened. The main threat is eutrophication, largely due to nutrient-rich runoff from land based sources. The high nutrient levels in eutrophic waters promote excessive growth of filamentous algae, which may suffocate the area's natural communities. Another characteristic feature of eutrophication is increased turbidity leading to shading of macroalgae and aquatic plants. Benthic fauna suffer when large mats of free-floating algal matter settle near the bottom in sheltered coastal areas, because the bacterial decomposition of these mats depletes the oxygen in the near-bottom waters.

Diversity

4.8 Due to exceptional salinity conditions, the Baltic Sea is characterized by low species diversity of freshwater and marine origin, as well as true brackish water species, forming a unique mixture of them. The number of macroscopic marine fauna species decreases from more than 800 in the Kattegat (with salinity of 23 psu) to less than 70 species in the low-salinity waters of the Stockholm archipelago, where salinity is approximately 5-6 psu. In the Gulf of Bothnia, only about 52 marine species have adapted to the low salinity. Further north in the Bothnian Bay, all but one of the 32 plant species are of freshwater origin. The same pattern is seen in the fish community. Marine species dominate in the Kattegat, while freshwater ones occur in coastal areas. More than 120 non-indigenous marine species have also been recorded in the Baltic and around 80 of those have established reproducing populations in some parts of the Baltic Sea.

4.9 The Baltic marine and coastal areas consist of globally important breeding grounds, nurseries, shelters and food sources for coastal birds and waterfowl. The diversity of coastal biotopes is high and the biotopes are characterized by a number of many threatened aquatic and terrestrial species.

4.10 From the colder phases of the Baltic Sea that prevailed in the earlier postglacial times, some relict animal species, such as the ringed seal (*Phoca hispida bottnica*) in the northern part of the Baltic and a few crustaceans, contribute to the specific pattern of biodiversity in the Baltic Sea area. It is believed that there are two distinct populations of harbour porpoises (*Phocoena phocoena*) in the Baltic Sea area: one in the Baltic Sea transition area encompassing Skagerrak, Kattegat, the Belt Sea, the Sounds and the Fehmarn Belt (ca. 40,000 individuals); and, a second one in the central Baltic Sea[1]. The latter population has become very rare (only a few hundred individuals) compared to the situation in the 19th and early 20th centuries when harbour porpoises were widespread throughout the entire Baltic Proper as far northeast as to the Åland Islands and the entrance of the Gulf of Finland. As a consequence of environmental programmes and conservation measures, the reproduction of many top predators such as the white tailed eagle, the grey seal (*Halichoerus grypus*) and the common seal (*Phoca vitulina*) has continuously increased during recent decades. Eutrophication changes the species composition significantly and leads to loss of biodiversity.

Spawning or Breeding Grounds

4.11 The Baltic Sea area encompasses many highly important staging areas for sea birds and more than 30 bird species breed along the shores. The Baltic Sea is an important breeding ground to over 24 bird species included in Annex I of the EU Bird Directive, and in addition to that, the Baltic Sea is important to tens of nationally threatened species. The shallow parts of the Baltic coastline are of great importance for migrating waterfowl, including millions of Arctic ducks, geese, swans, cranes, ducks and waders, on their way to northern breeding grounds in spring time. Other productive parts, like shallow marine hard-bottom areas of the Baltic Sea, are of international importance for diving ducks during the winter and migrations periods. The Baltic Sea is the principal wintering area for the Velvet Scoter (*Melanitta fusca*) in Europe (93% of the populations), the Common Scoter (*Melanitta nigra*) (60%) and the Long-tailed Duck (*Clangula hyemalis*)(91%). Eutrophication has impacts on the bird populations. While some bird species benefit from eutrophication most are adversely affected. The impacts are caused by change in habitat and food availability, but the health of many birds is also directly threatened by the toxins in harmful algae blooms (HAB).

4.12 For the marine fauna, including fish species, the Baltic coastal ecosystem serves as an important spawning and breeding environment, where shallow coastal waters and offshore banks covered with different habitats such as algal communities and seagrass beds often are of special importance as nursery areas. The ability of the Baltic Sea to serve these purposes is depending

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[1] Huggenberger S., Benke H., Kinze C.C. 2002. Geographical variation in harbour porpoise (*Phocoena phocoena*) skulls: support for a separate non-migratory population in the Baltic Proper. Ophelia 56 (1):1–12.

on the meteorological and hydrological processes in the drainage area and on the hydrographical conditions in the sea itself, which is very sensitive to disturbances, natural as well as those induced by man. Bladder wrack and eelgrass meadows are among the most important spawning and nursing grounds, but they are also among the most threatened by eutrophication when rapidly growing filamentous algae take over.

4.13 The most important commercial marine fish species in the Baltic Sea are cod, herring, salmon and sprat and in coastal waters eel, pike, perch and pikeperch. The main spawning areas are situated in the western and south-western parts of the Baltic Sea. Spring-spawning herring is also distributed throughout the Baltic Sea, forming several local stocks. Autumn-spawning herring is currently scarce. Sprat is distributed throughout most of the Baltic Sea and is regarded as one stock. It reproduces in the Baltic Proper, the Gulf of Riga and the Gulf of Finland. The species composition of fish changes significantly as eutrophication progresses. Cyprinids such as roach (*Rutilus rutilus*) and silver bream (*Blicca bjoerkna*) benefit but, e.g., Salmonids decrease.

Integrity

4.14 Over time, the effects of pollution have become evident in the Baltic Sea area. Eutrophication and the impact of oil spills and persistent hazardous substances have had a negative effect on the marine ecosystem and marine biodiversity. However, the Baltic Sea is still a unique biological living environment providing livelihood and possibilities of transportation.

4.15 Eutrophication is considered the most serious environmental challenge of the Baltic Sea; the photograph in annex 3 shows a condition affecting aquatic ecosystems, where excess nutrient inputs lead to elevated nutrient concentrations. This in turn stimulates the growth of algae leading to an imbalanced functioning of the system. This imbalance is seen as an increase in the production of organic matter, its sedimentation to the sea floor, and there is also an increase in oxygen consumption. All this leads to oxygen depletion and recurrent internal loading of nutrients as well as death of benthic organisms, including fish.

4.16 Excessive nitrogen and phosphorus loads coming from land-based sources are the main cause of the eutrophication of the Baltic Sea. About 75% of the nitrogen load and at least 95% of the phosphorus load enter the Baltic Sea via rivers or as direct waterborne discharges. About 25% of the nitrogen load comes as atmospheric deposition. Shipping adds to the problem of eutrophication of the Baltic Sea with its nutrient inputs from sewage discharges and nitrogen oxides (NOx) emissions. Additional information about the causes and effects of eutrophication in the Baltic Sea can be found in Baltic Sea Environmental Proceedings No. 115A[2] and 115B[3].

4.17 Eutrophication is one of the four thematic issues covered by the Baltic Sea Action Plan. In order to achieve "clear water", which is one of the main objectives of the HELCOM Baltic Sea Action Plan[4], phosphorous and nitrogen inputs to the Baltic Sea must be further cut by about 42% and 18%, respectively. Reductions in nutrient inputs have so far mainly been achieved through improvements at major point sources, such as sewage treatment plants and

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2 HELCOM 2009 Eutrophication in the Baltic Sea – An integrated thematic assessment of the effects of nutrient enrichment and eutrophication in the Baltic Sea region: Executive Summary. Balt. Sea Environ. Proc. No. 115A. Available at: http://www.helcom.fi/publications/en_GB/publications/.

3 HELCOM, 2009 Eutrophication in the Baltic Sea – An integrated thematic assessment of the effects of nutrient enrichment and eutrophication in the Baltic Sea region. Balt. Sea Environ. Proc. No. 115B. Available at: http://www.helcom.fi/publications/en_GB/publications/.

4 http://www.helcom.fi/stc/files/BSAP/BSAP_Final.pdf.

industrial waste-water outlets. Achieving further reductions will be a tougher task, requiring actions to address diffuse sources of nutrients such as run-off from over-fertilized agricultural lands. Reaching concentrations of nutrients close to natural levels requires measures to reduce loading from all sectors including shipping in the Baltic Sea. Therefore, the Baltic Sea countries have resolved to act jointly within the IMO to eliminate the discharge of sewage from ships, especially from passenger ships and ferries,

Vulnerability

4.18 The Baltic Sea is highly susceptible to degradation caused by human activities. The drainage basin is four times larger than the Baltic Sea and nine countries surround it with a total population of about 85 million people living in the drainage basin area. The sea receives human induced waste as discharges from municipalities and industry, runoff from agriculture, deposition from the air and ship-generated impact from operational and illegal pollution as well as ship accidents. Problems associated with eutrophication, toxic substances, transport, and physical activities are further accentuated in the almost enclosed Baltic Sea area where harmful substances are accumulated through time.

4.19 The Baltic Sea with its low number of species is considered to be very vulnerable to external disturbances. Each individual species is of special significance to the structure and dynamics of the whole ecosystem. The disappearance of single key-species could have a profound influence on the functioning of the whole system. The ban of a number of hazardous substances such as PCB and DDT have resulted in some improvements in the last 20 years, especially for species in the higher parts in the food web such as seals and birds of prey. However, eutrophication, alien species and overfishing are still threats that need to be taken seriously.

Bio-geographic importance

4.20 The Baltic Sea has a long coastline, including the sandy beaches in the south and the fragmented shores of extensive rocky archipelagos, which forms a diverse interface between land and sea. The land uplift is still an ongoing process along the coastal areas of the northern Baltic Sea area.

4.21 The archipelagos in the Baltic consist of several tens of thousands of islands, islets and skerries (i.e. small rocky islands) surrounded by bays and lagoons which contribute to an area of high and diverse productivity. The archipelago land- and seascape is made up by a fine patchwork of ecosystem types, each with a specific function and structure. The archipelago can be divided into different zones according to a topographical, climatological and botanical viewpoint, reaching from the mainland towards the open sea. The boundary lines coincide more or less with the tectonic features in the bedrock created in the Archean times. The *inner archipelago* contains thick foliage, meadows, silt and clay shores surrounded by shallow waters with reeds. The *central archipelago* consists of thin layers of soils and the shores are dominated by moraine, and large bays surround the islands. Specific for the *outer archipelago* is the richness of rocky shores and exposed bared islands with a high diversity of aquatic species.

4.22 The Baltic Sea area is influenced by Atlantic, continental and boreal ecological features. Due to species' distribution patterns, the Baltic Sea area can be further divided into the Kattegat, the Belt Sea and the Sound, the Baltic Proper, the Gulf of Riga, the Gulf of Finland, the Bothnian Sea and the Bothnian Bay. These areas are further described in annex 1.

Social and economic value, scientific and cultural significance

4.23 A fairly stable and largely urbanized population of about 85 million people live within the Baltic Sea catchment area. The urbanization rate is relatively high in the Baltic Sea catchment area, particularly in Denmark, Sweden and Germany, where more than 80% of the population is living in urban areas. In Estonia, Latvia and Lithuania the urbanization rate is about 70%. The least urbanized countries are Finland and Poland, in which the urbanization rate is below 70%.

4.24 The population is primarily distributed in settlements along the coast. Population density in the whole area varies considerably from over 500 inhabitants per km^2 in the urban areas of Poland, Germany and Denmark to less than 10 inhabitants per km^2 in the northern parts of Finland and Sweden.

Fishing areas of great commercial significance

4.25 In the Baltic Sea region fishery traditionally plays an important role in food supply. Fishing in the Baltic is mainly focused on marine species, but also on some freshwater species and those which migrate between the sea and rivers. The Baltic Sea ichthyofauna counts about 100 fish species. Cod, herring, sprat and salmon are the main commercially exploited species in sea fisheries and they are regulated by quotas. More than 90% of the total catch in the region fall on these species. Other commercially exploited species, mainly in the coastal areas are eel, sea trout, flat fish (e.g., flounder), pike, pike perch, perch, vendace and white fish. Some of these species are often exploited to the same, or an even higher, extent in recreational fisheries.

Aquaculture

4.26 Aquaculture has been traditionally practised in the Baltic Sea region and today it plays an important role for the food supply in the fishing industries in certain regions. Aquaculture could be considered as an alternative to lowering wild fish catches in the Baltic. Nowadays aquaculture for human consumption amounts to about 9% of sea fish landings. The most important fish farming activity in the Baltic Sea countries is salmon and trout farms located on rivers, lakes and in coastal waters.

Shipping

4.27 Shipping plays a key role within the Baltic Sea area as a unifying element in the region. Compared to land transport via rail and roads, shipping is a rather slow but relatively sustainable transport mode. The Baltic Sea has some of the densest maritime traffic in the world. Depending on the season, about 1,900 to 2,400 ships are en route in the Baltic on an average day, not including ferries, smaller fishing boats or leisure craft. Among those ships, around 200 are oil tankers with a cargo up to 150,000 tons.

4.28 Several ferry lines connect the States in the Baltic proper. Some of the world's biggest ferries are transporting goods and people between Sweden and Finland and there are several other ferry lines, i.e. between Sweden and Germany, Denmark and Germany and between Denmark and Sweden. In summertime large numbers of cruise ships from all over the world enter the Baltic Sea area to call at the many coastal cities of cultural interest, such as Helsinki, St. Petersburg, Tallinn, Riga, Gdansk, Rostock, Lübeck, Copenhagen, Visby and Stockholm, see the map in annex 1.

Table 1. The number of international passengers in major passenger-ports ports in the Baltic Sea area and the availability of reception facilities. The number of passengers represents the number of passengers who pass through the port including both arriving and departing passengers. The German figures do not include cruise passengers unless the cruise has either started or ended in Germany. (J. Särkijärvi, Centre for Maritime Studies, University of Turku. pers. comm. 18.9. 2009). The Danish Figures include cruise passengers only for the largest ports (J. Särkijärvi pers. comm. 2009). Figures from Gdynia are based on a personal communication by the Maritime Office in Gdynia.

Port	Number of international passengers			Sewage reception facilities available (according to the GISIS PRF Database)
	2006 Ref.: Baltic Port List, 2006[5]	**2007** Ref.: Baltic Port List, 2007[6]	**2008** Ref.: Baltic Port List, 2008[7]	
Denmark				
Copenhagen	829,000	871,000	1,397,000	yes
Fredrikshavn	2,594,000	2,624,000	1,979,000	yes
Gedser	1,507,000	1,612,000	1,643,000	yes
Grenaa	170,000	168,000	172,000	yes
Helsingør	10,721,000	10,966,000	10,912,000	yes
Rodby Faergehavn	6,789,000	7,058,000	6,756,000	yes
Rønne	1,409,000	1,421,000	1,429,000	yes
Estonia				
Tallinn	6,760,000	6,514,000	7,247,366	yes
Finland				
Helsinki	9,045,502	9,021,519	9,579,488	yes
Mariehamn	2,681,114	2,707,864	2,859,067	yes
Naantali	137,000	150,906	165,007	yes
Turku	3,162,612	3,022,447	3,008,546	yes
Vaasa	78,000	72,909	69,156	yes
Germany				
Kiel	1,465,603	1,543,703	1,754,326	n.i.
Lübeck	314,884	354,314	385,784	n.i.
Puttgarden/Fehmarn	6,789,335	7,068,942	6,767,770	n.i.
Rostock	2,541,144	2,583,043	2,689,551	n.i.
Sassnitz-M	582,000	714,839	717,871	n.i.
Latvia				
Riga	246,900	441,914	503,174	yes
Ventspils	51,700	50,720	32,525	yes
Lithuania				
Klaipeda	240,198	285,216	276,625	yes
Poland				
Gdansk	156,511	170,833	175,133	yes
Gdynia	509,139	530,975	498,724	yes
Kolobrzeg	37,968	34,391	37,336	yes
Świnoujście	929,899	876,427	833,228	yes
Russia				
St Petersburg	319,800	306,900	n.i.	yes
Sweden				
Gothenburg	2,199,150	2,102,663	1,856,088	yes

[5] Saurama, A., Holma, E., Tammi, K. 2008. Baltic Port List 2006. Annual cargo statistics of ports in the Baltic Sea Region. A publication from the Centre for Maritime Studies, University of Turku. ISBN 978-951-29-3625-0.

[6] Centre for Maritime Studies, University of Turku 2008. Baltic Port List 2007. Annual cargo statistics of ports in the Baltic Sea Region. A publication from the Centre for Maritime Studies, University of Turku. ISBN 978-951-29-3760-8.

[7] Centre for Maritime Studies, University of Turku 2009. Baltic Port List 2008. Annual cargo statistics of ports in the Baltic Sea Region. A publication from the Centre for Maritime Studies, University of Turku. In press.

Port	Number of international passengers			Sewage reception facilities available (according to the GISIS PRF Database)
	2006 Ref.: Baltic Port List, 2006[8]	**2007** Ref.: Baltic Port List, 2007[9]	**2008** Ref.: Baltic Port List, 2008[10]	
Helsingborg	10,763,267	10,973,554	10,914,193	yes
Kapellskär	1,381,798	1,184,469	953,924	yes
Karlshamn	110,815	118,194	108,814	yes
Karlskrona	414,944	432,860	381,043	yes
Malmö	156,603	174,980	207,278	yes
Nynäshamn	226,113	209,495	219,349	yes
Stockholm	8,249,304	8,434,842	9,006,387	yes
Trelleborg	1,696,646	1,816,301	1,820,810	yes
Umeå	77,669	71,017	68,857	yes
Varberg	170,332	168,206	172,130	yes
Visby	77,578	62,000	65,758	yes
Ystad	1,936,622	1,878,383	1,856,865	yes
Total	**87,529,150**	**88,798,862**	**89,520,208**	**34/39**

4.29 Statistics on ferry passengers departing from Finland are given in the figure below.

Figure 1. Ferry passengers departing from Finnish ports

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8 Saurama, A., Holma, E., Tammi, K. 2008. Baltic Port List 2006. Annual cargo statistics of ports in the Baltic Sea Region. A publication from the Centre for Maritime Studies, University of Turku. ISBN 978-951-29-3625-0.

9 Centre for Maritime Studies, University of Turku 2008. Baltic Port List 2007. Annual cargo statistics of ports in the Baltic Sea Region. A publication from the Centre for Maritime Studies, University of Turku. ISBN 978-951-29-3760-8.

10 Centre for Maritime Studies, University of Turku 2009. Baltic Port List 2008. Annual cargo statistics of ports in the Baltic Sea Region. A publication from the Centre for Maritime Studies, University of Turku. In press.

4.30 Statistics on cruise ship passengers arriving in Finnish ports are given below.

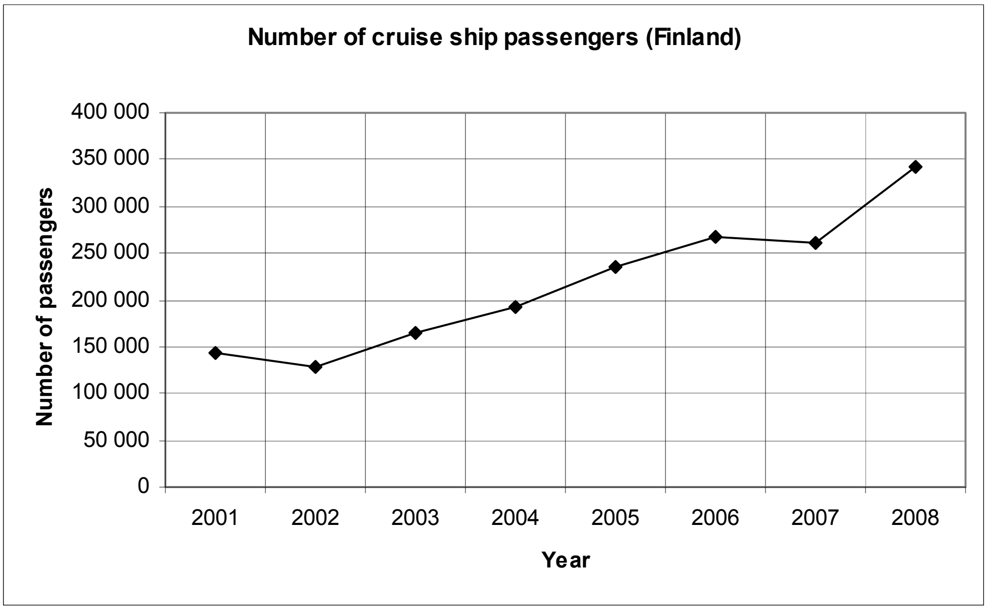

Figure 2. Cruise ship passengers arriving in Finnish ports

Recreation

4.31 The coastal zone is a traditional area of mass recreation and tourism activity. The Baltic Sea area is a vacation area for many people around the world and locals alike. This provides service jobs in tourism and recreation. Areas with a concentration of tourists are typically found in archipelagos, near large dunes and coastal lakes. Also the cruising industry has developed during the last decade. Stockholm harbour has faced a doubling in port calls since 1996 and even more when it comes to passenger numbers. The same trend goes for other ports of cultural or commercial interest along the Baltic Sea.

4.32 Migrating and nesting birds, wild nature, fishing villages with their old buildings still inhabited by a few coastal fishermen in some areas of the Baltic Sea have a significant value for tourists and bring essential economic benefits for the local population.

4.33 Altogether, tourism in the Baltic Sea Region is estimated to generate over USD 35 billion annually in foreign income. Forecasts by the World Tourism Organisation indicate higher growth of tourism in the Baltic Sea area compared with other parts of Europe up to 2020. From a socio-economic point of view eutrophication leads towards a less valuable state of the ecosystem with detrimental effects on tourism and leisure activities. Especially mass occurrences of blue-green algae and excessive amounts of dying filamentous algae on beaches decreases recreational values dramatically. Blue-green algal blooms often lead to swimming prohibitions in the summer because of their potentially toxic and carcinogenic properties. The toxicity of blue-green algae also poses a threat to pets. The mats of decomposing filamentous algae, on the other hand, are not toxic but cause adverse hygienic and aesthetic effects.

Research

4.34 Mediated by the Helsinki Commission since the late 1970s, assessments of the effects of the various pollutants on the Baltic Sea's natural resources have been prepared. The reports are unique compilations of scientific facts borne out of outstanding co-operation among the scientific community in the Baltic region. This has established a very solid platform consisting of long time-series of high-quality data that can be drawn upon for scientific studies in environmental sciences. Nine marine environmental research field stations are situated in the coastal areas of the Baltic Sea. Many other national and international research programmes focusing on the Baltic Sea have recently been established.

4.35 The Baltic is frequently referred to as one of the world's most polluted seas. It has also been described as the best researched sea in the world. One crucial goal of Baltic marine research is to provide information and expertise on environmental issues to help decision-makers. It is not possible to set effective management measures, regulations and guidelines to improve the state of the sea without reliable and objective research data.

4.36 The state of the whole of the Baltic Sea and the pollutant loads entering the sea are monitored co-operatively at international level, through the Baltic Marine Environment Protection Commission (HELCOM). National research institutes monitor the state of coasts and the open sea, also determining the concentrations of nutrients and toxic pollutants, examining how species adapt to changes in their marine habitats, and creating mathematical models to help predict changes and their effects. Fish stocks are monitored in co-operation with the International Council for the Exploration of the Sea (ICES). Research institutes also provide maritime weather forecasts and reports on ice and wave conditions for shipping. Universities offer education in marine science, and conduct basic research together with research institutes.

4.37 BONUS for the Baltic Sea Science – Network of Funding Agencies is an ERA NET project of the EU Sixth Framework Programme. It has the form of a consortium with 14 partners from all nine Baltic Sea countries, including research institutes and science funding agencies as well as ICES (International Council for the Exploration of the Sea). The project's aim is to build up a network of funding agencies and create conditions for a Joint Baltic Sea Research Programme. The BONUS Baltic Organisations Network for Funding Science EEIG (BONUS EEIG) was established in April 2007 in Helsinki to manage the Joint Baltic Sea Research Programme called BONUS-169, to be implemented under Article 169 of the EC Treaty.

Baseline and monitoring studies

4.38 The Helsinki Commission issued its first monitoring guidelines in 1979. The aim is to evaluate the influence of human activity on the Baltic Sea with regard to the effects of environmental policies and to identify serious ecological problems and geographical hot spots. The present guidelines of the Cooperative Monitoring in the Baltic Marine Environment (COMBINE) programme has ensured that the relevant monitoring data from different national programmes has been shared and integrated through a common system that amongst others encompass continuous international monitoring of natural fluctuations in the marine environment, the amounts and effects of anthropogenic nutrients and the levels and effects of contaminants in ecosystems.

Education

4.39 The Baltic Sea with its unique environmental characteristics, as well as its dense settlements along its shores and its peoples' close dependence on the sea, offers a special opportunity for universities and other higher educational centres, both from the region and from outside. Numerous universities in the Baltic Sea area have education programmes focusing on various aspects of the Baltic Sea environment, resources, shipping and tourism. Likewise, a broad number of school related activities in the Baltic Sea States covering the Baltic Sea are performed. Several excellent public information centres, museums and numerous websites on the Internet are in operation and give information on activities.

Environmental pressure from nutrient input

4.40 Compared to other sea areas, the Baltic Sea is unusually prone to eutrophication caused by phosphorous and nitrogen input. This is mainly due to its shallow average depth, its large catchment area with a population of 85 million people and the slow rate of water exchange. The nutrient input stems partly from natural atmospheric and riverine input, but mostly from anthropogenic sources such as agriculture, municipal waste waters, fish-farms, sewage from ships, atmospheric emissions from traffic and combustion of fossil fuels.

4.41 Efforts to reduce nutrient inputs are a top priority among the Baltic Sea States. Reductions have so far mainly been achieved through improvements at major point sources, such as municipal sewage treatment plants and industrial waste-water outlets. Achieving further reductions is demanding, and extra efforts should be directed to address diffuse sources of nutrients. The Helsinki Commission's Baltic Sea Action Plan (BSAP) was adopted by the ministers of the environment of the Baltic Sea States in 2007. It includes measures to reduce nutrient inputs to the Baltic Sea by, e.g., more stringent municipal waste-water standards, waste-water treatment also for single-family homes and small settlements, substitution of phosphorus in detergents and limiting the nutrient leakage from agriculture and other diffuse sources. Reducing nutrient discharges from shipping is also a requirement of the BSAP.

Environmental pressure from nutrient input due to ship-generated sewage

4.42 The Baltic Sea is one of the most intensively trafficked areas in the world. Both the number and the size of the ships have been growing during recent years, and this trend is expected to continue. Passenger and cruise traffic is also increasing rapidly in the Baltic Sea, significantly adding to the amount of sewage created on board. The submitters of this document do not wish to see the amount of nutrients discharged into the Baltic Sea, through the sewage of ships, grow at the same rate.

4.43 To estimate the amount of nutrients discharged into the Baltic Sea from ships' sewage, a theoretical study was conducted in 2006 and updated in 2009 (Hänninen & Sassi 2009[11]). The results show that the sewage annually produced on ships in the Baltic Sea area could contain maximum 356 tonnes of N and 119 tonnes of P. It is difficult to estimate the actual total amount of nutrients discharged into the sea from ships because even today a part of the sewage is discharged into port reception facilities based on voluntary agreements between ports and ship owners. If all sewage were discharged into the sea, the percentage of this input, compared to the total annual nutrient input into the Baltic Sea could be < 0.036% for N and < 0.35% for P.

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11 Hänninen, S. and Sassi, J. 2009. Estimated nutrient load from ship originated waste waters in the Baltic Sea area – updated 2009. VTT Research Report NO VTT-R-07396-08 | 20.3.2009 http://www.vtt.fi/inf/julkaisut/muut/2009/VTT_R_07396_08.pdf.

Although seemingly small, this amount is far from negligible. The nutrients from sewage are directly available for uptake by algae. Especially the growth of blue-green algae, which is limited by the amount of P in the water, is stimulated by sewage. One must also take into account that the discharges are concentrated spatially along the shipping routes, causing serious effects locally. Temporally, the sewage discharges are concentrated in the summer season when algae normally have used up most of the N and P dissolved in the water. Therefore, the nutrients in sewage cause far greater effects on the environment than the percentages mentioned above would suggest.

Other environmental pressures

Harmful substances

4.44 Pollution caused by hazardous substances refers to a massive number of different anthropogenic substances ending up in the marine environment including substances that do not occur naturally in the environment and substances occurring at concentrations exceeding natural levels. Although monitoring indicates that the loads of some hazardous substances have been reduced considerably over the past 20–30 years, problems still persist, and concentrations in the marine environment of some new substances have even increased (e.g., perfluorinated substances). Once released into the Baltic Sea, hazardous substances can remain in the marine environment for very long periods and can accumulate in the marine food web, up to levels that are toxic to marine organisms. Especially substances that are persistent and bio-accumulative may cause potential hazards to humans.

Maritime transport

4.45 During the last decade both the amount of maritime traffic and especially the volume of oil transported in the Baltic Sea have increased significantly. The main reason for the increase in oil transport is the new Russian oil terminals in the Gulf of Finland, which have resulted in an increase in the amount of transported oil in the Gulf of Finland from an annual 20 million tons in 1995 to over 145 million tons in 2008. Transports are expected to increase significantly in the coming years.

4.46 A major oil accident in the Baltic Sea would cause a tremendous amount of damage; thus, not only maritime safety needs to be improved, but also further development of the accident-response capacity is needed. The Baltic Sea countries have agreed on measures to improve maritime safety, and thus the number of accidents has not risen as rapidly as has the traffic flow. In addition, new technology has increased the safety of shipping.

Invasive species

4.47 An invasive species is an organism that spreads, as a result of human activities, beyond its accepted normal distribution. The Baltic Sea is a historically young, semi-enclosed sea area. Practically all the marine fauna and flora have invaded this area during the last 10,000 years, but due to human activities the invasion rate has accelerated drastically from the 1950s. The relatively low number of species makes the Baltic Sea vulnerable to the introduction of new species.

4.48 Shipping is the most important vector introducing new organisms into the Baltic Sea. New species can enter the Baltic either inside the ballast water tanks of ships or through biofouling on ship hulls (i.e. invasive species attached to a ship's hull). For example, the crustacean *Cergopagis pengoi*, the Chinese mitten crab *Eriocheir sinensis*, the polychaete *Marenzelleria viridis* and recently the American comb jelly, *Mnemiopsis leidyi*, have all reached the Baltic Sea through one of these pathways. It is very likely that new species have an ecological impact on native biodiversity and ecosystem functioning.

4.49 HELCOM has called member countries to ratify the 2004 International Convention for Control and Management of Ships' Ballast Water and Sediments (BWM Convention) as soon as possible, but in all cases not later than 2013.

Climate change

4.50 According to the BACC project (BALTEX Assessment of Climate Change for the Baltic Sea Basin, 2006) in the marine ecosystem of the Baltic Sea the assessment of climate-related change is particularly difficult because of the presence of strong non-climatic stressors (eutrophication, fishing, release of pollutants) related to human activities. Changing temperatures have been related to various effects, in particular to the composition of species. A lowering of salinity is thought to have a major influence on the distribution, growth and reproduction of the Baltic Sea fauna. Freshwater species are expected to enlarge their significance, and invaders from warmer seas (such as the zebra mussel *Dreissena polymorpha* or the North American comb jelly *Mnemiopsis leidyi*) are expected to widen their distribution area. Accelerated eutrophication is an expected consequence of the anthropogenic climate change in the Baltic Sea due to freshwater runoff determining most of the nutrient load on the Baltic Sea especially in the near-coastal areas.

4.51 Excessive inputs of nutrients are a major factor behind many of the most serious environmental problems in the Baltic Sea, such as eutrophication, oxygen depletion and excessive algal blooms. Besides the problems of pollutants, physical destruction and discharges of waste water from industries and municipalities, there are also other environmental stress factors. Discharges from offshore oil exploration and production may include emissions of drilling mud and drill cuttings, discharges of production water and incidental oil spills. Commercial offshore oil exploitation in the Baltic Sea Area is taking place off the Polish coast. Additional oil reserves might possibly also exist in the south-eastern region (Poland, Russian Kaliningrad region, Lithuania and Latvia), in which case a considerable future increase in offshore oil and gas operations can be expected. One offshore pipeline is currently in operation in the Baltic Sea area, but plans exist to lay several gas transmission pipelines between some countries.

4.52 Only a few offshore wind farms have so far been established in the Baltic Sea area. However, there are plans for additional expansion of offshore farms in the near future, which may conflict with a number of human interests such as commercial fishery, shipping, military activities, extraction of oil and gas, recreation activities and nature conservation, if not properly planned and located.

Measures already taken to protect the area

4.53 The Baltic Sea area is already designated as a Special Area under MARPOL Annex I and MARPOL Annex V of the MARPOL Convention and a SO_x Emission Control Area under MARPOL Annex VI.

4.54 The uniqueness of the Baltic Sea is reflected in many international conservation networks such as the network of 91 designated HELCOM Baltic Sea Protected Areas (BSPAs), many of which are also part of the EU Natura 2000 network and RAMSAR-sites. There are also several actions at national level to conserve the Baltic Sea, like national parks and seal sanctuaries. In addition, Bird Life International has defined 227 Important Bird Areas (IBAs) in the Baltic Sea (2000). Only part of these areas is currently protected by national legislation or by other means. The Baltic Sea is also a part of the north-east Atlantic Global ecoregion, one of the 238 areas worldwide that WWF regards as priority areas for nature conservation.

4.55 Nutrient limits from urban waste waters discharged into sensitive areas have been regulated in the European Union by European Council Directive 91/271/EEC since the early 2000s. Sensitive areas are identified in the Directive as areas that are found to be eutrophic or which in the near future may become eutrophic if protective action is not taken. For example, total phosphorus levels must not exceed 2mg/l (or 80% reduction) for waste-water treatment plants of 10,000 – 100,000 people and 1 mg/l (or 80% reduction) if the population exceeds 100,000 people. Total nitrogen for the same population groups must not exceed 15 mg/l (or 70-80%) or 10 mg/l (or 70-80%) respectively. In the Baltic Sea even more stringent nutrient limits are set out by HELCOM Recommendations 28E/5 and 28E/6 that were agreed upon by the Ministers of the Environment of the Baltic Sea as a part of the Baltic Sea Action plan in 2007 (see http://www.helcom.fi/stc/files/BSAP/BSAP_Final.pdf). According to Recommendation 28E/5, effluents from waste-water treatments plants with a population equivalent (p.e.) of more than 100,000, discharging directly into a marine environment, should not contain more than 0,5 mg/l P (or 90% reduction) and 10 mg/l N (or 70-80 % reduction). Slightly less stringent reduction levels are required of waste-water treatment plants for smaller populations. According to Recommendation 28E/6, even single family homes and settlements below 300 p.e. should treat their wastewaters to levels corresponding to 5mg/l P (or 70% reduction) and 25 mg/l N (or 29% reduction). These recommendations enter into force between 31.12.2010 and 31.12.2018 depending on the size of the population.

4.56 The overall goal of HELCOM is to have a Baltic Sea unaffected by eutrophication. The aim is to reach HELCOM's vision for a good environmental status in the Baltic Sea. For this reason HELCOM has adopted the following ecological objectives to describe the characteristics of a Baltic Sea which is unaffected by eutrophication:

- concentrations of nutrients close to natural levels;
- clear water;
- natural level of algal blooms;
- natural distribution and occurrence of plants and animals; and
- natural oxygen levels.

4.57 In order to diminish nutrient inputs in the Baltic Sea to the maximum allowable level, the Baltic Sea States have agreed to take action not later than 2016 to reduce the nutrient load from waterborne and airborne inputs aiming at reaching good ecological and environmental status by 2021. This agreement is part of the Baltic Sea Action Plan, adopted by the Baltic Sea States' ministers of the environment in Krakow, Poland on 15 November 2007 (http://www.helcom.fi/stc/files/BSAP/BSAP_Final.pdf).

4.58 In the Baltic Sea Action Plan the Baltic Sea States have agreed on the following country-wise provisional nutrient reduction requirements:

Table 2. Country-wise nutrient reduction requirements according to the Baltic Sea Action Plan.

	Phosphorus (tonnes)	Nitrogen (tonnes)
Denmark	16	17,210
Estonia	220	900
Finland	150	1,200
Germany	240	5,620
Latvia	300	2,560
Lithuania	880	11,750
Poland	8,760	62,400
Russia	2,500	6,970
Sweden	290	20,780
Transboundary Common pool	1,660	3,780

5 ANALYSIS OF HOW THE BALTIC SEA AREA FULFILS THE CRITERIA FOR THE DESIGNATION OF SPECIAL AREAS

5.1 The Baltic Sea clearly fulfils the criteria for the designation of a Special Area in Annex IV, as set out in the Guidelines for the Designation of Special Areas under MARPOL 73/78 (resolution A.927(22)), which are proposed to be amended (see MEPC 60/6/3).

5.2 The oceanographic conditions, especially the shallow depth, the large catchment area and the slow water exchange make the Baltic Sea very prone to eutrophication. Due to the sea's low salinity, young age, low temperatures and high productivity, no comparison can be found elsewhere.

5.3 The ecological conditions in the Baltic Sea are both unique and vulnerable. The extreme environmental circumstances cause the ecosystems to be fragile and susceptible to changes. Environmental pressures, such as alien species, oil pollution, air pollution, chemical pollution, overfishing and habitat change, are serious threats to the Baltic Sea. The most serious threat, however, is eutrophication. Important spawning, breeding and nursery areas are changing dramatically due to eutrophication, endangering some species, benefiting others. As a result of the changes biodiversity is usually reduced and economically important species decline.

5.4 The intense shipping traffic in the Baltic Sea is predicted to increase even more in the future. Sewage discharges are also on the rise, adding to the severe eutrophication of the sea. More than 2,000 ships are en route in the Baltic on an average day. Cargo ships constitute about 57%, oil tankers about 17% and passenger ships about 10% of the ship traffic in the Baltic Sea. During summertime, leisure boat activity is also high in the area. Some of the world's biggest ferries are transporting goods and people between Sweden and Finland and there are several other ferry lines, i.e. between Sweden and Germany, Sweden and Estonia, Estonia and Finland, Denmark and Germany and between Denmark and Sweden. During summertime, large numbers of cruise ships from all over the world enter the Baltic Sea area to call at the many coastal ports of cultural interest, such as Helsinki, St. Petersburg, Tallinn, Riga, Gdansk, Rostock, Lübeck, Copenhagen, Visby and Stockholm.

5.5 MARPOL Annex IV does not require ships to reduce the amount of nutrients in sewage discharged into the sea. However, considering the severe eutrophication of the Baltic Sea, justification for such a requirement in this area clearly exists.

6 INFORMATION ON THE AVAILABILITY OF ADEQUATE RECEPTION FACILITIES FOR SEWAGE IN THE BALTIC SEA AREA

6.1 Waste reception facilities for the sewage of ships are readily available in most of the ports of the Baltic Sea. According to the GISIS PRF database, sewage discharge facilities are available in most of the Baltic Sea ports. Details on the availability of reception facilities in some of the largest passenger ports in the Baltic Sea can be found in Table 1. Many ports have built sewers and receiving bays at ship quays where passenger ships berth, enabling the discharge of sewage directly to municipal sewage systems. Such port reception facilities for sewage are available, e.g., in the ports of Gdynia, Helsinki, St Petersburg and Stockholm. Other ports, like Gdansk, Kaliningrad, Ventspils, Vyborg and Copenhagen/Malmö, have adequate reception capacities using barges, tankers or tank trucks to receive sewage even from large cruise ships. However, some ports have not yet upgraded their reception facilities to a standard sufficient for large cruise ships.

6.2 The so called no-special-fee system of the Helsinki Commission entails that all ships are required to pay a waste fee, regardless of the amount of waste discharged ashore. According to information provided by the authorities of the Baltic Sea countries, the no-special-fee system is applied in almost all passenger ports of the Baltic Sea. Therefore, discharge of sewage to port reception facilities in the Baltic Sea ports does not significantly increase the costs for ship owners. Some ports, e.g., the port of Helsinki, receive sewage from passenger ships without any charge.

7 INFORMATION ON A SEWAGE TREATMENT PLANT CAPABLE OF REDUCING DISCHARGES OF NITROGEN AND PHOSPHORUS

7.1 As an alternative to delivery of sewage ashore, sewage could be treated to remove phosphorus and nitrogen. Apparently, sewage treatment plants currently on the market are not specifically designed for this purpose. However, at least one company is able to offer such equipment. The company in question designs, manufactures and markets environmentally friendly waste and waste-water collection and treatment solutions for the marine industry worldwide.

7.2 Technical information provided by the company is given below[12]. Although such treatment systems are not manufactured by all sewage treatment producers at the moment, demand would surely give rise to supply as well. The information is for a sewage treatment plant for a 3,300 person cruise vessel.

General presentation of the process

7.3 The process is a single stream advanced waste-water treatment system where all the waste streams are treated in one process (see schematic Figure 3). The process is based on effective equalizing and mixing of the incoming waste streams, pre-treatment by screens, an aerated biotank and a membrane bioreactor. In this proposal, a nutrient removal step is incorporated into the basic process.

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12 Hänninen, S. and Sassi, J. 2009. Estimated nutrient load from ship originated waste waters in the Baltic Sea area – updated 2009. VTT Research Report NO VTT-R-07396-08 | 20.3.2009 http://www.vtt.fi/inf/julkaisut/muut/2009/VTT_R_07396_08.pdf.

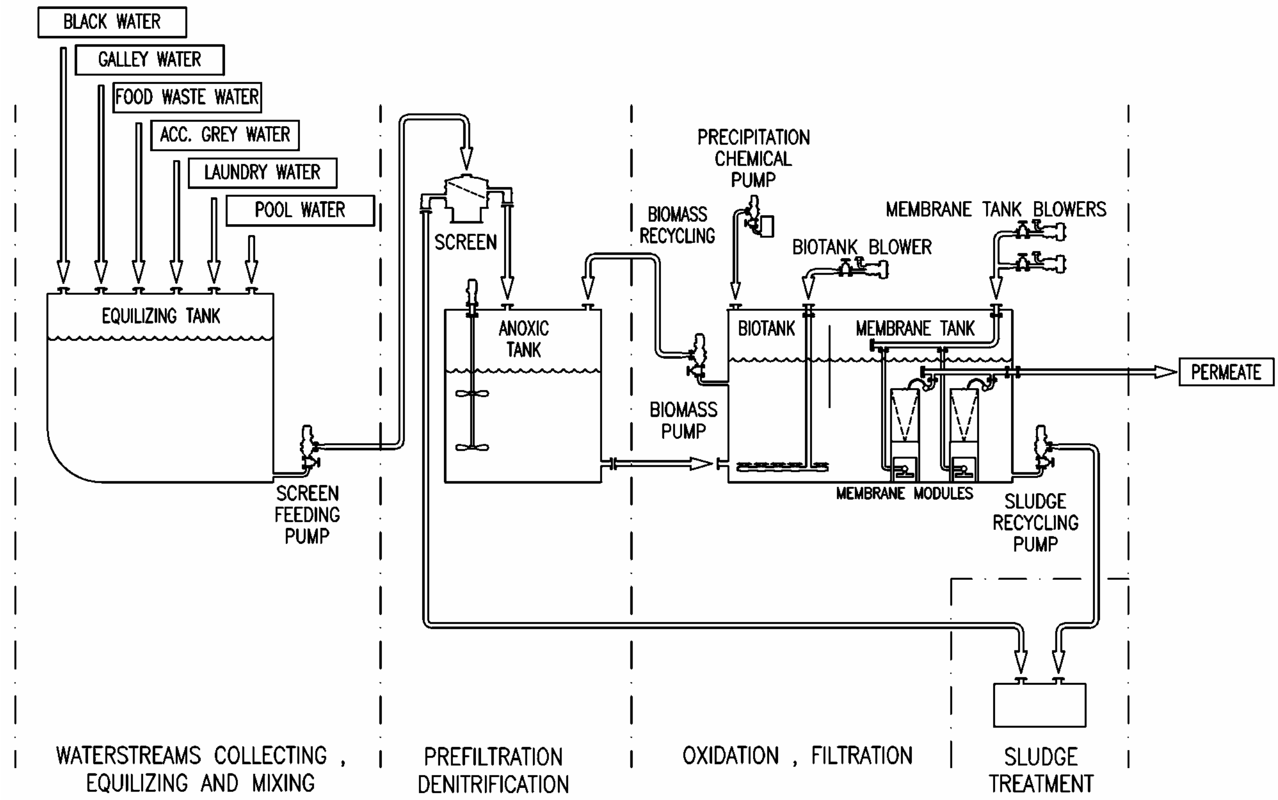

Figure 3. Schematic diagram of an advanced shipboard waste-water treatment plant utilizing a combination of biological removal of organics, nitrogen removal, coprecipitation of phosphorus and membrane filtration

7.4 The nutrient removal is accomplished by adding one anoxic tank for nitrogen removal and a dosing unit for phosphorus precipitation (see Figure 3) to the membrane bioreactor treatment unit (MBR) that includes a membrane tank with membrane modules.

7.5 Generally, biological nitrogen removal is not reversible and is carried out in two biological stages: aerobic nitrification of ammonia via hydroxylamine and nitrite to nitrate, and, subsequently, anoxic denitrification of nitrate via intermediate stages ($NO_3 \Rightarrow NO_2 \Rightarrow NO \Rightarrow N_2O \Rightarrow N_2$) to nitrogen gas. Normally, the rate limiting stage is nitrification. In the shown process, the nitrification takes place in the MBR process itself. The nitrogen will exit the treatment system in the anoxic tank as nitrogen gas. The anoxic tank is simply a non-aerated completely stirred tank that is normally around one third of volume of the main MBR process.

7.6 The removal of phosphorus from waste water involves the incorporation of phosphate into biomass solids on the main treatment process and subsequent removal of those solids. Phosphorus can be incorporated into the solids either by biological activity or by chemical precipitation. The most commonly used method, and also the method used in the shown process, is a chemical precipitation, where phosphorus is precipitated by adding metal salts or polymers. The solids and also the precipitated phosphorus are removed from the purified water by final membrane filtration.

7.7 The process is fully automated and controlled through a programmable controller of the plant by vacuum/pressure switches, level switches, DO, TSS and pH sensors, flow meters and foam detectors. Additional measurement of the final effluent quality, e.g., turbidity, ammonia and nitrate, can be included into the system, if requested.

Description of design data and performance for an advanced waste-water purification system for a cruise ships with 3,300 passengers and crew members

7.8 The process is designed by using the company's knowledge on waste-water concentrations that is based on several shipboard samplings and studies. The calculation also contains approximately 30% "built-in" redundancy for the different waste-water characteristics between different ships and waste-water fluctuations. It should also be noted that a typical waste-water amount per person on a cruise ship is 250 litres/person/day (calculation made on requested 185 litres/person/day).

7.9 The process is calculated for the following hydraulic loading:

- Black water: 3,300 people * 15 litres/day = 49.5 m^3/day
- Galley: 3,300 people * 32 litres/day = 105.6 m^3/day
- Food waste: 3,300 people * 3 litres/day = 9.9 m^3/day
- Accommodation grey water: 3,300 people * 110 litres = 363 m^3/day
- Laundry water: 3,300 people * 25 litres = 82.5 m^3/day

The total daily nominal flow is 610.5 m^3/day.

7.10 The expected effluent biological oxygen demand (BOD) and TSS values are below 10 mg/l. Onboard tests show that the membrane process effluent is fulfilling all current limits.

Table 3. Various sewage treatment standards for ships.

	IMO MARPOL	IMO MARPOL	USCG	Alaska	Navy NIAG	Rhine River	**WWTP**
	MEPC. 2(VI)	MEPC. 159(55)	33CFR 159 PT1-300	33DFR 159.309	2015		**Test results**
BOD_5 (Biochemical oxygen demand) mg/l	50	25		30	15	25	**< 3**
TSS (Total suspended solids) mg/l	50	35	150	30	50		**< 5**
COD (Chemical oxygen demand) mg/l		125				125	**< 50**
Faecal/Thermotolerant coliform cfu/100 ml	250	100	200	20	100		**BDL**
Residual Chlorine mg/l				10	0		**0**
pH		6-8.5		6-9			**Within limits**

7.11 The design values for nutrient concentrations in the effluent are:

Nitrogen: < 10 mg/l
Phosphorus: < 0.5 mg/l

Price estimate for a complete advanced waste-water treatment plant for an existing cruise ship

7.12 The price for one complete turnkey system is around 3-3.5 M€ for a 3,300 person cruise ship. The installation is approximately 50% of the cost (turnkey retrofit).

Contribution of the nutrient reduction components to the price of the complete treatment plant

7.13 The investment cost for the components of the waste-water treatment plant needed for N and P reduction would amount to 0.4-0.7 M€ depending on design and cost of installation. This represents around 11- 23% of the total cost of the treatment plant.

Operational costs for an advanced waste-water purification system for 3,300 passengers and crew members

7.14 The estimated annual operational costs (including electric power, chemical, membrane and filter consumption, labour costs) are around 153,000 €. The major overhaul costs for an assumed 30-year lifetime of the vessel, including costs of membrane replacement every 10 years, (i.e. twice) are about 686,000 €.

7.15 A theoretical annual cost can be calculated for the system described above making the following assumptions. An annual annuity is first calculated for the investment of 3M€ with an assumed repayment time/depreciation time of 10 years and an interest rate of 5%, giving us a factor of 0.1286 (as according to the methodology of the Nordic Environment Finance Corporation (NEFCO)[13]). By adding the annual operational costs (153,000 €) and overhaul costs (686,000 €/30 years = 22,867 €) we get a total annual cost of 3,000,000 € x 0.1296 + 153,000 € + 22,867 € = 564,667 €.

Contribution of the nutrient reduction to the operational costs of the advanced waste-water purification system for 3,300 passengers and crew members

7.16 Using the highest expected investment cost of 0.7 M€ (see section 7.13) for the nutrient reduction components with an assumed repayment time/depreciation time of 10 years and an interest rate of 5%, we get an annual cost of 700,000 € x 0.1296 = 90,720 €.

7.17 The cost for reducing P can be calculated by estimating the required amount of chemicals needed for precipitation. For the example case given above, about 17.4 kg of metal salt would be needed. The cost of the chemical is estimated to be 0.85 €/kg. Thus, we get an additional cost of about 15 €/day or about 5,400 €/year for reducing P.

7.18 The total annual additional cost for reducing N and P would thus be about 100,000 €/year, which is about 18% of the theoretical annual cost of the whole system (see section 7.15).

[13] NEFCO 2007. Methodology and basis for calculations regarding emission reductions and environmental impact within NEFCO's project portfolio. http://www.nefco.org/files/NEFCO%20Environmental%20Methodology.pdf

Comparison of the cost of nutrient removal in waste-water treatment plants of ships with the cost of nutrient removal from agriculture and municipal waste water

7.19 According to different sources referred to in VTT 2009[14], a person produces 0.00274-0.005 kg of P and 0.00822-0.015 kg of N per day (we assume a 100% reduction of these, since a residual of less than 20mg/l of N and less than 1 mg/l of P would affect the calculations very marginally). Multiplying the N and P amounts with 3,300 passengers and crew members of a large cruise ship and 365 days and dividing the annual costs with the results gives the following costs:

The cost for reducing P with the above mentioned treatment system is 16.6 – 30.3 €/kg P
The cost for reducing N with the above mentioned treatment system is 5.5 – 10.1 €/kg N

7.20 In reality, the lifetime of such a treatment system is not 10 years as is in these calculations but rather 20, or even 30 years. Taking this into account would significantly reduce the cost per kg of nutrient reduction. On the other hand, most cruise ships only spend a few months per year in the Baltic Sea. This will increase the cost if one argues that nutrient removal outside the Baltic Sea is redundant.

7.21 NEFCO has calculated the costs for reducing nutrients from, e.g., agriculture and municipal waste waters in the Nordic countries[15]. According to the results, reduction of P from municipal waste water and waste water from industry costs about 1790 €/kg, and reduction of N 125 €/kg. P reduction from agriculture costs 2,739 €/kg and N 37 €/kg. This indicates that in particular P reduction by treating the sewage of ships is very cost-effective, when compared to other ways of reducing nutrient discharges to the Baltic Sea. Discharging the sewage to port waste reception facilities would naturally be even more cost-effective.

8 ACTION REQUESTED OF THE COMMITTEE

8.1 The Committee is invited to take the information provided into account when considering the proposal of the Baltic Sea States to designate the Baltic Sea as a special area under Annex IV of MARPOL.

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[14] Hänninen, S. and Sassi, J. 2009. Estimated nutrient load from ship originated waste waters in the Baltic Sea area – updated 2009. VTT Research Report NO VTT-R-07396-08 | 20.3.2009. http://www.vtt.fi/inf/julkaisut/muut/2009/VTT_R_07396_08.pdf.

[15] NEFCO 2007. Methodology and basis for calculations regarding emission reductions and environmental impact within NEFCO's project portfolio. http://www.nefco.org/files/NEFCO%20Environmental%20Methodology.pdf.

ANNEX 1

MAP OF THE BALTIC SEA AREA.

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ANNEX 2

ICE CONDITIONS IN THE BALTIC SEA AREA

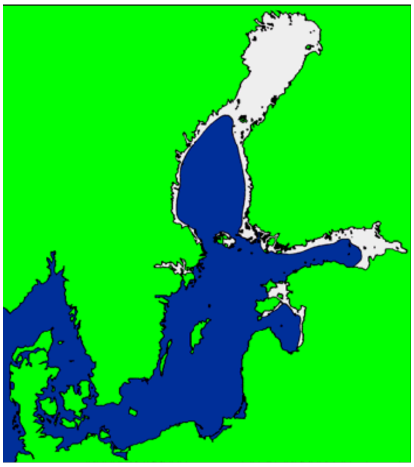

Figure 1. Extremely mild winter 1991/92, max. extent of ice cover 66,000 km²

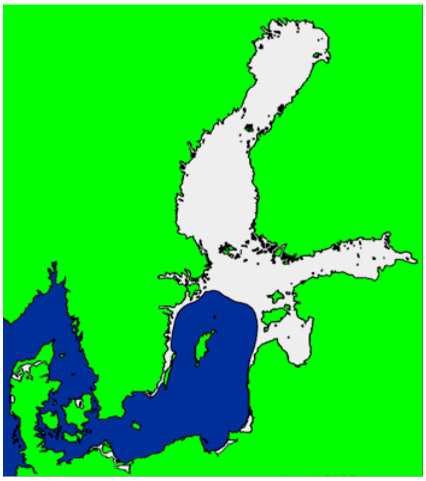

Figure 2. Average winter 1961-1990, max. extent of ice cover 204,000 km². The winter 2002/03 was close to an average winter, the maximum extent of the ice cover was 232,000 km² in early March 2003

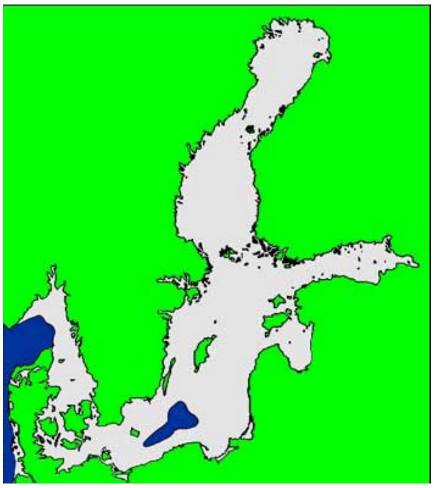

Figure 3. Extremely severe winter 1986/87, max. extent of ice cover 405,000 km²

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ANNEX 3

Blooms of blue-green algae are a recurring problem in the Baltic Sea during summer, both on a small scale (left, © Finnish Environment Institute) and on a larger scale (right, © The Finnish Boarder Guard/Air Patrol Squadron). The blooms, which may be toxic, are one of the symptoms of eutrophication caused by excess nutrients in the Baltic Sea.

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