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– Implementation report on the status and ecological coherence of the HELCOM BSPA network

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Preface

It is commonly known that most human activities are placing increasing pressure on the world’s oceans and their biodiversity. Two stress factors – pollution by nutrients and hazardous substances and fishing – produce probably the most harmful effects on marine ecosystems and their components. Other anthropogenic pursuits such as shipping, extraction of seabed resources and inshore and offshore installations also lead to disturbance of species and habitats and general degradation of marine ecosystem health.

To restore biodiversity and sustain the vital resources provided by the marine environment several conventions and political frameworks at international and national levels have been signed since 1974. These frameworks and conventions call for the implementation of an array of different tools and management, including the designation of marine protected areas as one major means. Until recently however, most efforts to establish MPAs have focused on areas with scenic and recreational value or have focused on ways to conserve individual species or habitats. This approach has led to the creation of ad hoc networks where sites are selected one by one, often on a national basis.

As more marine environments become vulnerable to environmental degradation and more habitats and species are threatened or under decline, there has been a growing interest in designing comprehensive networks of MPAs that also take account of social and economic considerations. Well-designed and well-managed MPA networks ensure that entire ecosystem complexes of larger regions can become more resilient to external threats such as eutrophication, invasive species or climate change. Furthermore, in most cases they provide the opportunity for a sustainable use of marine resources.

In 2003, during the first joint Ministerial Meeting of the Helsinki and OSPAR Commissions in Germany, governments of all European nations bordering the Northeast Atlantic and the Baltic Sea as well as the European Commission agreed on a Joint Work Programme (JWP). Its aim was to complete the networks of Baltic Sea Protected Areas (BSPAs) and OSPAR marine protected areas by 2010. These HELCOM and OSPAR Marine Protected Areas were to be well-managed and along with the marine SPAs and SCIs of Natura 2000, were intended to form an ecologically coherent network in the Northeast Atlantic and the Baltic Sea. This commitment was reaffirmed in 2007 by the HELCOM Baltic Sea Action Plan. Further, it was decided that by 2009 EU Member States shall designate appropriate marine Natura 2000 sites as HELCOM BSPAs and that by 2010 all HELCOM Contracting States shall designate when appropriate, additional BSPAs under special consideration of offshore sites beyond their Territorial Waters. Contracting Parties also agreed to improve the protection efficiency of the network, and to assess the ecological coherence of the BSPA network together with the marine Natura 2000 sites in 2010.

One of the recommendations put forward by the HELCOM thematic assessment on biodiversity and nature conservation (HELCOM 2009) was a proposal to use a regional systematic approach to site selection to maximize the chance of creating a network of marine protected areas that would efficiently meet all conservation targets while minimising conflicts with other interests. In 2009 HELCOM decided that a Baltic-wide regional systematic approach for the selection of additional BSPAs would be applied to fulfil these agreements.

The results of the report on the present status of the BSPA network are encouraging: Up to the end of February 2010, 159 BSPAs had been officially designated by the nine Baltic Sea nations. This amounts to an area of 42,823 km² covering total over 10.3% of the HELCOM marine area. Based on the available information it can be asserted that in the year of biodiversity, the Baltic Sea is the first marine region to achieve the target of the CBD WSSD, and CBD decision (VII/30), which called for the effective conservation of at least 10% of each of the world's ecological regions by 2010 and for MPAs by 2012. With the BSPAs and Natura 2000 sites combined, 12% of the Baltic Sea is protected.

This report presents the work of investigating and evaluating the status and ecological coherence of the BSPA and marine Natura 2000 networks. It also reveals the results of the site selection analyses carried out using the decision support tool Marxan.

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1 Towards an ecologically coherent network of BSPAs

1.1 Introduction

This chapter provides HELCOM and the public with the current status of the network of HELCOM marine and coastal Baltic Sea Protected Areas (BSPA). Further, it assesses the ecological coherence of the joint network of well-managed marine protected areas of OSPAR and HELCOM. Combined with the Natura 2000 network, these areas should be ecologically coherent by 2010.

The chapter includes a detailed analysis of the BSPA database comprising information on variables such as management measures, threats and the protected species, habitats, biotopes and biotope complexes. Germany and the HELCOM Secretariat supported by a contractor from the Vechta University (Germany) were appointed as Lead Parties for this work. The use of time-consuming operational tools meant that the assessment of ecological coherence had to be restricted only to data available up to July 2009. Assessments were performed for all BSPAs and Natura 2000 sites as well as for a combination of BSPAs and Natura 2000 sites. The latter was only assessed regarding the location and geometries of SPAs and SCIs since no metainformation on marine Natura 2000 sites was available for all Baltic Sea nations at that time. Since the designation of Natura 2000 sites as BSPAs is accepted by HELCOM as an adequate implementation of the JWP, the Natura 2000 network was to be included in the analyses.

As a result the ecological coherence of BSPAs, the Natura 2000 network and a combination of both elements were investigated with reference to three spatial units: the entire Baltic Sea, the seven Baltic Sea Basins and each Contracting State's Territorial Waters (TW) and Exclusive Economic Zones (EEZ). To achieve the objectives outlined, the following work packages were developed:

- Distribution of a survey questionnaire to verify and update the BSPA database → Chapter 1.2.
- Evaluation of the representation of the HELCOM List of threatened and/or declining species and habitats/biotopes (HELCOM 2007c) species and habitats/biotopes within BSPAs and their protection through national policies → Chapter 1.3.1.
- Evaluation of the representation of all other species, habitats/biotopes listed in the BSPA database and their protection under national policies → Chapter 1.3.1.
- Evaluation of the representation of essential habitats or, alternatively, benthic and coastal landscape types within the BSPA network → Chapter 1.3.1.
- Analysis of Natura 2000 sites that overlap with BSPAs to evaluate the use of Natura 2000 protection measures for the BSPA network → Chapter 1.3.2.
- Analysis and evaluation of the ecological coherence of the marine BSPAs applying the HELCOM assessment criteria for the entire Baltic Sea area, the Baltic Sea basins and the marine area of each Contracting State, respectivelyv → Chapter 1.4.

During the course of the assessment some of these tasks were slightly altered in agreement with the BfN and the HELCOM Secretariat.

All new data resulting from this survey were integrated into the appropriate BSPA tools and analysed according to the relevant criteria. Although the actual BSPA database contains more data than was available before the survey for this report, information is still not complete and therefore it is not possible to present any assessment with a high level of significance.

1.1.1 Historical review of steps towards marine conservation

For a long time, there was no worldwide organisation advocating or governing marine conservation. This was particularly the case with respect to the establishment of marine protected areas. Although environmental degradation was steadily increasing in all seas over decades, only few MPAs were designated by coastal states even so, only on an *ad hoc* basis. This was the case until 1985, when the International Union for Conservation of Nature established its IUCN Marine Conservation Programme.

For the first time a model was established, demonstrating how conservation and development could protect marine and coastal species and ecosystems, enhance awareness of marine and coastal conservation issues and management and mobilise the global conservation community to work for marine and coastal conservation (Kelleher & Kenchington,1991). Generally, the protection of marine ecosystems and marine biodiversity continues to lag far behind terrestrial conservation policies and programmes. In 2003 only 0.5% of the world's oceans were assigned as MPAs compared to 12% of land, not counting an additional 10% of the Antarctic continent (Durban Summit).

Finally, in 1988, the 17th Session of the General Assembly of IUCN recognised the need for a coordinated approach to protecting MPA networks. Other high-level conferences such as the World Congress on national parks and protected areas, held in Caracas, Venezuela in 1992 called for the establishment of a global network of MPAs as useful tool in the protection of marine biodiversity. In the same year the first UN Earth Summit in Rio de Janeiro, Brazil decided on the establishment and management of marine protected areas and the sustainable use of marine resources by means of Integrated Coastal Management (Agenda 21, Article 17) when the summit established the Convention on Biological Diversity (CBD).

Since the adoption of this worldwide Convention, there has been a heated ongoing debate between coastal states and environmental organisations regarding the available options for and the type and scope of conservation measures to protect marine areas. However, it took another ten years before the United Nations World Summit on Sustainable Development, in Johannesburg, South Africa (UN WSSD, 2002), agreed on the first set of concrete targets in combination with a solid road map. The conference adopted among other issues a global target of 10% for all marine ecological regions to be effectively conserved by marine protected areas within representative networks by 2012. The 6th Conference of the Parties to the CBD (CBD COP 6) reaffirmed the decisions of the WSSD in 2002 and endorsed the creation of such a network of MPAs by 2012 as a key contribution to the 2010 target of IUCN's Countdown 2010 process. Countdown 2010 was to mobilise action to ensure that all governments would take the necessary actions to halt the loss of biodiversity by 2010.

The history shows that well-managed networks of marine protected areas (MPAs) were only very recently recognized and promoted as one of the most important and effective measures to achieve substantial marine conservation. It is, however, not a silver bullet solution for marine conservation. Well-managed MPA networks have to be complemented by ongoing single-species protection measures, habitat enhancement, reduction of eutrophication and pollution, prevention of harmful discharges into seas as well as the reduction of pressures arising from unsustainable resource extraction (von Nordheim et al. 2006).

There are many ways in which MPAs can help regulate the threats outlined above, and in so doing, contribute to healthier seas. They ensure that entire ecosystem complexes of larger regions are more resilient to external threats. Furthermore, MPAs create opportunities to integrate human uses of marine resources with conservation initiatives since in most cases they are not designed as no-take or

Gravel, stones, Blue mussel (*Mytilus trossulus*), *Potamogeton* sp.


Hailuoto, Finland

no-use zones. However, without legal safeguards and proper management an MPA does not guarantee any protection.

1.1.2 History of Marine and Coastal Baltic Sea Protected Areas

New Article 15 of the 1992 Helsinki Convention

The Baltic Sea has been used and exploited by men for centuries. Impacts arising from such human activities magnify the natural sensitivity of this brackish water body. As far back as 1974, in the middle of the cold war, riparian states on the Baltic Sea recognized the urgent need for effective protection and restoration of the Baltic marine ecosystem and established the Helsinki Convention.

For the first time ever, a regional sea convention provided a legal framework, based on international law, to combat all the sources of pollution around an entire regional sea area. It was signed by the then seven Baltic coastal states and entered into force on 3 May 1980. In light of political changes and developments in international environmental and maritime law, a new convention was signed in 1992 by all the existing nine states bordering the Baltic Sea, and the European Community. The new convention entered into force on 17 January 2000 and covers the entire water body of the Baltic Sea area.

The new Article 15 on nature conservation and biodiversity impacts directly on nature conservation. It requires Contracting Parties individually and jointly to take all appropriate measures to conserve natural habitats and biological diversity and to protect ecological processes in the Baltic Sea area. As the governing body of the convention, the Helsinki Commission (HELCOM) implements the Convention via a process of intergovernmental co-operation among the Contracting Parties.

HELCOM Recommendation 15/5 on BSPAs

To implement the Article 15, HELCOM established a permanent Working Group on Nature Conservation and Biodiversity in 1992. One of the most important task for this group was to work towards a regional network of marine protected areas. Based on the work of this expert group HELCOM issued in 1994 Recommendation 15/5 on the establishment of a network of coastal and marine Baltic Sea Protected Areas (BSPAs). At that time, it was the only international network of marine protected areas in a regional sea area. All Contracting States to the Helsinki Convention contributed by identifying and nominating an initial suite of 62 sites. Contracting States also made commitments to expeditiously define specific boundaries and management measures and to include additional BSPAs, particularly offshore sites outside their Territorial Waters (www.helcom.fi, BfN 2008, HELCOM 2009a).

In 1996 the Working Group on Nature Conservation and Biodiversity agreed on Selection Guidelines for BSPAs to advance implementation of Recommendation 15/5. Further, it compiled a comprehensive overview of all existing coastal and marine protected areas (not only BSPAs) in the Baltic Sea area (HELCOM 1996). This work showed that there already existed a wide range of coastal terrestrial and nearshore marine protected areas in all Baltic Sea states. However, many of them were not included in the BSPA system, although they would have qualified on the basis of the selection guidelines. The assessment also made it clear that there was a Baltic Sea -wide lack of offshore protected sites. Consequently, another expert opinion was commissioned to identify potential offshore BSPAs: Hägerhäll & Skov (1998) proposed 24 ecologically significant offshore sites, but only some of them have been subsequently designated as new BSPAs. Further progress towards the establishment of the BSPA network slowed down after the accession talks between Poland, the three Baltic States and the EU had gained traction. These nations therefore had to prioritise efforts for the establishment and management of the Natura 2000 network (**Box 1**). Unlike HELCOM Recommendation 15/5 this initiative is enforceable using legal action, in the event of non-compliance of Member States with the Birds and Habitats Directives (HELCOM 2009a).

2010 Target and JWP agreed by HELCOM and OSPAR

In 2003, the HELCOM and OSPAR Commissions tried to jointly reinforce and accelerate the implementation process for HELCOM Recommendation 15/5 and a similar "OSPAR Recommendation 2003/3" on the establishment of an MPA network in the Northeast Atlantic, known as the OSPAR Maritime Area. At the high-level phase of the first joint Commission meeting (in Bremen, Germany), Ministers reaffirmed their commitment to establish a coherent network of well-managed marine protected areas by 2010 (hereafter referred to as the 2010 target) and adopted a Joint Work Programme (JWP) for the OSPAR and HELCOM convention areas (**Box 2**).

At the same meeting, the governments of the signatory states to the two conventions adopted a ministerial declaration[1], in which they sought to combine efforts with the European Union to establish a coherent network of MPAs in the Northeast Atlantic and the Baltic Sea: *"We reaffirm our commitments to establish a network of well-managed marine protected areas. … Working with the European Community, we shall have identified the first set of such areas by 2006, and shall then establish what gaps remain and complete by 2010 a joint network of well-managed marine protected areas that, together with the NATURA 2000 network, is ecologically coherent."*

Box 1. Natura 2000 network of protected areas in the European Union

Natura 2000 is a network of protected areas legislated by the European Union. This network is based on requirements of the Birds Directive[1] and the Habitats Directive[2] adopted in 1979 and 1992, respectively. The overall objective of the Natura 2000 network is to achieve or maintain favourable conservation status for European biodiversity features. To meet this objective, each EU Member State must establish a suite of Special Protection Areas (SPAs) for birds and Sites of Community Importance (SCIs) for non-bird species and habitats listed in the annexes to the directives and manage these protected areas appropriately. In a later step SCIs can be designated as Special Areas of Conservation (SACs). Thus far no marine SACs exists in the Baltic Sea. The mere designation of an SPA and/or an SAC is not enough to ensure favourable conservation status but must be followed by specific species and/or habitat protection measures, in particular, management measures. It is therefore important to note that BSPAs may protect a wider range of marine species, habitats, biotopes and natural processes than those listed in the nature directives if the corresponding HELCOM lists are taken into account (HELCOM 2007b). The Habitats Directive stipulates specific criteria for the identification and assessment of sites proposed by EU Member States in accordance with the Directive.

[1] Council Directive 79/409/EEC on the Conservation of Wild Birds

[2] Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora

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[1] http://www.helcom.fi/stc/files/MinisterialDeclarations/HelcomOsparMinDecl2003.pdf

BOX 2. HELCOM objectives and criteria for the assessment of the status and the coherence of the BSPA network[1]

1. A BSPA should give particular protection to the species, natural habitats and nature types to conserve biological and genetic diversity.
2. It should protect ecological processes and ensure ecological function.
3. It should enable the natural habitat types and the species' habitats concerned to be maintained at or, where appropriate, restored to a favourable conservation status in their natural range.
4. The network should protect areas with:
    - threatened and/or declining species and habitats
    - important species and habitats
    - ecological significance
        - – a high proportion of habitats of migratory species
        - – important feeding, breeding, moulting, wintering or resting sites
        - – important nursery, juvenile or spawning areas
        - – a high natural biological productivity of the species or features being represented
    - high natural biodiversity
    - rare, unique, or representative geological or geomorphological structures or processes
    - high sensitivity.
5. The minimum marine size of a BSPA should preferably be 3000 ha for marine/lagoon parts.
6. The system should be enlarged stepwise by additional areas, preferably purely marine areas.
7. Criteria for the assessment of the ecological coherence[2]: adequacy, representativeness, replication of features, connectivity.

[1] The objectives and criteria are based on the Joint HELCOM/ OSPAR Work Programme on Marine Protected Areas (Bremen 2003, available at: http://www.helcom.fi/stc/files/BremenDocs/ Joint_MPA_Work_Programme.pdf), HELCOM Recommendation 15/5 on the System of Coastal and Marine Baltic Sea Protected Areas (BSPA, available at: http://www.helcom.fi/Recommendations/en_GB/rec15_5/), and to the Minutes of the Eight Meeting of Nature Protection and Biodiversity Group (HELCOM HABITAT 8/2006, available at: http://meeting.helcom.fi/c/document_ library/get_file?p_l_id=16352&folderId=73533&name=DL FE-29471.pdf).

[2] According to the EC Habitats Directive, a coherent European ecological network of special areas of conservation (Natura 2000) is composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, and enables the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.

With the ministerial declaration and the JWP HELCOM's impetus, further work on establishing the BSPA network was based on a clear political commitment and a solid road map with clear timetables. The meeting was followed by a first assessment of the network of protected areas in the Baltic Sea Region in 2004. For that purpose, a comprehensive database was established containing information on the quantity, size and geographical position of BSPAs as well as their protected species, habitats, biotopes and biotope complexes. Furthermore, specific information on protection status and management plans was provided.

HELCOM (2007b) provides a detailed explanation of the database content and its evaluation with respect to the 2010 target. The database is public and provides online access for the Contracting Parties to adjust the information based on changes to BSPAs or the addition of new areas. The BSR INTERREG IIIB Project Balance conducted a complementary assessment on BSPAs and Natura 2000 sites (Piekäinen and Korpinen 2007). Here, the network was investigated with respect to ecological coherence based primarily on the spatial distribution of benthic marine landscapes. The landscape maps were used as a proxy for the broad-scale distribution and extent of ecologically relevant entities of the seafloor (Al-Hamdani and Reker 2007; Andersson et al. 2007; Piekäinen and Korpinen 2007).

Both the HELCOM and Balance evaluations concluded that the BSPA network at the time did not fulfil the required criteria for ecological coherence and consequently did not meet the 2010 target. An additional assessment of the BSPA network was conducted in 2008 resulting in the same conclusions (HELCOM 2009a).

BSPAs in the Baltic Sea Action Plan

When HELCOM met again at the ministerial level in November 2007 in Krakow, Poland to agree on the Baltic Sea Action Plan (BSAP), Contracting Parties were aware that additional efforts were needed for the fulfilment of the 2010 target. In the BSAP, Contracting States recalled and slightly modified their 2010 commitment by adopting the HELCOM Baltic Sea Action Plan (BSAP) (HELCOM 2007a). Aligning themselves to the action plan, the Contracting States decided to "designate by 2009 already established marine Natura 2000 sites, where appropriate, as HELCOM BSPAs and to designate by 2010 additional BSPAs especially in the offshore areas beyond territorial waters" (HELCOM 2007a). Furthermore, they agreed to improve the protection efficiency of the BSPA network by assessing its ecological coherence in conjunction with the Natura 2000 network in 2010.

1.2 Update of the BSPA database

Digital questionnaires. To revise and update information on BSPAs the lead parties distributed questionnaires to the respective authorities in the Contracting States (see Annex I). One MS Excel questionnaire each was produced for all existing BSPAs following the structure of the HELCOM BSPA database. Accordingly each questionnaire consisted of eight spreadsheets that included the following categories: *general, selection, management, threats, species, habitats, biotopes* and *biotope complexes*. In the first category, general information on the respective BSPA was requested. This included information for the identification of the site (*BSPA ID, site name, name of the responsible organisation and contact person, etc.*), its MPA status *(managed, designated, proposed or expert opinion*), its geographical position and size including percentage of overlap with other national and international MPA areas, and basic information on existing management plans.

Furthermore, space was provided for additional information on variables such as species and habitats not listed in the remaining seven spreadsheet categories. Additionally, the category selection provided 19 different reasons for the designation of an area as a BSPA. The *management* section solicited information on the details of the management plan as well as activities in the area that either required permission, or were forbidden or restricted.

Threats sought to determine existing and potential activities and other factors that could endanger the area. The subsequent four spreadsheet categories provided lists of *species, habitats, biotopes* and *biotope complexes* from which (1) protected and (2) present but not protected items were to be chosen.

For *existing* BSPAs the MS Excel questionnaires were completed using the information available in the BSPA database at that time. Contracting States were then asked to verify the respective database entries and where necessary to update the entries and / or provide additional information. For *new* BSPAs empty questionnaires were provided. It was decided by HELCOM HABITAT 11 (Kotka, Finland, 2009) that Contracting States should respond to the questionnaire by mid September 2009 at the latest. Answers submitted after this deadline could not be recognized in the analysis except basic information such as the number, location and area of BSPAs.

Special case Germany. While questionnaires were sent to Denmark, Estonia, Finland, Latvia, Lithuania, Poland, Russia and Sweden, a different experimental procedure was applied in the case of Germany. In 2005, HELCOM HABITAT 7 decided that the designation of Natura 2000 sites as BSPAs by the EU Member states would be accepted by HELCOM as an adequate means of implementing a coherent network of MPAs according to HELCOM Recommendation 15/5. Following this decision, most of the Contracting States announced several of their Natura 2000 sites as BSPAs to HELCOM.

The Natura 2000 network encompasses two distinct types of areas. Those protected under the Habitats Directive are named Sites of Community Importance (SCIs) and those protected under the Birds Directive are termed Special Protection Areas (SPAs). In certain cases, an area may either completely or partly be described according to both Directives. Since the processes of BSPA and Natura 2000 designation do not follow the same principles, a BSPA may cover several Natura 2000 sites with completely or partly overlapping SPA and SCI sites.

One major commitment of both Directives is the obligation to report on the current status of the protected areas at regular intervals of six years in the case of the Habitats Directive and three years in the case of the Birds Directive. The use of standard data forms provides a common baseline for reporting. As a result, regularly updated and consistent information about BSPAs which are also Natura 2000 sites is available and may be utilized by compiling data from SPA and SCI standard data forms and transferring it to the respective categories of the BSPA Database. This methodolgy was tested for German BSPAs.

To gain as much information as possible from the SCI and SPA standard data forms the existing ten designated and two managed German BSPAs in the HELCOM database were replaced by the spatially coinciding 30 SPAs and SCIs. These new sites may be termed sub-sites and all but four are officially designated as BSPA or part of a BSPA area. Those SCIs and SPAs designated as BSPAs were added to the database in conformity with their respective *former* BSPAs. Although not officially nominated as BSPA, the remaining four Natura 2000 sites spatially coincide with the BSPA "Östliche Kieler Bucht" so that information from the standard data forms was used, but not added to the database. Since the BSPA questionnaire and the Natura 2000 standard data forms were not identical only information from certain corresponding categories could be transferred.

Furthermore, to avoid the loss of data from the former BSPA entries the corresponding information was assigned to the new BSPA site. Annex II gives an overview of all Natura 2000 categories and the related fields in the BSPA questionnaire and details the changes made to the original HELCOM database.

It is important to note that while the German sites were transposed within the HELCOM database to gain information on management measures, selection criteria, and threats as well as protected species, habitats, biotopes and biotope complexes, the original single-layer GIS shapes were retained to avoid duplication. Furthermore, to allow for comparison between countries and to avoid confusion and pseudo replication, the information gained from spatially coinciding SCIs and SPAs was re-integrated into the former BSPAs for the purpose of the analysis. The report therefore refers to the previous number of German sites.

GIS maps. In addition to the MS Excel questionnaires, a set of maps was provided for Contracting States to illustrate the current state of BSPAs in each country (Annex IV). The set contained maps depicting the spatial extent of the BSPAs with information on their protection status as documented in the BSPA database. Additional maps depicted overlays of these BSPAs with sites recommended by HELCOM 15/5 or Hägerhall & Skov (1998), as well as with marine Natura 2000 sites, Ramsar sites (*Wetlands of International Importance*), Important Bird Areas (IBAs) and National Marine Reserves (≥ 3000 ha). Denmark and Sweden received additional maps showing an overlay of BSPAs with OSPAR marine protected areas in the Kattegat region. All Contracting States were asked to review the maps for spatial inconsistencies and to determine whether the existing BSPA network could be supplemented by sites from other protection programmes.

Table 1. Number and size of managed or designated BSPAs. The Helsinki Convention marine area, Territorial Waters (TW) and Exclusive Economic Zone (EEZ) of each Contracting State and the proportion protected is given. (Status: February 2010). Data for the Baltic Sea from assessments in 2008 and 2004 is provided (HELCOM 2006, HELCOM 2009).

	No. of BSPAs	Total area of BSPAs [km^2]	Marine fraction of BSPAs [km^2]		Marine area [km^2]			Protected marine area [%]			Protected marine area [km^2]	
			Sum	(%)	TW	EEZ	Total	TW	EEZ	Total	TW	EEZ
Denmark	67[1]	10 976	10 008	(91.2)	32 280	13 098	45 378	27.6	8.3	22.1	8 920	1 088
Estonia	7	7 237	5 980	(82.6)	24 728	11 593	36 320	24.0	0.4	16.5	5 937	43
Finland	22	6 100	5 512	(90.3)	51 809	28 962	80 771	10.6	0.0	6.8	5 509	2
Germany	12	4 866	4 561	(93.7)	10 806	4 529	15 335	19.4	54.5	29.7	2 092	2 469
Latvia	4	949	863	(91.0)	12 625	16 126	28 751	6.7	0.1	3.0	840	24
Lithuania	4	761	363	(47.7)	2 274	4 238	6 512	15.9	0.0	5.6	363	0
Poland	9	7 939	7 175	(90.4)	10 076	19 494	29 570	54.6	8.6	24.3	5 507	1 668
Russia	6	1 572	1 089	(69.2)	16 533	7 369	23 901	6.6	0.0	4.6	1 089	0
Sweden	28	8 383	7 273	(86.8)	76 055	71 352	147 407	5.9	3.9	4.9	4 523	2 749
Baltic Sea												
Feb. 2010	159	48 784	42 823	(87.8)	237 186	176 760	413 946	14.7	4.6	10.3	34 779	8 044
Dec. 2009	104	34 009	29 058	(85.4)	237 186	176 760	413 946	10.0	3.1	7.0	23 661	5 397
2008	89	27 405	22 569	(82.4)	/	/	413 946	/	/	5.5	/	/
2004	78	27 020	16 022	(59.3)	/	/	413 946	/	/	3.9	/	/

[1] one BSPA terrestrial only

1.3 Status of MPA networks

The aim of the project at hand was not only to assess the ecological coherence of the network of marine protected areas within the Helsinki Convention framework, but also to evaluate the status of the network with respect to the JWP and HELCOM Recommendation 15/5. The primary focus was therefore the BSPAs, as they fall under the direct jurisdiction of HELCOM. Secondly, the network of marine areas protected under the European Birds Directive (Special Protected Areas, SPAs) and Habitats Directive (Sites of Community Importance, SCIs), commonly referred to as Natura 2000 sites, was assessed. The status of both networks is referenced in the report. All data preparation and analysis, including the assessment of ecological coherence (Chapter 1.4) was conducted using ESRI ArcView 3.3 and ArcGIS 9.3. As a spatial reference the ETRS_1989_LAEA (Lambert Azimuthal Equal Areas) projection was used.

1.3.1 Baltic Sea Protected Areas (BSPAs)

Following consolidation of the information provided by the survey questionnaire, the HELCOM Access and GIS databases were interlinked and several queries generated to give a basic descriptive overview of the updated status of each country's BSPAs and the BSPA network as a whole.

Altogether 159 BSPA sites were documented as either designated or managed in the updated HELCOM database (status February 2010) (**Table 1**). Compared to the previous assessment in 2008 (HELCOM 2009) the BSPA database was supplemented by 51 Danish BSPAs in addition to two Estonian, one Lithuanian, five Polish, four Russian and seven Swedish BSPAs. Estonia now holds a total of seven BSPAS, Poland nine and Russia six. Latvia and Lithuania contribute four areas each to the network. While Denmark is the Contracting State with the largest number of sites (67), Finland and Sweden both hold more than 20 sites each (22 and 28, respectively) and Germany 12. In addition to the designated and managed BSPAs some further sites remain "proposed" under HELCOM Recommendation 15/5 and "suggested" according to the expert opinion of Hägerhall & Skov (1998). Some of the latter suggestions have been replaced by or supplemented with more significant expert suggestions either on national or international levels. As proposed and recommended sites will not be analysed any further in this report, and for clarity, designated and managed BSPAs will hereafter be commonly referred to as BSPAs.


Red algea, *Aurelia aurita*

In addition to the changes in the number of BSPAs, the BSPA borders and coverage were altered and adjusted since the last assessment. At the time of this report the BSPA network covers a total area of 48,784 km² (compared to 27,405 km² in 2008) of which 87.8% fall within the marine realm. Thus 10.3% of the Baltic Sea marine area is protected under HELCOM today. Since the last assessment in 2008, the marine BSPA area grew by 20,254 km², which corresponds to an increase of of 4.8% in marine area protection. Compared to 2004 the area expanded by 6.4% (**Table 1**). However, it must be noted that in 2004 information on the area of coverage was unavailable for some BSPAs, so that the number given in the respective report might be an underestimation (HELCOM 2007b).

Germany has the largest proportion of its marine area in the Baltic Sea protected as BSPAs – nearly 30%, followed by Poland with 24.3%, Denmark with 22.1% and Estonia with 16.5%. All other states mostly appointed between 3 and 7% of their marine area as BSPAs (**Table 1**). However, in terms of the total marine area protected by each state, the largest area can be found in the Danish Baltic Sea zone followed by Sweden and Poland.

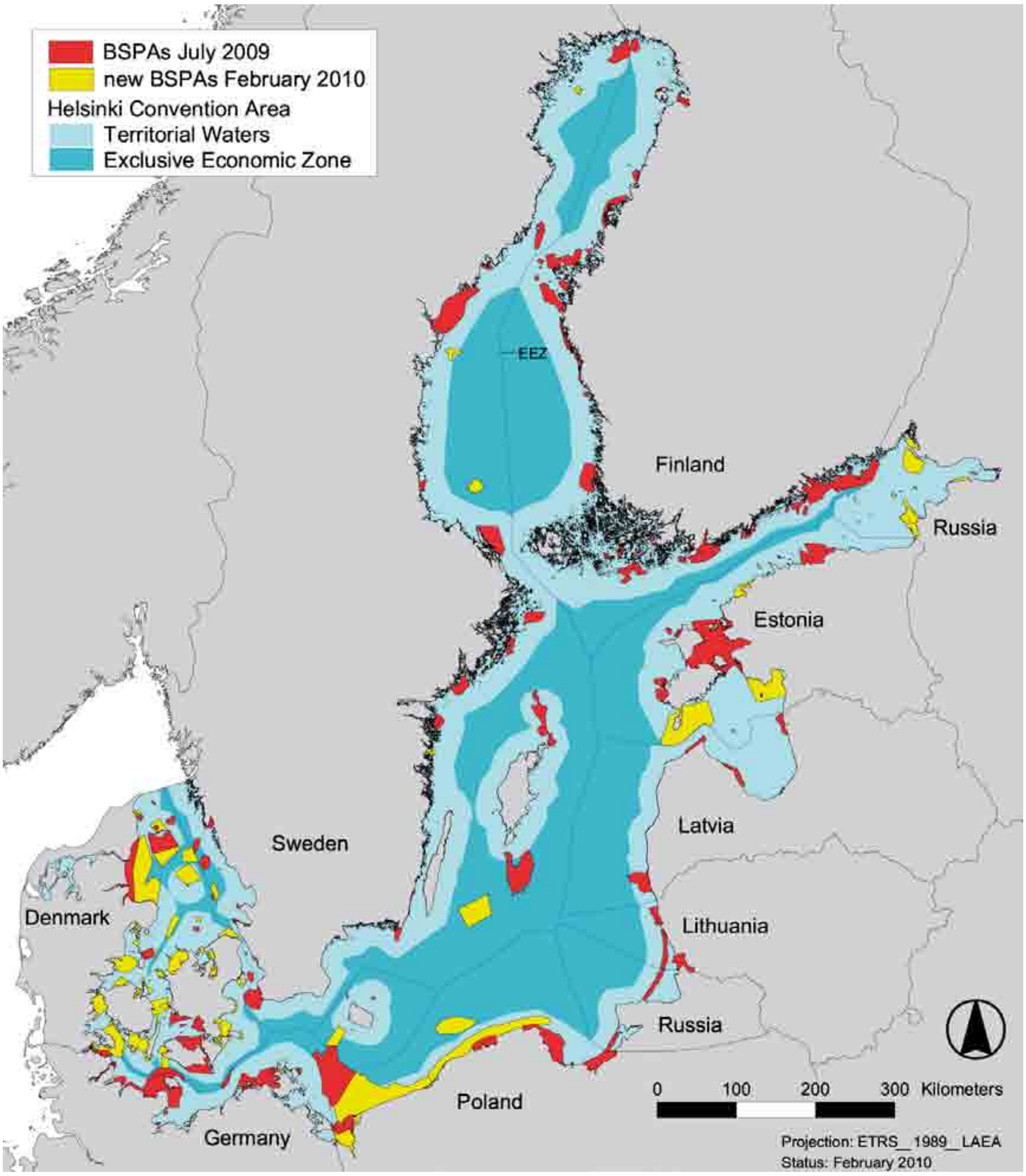

Figure 1. Overview of marine BSPAs within the Baltic Sea. BSPAs which were designated before July 2009 are marked in red. BSPAs designated after July 2009 and before March 2010 (status: February 2010) are marked in yellow.

Figure 1 depicts the current geographical location and shape of BSPAs (status February 2010). In general, the BSPAs are mainly distributed along the coasts of the riparian states or in the direct vicinity of islands located in coastal terrestrial and near shore marine areas in Territorial Waters. There are of course some exceptions such as two large BSPAs south of the Swedish island of Gotland, two German BSPAs situated at its marine EEZ borders with Denmark and Poland, respectively, as well as some smaller Danish BSPAs in the waters around the island of Bornholm, and the HELCOM subbasins Kattegat and the Sound.

There has been a considerable increase in the marine component of the BSPA network since 2004 - from 59 to 88%. While 81.2% of the total BSPA area is located within the TW of the Contracting States, only 18.8% are protected waters in the EEZ . Germany and Sweden hold by far the largest area of BSPAs within their EEZs, about 2,500 km² and over 2,700 km², respectively. For

Germany, this corresponds to more than 50% of its total EEZ and about 4% for Sweden due to its larger EEZ. Overall, Germany is the only Contracting State that maintains a balance between the areas protected in its TW and its EEZ.

Description of the BSPA network in each Contracting State

The following provides a short description on the current status of BSPAs in each country.

Denmark currently has 67 designated BSPAs. The designated sites protect 10,008 km² (22%) of Danish waters, and encompass the waters around Bornholm island and fringing the mainland, including the Danish islands in the Belt Sea and the Sound. 11% of the Danish BSPA area is located outside its TW. The sites range from 27 to 178,158 ha in size. 51 of the designated sites were nominated after July 2009. A management plan exists for five of the sites designated before July 2009, while plans are still under development for a further eleven sites. All marine BSPAs relate to Natura 2000.

Up to February 2010, **Estonia** had seven BSPAs officially designated. Three of these areas were designated after July 2009. They are included in the general overview on BSPAs but could not be included in the database analysis and assessment on ecological coherence. The seven areas have a total marine area of 5,980 km² (16.5% of the Estonian marine area protected), of which less than 1% protect waters outside the TW. The Estonian BSPAs range in size from 7,676 to 223,946 ha. The BSPA Väinameri is the largest BSPA in the Baltic Sea. Many of the BSPAs relate to Natura 2000 sites so that 91% of the Estonian marine Nature 2000 sites are also BSPAs. No management plans exist for any of the official BSPAs, however plans are in development for three of them. At HELCOM HABITAT 11/2009 Estonia stated that research activities continue to assess the need for additional BSPA nominations.

Finland currently protects 6.8% of its marine area with a total of 22 BSPAs. In addition there are five new sites in the official designation process. The area of designated BSPAs ranges from 148 to 116,296 ha. **Figure 1** shows many BSPAs scattered as a series of small patches especially in the south of Finland. 81% of the area of Finnish marine Natura 2000 sites overlaps with BSPAs.

Chara meadow, Finland

Finland has provided information on the management status of all but one official BSPA. Management plans exist for eleven BSPAs, of which six are in force. Plans are still being prepared for three BSPAs while one BSPA has no management plan yet.

At HELCOM HABITAT 11/2009 Finland stated that not all Natura 2000 sites would be nominated as BSPAs. While the five future BSPAs correspond to new Natura 2000 sites in the off-shore regions (four reefs and one sandbank), some new sites in the Åland Islands might also be nominated in the future. Finland is currently working on the creation of additional management plans.

Germany currently holds twelve designated BSPAs. The twelve BSPA sites range from 635 to 208,945 ha in size and cover 29.7% of the German marine area. Thus, Germany is the Contracting State with the largest percentage of BSPAs within its marine area. After Sweden, Germany protects the largest portion of its EEZ area, some 246,900 ha. Currently, 58% of the total area of German marine Natura 2000 sites is covered by BSPAs.

Germany represents a special case because information from standard data forms on Natura 2000 sites that spatially coincide with designated and managed BSPAs was used for the analysis. However, it was not possible to transfer all Natura 2000 information to the BSPA questionnaire. Information was gathered on selection criteria, threats to the area, and protected species and habitats. Additional information on the BSPA sites 210 'Flensburger Förde', 212 'Schlei', 229 'Pommersche

Table 2. Number and size of managed or designated BSPAs used for the ecological coherence assessment. (Status: July 2009)

	No. of BSPAs	Total area of BSPAs [km²]	Marine fraction of BSPAs [km²]		Protected marine area [%]			Protected marine area [km²]	
			Sum	(%)	TW	EEZ	Total	TW	EEZ
Denmark	16	3 022	2 659	(88.0)	8.2	0.2	5.9	2 633	26
Estonia	4	3 888	2 777	(71.4)	11.2	0.0	7.6	2 777	0
Finland	22	6 100	5 512	(90.3)	10.6	0.0	6.8	5 509	2
Germany	12	4 866	4 561	(93.7)	19.4	54.5	29.7	2 092	2 469
Latvia	4	949	863	(91.0)	6.7	0.1	3.0	840	24
Lithuania	4	761	363	(47.7)	15.9	0.0	5.6	363	0
Poland	4	2 045	1 299	(63.5)	12.9	0.0	4.4	1 299	0
Russia	2	343	246	(71.7)	1.5	0.0	1.0	246	0
Sweden	21	6 781	5 687	(83.9)	5.6	2.0	3.9	4 287	1 400
Baltic Sea	89	28 755	23 967	(83.3)	8.5	2.2	5.8	20 046	3 921

Bucht', and 231 'Fehmarnbelt' was taken from the HELCOM database. Management plans exist for just two of the German BSPAs, while plans are being drawn up for two others.

At HELCOM HABITAT 11/2009 Germany stated that no additional BSPAs will be nominated for the EEZ and the western coastal areas. All current largely marine Natura 2000 sites have been nominated as BSPAs, except for several Natura 2000 sites located within the coastal waters off Mecklenburg-Vorpommern. Here, the designation of the Natura 2000 network was finalized in 2008 and marine sites are currently being considered for nomination as BSPAs as well.

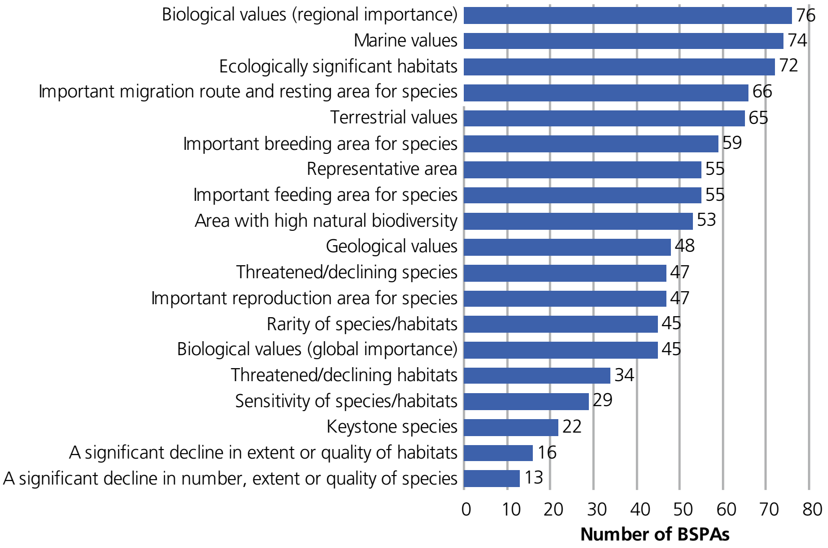

Figure 2. Reasons for selection. Number of BSPAs for which the respective category was chosen. No information was available for two sites: one German site and one Russian. (Status: July 2009)

Latvia has four designated and one proposed BSPA documented in the HELCOM database. The size of the marine portions of the designated BSPAs varies from 9,342 and 48,628 ha and amounts to a total of 863 km² (3% of the Latvian marine area). 6.7% of the TW and 0.1% of the EEZ are protected. Management plans are being prepared for all four designated BSPAs. The Latvian marine Natura 2000 sites overlap with Latvian BSPAs to a degree of 45%.

Latvia advised that seven new marine protected areas had been designated in January 2010 in accordance with national legislation. They cover 34.4% of the territorial waters of Latvia. All marine protected areas are to be added to the Natura 2000 network and will be nominated as BSPAs. In cases where the established MPAs overlap with previously designated BSPAs the borders will be modified. Two of the newly established MPAs have management plans laid out and approved by the Latvian Minister of Environment. These areas include BSPAs "Pape/Perkone area" and "Kaltene/Engure area".

Lithuania protects 5.6% of its marine area in four BSPAs. The BSPAs vary from 2,499 to 16,578 ha in size and are all located within the TW. Three BSPAs possess management plans, for one BSPA such a plan is in preparation. The Lithuanian marine Natura 2000 sites overlap with BSPA to 53 %.

At HELCOM HABITAT 11/2009 Lithuania stated that all Natura 2000 sites had been nominated as BSPAs and no new areas were to be designated. Management plans for the Nemunas Delta Regional Park have been developed but not approved. Pajuris Regional Park has an approved management plan and the State Marine Reserve has none. Currently, Lithuania does not intend to nominate BSPAs in its EEZ.

Poland has designated nine BSPAs ranging from 1,178 to 310,120 ha in size and covering 54.6% of the Polish TW and 8.6% of the EEZ. Out of three further areas referred to as proposed BSPAs by HELCOM 15/5 and one documented as recommended by Hägerhall & Skov (1998), three have officially been designated as BSPAs. These are "Baltic Coastal waters", "Pomeranian Bay" and "Slups Bank". The fourth area has been included in the enlarged "Puck Bay" site, previously known as "Nadmorski Landscape Park". Management plans are being developed for four BSPAs designated before July 2009. Polish BSPAs cover 100% of Polish marine Natura 2000 sites. No new BSPAs are currently planned within Polish waters.

Russia currently holds six designated BSPAs. They vary in size between 6,088 and 44,744 ha. Combining the two separate Russian marine areas a total of 4.6% is protected under HELCOM. A management plan exists for only one of the two BSPAs designated before July 2009.

Sweden protects 4.9% of its marine HELCOM area in 28 BSPAs, seven of which were designated after July 2009 and could therefore not be included in the analysis of the database and the assessment of ecological coherence. The Swedish BSPAs range from 566 to 122,627 ha in size. In total they represent the largest area protected under HELCOM (727,200 ha). Sweden also protects the largest area of its EEZ. However, due to the large size of the Swedish EEZ, proportionally, this accounts only for 3.9% protection compared to other countries. Management plans exist or are in force for 15 officially designated BSPAs. Plans are being drawn up for five BSPAs while one BSPA has no management plan yet. The total BSPA area covers 73% of the Swedish marine Natura 2000 sites.

At HELCOM HABITAT 11/2009 Sweden reported on a 3-year project to develop long-term, functional management plans for four BSPAs. The work was to be executed out in cooperation with stakeholders and relevant authorities.

Analysis of the HELCOM BSPA database

The following analysis is based only on information on BSPAs received up to July 2009. Furthermore, neither BSPAs proposed under Recommendation 15/5 or suggested by the expert opinion of Hägerhall & Skov (1998) are included. **Table 1** shows the status of BSPAs designated by February 2010, while **Table 2** presents the status of BSPAs designated by July 2009. Both types of BSPAs are shown in **Figure 1**.

Reasons for selection. Contracting States were provided with a pre-defined list of possible selection criteria and asked to state which of these were considered when the area in question was nominated as a BSPA. Multiple entries could be made for each BSPA, resulting in a total of 911 database entries (**Figure 2**). The selection criteria are quite diverse and no clear tendency can be observed. In most cases (76 sites) a BSPA was selected due to biological values of regional importance, followed

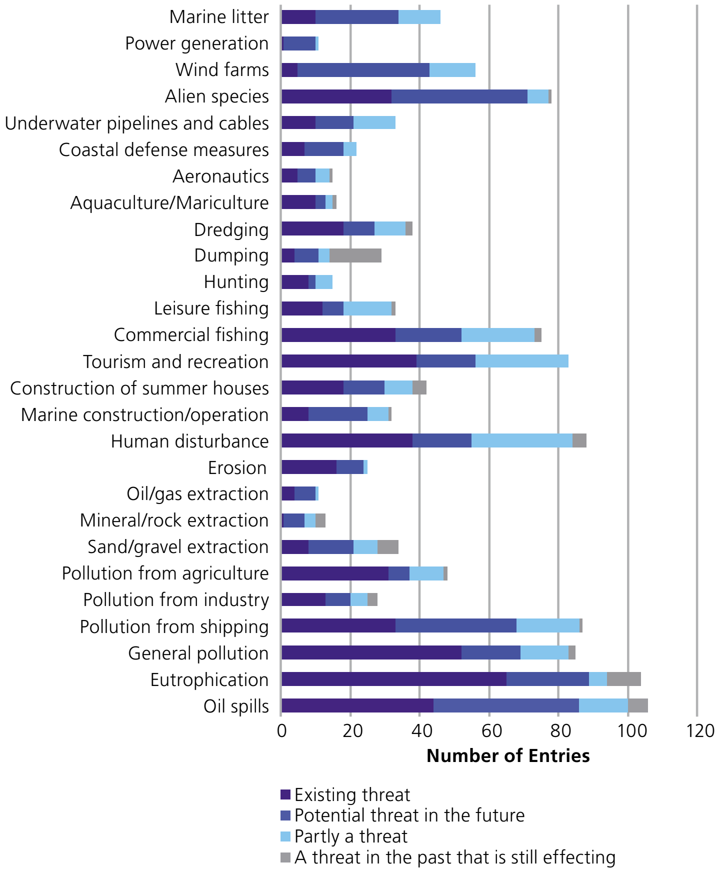

Figure 3. Existing, potential, partly or past threats (predefined list) and the frequency with which they were chosen for a BSPA in each category. A threat may have been identified in several categories for the same BSPA. No information on threats was provided in the case of one Russian site. (Status: July 2009)

by sites that were chosen because of marine values (74 sites) and ecologically significant habitats (72 sites). Other important reasons were 'Important migration route and resting area for species' (66 sites), 'Because of terrestrial values' (65 sites) and 'Important breeding areas for species' (59 sites).

The least popular criteria were 'A significant decline in extent or quality of habitats' (16 sites) and 'A significant decline in extent or quality of species (13 sites). One German and one Russian site did not provide information on selection criteria.

Threats to the area. With respect to 'Existing threats to the area' 519 database entries were collected (**Figure 3** and **Table 3**). A predefined list of options was provided, allowing multiple entries for each BSPA. Each impact factor could be classified as an existing threat, a potential threat in the future, partly a threat or a threat in the past still affecting the area. In the majority of cases 'Eutrophication' is marked as an existing threat to BSPA (66 sites), followed by 'General pollution' (55 sites), 'Oil spills' (42 sites) and 'Tourism and recreation' (40 sites). The least recognised threats were 'Power generation' (1 site), 'Mineral rock extraction' (2 sites), 'Aeronautics' (3 sites) as well as 'Wind farms' and 'Dumping' (4 sites each). The threat most often cited as a potential future risk was 'Oil spills' (42 sites). 'Human disturbance' (29 sites) was the most named partial threat, and 'Dumping' (15 sites) was most often selected as a reported threat in the past still affecting the area. One Russian site did not provide any information on threats.

Management measures. The selection criteria and threats reported for BSPAs imply that individ-

Table 3. Threats to BSPAs reported in the HELCOM database, including the number of BSPAs for which a threat was reported as existing, potential, partly or past. (Status: July 2009)

Threat	Existing threat	Potential threat in the future	Partly a threat	A threat in the past that is still effecting	Total
Oil spills	44	42	14	6	**106**
Eutrophication	65	24	5	10	**104**
General pollution	52	17	14	2	**85**
Pollution from shipping	33	35	18	1	**87**
Pollution from industry	13	7	5	3	**28**
Pollution from agriculture	31	6	10	1	**48**
Sand/gravel extraction	8	13	7	6	**34**
Mineral/rock extraction	1	6	3	3	**13**
Oil/gas extraction	4	6	1		**11**
Erosion	16	8	1		**25**
Human disturbance	38	17	29	4	**88**
Marine construction/ operation	8	17	6	1	**32**
Construction of summer houses	18	12	8	4	**42**
Tourism and recreation	39	17	27		**83**
Commercial fishing	33	19	21	2	**75**
Leisure fishing	12	6	14	1	**33**
Hunting	8	2	5		**15**
Dumping	4	7	3	15	**29**
Dredging	18	9	9	2	**38**
Aquaculture/Mariculture	10	3	2	1	**16**
Aeronautics	5	5	4	1	**15**
Coastal defense measures	7	11	4		**22**
Underwater pipelines and cables	10	11	12		**33**
Alien species	32	39	6	1	**78**
Wind farms	5	38	13		**56**
Power generation	1	9	1		**11**
Marine litter	10	24	12		**46**

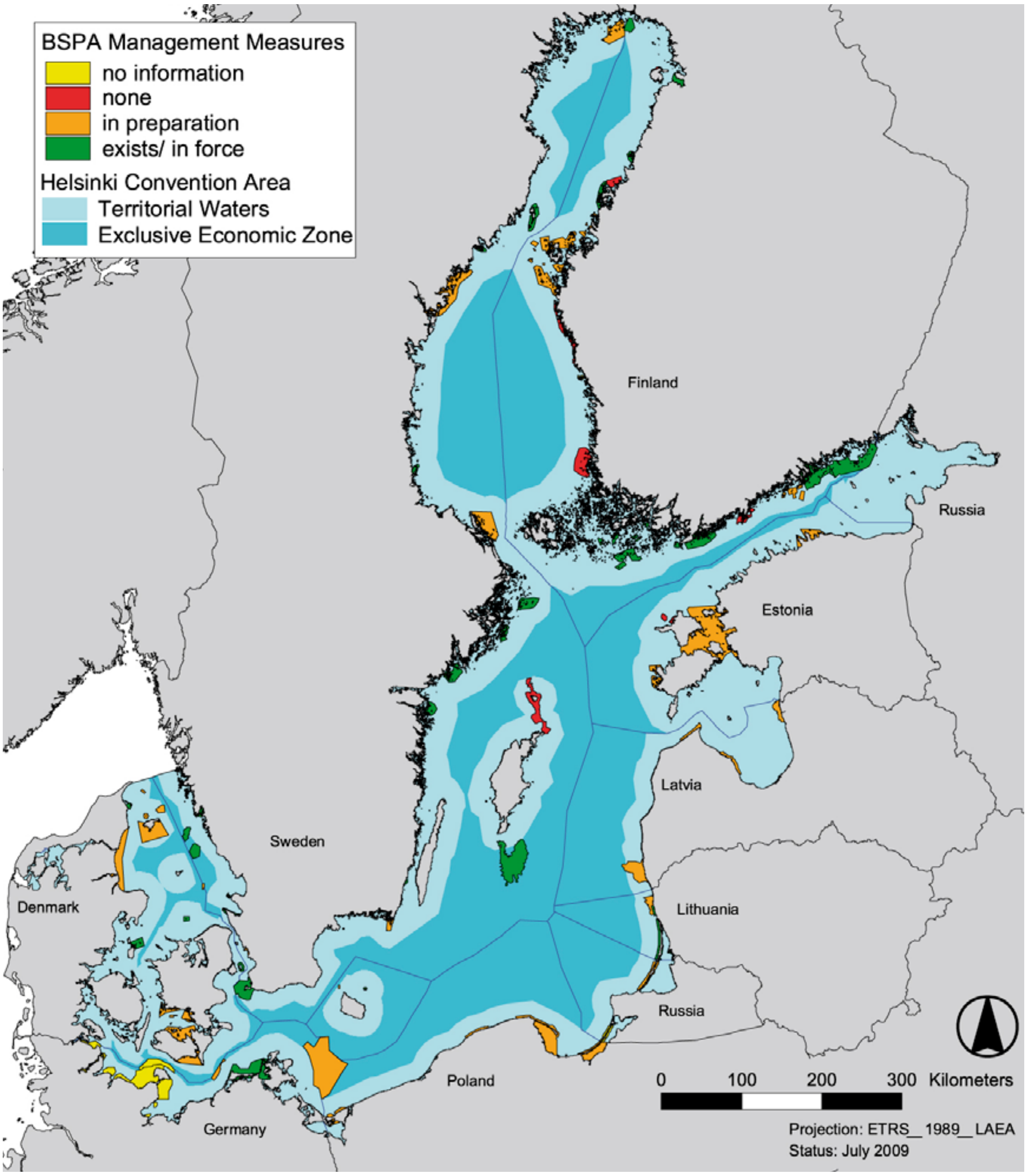

Figure 4. Status of management measures in BSPAs as reported in the HELCOM database. The categories 'exist' and 'in force' were combined. (Status: July 2009)

ual management measures are needed to accomplish the objectives of the measures agreed in the Helsinki Convention. **Figure 4** gives an overview of BSPAs and their management status. A total of 36 BSPAs (40%) possess management measures reported as existing or in force, while a further 34 BSPAs have management measures under preparation. Nine sites did not have any management measures at the time of reporting and for a further ten BSPAs no information was provided. The detailed numbers for the management status of each Contracting States' BSPAs can be found in the short description of the current status of BSPAs in each country and in **Table 4**.

Regulated activities. Efficient management and the design of the MPA network should be coordinated with the management of human activities affecting these areas. It should take into account of factors such as maritime transport, fisheries, dredging, construction and inputs of pollutants to meet the long-term conservation goals of the protected areas network, and also to secure the protection of single sites. The HELCOM BSPA database holds detailed data on the regulation of certain activities within each area but does not provide any detailed information on the individual management plans developed and implemented by each Contracting State.

Table 4. Status of management measures in BSPAs reported in the HELCOM database. The categories 'exist' and 'in force' were combined. (Status: July 2009)

	Management measures			
	None	In preparation	Exist / In force	A threat in the past that is still effecting
Denmark		11	5	
Estonia	1	3		
Finland	7	3	11	1
Germany		2	2	8
Latvia		4		
Lithuania		1	3	
Poland		4		
Russia		1		1
Sweden	1	5	15	
Baltic Sea	**9**	**34**	**36**	**10**

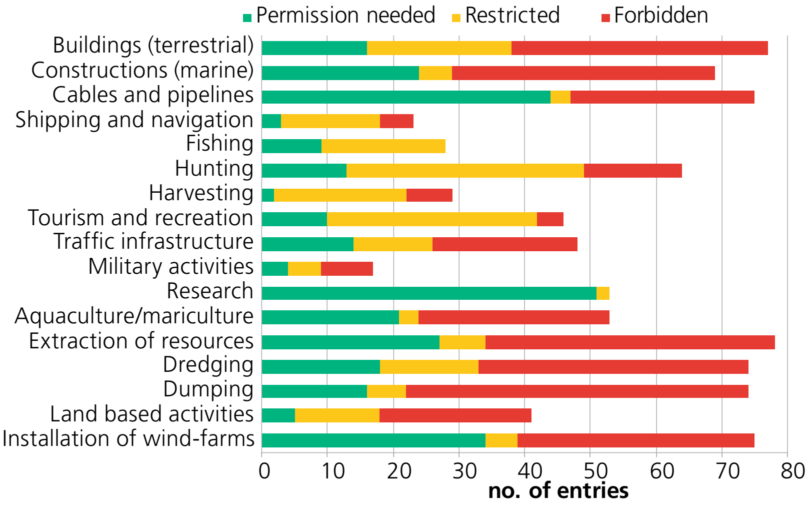

Figure 5. The frequency with which an activity was selected from the predefined list of regulated activities in BSPAs. Regulation included permission required, restricted, or forbidden. (Status: July 2009)

The data-collection questionnaire asked Contracting States to choose from a predefined list of activities and state whether these activities were permitted, restricted or forbidden in the BSPA in question. **Figure 5** illustrates the findings of this question. 'Research' was chosen for most (51) sites as an activity that required permission, followed by 'Cables and pipelines' (44 sites), 'Installation of wind farms' (34 sites) and 'Extraction of resources' (27 sites). In terms of forbidden activities 'Dumping' was chosen most frequently (52 sites) followed by 'Extraction of resources' (44 sites), 'Dredging' (41 sites), 'Construction (marine)' (40 sites) and 'Buildings (terrestrial)' (39 sites). The only activities that were not forbidden in any BSPA are ´Fishing` and ´Research`. ´Hunting` and ´Tourism and recreation` were the activities most often identified as restricted (**Table 5**). No information whatsoever on regulated activities was provided for 14 sites. These included ten German sites and one site each in Lithuania, Russia, Sweden and Finland.

Protected species. In the HELCOM BSPA database a total of 268 species were reported as protected within those BSPAs that were officially nominated by July 2009. Compared to the last assessment in 2008 the number of protected species was thus augmented by 61 (HELCOM 2009). As in 2008, more than 50% of all protected species were bird species, including nesting, migratory and wintering birds. Only 12% of the reported species were fish, 5% were mammals and 4% were algae. Another 13%, 10% and 2% accounted for invertebrates, vascular plants and amphibians, respectively (**Figure 6a**). No information on protected species was provided for eight BSPAs by July 2009. These include five Danish sites, two German sites and one Swedish BSPA.

The list of species provided in the BSPA database also includes 59 species from the HELCOM list of threatened and/or declining species (HELCOM 2007b). These 59 species are in urgent need of protection measures, a fact highlighted in the Baltic Sea Action Plan. According to the BSPA database updated by each Contracting State before July 2009, only 43 of these species are protected in the BSPAs network. All listed birds and mammals are protected and only one listed vascular plant species and two algae and inverte-

Table 5. Regulated BSPA activities reported in the HELCOM database, showing the number of BSPAs for which an activity was reported to require permission, being restricted or forbidden. (Status: July 2009)

Activity	Permission needed	Restricted	Forbidden	Total
Installation of wind-farms	34	5	36	75
Land based activities	5	13	23	41
Dumping	16	6	52	74
Dredging	18	15	41	74
Extraction of resources	27	7	44	78
Aquaculture/mariculture	21	3	29	53
Research	51	2	0	53
Military activities	4	5	8	17
Traffic infrastructure	14	12	22	48
Tourism and recreation	10	32	4	46
Harvesting	2	20	7	29
Hunting	13	36	15	64
Fishing	9	19	0	28
Shipping and navigation	3	15	5	23
Cables and pipelines	44	3	28	75
Constructions (marine)	24	5	40	69
Buildings (terrestrial)	16	22	39	77

brate species each are unaccounted for. Only half of the 26 fish species listed as threatened and/or declining by HELCOM are protected (**Figure 6b**).

Protected habitats and biotopes. Apart from information on protected species, the BSPA database also includes data on protected habitats and biotopes. The terms *habitat* and *biotope* were chosen to distinguish between the different supporting documents which form the basis for the lists provided, rather than to refer to their biological meaning. The list of habitats was derived from Annex I of the EC Habitats Directive and includes 267 habitats of which 89 are protected within the BSPA network (**Table 6**). For three BSPAs no information was provided for that category. The list of biotopes is based on the *HELCOM Red List of Biotopes* (HELCOM 1998) and includes 203 biotope types of which 147 are reported as protected in the BSPA network (**Table 7**). 21 BSPAs do not provide any information on protected biotopes. The analysis also considered whether the 16 biotopes/habitats from the HELCOM list of threatened and/or declining biotopes/habitats (HELCOM 2007b) were protected in the BSPA network.

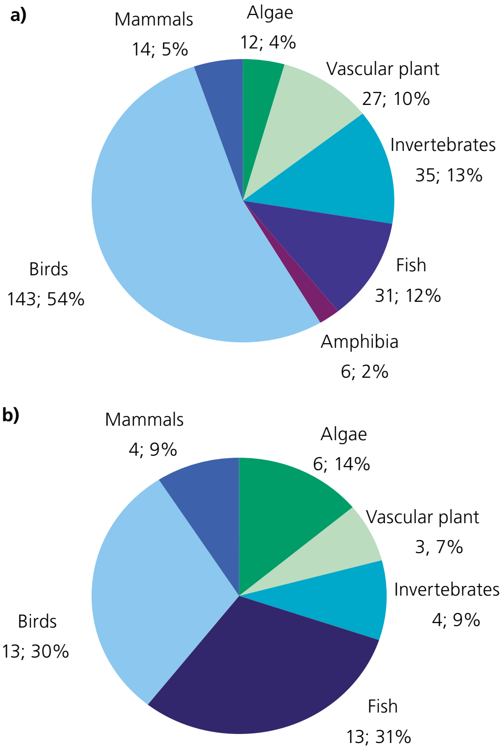

Figure 6. Number and percentage of species reported to be protected in BSPAs. a) All species reported in the BSPA network (n=268) and b) protected species from the HELCOM lists of threatened and/or declining species (n=59) (HELCOM 2007b). (Status: July 2009)

Table 6. **The number of BSPAs where each habitat type is protected as reported in the HELCOM BSPA database. Countries have reported the following 89 habitats to be protected in BSPAs. Three BSPAs did not provide any information on protected habitats. (Status: July 2009)**

Database ID	Protected habitats	No. of BSPAs
2	Open sea and tidal areas	1
3	Sandbanks which are slightly covered by sea water all the time	55
5	Estuaries	16
6	Mudflats and sandflats not covered by seawater at low tide	20
7	Coastal lagoons	56
8	Large shallow inlets and bays	27
9	Reefs	59
10	Submarine structures made by leaking gases	7
12	Annual vegetation of drift lines	40
13	Perennial vegetation of stony banks	41
14	Vegetated sea cliffs of the Atlantic and Baltic Coasts	34
18	*Salicornia* and other annuals colonizing mud and sand	18
20	Atlantic salt meadows *(Glauco-Puccinellietalia maritimae)*	21
30	Boreal Baltic archipelago, coastal and landupheaval areas	2
31	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	4
32	Boreal Baltic islets and small islands	34
33	Boreal Baltic coastal meadows	34
34	Boreal Baltic sandy beaches with perennial vegetation	27
35	COASTAL SAND DUNES AND INLAND DUNES	1
36	Sea dunes of the Atlantic, North Sea and Baltic coasts	1
37	Embryonic shifting dunes	24
38	Shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes")	30
39	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	33
40	Decalcified fixed dunes with *Empetrum nigrum*	16
41	Atlantic decalcified fixed dunes *(Calluno-Ulicetea)*	2
42	Dunes with *Hippophaë rhamnoides*	1
43	Dunes with *Salix repens* ssp. argentea *(Salicion arenariae)*	7
44	Wooded dunes of the Atlantic, Continental and Boreal region	17
45	Humid dune slacks	19
51	Coastal dunes with *Juniperus* spp.	1
55	Dry sand heaths with *Calluna* and *Genista*	1
56	Dry sand heaths with *Calluna* and *Empetrum nigrum*	6
57	Inland dunes with open *Corynephorus* and *Agrostis* grasslands	2
59	FRESHWATER HABITATS	1
61	Oligotrophic waters containing very few minerals of sandy plains *(Littorelletalia uniflorae)*	1
63	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*	2
64	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* formations	4
65	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* – type vegetation	9
66	Natural dystrophic lakes and ponds	8
77	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	9
82	Northern Atlantic wet heaths with *Erica tetralix*	4
84	European dry heaths	17
96	*Juniperus communis* formations on heaths or calcareous grasslands	8
112	Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	1
113	Xeric sand calcareous grasslands	4
114	*Calaminarian* grasslands of the *Violetalia calaminariae*	1
122	Semi-natural dry grasslands and scrubland facies on calcareous substrates *(Festuco-Brometalia)* (* important orchid sites)	11

124	Species-rich Nardus grasslands, on silicious substrates in mountain areas (and sub-mountain areas in Continental Europe)	13
128	Fennoscandian lowland species-rich dry to mesic grasslands	18
129	Nordic alvar and precambrian calcareous flatrocks	6
135	*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils *(Molinion caeruleae)*	13
137	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	19
139	Northern boreal alluvial meadows	2
142	Lowland hay meadows *(Alopecurus pratensis, Sanguisorba officinalis)*	12
143	Mountain hay meadows	1
144	Fennoscandian wooded meadows	4
147	Active raised bogs	5
148	Degraded raised bogs still capable of natural regeneration	3
149	Blanket bogs (* if active bog)	2
150	Transition mires and quaking bogs	19
151	Depressions on peat substrates of the Rhynchosporion	2
152	Fennoscandian mineral-rich springs and springfens	8
154	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	6
155	Petrifying springs with tufa formation (Cratoneurion)	4
156	Alkaline fens	14
159	Aapa mires	1
161	ROCKY HABITATS AND CAVES	1
170	Calcareous rocky slopes with chasmophytic vegetation	3
171	Siliceous rocky slopes with chasmophytic vegetation	8
172	Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*	6
173	Limestone pavements	2
175	Caves not open to the public	1
181	Western Taïga	21
182	Fennoscandian hemiboreal natural old broad-leaved deciduous forests *(Quercus, Tilia, Acer, Fraxinus or Ulmus)* rich in epiphytes	11
183	Natural forests of primary succession stages of landupheaval coast	17
185	Fennoscandian herb-rich forests with *Picea abies*	14
186	Coniferous forests on, or connected to, glaciofluvial eskers	4
187	Fennoscandian wooded pastures	12
188	Fennoscandian deciduous swamp woods	12
190	*Luzulo-Fagetum* beech forests	7
191	Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrub-layer *(Quercion robori-petraeae* or *Ilici-Fagenion)*	1
192	*Asperulo-Fagetum* beech forests	10
195	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*	8
196	*Tilio-Acerion* forests of slopes, screes and ravines	7
197	Old acidophilous oak woods with *Quercus robur* on sandy plains	10
201	Bog woodland	21
202	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)*	10
258	*Zostera* beds	1
267	Boreal Baltic narrow inlets	5
Total		**1081**

Table 7. **The number of BSPAs where each biotope type is protected as reported in the HELCOM BSPA database. Countries have reported the following 147 biotopes to be protected in BSPAs. 21 BSPAs did not provide any information on protected biotopes. (Status: July 2009)**

ID	Protected biotopes	No. of BSPAs
1	PELAGIC MARINE BIOTOPES	1
2	Offshore (deep) waters	6
3	Offshore (deep) waters above the halocline	2
4	Offshore (deep) waters below the halocline	1
5	Coastal (shallow) waters	14
6	Outer coastal (shallow) waters	5
7	Inner coastal (shallow) waters	4
8	BENTHIC MARINE BIOTOPES	4
9	Rocky bottoms	16
10	Soft rock bottoms	2
11	Soft rock bottoms of the aphotic zone	1
12	Sublittoral photic zone	1
13	Sublittoral level soft rock bottoms with little or no macrophyte vegetation of the photic zone	1
14	Sublittoral level soft rock bottoms dominated by macrophyte vegetation	1
15	Sublittoral soft rock reefs of the photic zone with little or no macrophyte vegetation	1
16	Hydrolittoral	1
17	Hydrolittoral level soft rock bottoms with little or no macrophyte vegetation	1
18	Hydrolittoral level soft rock bottoms dominated by macrophyte vegetation	1
20	Solid rock bottoms (bedrock)	1
21	Solid rock bottoms of the aphotic zone	1
22	Sublittoral photic zone	1
23	Sublittoral level solid rock bottoms with little or no macrophyte vegetation of the photic zone	2
24	Sublittoral level solid rock bottoms dominated by macrophyte vegetation	1
25	Sublittoral solid rock reefs of the photic zone with or without macrophyte vegetation	2
26	Hydrolittoral	1
27	Hydrolittoral level solid rock bottoms with little or no macrophyte vegetation	2
28	Hydrolittoral level solid rock bottoms dominated by macrophyte vegetation	2
29	Hydrolittoral solid rock reefs with or without macrophyte vegetation	2
30	Stony bottoms	12
31	Stony bottoms of the aphotic zone	1
33	Sublittoral level stony bottoms with little or no macrophyte vegetation of the photic zone	2
34	Sublittoral level stony bottoms dominated by macrophyte vegetation	2
35	Sublittoral stony reefs of the photic zone with or without macrophyte vegetation	2
37	Hydrolittoral level stony bottoms with little or no macrophyte vegetation	2
38	Hydrolittoral level stony bottoms dominated by macophyte vegetation	1
39	Stony reefs of the hydrolittoral with or without macrophyte vegetation	2
40	Hard clay bottoms	1
41	Hard clay bottoms of the aphotic zone	1
43	Sublittoral hard clay bottoms with little or no macrophyte vegetation of the photic zone	1
45	Hydrolittoral hard clay bottoms with little or no macrophyte vegetation	1
46	Gravel bottoms	5
47	Gravel bottoms of the aphotic zone	1
49	Sublittoral level gravel bottoms with little or no macrophyte vegetation of the photic zone	2
50	Sublittoral level gravel bottoms dominated by macrophyte vegetation	2
53	Hydrolittoral level gravel bottoms with little or no macrophyte vegetation	1
54	Hydrolittoral level gravel bottoms dominated by macrophyte vegetation	1
56	Sandy bottoms	36
58	Sublittoral photic zone	1

59	Sublittoral level sandy bottoms with little or no macrophyte vegetation of the photic zone	3
60	Sublittoral level sandy bottoms dominated by macrophyte vegetation	1
61	Sand bars of the sublittoral photic zone	1
64	Hydrolittoral level sandy bottoms with little or no macrophyte vegetation	2
67	Hydrolittoral sand banks with or without macrophyte vegetation	1
70	Sublittoral shell gravel bottoms of the photic zone	1
71	Muddy bottoms	16
72	Muddy bottoms of the aphotic zone	1
74	Sublittoral muddy bottoms with little or no macrophyte vegetation of the photic zone	2
75	Sublittoral muddy bottoms dominated by macrophyte vegetation	1
77	Hydrolittoral muddy bottoms with little or no macrophyte vegetation	2
78	Hydrolittoral muddy bottoms dominated by macrophyte vegetation	2
79	Mixed sediment bottoms	9
80	Mixed sediment of the aphotic zone	1
81	Sublittoral photic zone	1
82	Sublittoral mixed sediments with little or no macrophyte vegetation of the photic zone	2
83	Sublittoral mixed sediments dominated by macrophyte vegetation	2
85	Hydrolittoral mixed sediments with little or no macrophyte vegetation	1
86	Hydrolittoral mixed sediments dominated by macrophyte vegetation	1
87	Mussel beds	7
88	Mussel beds of the aphotic zone	1
89	Sublittoral mussel beds of the photic zone	1
90	Sublittoral mussel beds with little or no macrophyte vegetation of the photic zone	1
91	Sublittoral mussel beds covered with macrophyte vegetation	7
92	Hydrolittoral	2
93	Hydrolittoral mussel beds with little or no macrophyte vegetation	1
95	Bubbling reefs	5
101	Sublittoral peat bottoms	2
103	TERRESTRIAL BIOTOPES	2
104	Spits/bars	5
105	Beaches	2
106	Sandy beaches	21
107	Gravel and shingle beaches	5
108	Boulder beaches	6
109	Beach ridges	1
110	Sandy beach ridges	1
111	Sandy beach ridges with no or low vegetation	4
112	Sandy beach ridges dominated by shrubs or trees	3
114	Beach ridges consisting of gravel, pebbles and/or boulders with no or low vegetation	1
117	Coastal dunes	15
118	Foredunes	8
119	White dunes	3
120	White dunes s.str.	6
121	Green dunes	1
122	Grey dunes	9
123	Brown dunes with dwarf shrubs	1
124	Brown dunes with dune shrubbery	4
125	Brown dunes covered with trees	1
126	Natural or almost natural coniferous forest on dunes	8
127	Natural or almost natural cdeciduous forest on dunes (beech, oak, birch forest)	8
128	Wet dune slacks	1
129	Wet dune slacks, incl. coastal fens with low vegetation	7
130	Wet dune slacks, incl. coastal fens dominated by shrubs or trees	5
131	Migrating dunes	2
132	Gently sloping rocky shores	1
139	Crystalline bedrock shores	2

140	Gently sloping crystalline bedrock shores with no vegetation	2
141	Gently sloping crystalline bedrock shores with low vegetation	2
142	Gently sloping crystalline bedrock shores dominated by shrubs or trees	2
143	Coastal cliffs and caves	19
148	Sandstone cliffs with no or low vegetation	2
153	Crystalline bedrock cliffs	1
154	Crystalline bedrock cliffs with no or low vegetation	1
155	Crystalline bedrock cliffs dominated by shrubs or trees	1
156	Moraine cliffs	1
157	Moraine cliffs with no or low vegetation	5
158	Moraine cliffs dominated by shrubs or trees	3
160	Coastal wetlands and meadows	3
161	Reed, rush and sedge stands	2
162	Natural reed, rush and sedge stands	4
163	Harvested reed, rush and sedge stands	7
164	Meadows/pastures	3
165	Salt pioneer swards	4
166	Lower meadows	2
167	Upper meadows	4
168	Dry meadows (incl. alvars)	4
169	Tall herb stands	5
171	Swamps with low vegetation	5
172	Swamps dominated by shrubs or trees (natural or almost natural wet forests)	3
173	Coastal bogs	2
174	Coastal fens	19
176	Acid fens (poor fens)	17
177	COASTAL LAKES, POOLS and GLO-LAKES	3
179	Brackish coastal lakes	2
180	Eutrophic brackish coastal lakes	1
181	Mesotrophic brackish coastal lakes	1
186	Glo-lakes	1
189	Permanent pools (incl. rock pools etc.)	1
190	Permanent brackish pools	1
191	Permanent eutrophic brackish pools (incl. rock pools etc.)	1
192	Permanent mesotrophic brackish pools (incl. rock pools etc.)	2
195	Permanent eutrophic freshwater pools (incl. rock pools etc.)	1
196	Permanent mesotrophic freshwater pools (incl. rock pools etc.)	1
197	Temporary pools (incl. rock pools etc.)	1
198	Temporary brackish pools (rock pools etc.)	1
199	Temporary freshwater pools (rock pools etc.)	3
201	River beds	3
202	River banks	4
Total		**515**

The study first investigated which of the habitats and biotopes listed in the BSPA database corresponded to the 16 threatened and/or declining HELCOM biotopes/habitats, then determined whether or not they were protected within the BSPA network (**Table 8**). No corresponding habitats or biotopes could be identified in the database for three of the 16 biotopes/habitats from the HELCOM list of threatened and/or declining biotopes/habitats. These included 'macrophyte meadows and beds', 'gravel bottoms with *Ophelia* species', and 'maerl beds'. Of the remaining 13 threatened and/or declining biotopes/habitats eleven were protected within the BSPA network.

Protected biotope complexes. The BSPA database also includes information on the protection status of biotope complexes in the BSPA network. However, information was provided for only eleven BSPAs. Nine of the total 13 listed biotope complexes are protected (**Table 9**).

Table 8. **Threatened and/or declining biotopes/habitats listed in The Baltic Sea Environmental Proceedings (BSEP 113) and number of BSPAs where protected. Where two figures are given for a number of BSPAs, the first represents the number of protected habitats and the second the number of protected biotopes. Multiple entries were possible. The respective codes for habitats and biotopes in the HELCOM BSPA database are also provided. For three threatened and/or declining biotopes/habitats no corresponding information is provided in the database. Note that out of 89 BSPAs in the network 21 sites provided no information on protected biotopes and 3 sites did not provide information on habitats. (Status: July 2009)**

HELCOM list of threatened and/or declining biotopes/habitats	BSPA database			
	Habitat code	Biotope code	Name	No. of BSPAs
Offshore (deep) waters below the halocline		1.1.2	Offshore (deep) waters below the halocline	1
Shell gravel bottoms		2,6	Shell gravel bottoms	---
Seagrass beds	O10		Zostera beds	1
Macrophyte meadows and beds			NOT IN DATABASE	
Gravel bottoms with *Ophelia* species			NOT IN DATABASE	
Sandbanks which are slightly covered by sea water all the time	1110		Sandbanks which are slightly covered by sea water all the time	55
Estuaries	1130		Estuaries	16
Mudflats and sandflats not covered by seawater at tow tide	1140		Mudflats and sandflats not covered by seawater at low tide	20
Coastal lagoons	1150		Coastal lagoons	56
Large shallow inlets and bays	1160		Large shallow inlets and bays	27
Reefs	1170		Reefs	59
Submarine structures made by leaking gases (bubbling reefs)	1180	2.10	Submarine structures made by leaking gases / Bubbling Reefs	7 / 5
Baltic eaker islands with sandy, rocky and shingle beach vegetation and sub-littoral vegetation	1610		Baltic esker islands with sandy, rocky and shingle beach vegetation and sub-littoral vegetation	4
Boreal Baltic narrow inlets (Fjords)	1650		Boreal Baltic narrow inlets	5
Maerl beds			NOT IN DATABASE	
Sea pens and burrowing megafauna communities	O7		Sea-pen and burrowing megafauna communities	---

Table 9. **The number of BSPAs where each biotope complexes are protected as reported in the HELCOM BSPA database. 78 BSPAs do not provide information. (Status: July 2009)**

Database ID	Protected biotope complexes	No. of BSPAs
1	Rocky coasts	2
2	Sandy coasts	4
3	Moraine coasts	4
4	Flat coasts subject to intensive land upheaval	3
7	Lagoons including Bodden, barrier lagoons and Fladas	4
8	Large spits of sand and/or gravel separating a lagoon form the sea	3
11	Archipelagos	5
12	Solitary islands	2
13	Esker islands	1

Conclusion and recommendations

Generally, all Contracting States provided good feedback to the survey questionnaire, updating and providing new information. Nevertheless, several categories lacked information for some or even all BSPAs (**Table 10**). Overall, based on the results of the survey, we advocate streamlining the HELCOM database to improve user-friendliness and to include only reliable and comparable data. Furthermore, the database should be standardised to allow for easier transfer of information from Natura 2000 standard data forms. Detailed recommendations for the improvement of the structure and the content of the HELCOM BSPA database are provided in Annex III.

Table 10. Information on distinct categories of the HELCOM database for each BSPA. The x indicates that information was provided. (Status: July 2009)

Country	BSPA ID	Management status	Reasons for selection	Biogeographic region	Contents of management Plan	Activities	Degrees of endangerment	Threat types for degree of endangerment	Threats	Species	Habitats	Biotopes	Biotope complexes
Denmark	126	x	x	x	x	x			x		x	x	
	128	x	x	x	x	x			x	x	x		
	129	x	x	x	x	x			x	x	x	x	
	130	x	x	x	x	x			x	x	x	x	
	131	x	x	x	x	x			x	x	x	x	
	132	x	x	x	x	x			x		x	x	
	133	x	x	x	x	x			x	x	x	x	
	134	x	x	x	x	x			x	x	x	x	
	135	x	x	x	x	x			x	x	x	x	
	136	x	x	x	x	x			x		x	x	
	137	x	x	x	x	x			x		x	x	
	184	x	x	x	x				x	x	x	x	
	185	x	x	x	x	x			x		x	x	
	186	x	x	x	x	x			x	x	x		
	187	x	x	x	x	x			x	x	x		
	188	x	x	x	x	x			x	x	x	x	
Estonia	88	x	x	x					x	x	x		
	90	x	x	x					x	x	x		
	91	x	x	x					x	x	x		
	207	x	x						x	x	x		
Finland	139	x	x	x	x	x			x	x	x	x	x
	140	x	x	x	x	x			x	x	x	x	
	141		x	x					x	x	x		
	142	x	x	x	x	x			x	x	x	x	
	143	x	x	x	x	x			x	x	x	x	
	144	x	x	x	x	x			x	x	x	x	
	145	x	x	x	x	x			x	x	x	x	x
	147	x	x	x	x	x			x	x	x	x	
	148	x	x	x	x	x			x	x	x	x	
	149	x	x	x	x	x			x	x	x	x	
	150	x	x	x	x	x			x	x	x	x	
	151	x	x	x	x	x			x	x	x	x	
	152	x	x	x	x	x			x	x	x	x	
	153	x	x	x	x	x			x	x	x	x	
	154	x	x	x	x	x			x	x	x	x	
	155	x	x	x	x	x			x	x	x	x	
	156	x	x	x	x	x			x	x	x	x	
	157	x	x	x	x	x			x	x	x	x	
	158	x	x	x		x			x	x	x	x	
	159	x	x	x	x	x			x	x	x	x	
	160	x	x	x	x	x			x	x	x	x	

Country	BSPA ID	Management status	Reasons for selection	Biogeographic region	Contents of management Plan	Activities	Degrees of endangerment	Threat types for degree of endangerment	Threats	Species	Habitats	Biotopes	Biotope complexes
	161	x	x	x	x	x			x	x	x	x	
Germany	2	x	x		x	x			x	x		x	
	3	x	x		x	x			x	x		x	
	171		x						x		x	x	
	172		x	x					x	x	x		
	173				x				x	x	x	x	
	174		x	x	x				x	x	x	x	
	175		x						x		x		
	176		x						x	x	x		
	177		x						x	x	x		
	178		x						x	x	x		
	180		x	x					x	x	x		
	181	x	x						x	x	x		
Latvia	96	x	x	x		x			x	x	x	x	
	97	x	x	x	x	x			x	x	x	x	
	98	x	x	x		x			x	x	x	x	
	99	x	x	x		x			x	x	x	x	
Lithuania	122	x	x	x	x	x			x	x	x	x	x
	123	x	x	x	x	x			x	x	x	x	x
	124	x	x	x	x	x			x	x	x	x	
	125	x	x	x					x	x	x		
Poland	83	x	x	x	x	x			x	x	x	x	
	84	x	x		x	x			x	x	x	x	
	85	x	x		x	x			x	x	x	x	
	86	x	x		x	x			x	x	x	x	
Russia	163	x	x	x	x	x			x	x	x	x	x
	164			x		x				x		x	
Sweden	101	x	x	x	x	x			x	x	x	x	x
	103	x	x	x	x	x			x	x	x		
	104	x	x	x		x			x	x	x		
	105	x	x	x					x	x	x	x	x
	106	x	x	x	x	x			x	x	x	x	
	107	x	x	x	x	x			x	x	x	x	
	108	x	x	x	x	x			x	x	x	x	x
	109	x	x	x	x	x			x	x	x	x	
	110	x	x	x		x			x	x	x	x	x
	111	x	x	x	x	x			x	x	x	x	x
	112	x	x	x	x	x			x	x	x	x	
	113	x	x	x	x	x			x	x	x	x	
	115	x	x	x	x	x			x	x	x	x	
	118	x	x	x	x	x			x	x	x	x	
	119	x	x	x	x	x			x	x	x	x	
	189	x	x	x	x	x			x	x	x		
	190	x	x	x	x	x			x	x	x	x	x
	191	x	x	x	x	x			x	x	x	x	
	192	x	x	x	x	x			x	x	x		
	193	x	x	x	x	x			x		x		
	194	x	x	x	x	x			x	x	x	x	
No. of BSPAs without information		**11**	**2**	**13**	**22**	**18**	**89**	**89**	**1**	**8**	**3**	**21**	**78**

1.3.2 Natura 2000 network

Background. In 2003 HELCOM and the OSPAR Commission decided that the BSPAs were to be extended by the addition of Natura 2000 sites to form an ecologically coherent network of MPAs in the Baltic Sea. Furthermore, the BSAP states that all Natura 2000 sites should be designated as BSPAs (HELCOM 2007a). Thus the marine Natura 2000 network was included in the overall assessment of ecological coherence. The Natura 2000 network of protected areas in the EU comprises sites designated under the EC Birds (1979) and Habitats Directives (1992). The EC Birds Directive is formally known as the Directive on the Conservation of Wild Birds (EEC/79/409 Directive) and was signed and ratified by the EU member states, making it a legal instrument for the conservation of all birds that exist naturally across Europe. SPAs (Special Protected Areas) were established under the EC Birds Directive, specifically for the protection of habitats for endangered and migratory bird species.

The EC Habitats Directive (EEC/92/43 Directive), more formally known as the Directive on the Conservation of Natural Habitats and Wild Flora and Fauna, calls for the designation of SACs (Special Areas of Conservation). SACs serve to protect species and habitats listed in Annex I and II of the directive. The EC Habitats Directive was signed in 1992 and meets the obligations of the Convention of European Wildlife and Natural Habitats (Bern Convention). Contrary to BSPAs, which are designated under the “soft laws” of Recommendation 15/5, EU Member states are obliged by EU law to designate, protect and manage Natura 2000 sites.

Status overview. The analysis of the Natura 2000 network is limited to geographical data on SPAs and SCIs provided by the BfN and German federal environmental authorities from Schleswig-Holstein and Mecklenburg-Vorpommern. Since the Natura 2000 database with information on management measures, threats and protected species and habitats was not available no further analysis was performed. **Table 11** and **Figure 7** are based on Natura 2000 and BSPA information reported by December 2009. Any further analysis such as the assessment of ecological coherence was based on data received up to July 2009. Details of the Natura 2000 data used for these additional assessments can be found in **Table 12** and **Figure 8**.

Up to December 2009 a total of 44,203 km² of the marine Helsinki Convention area was protected by the Natura 2000 network. The total area of SCIs amounts to 32,267 km², while the area of SPAs covers 39,369 km². As some sites are totally or partially assigned under both directives, there are several areas of overlap between SCIs and SPAs.

Altogether, 85% of the BSPA network area enjoys additional protection under the Natura 2000 Habitats or Birds Directive[2]. All of the Estonian, German, Lithuanian and Polish BSPAs as well as most of the Finnish BSPA areas are also Natura 2000 sites. Sweden only shares 68%, Latvia 30% and Denmark 79% of their BSPAs with the Natura 2000 network. In addition, there remains a large area in the Baltic Sea protected under the Birds and/or Habitats Directives, which has not yet been assigned to the HELCOM network of BSPAs.

In general, it can be said that, as with BSPAs, the majority of Natura 2000 sites are located along the coastlines of the Baltic Sea riparian states. While the Helsinki Convention specifically targets conservation of the Baltic Sea area, the EC Birds and Habitats Directives aim to protect both marine and terrestrial flora and fauna. Consequently, most Natura 2000 sites are located near the coast and to a large extent, stretch further into the terrestrial environment. Some exceptions exist, however, such as two larger areas south of the Swedish island of Gotland (also designated as BSPAs) and one large area in the EEZ of Poland.

Conclusions and recommendations. Despite the decision to designate existing Natura 2000 sites (where appropriate) as HELCOM BSPAs (HELCOM 2007a) by 2009, there still remains a large area in the Baltic Sea, protected under the Habitats or Birds Directive, which has still not been assigned to HELCOM. While some Contracting States quickly moved to designate more of their Natura 2000 sites as BSPAs, others still have to catch up. However, it has to be recognised that more than 80% of the Natura 2000 sites cover an area below the HELCOM minimum recommended size of 3000 ha for marine sites (HELCOM 2009). Natura 2000 sites should consequently be expanded by annexing adjacent areas or several Natura 2000 sites should be combined for

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[2] Due to the use of data sets from various sources inconsistencies in the case of country borders and MPA geometries occur. An MPA designated by one country may thus slightly fall into the marine area of another country when applying GIS procedures. Wherever, when these inconsistencies became evident they were referred to as MPA geometries rather than country borders.

the designation as BSPA. The latter option seems feasible, because several Natura 2000 sites share the same borders or even overlap due to the distinction between SCIs and SPAs.

Table 11. Natura 2000 sites and overlap with BSPAs. Due to the use of different data sources the calculations on area overlaps may differ slightly from true values. (Status Natura 2000: December 2009; Status BSPAs: February 2010)

	Marine area [km^2]			Intersect N2000 - BSPA		BSPA = N2000 [%]	BSPA + N2000[2] Protected marine area			
	SCI	SPA	N2000	[km^2]	[%]		total [km^2]	[%]	TW [%]	EEZ [%]
Denmark	5 370	7 267	7 949	7 894	99.3	78.9	10 064	22.2	27.8	8.4
Estonia	3 678	6 442	6 539	5 979	91.4	100.0	6 539	18.0	26.3	0.4
Finland	6 360	6 295	6 697	5 392	80.5	97.8	7 117	8.8	13.6	0.3
Germany	5 611	6 891	7 829	4 557	58.2	99.9	7 834	51.1	49.6	54.7
Latvia	559	519	559	252	45.1	29.2	1 170	4.1	9.1	0.1
Lithuania	686	366	686	362	52.7	99.7	688	10.6	30.2	0.0
Poland	4 318	7 145	7 204	7 175	99.6	100.0	7 205	24.4	54.9	8.6
Russia[1]	n/a	n/a	n/a	n/a	n/a	n/a	1 268	5.3	7.7	0.0
Sweden	5 685	4 444	6 740	4 925	73.1	67.7	9 088	6.2	8.3	3.9
Baltic Sea	**32 267**	**39 369**	**44 203**	**36 536**	**82.7**	**85.3**	**50 972**	**12.3**	**18.1**	**4.6**

1 non-EU Country, no Natura 2000 sites

2 including five Finnish BSPAs which are in the process of designation and three Russian Ramsar sites located in the Gulf of Finland

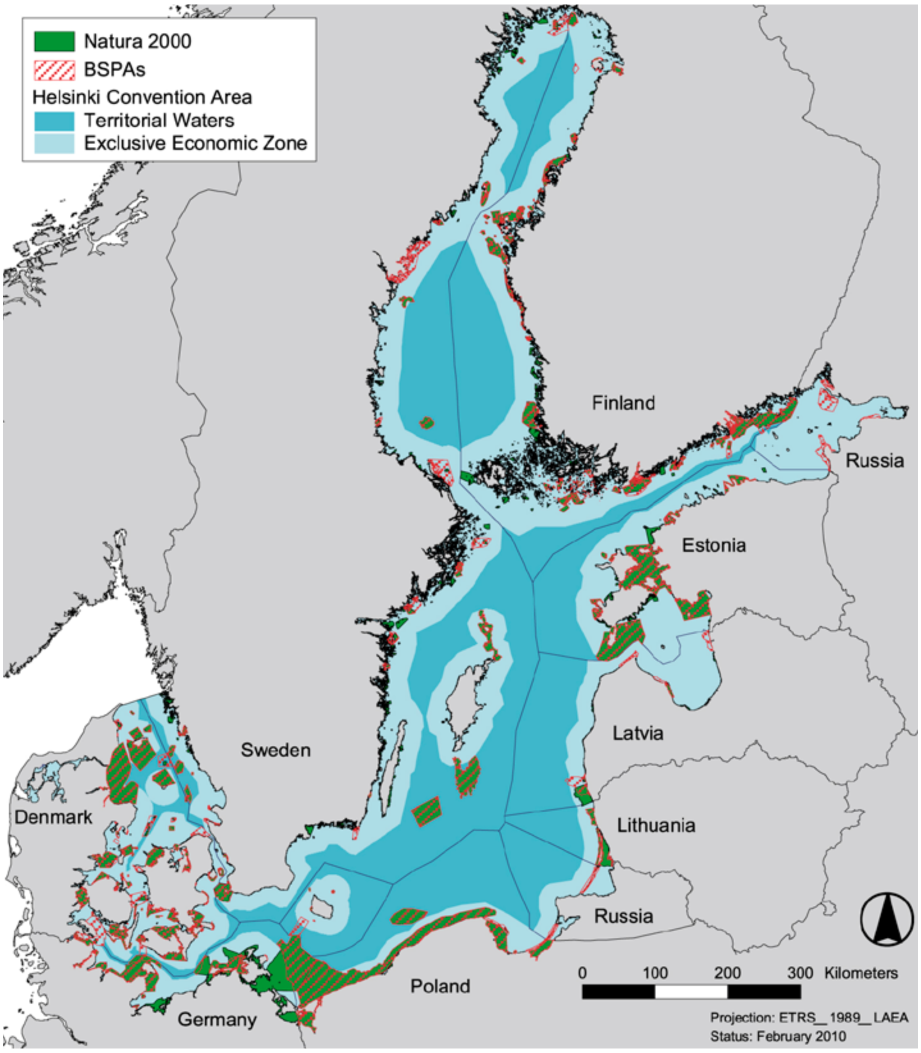

Figure 7. Natura 2000 sites (SCIs and SPAs) reported by December 2009 and BSPAs reported by February 2010.

Table 12. Natura 2000 sites and their overlap with BSPAs. Due to the use of different data sources the calculations of area overlaps may differ slightly from true values. (Status: July 2009)

	Marine area [km²]			Intersect N2000 - BSPA		BSPA = N2000 [%]	BSPA + N2000[2] Protected marine area			
							total		TW	EEZ
	SCI	SPA	N2000	[km²]	[%]		[km²]	[%]	[%]	[%]
Denmark	5 370	7 267	7 950	2 637	33.2	99	7 973	17.6	23.2	3.7
Estonia	3 678	6 442	6 532	2 777	42.5	100	6 533	18.0	26.2	0.4
Finland	6 360	6 295	6 695	5 392	80.5	98	6 815	8.4	13.1	0.0
Germany	4 569	4 961	6 208	4 550	73.3	100	6 220	40.6	34.7	54.6
Latvia	559	519	560	252	45.0	29	1 171	4.1	9.1	0.1
Lithuania	686	366	691	362	52.3	100	693	10.6	30.4	0.0
Poland	4 318	7 145	7 205	1 146	15.9	88	7 360	24.9	56.5	8.6
Russia[1]	n/a	n/a	n/a	n/a	n/a	n/a	246	1.0	1.5	0.0
Sweden	5 685	4 444	6 744	3 351	49.7	59	9 084	6.2	8.3	3.9
Baltic Sea	**31 225**	**37 439**	**42 587**	**20 466**	**48.1**	**85**	**46 093**	**11.1**	**16.3**	**4.2**

[1] non-EU Country, no Natura 2000 sites

[2] including five Finnish BSPAs which are in the process of designation and three Russian Ramsar sites located in the Gulf of Finland

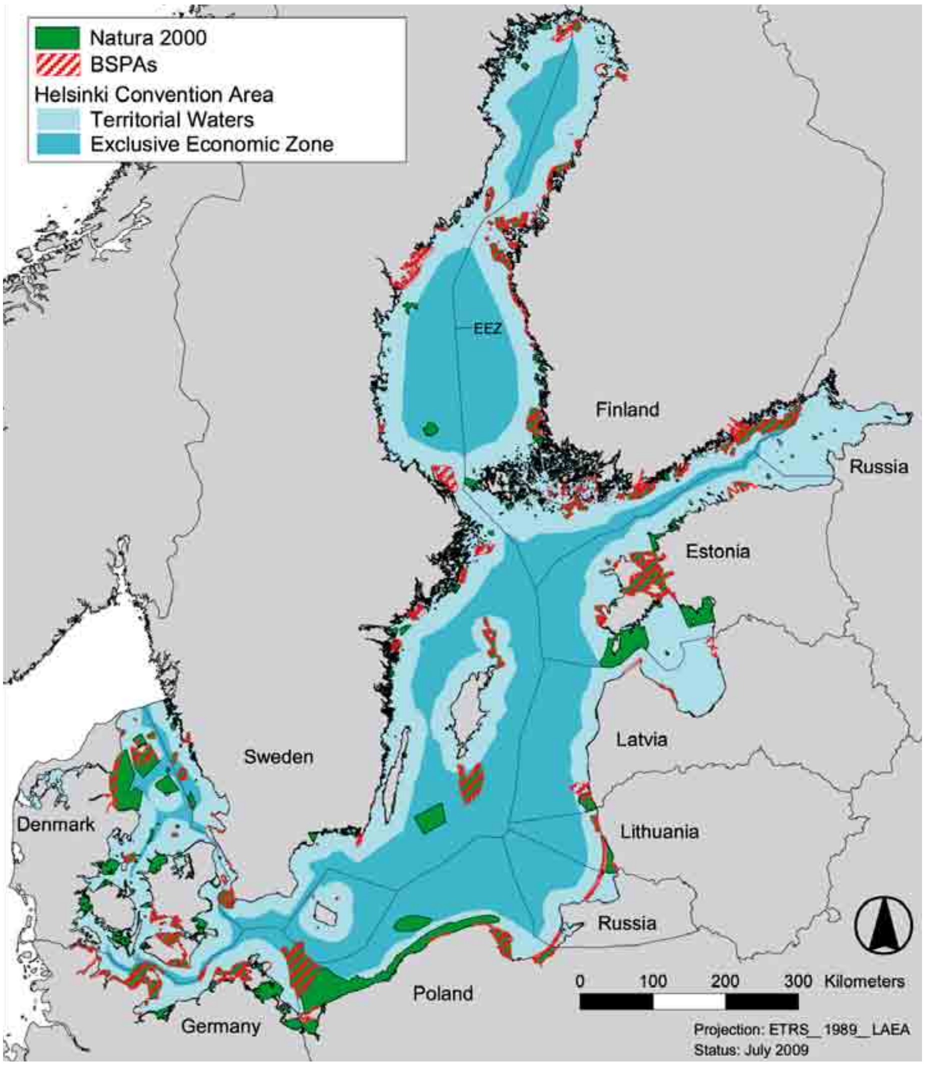

Figure 8. Natura 2000 sites (SCIs and SPAs) and BSPAs reported by July 2009.

1.4 Assessment on the ecological coherence of Baltic Sea MPA networks

A major aim of HELCOM is to establish by 2010 an ecologically coherent network of well-managed MPAs comprising BSPAs and marine Natura 2000 sites in the Baltic Sea. The first review of progress towards the 2010 target was conducted in 2004 (HELCOM 2005) and the second followed in 2006 (HELCOM 2006).

The first real assessment of BSPAs and Natura 2000 sites was conducted as part of the BSR INTERREG IIIB Project Balance in 2007 (Piekäinen and Korpinen 2008) the results of which are also discussed in the HELCOM BIO assessment (HELCOM 2009). Both the HELCOM and Balance project evaluations found that at the time the BSPA network did not fulfil the required criteria for ecological coherence and the 2010 target. The next sub-chapter describes how well the ecological coherence criteria are currently being met using geographical information on BSPAs and Natura 2000 sites as reported up to July 2009. The ecological coherence criteria used in this assessment comply with the criteria applied in the Balance project and follow-up assessments of the BSPA network. The criteria are: *adequacy, representativity, replication* and *connectivity.* A section is devoted to each criterion in which its scientific basis is explained and the applied measures and results are presented.

To analyse the ecological coherence of MPAs in the Baltic Sea in detail and to outline respective recommendations the following networks were assessed: (1) the BSPA network, (2) the Natura 2000 network (distinguished between SCIs and SPAs), and (3) a combined Natura 2000 - BSPA network (termed BSPA/N2000). In the case of the latter, the SCI and SPA geometries were merged into one Natura 2000 shape file since the sub-networks partly overlap. Furthermore, the combined Natura 2000 - BSPA network was extended to include three Russian Ramsar areas and five Finnish BSPAs, which were finalising official designation at the time of the assessment. All networks were demarcated based on their marine areas located within the marine Helsinki Convention Area, if not noted otherwise.

The assessment of ecological coherence was conducted for all three networks with spatial reference to the entire Baltic Sea, the Baltic Sea basins and the marine areas of the Contracting States. The Baltic Sea area is defined by the marine Helsinki Convention area and amounts 413,946 km². The Baltic Sea basins were delineated by HELCOM with divisions based on boundaries agreed by the HELCOM

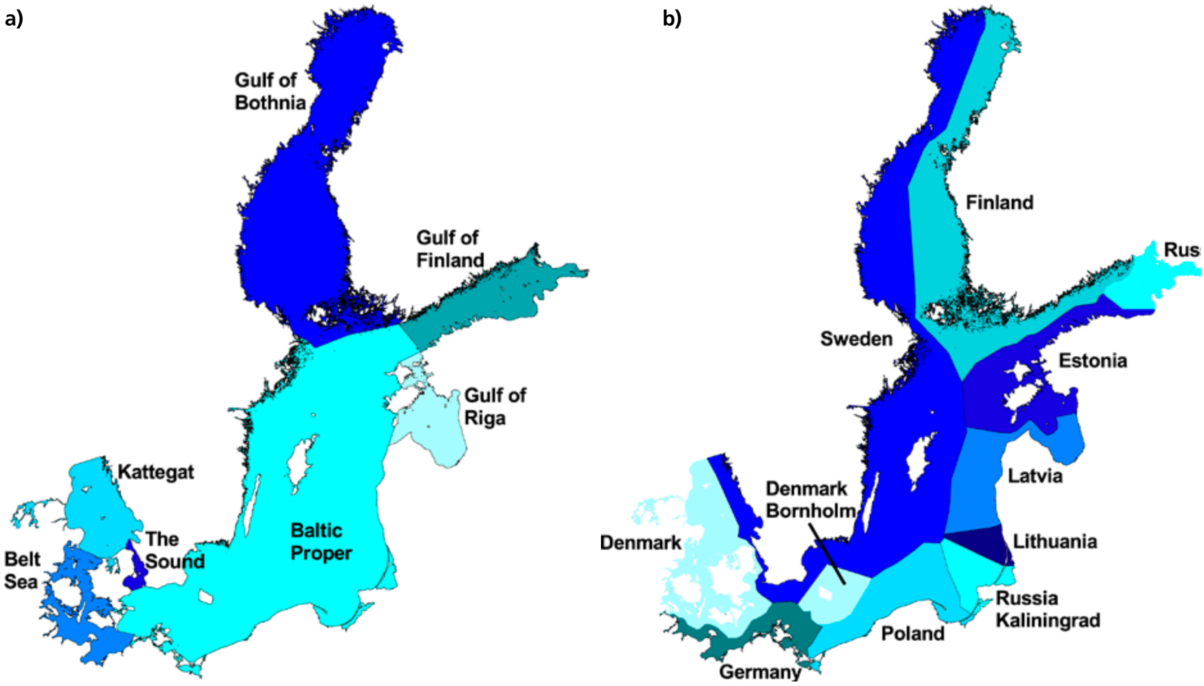

Figure 9. a) Baltic Sea basins and b) HELCOM marine areas of the Contracting States.

Goldsinny-wrasse (*Ctenolabrus rupestris*), Bubbling reef, Kattegat

COMBINE Monitoring Programme[3] (**Figure 9**). The boundaries correspond to shifts in the salinity range and topographic seafloor characteristics. The size of each basin is provided in **Table 13**. The marine areas of the Contracting States include the Inner Waters, TW and the EEZ of each state.

Table 13. Size of HELCOM Baltic Sea basins.

	Area [km²]		
Basin	**TW**	**EEZ**	**Total**
Baltic Proper	86 175	121 073	207 248
Belt Sea	16 548	1 938	18 486
Gulf of Bothnia	69 897	44 466	114 362
Gulf of Finland	26 153	3 399	29 551
Gulf of Riga	18 790	3	18 793
Kattegat	17 328	5 893	23 221
The Sound	2 259	24	2 284
Baltic Sea	**237 150**	**176 796**	**413 946**

The assessment of ecological coherence conforms to the methodology applied in the BSR INTERREG IIIB Project Balance. To a large extent, the assessment therefore relies on benthic marine landscape maps, which were used as a proxy for the broad-scale distribution and extent of ecologically relevant entities on the sea floor (Al-Hamdani and Reker 2007; Andersson et al. 2007; Piekäinen and Korpinen 2008). The benthic landscape map was calculated by raster grid overlay analysis using data on bottom substrate type, depth zonation (photic or non-photic) and seafloor salinity as basic mapping entities. As a result, 60 benthic landscape types were identified (**Figure 10**). For more details on the creation of the landscape map please refer to Al-Hamdani and Reker (2007).

The analysis of ecological coherence is carried out for all four assessment criteria. In each case a short introduction is provided, followed by a description of the methodology and the results.

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[3] http://www.helcom.fi/groups/monas/CombineManual/en_GB/Contents/

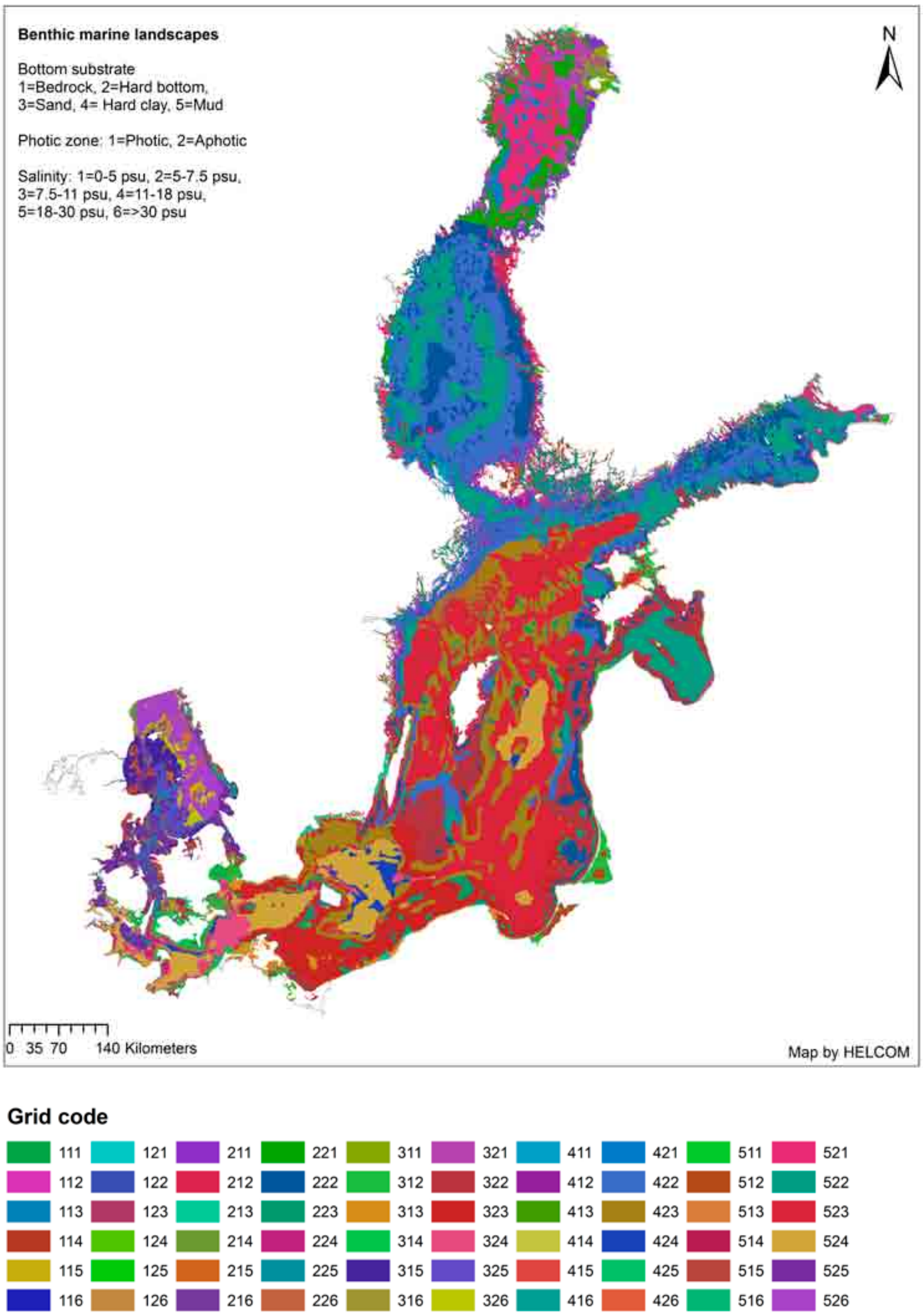

Figure 10. **Benthic marine landscapes in the HELCOM marine area (Al-Hamdani & Reker 2007). The first digit of the grid code refers to bottom substrate (1-5), the second digit refers to photic zone (1 or 2) and the last digit refers to salinity (1-6). Explanations of the code are provided in the map.**

1.4.1 Adequacy

For an MPA to be considered adequate, several factors have to be satisfied. The area should have an appropriate size and shape, as well as a satisfactory location and characteristics that minimise the impact of natural or anthropogenic threats. Overall, it has to safeguard the ecological viability and integrity of the populations, species, and communities; and can thus be understood as a prerequisite for a functioning coherent network. As in previous studies, the assessments on size, shape and quality of a network of marine protected areas were performed on a site-by-site basis. The quality of a site was analysed on the basis of available geoinformation on eutrophication status, ship traffic intensity and fishing intensity. Furthermore, the overall protection of certain indicator species and biotopes as well as the coverage of selected essential habitats were investigated to develop a more comprehensive picture of the adequacy of the entire networks.

Methodology

Adequacy was evaluated on a site-by-site basis in relation to size and quality. According to HELCOM Recommendation 15/5, the minimum size for a terrestrial site should be 1000 ha and for a marine/lagoon BSPA 3000 ha. The quality of a site was investigated with reference to available geoinformation on eutrophication status, ship traffic intensity and fishing intensity.

Eutrophication. The assessment of eutrophication status was based on data from the HELCOM indicator based assessment tool for eutrophication (HEAT). HEAT uses a set of existing indicators, which have been grouped as follows:
(1) physico-chemical features
(2) phytoplankton
(3) submerged aquatic vegetation and
(4) benthic invertebrate communities.
Groups 1 and 2 are considered ‘primary signals’ of eutrophication, while groups 3 and 4 are considered ‘secondary signals’. For each individual indicator, an interim classification was performed before combining them in groups (quality elements). The quality elements was then combined to develop assessment of ‘overall eutrophication status’. This final step makes use of the ‘One out – All out’ principles of the EU Water Framework Directive. This implies that the overall determination of eutrophication status is based on the most sensitive quality element. The classification system has five categories: “high” and “good” indicate ‘areas not affected by eutrophication’ and “moderate”, “poor” and “bad”, which denote ‘areas affected by eutrophication’. Details of the classifications, including a description of methodology and overview of the indicators used, are available in HELCOM (2009b and Andersen et al. 2010a,b).

Measurement data for the assessment of eutrophication status were collected between 2001 and 2006. To allow for a spatially inclusive and comprehensive assessment of the eutrophication status of MPAs the classification procedure outlined previously was applied to punctual measurement data followed by a specific interpolation technique to extrapolate the resulting point values to a raster map.

Eutrophied bay, Archipelago Sea, Finland

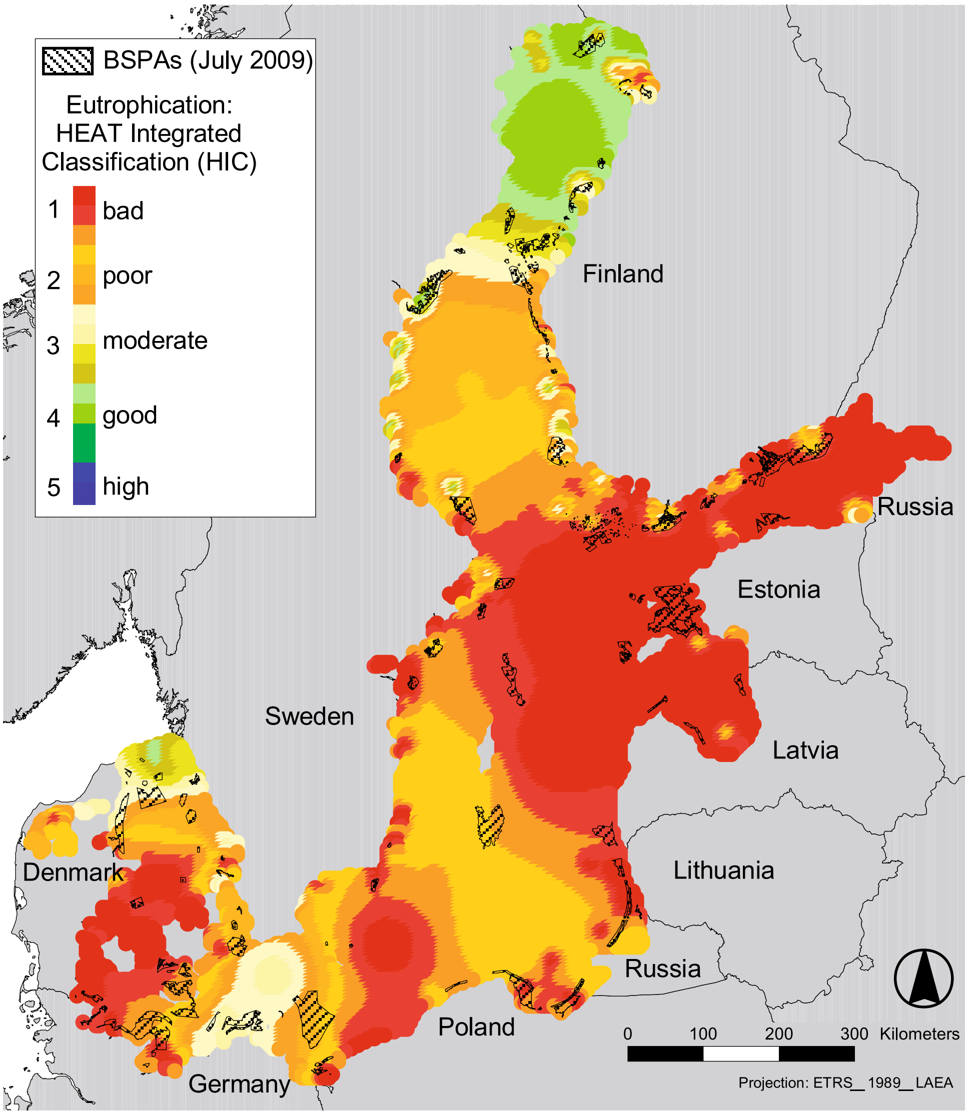

Figure 11. Eutrophication status of the Baltic Sea. Data source: HELCOM indicator-based assessment tool for eutrophication (HELCOM 2009b).

The initial data were derived from two types of monitoring stations: coastal and offshore. Since each category was assumed to have a different range of influence they were treated separately in the interpolation process. First the offshore point layer was interpolated in terms of a point raster. For the coastal stations a buffer of 25 km was generated around each coastal point. The 25 km distance was thereby assumed to be the influence range of each coastal station with respect to eutrophication effects. The buffers around the coastal points were then used to clip the offshore point grid (see above) and the coastal points were merged with the cut layer. The empty spaces around the coastal points were applied to give them more influence in the succeeding interpolation by the Inverse Distance Weighted (IDW) method. The specific options were set to generate smooth gradient between coastal and offshore points. The final raster layer is shown in **Figure 11**.

To identify the overall eutrophication status of the assessed MPAs they were buffered by 2170 m (½ cell size of the eutrophication point grid) and then intersected with the HEAT point raster layer. The mean eutrophication value was calculated for each BSPA, SCI and SPA.

Ship traffic. The data on ship traffic density was provided by the Finnish Meteorological Institute and illustrates the relative shipping frequency over 3 months in 2008 (April, August and December).

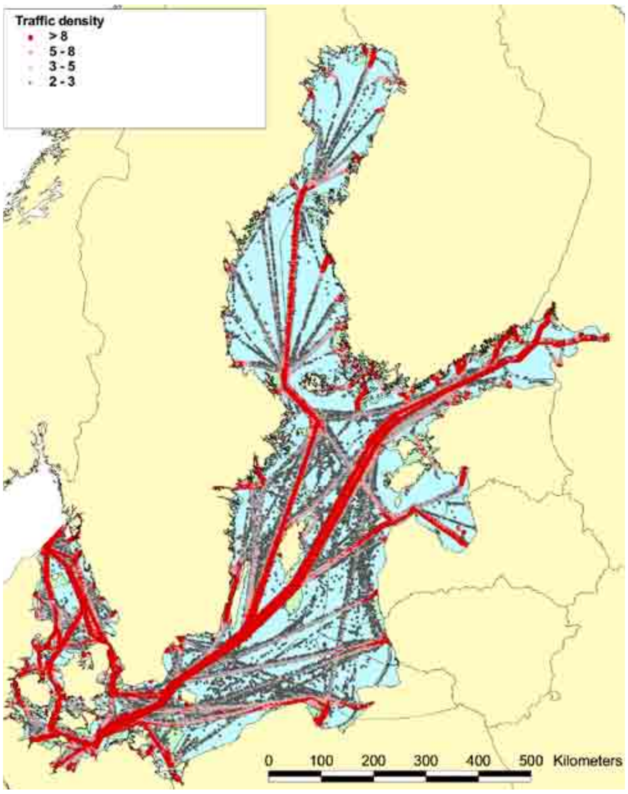

Figure 12. Relative ship traffic density in the Baltic Sea for four different ship traffic types: (a) cargo traffic, (b) passenger traffic, (c) tanker traffic, (d) other traffic and (e) all traffic and BSPAs (status: July 2009). The number of AIS-equipped ships travelling in grid cells (8x8 km) was recorded at 15-minute intervals and then totalled over the period of data acquisition (April, August and December 2008). Continues.

The relative traffic density in 8 x 8 km squares is given for four different shipping traffic types: cargo traffic, passenger traffic, tanker traffic and other traffic (**Figure 12**). The number of ships within each grid cell was recorded at 15-minute intervals then aggregated over the period of data acquisition. The numbers were based on the HELCOM AIS (Automatic Identification System)[4] data and therefore only AIS-equipped ships are included. Some of the grid cells (e.g. on land) include very small density numbers due to disruptions in the AIS signal. When the signal breaks and resumes the distance is automatically interpolated as a straight line between the two known signals. If the break has been long, e.g. 2 days, the ship may have moved significantly during that time, therefore the interpolated straight line also includes land areas where there are no shipping lanes. The four distinct maps on ship traffic were cross-referenced with BSPAs, SCIs, and the BSPA/N2000 network. The derived values for ship traffic densities within each MPA were then compiled and the median number of ships for each traffic type calculated. Thus, one single value was derived for each protected area defining a theoretical relative ship density. As no individual sites are distinguished for the BSPA/N2000 network, a median value could only be calculated for the basin-wide and country-specific networks.

Fishing intensity. The data on fishing intensity represent commercial fisheries in the Baltic Sea. It is based on fisheries data reported by all countries surrounding the Baltic Sea except Russia, for which data was taken from ICES reports. All data is from the year 2007 except for data from Lithuania, which is from 2008. The data includes landings or catches in tonnes as reported by the countries. The landings/catches for all countries have been calculated per ICES (International Council for the Exploration of the Sea) square and include the gear categories ‘unspecified’, ‘surface and mid-water’, ‘bottom trawling’, and ‘coastal and stationary’ (**Figure 13**).

The map of total landings/catches was clipped with the maps of Baltic Sea wide BSPA, SCI and SPA networks. As the individual MPAs overlapped with several ICES squares, the proportional landings/catches per MPA fraction were calculated and summed up to derive the theoretical total landings/catches in tonnes per protected area. For better comprehensibility and comparability the derived information on all protected areas was grouped into five categories for each network type and for each Contracting State. The analysis could not be conducted for the BSPA/N2000 network as no individual areas could be distinguished due to overlaps between BSPAs, SCIs and SPAs.

Indicator species and biotopes. Furthermore, adequacy was evaluated in relation to the protection of chosen indicator species and biotopes[5] as well as the coverage of selected essential habitats. The seven agreed biotope indicators are sandbanks, estuaries, lagoons, shallow inlets and bays, reefs, bubbling reefs, and macrophytes. Information on the respective HELCOM database categories is found in **Table 14** and the list of indicator species in **Table 15**. As information on protected

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[4] The HELCOM AIS is a land-based monitoring system which monitors AIS signal transmitter-equipped ships in the Baltic Sea in real-time.

[5] The indicator species and biotopes were chosen in accordance with the German Federal Agency of Nature Conservation and the HELCOM secretariat.

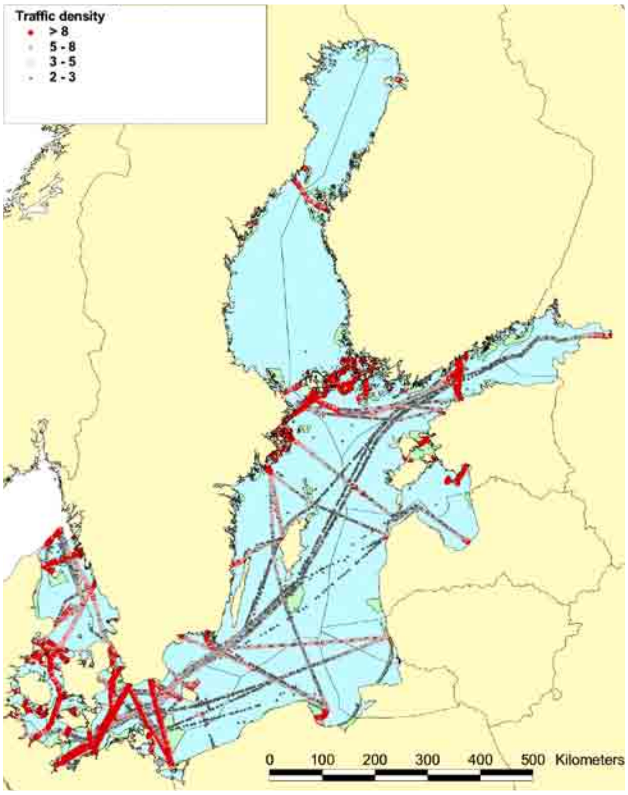

Figure 12. Continued. (b) Relative passenger ship traffic density in the Baltic Sea.

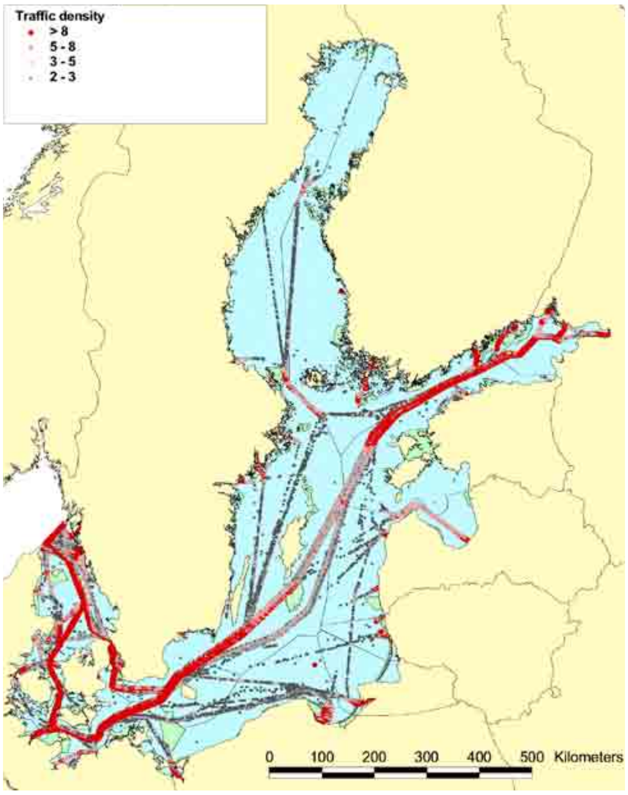

Figure 12. Continued. (c) Relative tanker ship traffic density in the Baltic Sea.

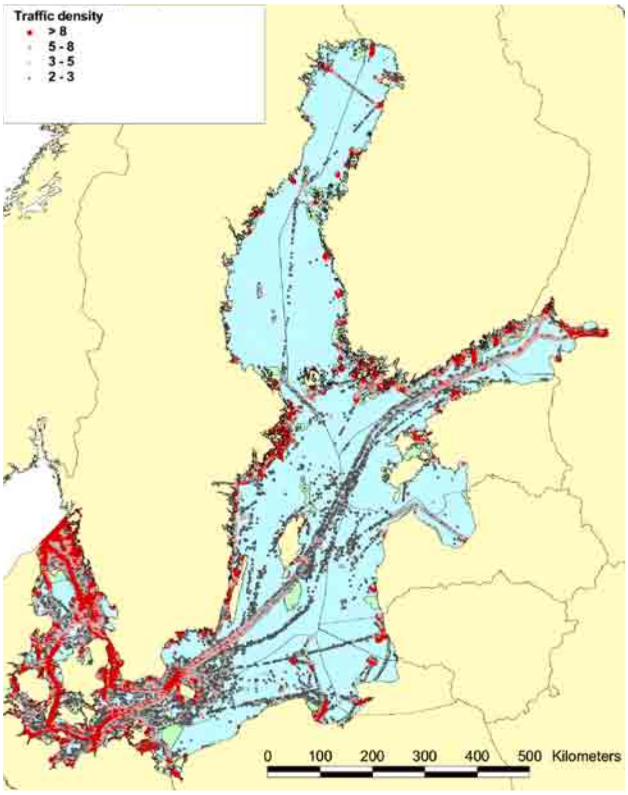

Figure 12. Continued. (d) Relative traffic density of other ship types in the Baltic Sea.

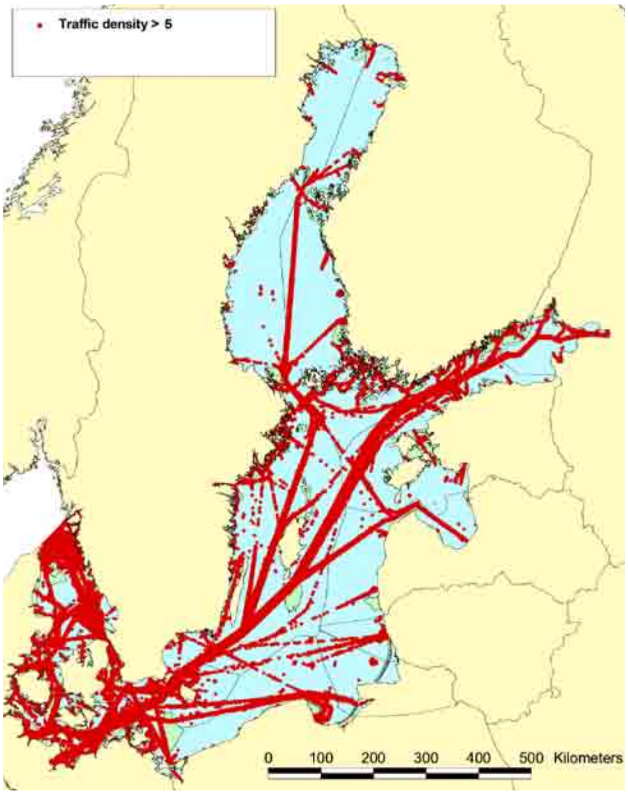

Figure 12. Continued. (e) Relative overall shipping traffic density in the Baltic Sea.

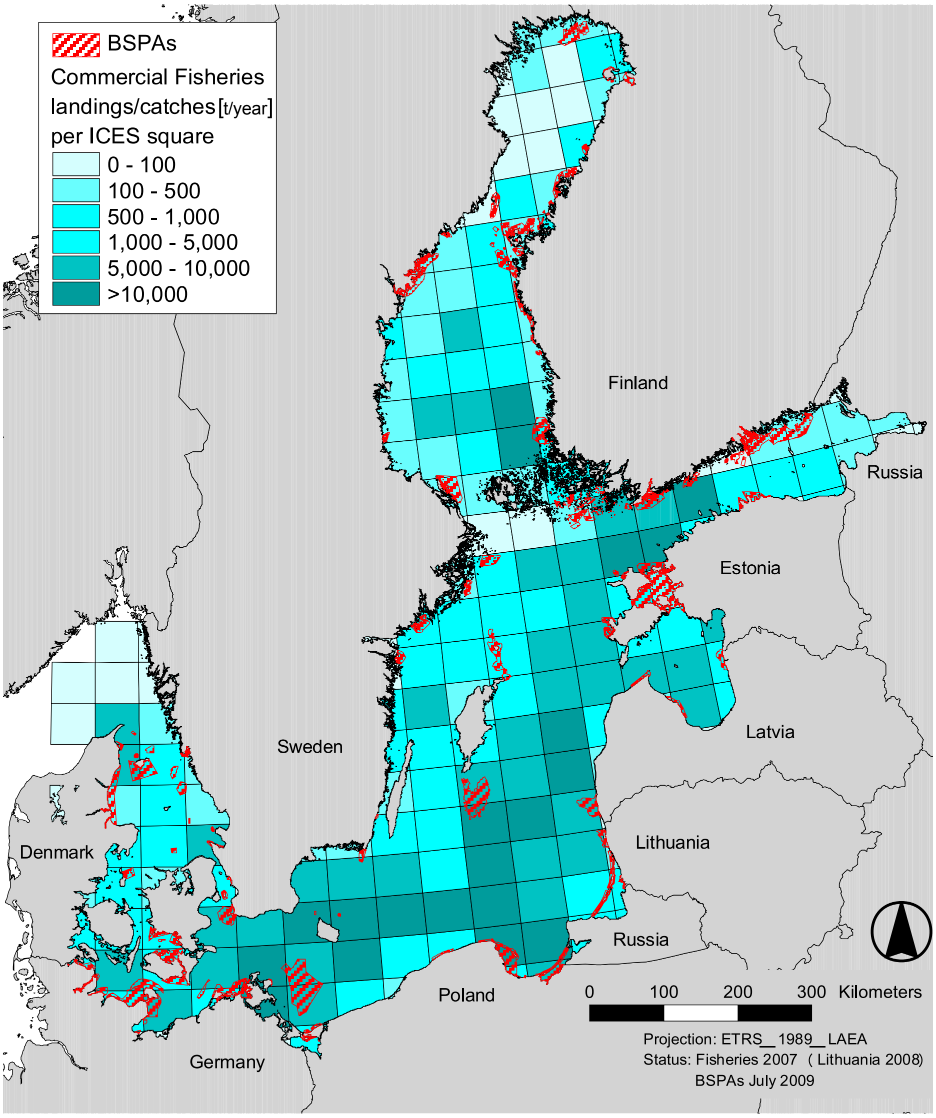

Figure 13. Fishing intensity in the Baltic Sea. Based on landings and catches in tonnes/year reported by all countries surrounding the Baltic Sea, except Russia, for which data was gathered from ICES reports. All data is for the year 2007 except data from Lithuania which is for 2008. The landings/catches have been aggregated for each ICES (International Council for the Exploration of the Sea) square and include all gear categories.

species and habitats/biotopes was not available for Natura 2000 sites, such analysis was performed only for the BSPA network. For the network to be considered adequate, all indicator species and biotopes should be protected within at least one BSPA. The coverage of essential habitats was performed in terms of four data layers: 'Important Birds Areas' (IBAs), 'Grey seal haul-out sites', and *Zostera* and Charophyte distribution sites.

Important Bird Areas (IBAs). Marine IBAs are areas selected under the Important Bird Areas programme of BirdLife International and are selected using quantitative, standardised, and globally-agreed criteria. IBAs are essential for the long-term viability of bird populations and are, by definition, an internationally-agreed priority for conservation action. IBAs are identified, monitored and maintained by national and local organisations and individuals. Conservation actions are in progress at many of these sites and therefore benefit from enhanced formal and informal protection status. Geographical information on IBAs in the Baltic Sea are based on BirdLife (2000) dataset and depict the spatial distribution of the IBAs in the Baltic Sea area. The map is illustrated in **Figure 14**. The determination of the

Table 14. Indicator biotope and respective categories from the HELCOM BSPA database.

	Sandbank	Estuaries	Lagoon	Shallow inlets & bays	Reefs	Bubbling reefs	Macrophytes
Habitat type	1110	1130	1150	1160	1170	1180	
Biotopes	all categories including "sandbanks", excluding those with marophytes	5.1 to 5.3	4.1 (all) + 4.2.1		all categories including "reefs" or "mussle beds", excluding reefs and those with macrophytes	2.10, excluding those with macrophytes	all benthic marine biotopes dominated by macrophytes
Biotope complexes		J & I	G	D & E			

overlap between IBAs and the MPAs being evaluated was performed by means of GIS intersection.

Grey Seal haul-out sites. The grey seal is the most abundant and most widely-distributed of the three seal species in the Baltic Sea area. At the beginning of the 20th century Baltic grey seals may have numbered up to 100,000 individuals and were widespread in the entire Baltic Sea, however, the population drastically declined to only a few thousand in the 1970s. The decline was brought about by intensive hunting pressure and by a reduced reproductive capacity due to environmental pollution (Hårding & Härkönen 1999, Kokko et al. 1999, Uhd Jepsen 2000). Today the grey seal population has recovered in areas north of 59° N and continues to grow as their reproductive rate improves. In 2008, an international census found 22,300 individuals present Baltic Sea -wide (Finnish Game and Fisheries Research Institute (FGFRI) 2008). However, Baltic seals still face severe threats and their current and future status will be affected by a number of anthropogenic factors. According to the HELCOM List of threatened and/or declining species, grey seals are still threatened in the Southern Baltic Sea (HELCOM 2007c). Further, the species is listed in Annex II of the EU Habitats Directive, obliging EU member states to designate special areas of conservation (SAC) for grey seals (thus far no marina SAC exists in the Baltic Sea). Finally, according to the HELCOM Guidelines for designating BSPAs, habitats of endemic, rare or threatened species are to be protected.

Table 15. List of Indicator species. For information on HELCOM regions where the species are present or threatened see HELCOM 2007c.

	Species	English name
Algae	*Chara* spp. *	Stoneward
	Fucus searratus	Serrated wrack
	Fucus vesiculosus	Bladder wrack, Black tang
	Furcellaria lumbricalis	Black carrageen
Vascular plant	*Zostera marina*	Eelgrass
	Zostera noltii	Dwarf eelgrass
Fish	*Anguilla anguilla*	European eel
	Lampetra fluviatilis	River lamprey
	Alosa fallax	Twaite shad
	Salmo salar	Atlantic salmon
	Gadus morhua	Cod
Birds	*Gavia arctica*	Black-throated Diver
	Gavia stellata	Red-throated Diver
	Gavia immer	Great Northern Diver
	Tadorna tadorna	Common Shelduck
	Mergus serrator	Red breasted Merganser
	Sterna albifrons	Little tern
Mammals	*Halichoerus grypus*	Grey seal
	Phoca vitulina	Harbour (Common) seal
	Phoca hispida botnica	Ringed seal
	Phocoena phocoena	Harbour (Common) porpoise

* *C. canescens, C. horrida, C. tomentosa, C. braunii, C. baltica, C. aspera, C. connivens*

For these reasons, in 2006 the Helsinki Commission agreed on a new HELCOM Recommendation 27-28/2 for the Conservation of Seals in the Baltic Sea Area and established an *ad hoc* HELCOM Seal Expert Group (HELCOM SEAL) with concrete Terms of Reference for the implementation of the Recommendation. One duty of the HELCOM SEAL was to identify and establish a network of protected areas for important actual and potential seal habitats across the Baltic Sea area. For this purpose, in 2008 and 2009 a specific distribution team of the HELCOM SEAL reviewed the HELCOM BSPA- and EUNIS-Natura 2000 databases (EUNIS 2006) concerning entries for seal data. The results were unsatisfactory, because both databases included only limited information on grey seals (Maschner 2009).

At the second meeting of the HELCOM SEAL (2/2008) in March 2008 the meeting concluded that data on grey seal moulting areas should be

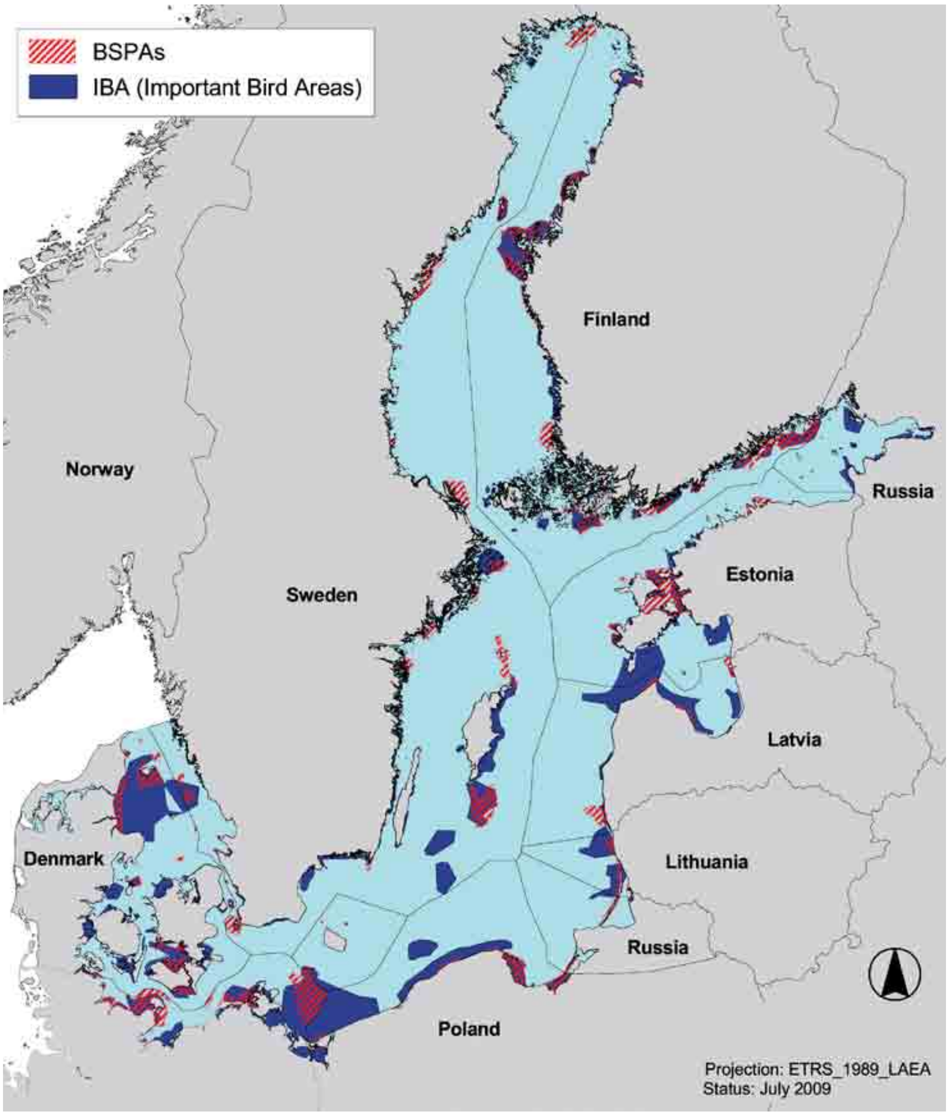

Figure 14. Important Bird Areas (IBAs) and their overlap with BSPAs. Data source: BirdLife International 2000

available in a common format from the year 2000. The HELCOM SEAL further agreed that moulting sites do not shift over time, which means they are relatively stable. Breeding sites depend on ice conditions; when there is ice, breeding takes place on ice, when there is no ice, breeding takes place on the shores. As a result, the 2008 HELCOM SEAL meeting proposed a Baltic-wide point GIS map for moulting and (where possible) breeding site distribution for grey seals. To produce such a map, the distribution team assessed data on haul-out sites of grey seals provided by the HELCOM states. The data indicated that a number of the designated HELCOM BSPA sites host grey seal moulting or breeding areas, although in some cases grey seals have not been listed as protected in the BSPA database. Additionally, some of the haul-out sites would not be inside BSPAs or SCIs.

During the work of this report it became clear that the present data set is not sufficiently significant and convincing for a scientifically sound assessment of the coherence of the BSPA network for grey seals. The use of the information collected from HELCOM SEAL members for grey seal breeding and haul-out (moulting) sites can be seen as a first endeavour but in order to improve the assessment and to publish a map, extensive additional data is needed. We consequently recommend that Contracting States should strive to complete the BSPA database with the most recent information on seal presence and protection in their BSPAs, and

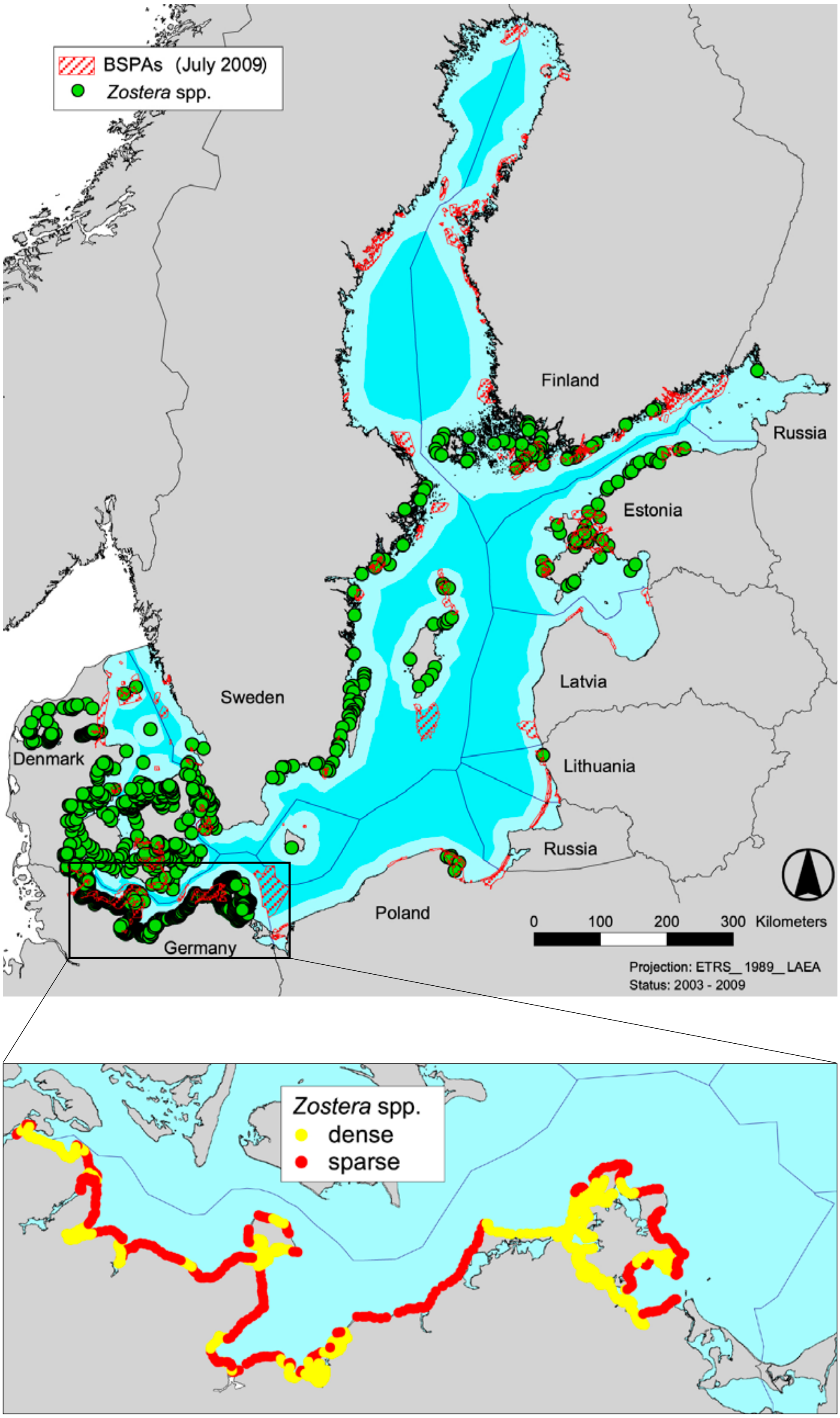

Figure 15. ***Zostera marina*** **and** ***Z. noltii*** **distribution in the marine Helsinki Convention Area. Data for German waters contain information on** ***Zostera*** **coverage (dense or sparse). Data source: see Table 48**

also provide the HELCOM SEAL distribution team with more significant data to produce an appropriate distribution map (Maschner 2009).

***Zostera* distribution.** The third essential habitat type chosen for the assessment of adequacy were habitats of *Zostera* species. Two *Zostera* species are present in the Baltic Sea: *Zostera marina*, the Eelgrass, and *Zostera noltii*, the Dwarf eelgrass. While *Z. marina* is the most widely-distributed marine angiosperm in the northern hemisphere, *Z. noltii* is very rare. Within the HELCOM area *Z. noltii* is distributed mainly along the Swedish west coast and the Danish coast. Outside HELCOM its distribution broadens to include the Mediterranean and European Atlantic coasts, including Great Britain. *Zostera* meadows were severely reduced in Europe due to an epidemic outbreak of diseases in the 1920's. Since then, recovery has been slow and sporadic. Furthermore, the coastal habitats favoured by *Z. noltii* are under increasing threat from coastal development, pollution and other forms of human disturbance as well as severe nutrient enrichment. As for *Z. noltii*, the distribution and depth limits of the eelgrass *Z. marina* have considerably declined in the past 100 years. The reduction started in the 1930s with the "wasting disease", when about 90% of the entire North European stock disappeared. Increasing nutrient loading has reduced vertical recovery and the depth distribution is therefore much shallower than before. Eutrophication of the Baltic Sea has resulted in significant declines of eelgrass meadows in Danish, Swedish and Polish coastal areas. In the northern Baltic, no clear changes in the distribution of eelgrass meadows have been recorded, but the long-term changes found in the eelgrass associated invertebrate assemblages have been linked to the effects of eutrophication. (Lundberg, 2005 and references therein). Ongoing eutrophication may cause a shift from eelgrass meadows to communities dominated by fast-growing macroalgae and this may result in the decline of valuable habitats and consequent loss of overall biodiversity (Boström et al., 2002 and references therein).


Eelgrass meadow

In the Baltic Sea today, the northern and eastern distribution limits of eelgrass correlate with the 5 psu salinity distribution of surface seawater and the species is usually found at a depth of 2-4 m (range 1-10 m). The data set used for the adequacy assessment consisted of a distribution map of both *Z. marina* and *Z. noltii* in the Baltic Sea and was compiled from different sources dating from 2003 up to 2009 (Annex IV) The available data provided point information on the distribution of *Zostera* species in the Baltic Sea. Communities are mainly distributed along the Danish, Estonian and German coast as well as the southern coast of Sweden and Finland. In Finland, *Zostera marina* reproduces asexually, which leads to a high degree of clonality. Some patchy sightings were made in Poland, Lithuania and Russia. Neither *Z. marina* nor *Z. noltii* have been reported in Latvian waters. The map in **Figure 15** depicts the reported *Zostera* sightings in the Baltic Sea as point data. Data on *Zostera* distribution in Germany includes categorisations into dense and sparse coverage, whereas data for the rest of the Baltic Sea only provides information on the presence of either of the two species in a certain area. To define the coverage of *Zostera* habitats by MPAs

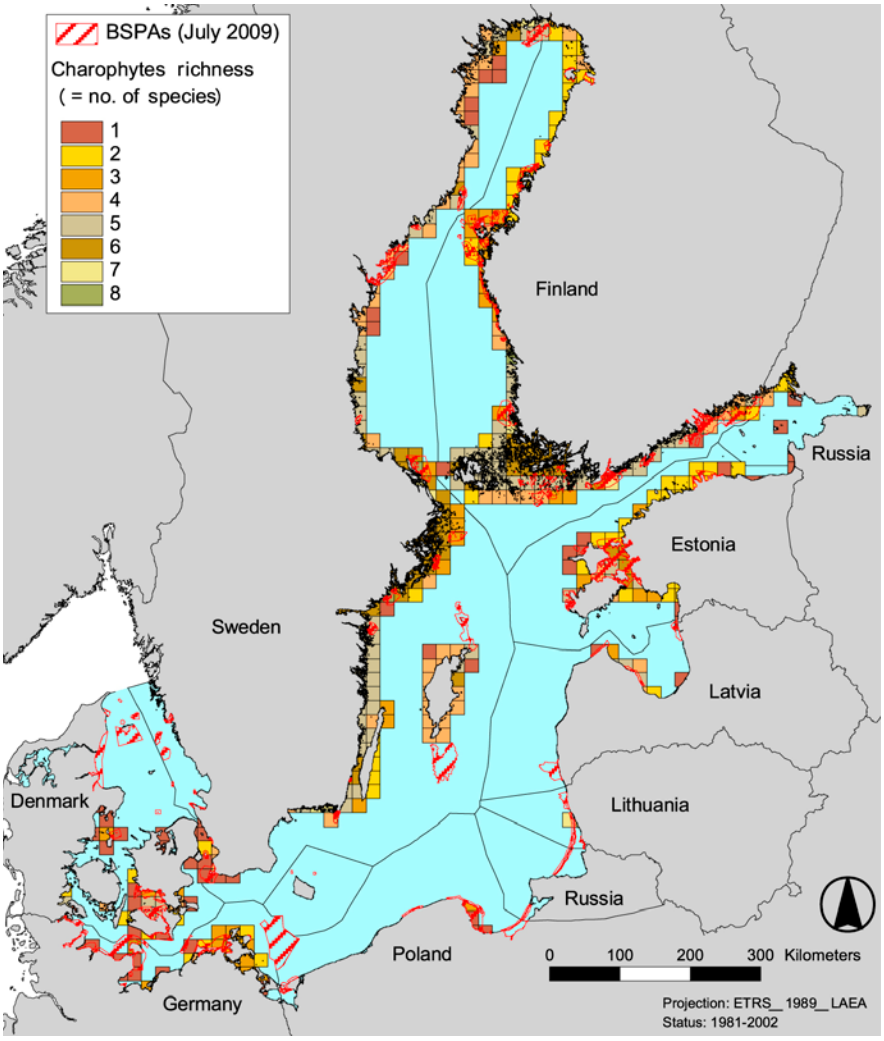

Figure 16. Distribution and richness of Charophyte species in the marine Helsinki Convention Area. Resolution: 20x20 km. Data source: see chapter 1.4.1

the map of *Zostera* distribution was intersected with BSPAs, Natura 2000 sites and the BSPA/N2000 network. The total number of *Zostera* sightings located in MPAs was calculated per marine area of the Contracting States to determine the number of MPAs exhibiting *Zostera* sightings. The differentiation between sparse and dense *Zostera* distribution in German waters was eliminated to allow for easy comparison.

Charophyte distribution. The fourth essential habitat type selected for the assessment of adequacy were areas colonised by Charophyte species. Charophytes, a group of green algae, are useful indicators of a healthy ecosystem as many species require high water quality and clarity for survival. When water becomes polluted, murky or eutrophic the species declines, resulting in a loss of habitat for invertebrates, as well as food for invertebrates and water birds. Charophyte distribution maps for the Baltic Sea area are based on Shubert & Blindow (2003, revised 2009) and include data gathered during the period 1981-2002. The data set contains the following Charophyte species: *Chara aspera*, *C. baltica, C. braunii, C. canescens, C. connivens, C. contraria, C. contraria, C. fragifera, C. galioides, C. globularis, C, hispida, C. horrida, C. intermedia, C. polyacantha, C. tomentosa, C. virgata, C. vulgaris, Lamprothamnium papulosum, L. sonderi, Nitella confervacea, N. flexilis, N. gracilis, N. hyalina, N. mucronata, N. opaca, N. syncarpa, N. wahlbergiana, Nitellopsis obtusa* and *Tolypella nidifica*. Information is provided on the type of species and species richness (number of species) found within each 20 x 20 km² raster cell (**Figure 16**). The map on Charophyte distribution was intersected with

BSPAs, SCIs, SPAs and the BSPA/N2000 network to assess how many of the species present in the Baltic Sea and the marine areas of the Contracting states are found in MPAs.

Results

The following sections present the results of the assessment of adequacy in relation to the different adequacy factors described in Chapter 1.4.1: size, quality aspects (eutrophication, ship traffic density, fishing intensity), indicator species, indicator biotopes as well as essential habitats (Important Birds Areas, *Zostera* and Charophyte distribution).

Size. Sizes of MPAs in the Baltic Sea vary considerably. **Figure 17** depicts the size distribution of BSPAs, SCIs and SPAs per country grouped into three categories: > 3,000 ha, 1,000-3,000 ha and < 1,000 ha. The categorisation was selected on the basis of HELCOM Recommendation 15/5 and additional guidelines stating that a BSPA should comprise at least 1000 ha for terrestrial areas and 3,000 ha for marine sites. **Figure 17** shows that most marine BSPAs (77.5%) exceed 3,000 ha. Another 16.9% are between 1,000 and 3,000 ha in size, and only 5.6% have an area smaller than 1,000 ha. Three-quarters of all BSPAs therefore fulfil the requirement for adequacy of size.

Conversely, the same proportion of sites protected under the EC Habitats Directive are smaller than 1,000 ha (75%) and another 10% range between 1,000 and 3,000 ha. Only 15% of all SCIs are adequate in size, most of which are located in Denmark, Finland and Sweden. With respect to SPAs the total amount of adequately sized areas doubles to 30%. Furthermore, the number of areas from 1,000 to 3,000 ha in size is 4% higher than for SCIs, meaning that little more than half of all SPAs are smaller than 1,000 ha. Again, most of the adequate sites are located in Danish, Finnish and Swedish marine waters. However, the number of adequate sites in Finland and Sweden represents only a small fraction of the total number of sites. With 29 out of 37 SPAs the proportion of adequate SPAs in Denmark is much higher. The same holds true for Germany and Poland. Overall, it can be stated that the network of BSPAs is by far the most adequate in terms of the criteria laid down in HELCOM Recommendation 15/5. It should be noted that there are no size limitations for Natura 2000 sites mentioned in the Habitats or Birds Directive. Adequacy is thus determined on the basis HELCOM requirements only.

Eutrophication. The number of protected areas in each HEAT integrated classification category is shown in **Figure 18**. Accordingly, neither the BSPA network nor the SCI or SPA networks showed areas considered to be of 'high' quality. Sites with a 'good' eutrophication status represent only a small proportion, i.e. 3 and 4% of BSPAs and SPAs, respectively, and 9% of SCIs. The rest of the sites were considered to be `affected by eutrophication', with most of them classified as 'poor' or 'bad' quality areas. Overall, the quality of all three networks can be described as inadequate with respect to eutrophication status.

Separate evaluation of the MPA networks of the Contracting States found that BSPAs, SCIs and SPAs of 'good' quality could be found only in Finland and Sweden, and that most of those sites were

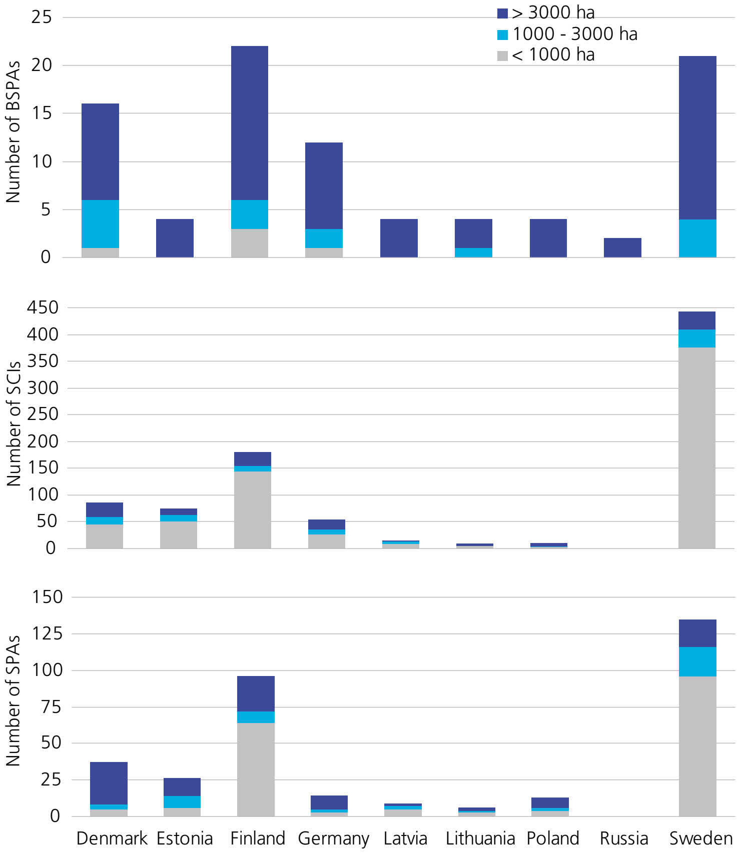

Figure 17. Distribution and richness of Charophyte species in the marine Helsinki Convention Area. Resolution: 20x20 km. Data source: see chapter 1.4.1

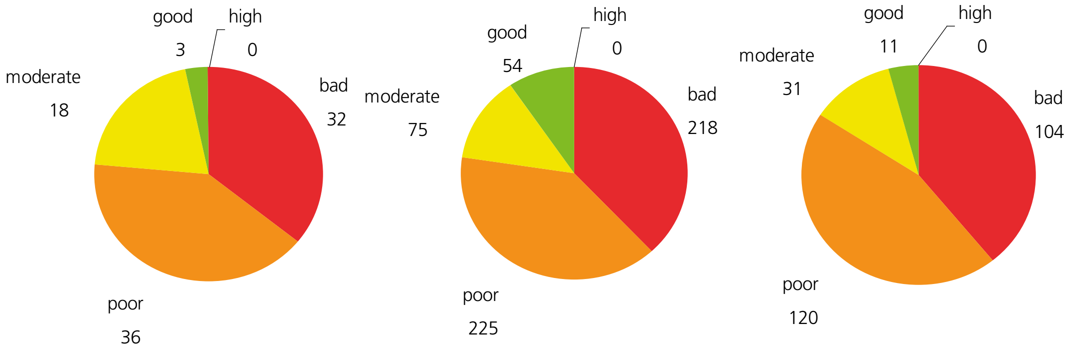

Figure 18. Eutrophication status in BSPAs, SCIs and SPAs (number of sites).

Table 16. Eutrophication status and number of MPAs in Contracting States' BSPA, SCI and SPA network[1]. The calculated eutrophication status of each MPA is based on data from the HELCOM Eutrophication Assessment Tool (HEAT) collected between 2001 and 2006 (HELCOM 2009).

	Eutrophication status											
	bad			poor			moderate			good		
	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA
Denmark	4	43	16	7	18	13	5	7	4			
Estonia	4	51	25		4							
Finland	6	28	17	8	55	29	6	18	11	2	14	10
Germany	4	9	4	6	17	6	2	13	1			
Latvia	4	13[2]	9[3]									
Lithuania	4	4	5									
Poland	1	5	4	3	4	5						
Russia		n/a	n/a	2	n/a	n/a		n/a	n/a		n/a	n/a
Sweden	5	65	24	10	127	67	5	37	15	1	40	1
Baltic Sea	**32**	**218**	**104**	**36**	**225**	**120**	**18**	**75**	**31**	**3**	**54**	**11**
	Affected by eutrophication									Not affected		

1 Note that both the SCI and SPA networks also include sites which have been nominated as SCI and SPA at the same time. Furthermore, due to deviations in geographical shapes of administrative borders, some Natura 2000 sites which are officially nominated as terrestrial only may have been identified as having a marine fraction.

2 Including six sites which have been officially nominated as terrestrial only.

3 Including four sites which have been officially nominated as terrestrial only.

SCIs (**Table 16**). MPAs of 'moderate' eutrophication status were identified in Denmark and Germany, while in general Polish MPAs were found to be 'poor'. Estonia possessed four SCIs of 'poor' quality while all BSPAs and SPAs were categorised as having a 'bad' eutrophication status. The quality of all Lithuanian and Latvian MPAs was 'bad'.

Ship traffic. Figure 19 shows the relative ship traffic density in each MPA for the BSPA, SCI and SPA networks for four shipping types: cargo, passenger, tanker and other ships. The BSPA network was found to be most affected by cargo traffic, because it holds the largest percentage of sites with a median number of more than 10 cargo ships. The highest relative passenger ship density was found in SPAs. The largest number of MPAs with a relative ship density of more than 10 tankers and other shipping types was identified in the BSPA network. Tanker ships were the least abundant in all three network types, followed by cargo ships. Overall, it can be stated that the adequacy of Baltic Sea -wide networks is worst with respect to passenger ships and other ship traffic, because many of the MPAs are located within heavily used shipping lanes. Consequently, the BSPA network was found to be most affected by ship traffic passing through the protected areas and therefore highly inadequate. **Table 17** presents the relative ship traffic density of MPA networks in each of the Contracting States. Overall, Lithuania possesses the largest number of

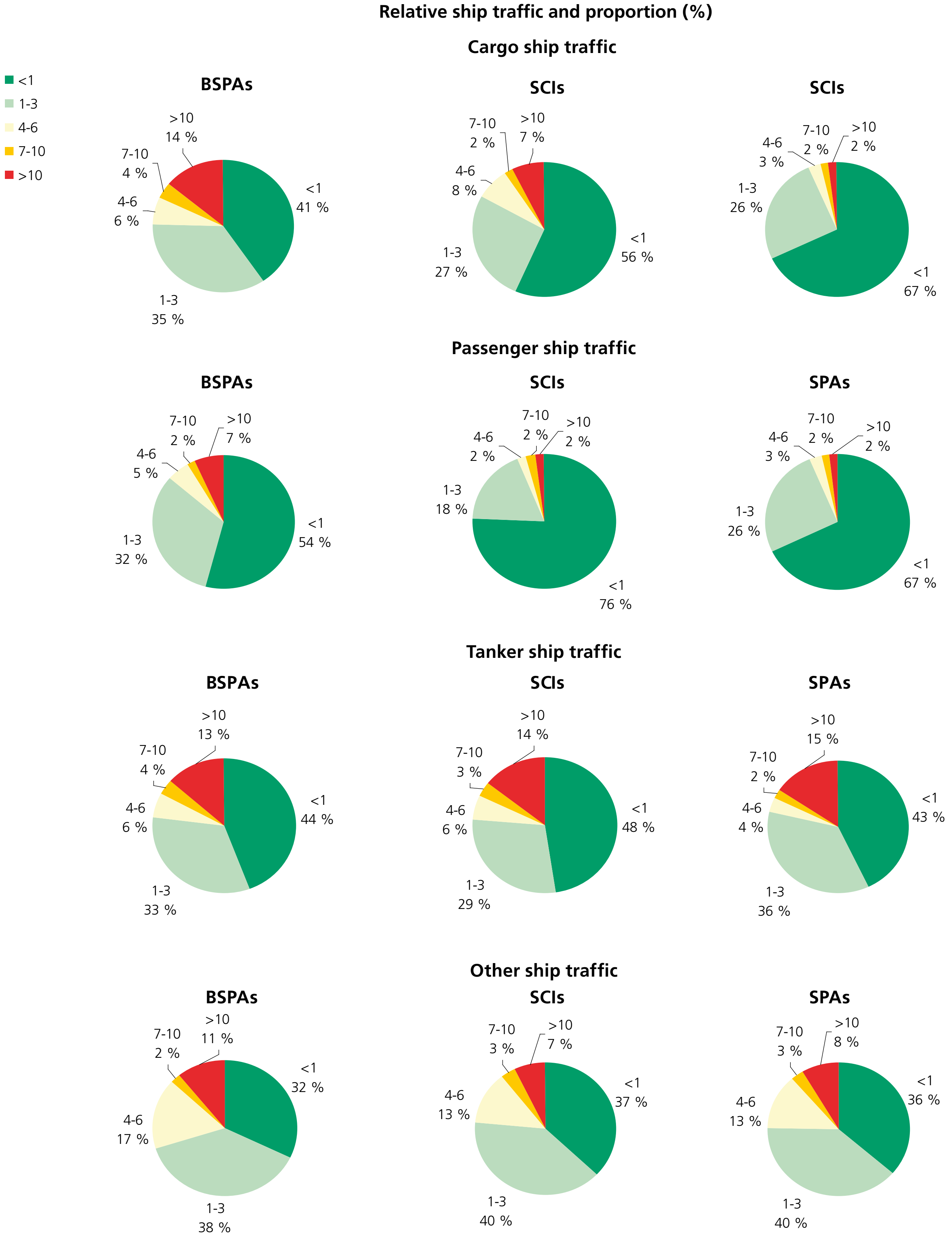

Figure 19. Relative shipping traffic density in BSPAs, SCIs and SPAs. The number of AIS-equipped ships within grid cells (8x8 km) at 15-minute intervals was recorded and totalled over the period of data acquisition (April, August and December 2008). The median value of the relative shipping concentration in each MPA was calculated and categorised. The table shows the percentage of the total number of each networks' sites for the selected traffic categories.

Table 17. **Relative shipping traffic density in the MPA networks of the Contracting States. The number of AIS-equipped ships in grid cells (8x8 km) was recorded at 15-minute intervals then totalled up over the period of data acquisition (April, August and December 2008) (based on data provided by the Finnish Meteorological Institute). The table shows the median value of the relative density of shipping traffic in Contracting States' MPA networks.**

	Mean number of ships in MPAs per network															
	Cargo				Tanker				Passenger				Other			
	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000
Denmark	2.8	2.2	2.5	2.5	1.2	0.9	1.1	1.1	23.5	20.9	17.7	15.1	3.7	4.2	3.3	3.2
Estonia	1.0	1.1	1.6	1.6	0	0.6	0.6	0.6	27.0	23.6	12.7	12.9	2.7	3.4	2.7	2.8
Finland	3.4	3.1	3.1	3.1	1.7	1.6	1.6	1.5	1.3	1.9	2.0	1.9	3.0	3.0	3.0	2.8
Germany	10.5	13.3	3.4	10.1	6.0	6.7	1.2	5.7	4.8	5.6	2.4	4.5	4.6	5.4	4.4	4.8
Latvia	1.0	0.9	0.9	1.0	0.1	0.2	0.2	0.2	0	0	0	0.2	0.2	0.2	0.3	0.3
Lithuania	47.4	48.8	47.4	46.8	44.2	44.2	44.2	41.8	10.2	11.2	10.2	11.2	47.0	46.2	47.0	45.7
Poland	7.9	2.9	3.9	3.9	4.9	1.1	1.8	1.8	3.2	1.6	1.6	1.6	5.1	1.6	2.2	2.2
Russia	14.8	n/a	n/a	1.6	26.0	n/a	n/a	1.6	3.0	n/a	n/a	0.2	200.0	n/a	n/a	2.1
Sweden	5.3	5.2	6.7	5.2	2.5	2.2	2.6	2.2	1.4	1.7	1.6	1.5	1.8	2.3	2.2	2.0

inadequate networks of BSPAs, SCIs, SPAs, with the relative passenger ship density exceeded only by Estonian and Finnish MPAs. The Contracting State with the highest number of adequate networks with respect to ship traffic is Latvia.

Fishing intensity. Figure 13 describes fishing intensity in the Baltic Sea region and shows that the Baltic Proper, Bornholm Basin, Arkona Basin and Bothnian Sea areas in particular are heavily-exploited since they contain the highest number of annual catches/landings. However, as many of the more heavily-fished areas are located further off the coast, the MPAs are found mostly in areas where smaller amounts of fish are extracted from the sea. Thus more than half of all BSPAs fall in the lowest category (0 –100 t/year) of fish landings/catches per site and another 30% in the second category (100 –500 t/year) (**Figure 20**). Only one site is located in a heavily fished area. SCIs and SPAs are even better located with respect to fishing intensity as over 90% and 80%, respectively, are located in regions of the Baltic Sea with the lowest levels of fishing activity. Furthermore, no sites fall within the category of >10,000 t/year per site and only four SPAs could be categorised in the 5,000 - 10,000 t/year level. It can therefore be concluded that with respect to fishing intensity, the BSPA network is less adequate than the SCI and SPA networks.

In terms of adequacy, Finland possesses the best-located MPAs, followed by Sweden and Denmark (**Table 18**). However, it must be noted that fish landings/catches per area represents only a theoretical estimate, which is dependent on area size and may

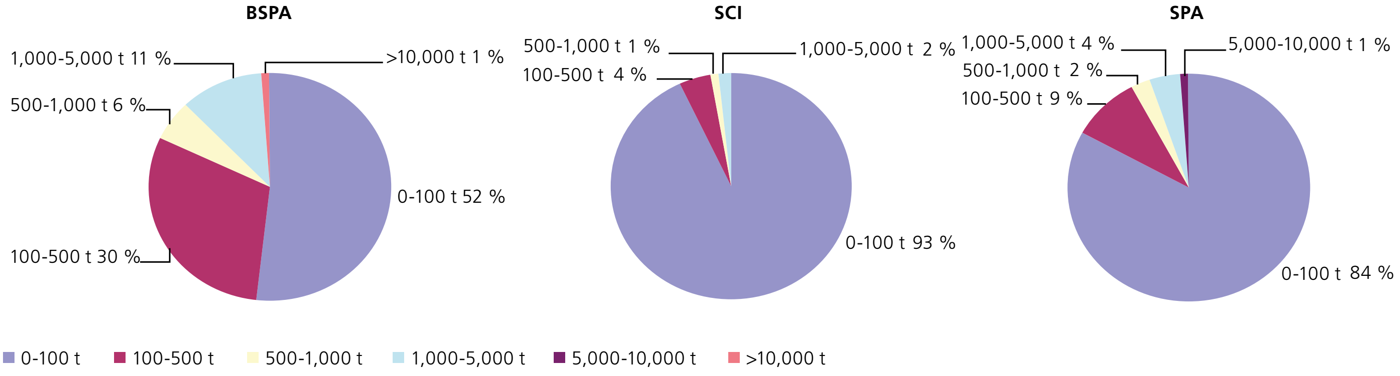

Figure 20. **Fishing intensity in BSPA, SCI and SPA networks. Percentages of areas falling into different total fish landings/catches categories (tonnes/year).**

Table 18. Fishing intensity in the BSPA, SCI and SPA networks of the HELCOM Contracting States. The number of protected areas within a certain category of fish landings/catches is given. (Based on data provided by all countries surrounding the Baltic Sea, except Russia, for which data was taken from the ICES reports)

	Number of MPAs with total landings/catches [t/year]																	
	0-100 t			100-500 t			500-1,000 t			1,000-5,000 t			5,000-10,000 t			>10,000 t		
	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA
Denmark	12	75	22	1	6	11	2	4	2	1	1	2						
Estonia		63	17	3	6	4		1	1	1	2	3			1			
Finland	15	173	87	5	6	6			1	2	2	2						
Germany	3	35	5	5	11	4	1	1	1	3	4	4						
Latvia		12	7	2	1	1	1	1	1	1								
Lithuania	2	5	4	2	3	2		1										
Poland	1	5	5	1	1	2		1	1	1	4	2			3	1		
Russia	1	n/a	n/a	1	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a
Sweden	12	438	132	7	2	1	1	1	1	1	1	1						
Baltic Sea	**46**	**806**	**279**	**27**	**36**	**31**	**5**	**10**	**8**	**10**	**14**	**14**			**4**	**1**		

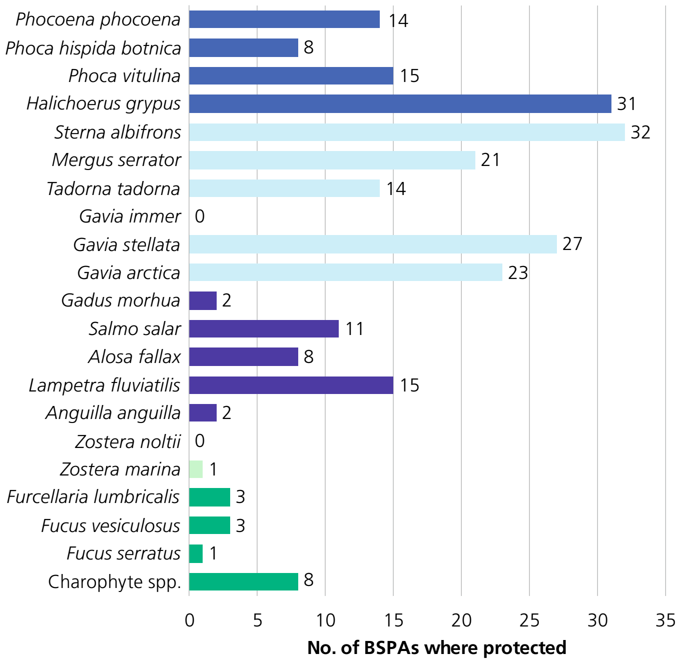

Figure 21. Indicator species and number of BSPAs in which they are protected. (Status: July 2009)

not correspond with reality. Furthermore, no management measures were taken into account, which might characterise an area as a low–take or no-take zone.

Indicator species. Altogether 21 indicator species were chosen from the list of species in the HELCOM database. They included algae, vascular plants, fish, birds and mammals (**Table 14**)[6]. Due to a lack of database entries for invertebrates, they were not included as indicator species for the assessment. For the algae group four species were chosen as indicators, with the eight existing *Chara* species listed in the BSPA database aggregated into one category, *Chara* spp. As a result, all algae species in the BSPA network were found to be protected , except for one of the *Chara* species, *Chara braunii* (not depicted in **Figure 21**). *Fucus serratus* was reported to be protected in one area and *Fucus vesiculosus* and *Furcellaria lumbricalis* are both conserved in three BSPAs. Of the two vascular plant species only *Zostera marina* was reported as protected in one BSPA, while *Zostera noltii* was not protected. The five selected fish species were all protected in the BSPA network, with *Gadus morhua* and *Anguilla anguilla* reported in two BSPAs each, *Alosa fallax* in eight, *Salmo salar* in eleven and *Lampetra fluviatilis* in 15 BSPAs.

Of the six chosen bird indicator species, *Gavia immer* was not listed in any BSPA. The other five species were found to be protected in 14 to 32 BSPAs. Thus, the bird indicator species enjoys the highest level of protection as they are protected in the highest number of BSPAs. Mammal indicators were comparably well protected, with each of the four indicator species listed in several BSPAs. The grey seal *Halichoerus grypus* was thus the second best-protected species, with *Sterna albifrons* afforded the highest level of protection

With respect to the protection of indicator species, the BSPA network did not meet the

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[6] Neither the distribution nor the abundance of indicator species in the Baltic Sea marine regions was considered in the analysis. *Fucus serratus*, *Phoca vitulina* and *Zostera noltii*, for example, are not present in the Finnish part of the Baltic Sea, *Gadus morhua* and *Alosa fallax* are very rare and *Gavia immer* merely migrate through Finnish waters.

adequacy requirement for all of the 21 indicator species. The number of BSPAs that provided protection for a certain species has only limited value since the overall distribution of the species assessed is not incorporated into the analysis. Therefore, a different approach relying on an extended database for each indicator species would be needed for a more in-depth evaluation.

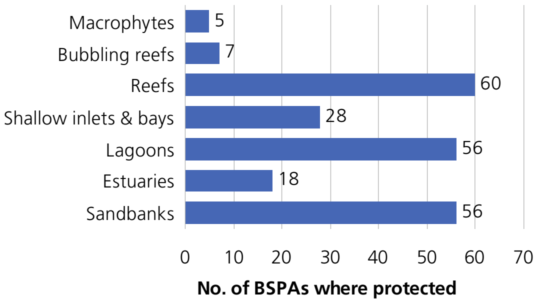

Figure 22. Indicator biotopes and number of BSPAs in which they are protected. (Status: July 2009)

Indicator biotopes. All seven biotope indicators were found to be protected in the network of BSPAs, with 'Reefs' reported in most (60) BSPAs (**Figure 22**). 'Lagoons' and 'Sandbanks' were equally well protected as they were each reported in 56 BSPAs. These three best-protected biotope indicators were followed by 'Shallow inlets & bays' (protected in 28 BSPAs), 'Estuaries' (18 BSPAs), 'Bubbling reefs' (7 BSPAs) and 'Macrophytes' (5 BSPAs). Information on the protection status of biotope indicators was gathered from the list of protected habitats, biotopes and biotope complexes in the HELCOM BSPA database. No information was provided on the protec-

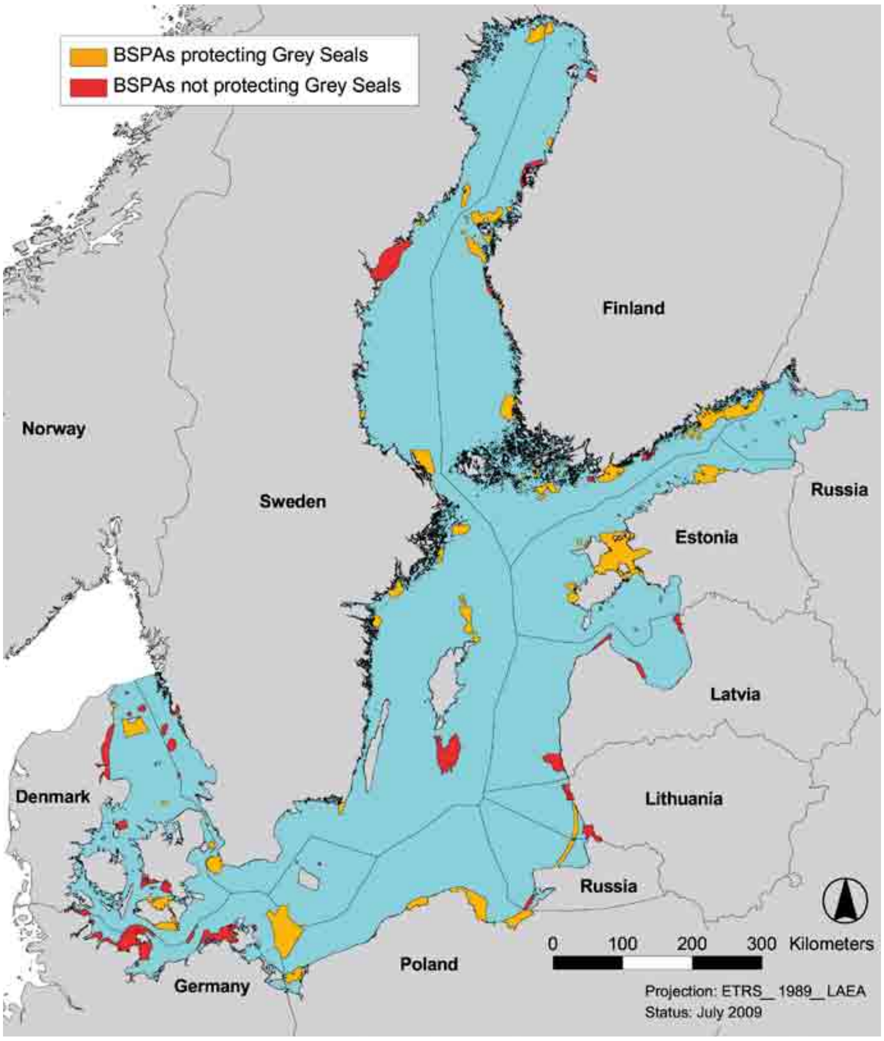

Figure 23. BSPAs with information on the protection status of Grey Seals, reported in the HELCOM BSPA database by July 2009 (up-dates as of March 2010).

Table 19. **Important bird areas (IBA, BirdLife International 2000) and convergence with the BSPA, SCI, SPA and the combined BSPA/N2000 networks.**

	IBA marine [km²] (%)		% IBA overlap with			
			BSPA	SCI	SPA	BSPA/ N2000
Denmark	10 610	(23.4)	23.2	44.7	65.2	66.8
Estonia	4 613	(12.7)	28.8	42.8	98.1	98.1
Finland	6 619	(8.2)	52.3	56.6	57.7	59.5
Germany	7 258	(47.3)	49.2	53.2	61.1	70.9
Latvia	3 905	(13.6)	8.5	6.1	5.8	11.5
Lithuania	1 728	(26.5)	18.2	23.0	18.7	23.0
Poland	7 865	(26.6)	14.3	52.0	84.1	84.6
Russia	1 390	(5.8)	0.1	n/a	n/a	0.1
Sweden	8 511	(5.8)	23.2	24.5	30.2	36.1
Baltic Sea	**52 499**	**(12.7)**	**27.8**	**40.3**	**56.1**	**59.6**

Table 20. **Number of BSPAs in the HELCOM BSPA database reported to be protecting Grey Seals (Status: July 2009)**

	BSPAs protecting Grey Seals
Denmark	5
Estonia	4
Finland	10
Germany	1
Latvia	0
Lithuania	1
Poland	4
Russia	1
Sweden	12
Baltic Sea	**38**

Table 21. ***Zostera*** **distribution. The number of** ***Zostera marina*** **or** ***Z. noltii*** **sightings within BSPAs, Natura 2000 and BSPA/N2000 sites is given. The digit in brackets represents the number of individual MPAs in which the** ***Zostera*** **sites are located. (For information on data sources see Table 48)**

Country	Total no. *Zostera* sightings	No. *Zostera* sightings within						
				Natura 2000				
		BSPAs		SCIs		SPAs		BSPA/ N2000
Denmark	3336	437	(7)	1020	(18)	944	(17)	1027
Estonia	43	21	(3)	26	(8)	30	(9)	30
Finland	46	12	(3)	10	(3)	11	(3)	12
Germany	1009	438	(8)	710	(21)	735	(10)	796
Latvia	0	0	0	0	0	0	0	0
Lithuania	1	1	(1)	1	(1)	1	(1)	1
Poland	5	5	(1)	3	(1)	5	(1)	5
Russia	1	0		0		0		1
Sweden	86	14	(5)	21	(14)	14	(7)	21
Baltic Sea	**4527**	**928**	**(28)**	**1791**	**(66)**	**1740**	**(48)**	**1893**

tion status of three habitats, 21 biotopes and 78 biotope complexes.

In general it can be stated that with respect to the protection status of biotope indicators the BSPA network can be termed adequate because all seven indicators are listed as protected. As for indicator species, it is impossible to estimate the number of BSPAs providing biotope protection since this figure depends on the overall distribution of the biotope assessed. Here, too, a different approach based on more information would be needed for in-depth evaluation.

Important Bird Areas. The marine IBAs in the Baltic Sea cover 52,499 km², corresponding to 12.7% of the marine Helsinki Convention Area. Nearly 28% of that area overlaps with the BSPA network. With 40% and 56% area overlap the SCI and SPA networks, respectively, cover nearly twice the IBA area compared to the BSPA network. The combined BSPA/N2000 network extends across almost 60%. The combined network would thus be the most adequate in terms of coverage of IBAs. A detailed view of the country-specific overlap of IBAs and the assessed networks is provided in **Table 19**. Apart from the combined BSPA/N2000 network, the SPA network is most adequate in almost all countries. In Lithuanian and Latvian waters IBAs are covered to a larger extend by SCIs. The BSPA network covers the smallest IBA area in all Countries and can thus be considers the least adequate.

Grey Seal distribution. Although data was available and processed, adequacy in terms of protection of grey seal habitats could not be properly assessed on the basis of the given data (see Chapter 1.4.1). **Figure 23** and **Table 20** reflect the information taken from the BSPA database on the protection status of grey seals inside BSPAs as of July 2009.

Zostera **distribution.** The Polish and Lithuanian *Zostera* distribution sites were all found to be protected by BSPAs and Natura 2000 sites while *Zostera* habitats in the other countries were less suitably protected (**Table 21**). Overall, the adequacy of the BSPA network in terms of *Zostera* habitat coverage is very limited, as only one fifth is protected out of a total of 28 BSPAs. Of these 28 areas the HELCOM BSPA database reported that *Zostera marina* was protected in only one Finnish BSPA. Another two BSPAs, one Swedish and one Lithuanian, also reported protection of *Zostera marina*, but no *Zostera* sightings were recorded in these two areas in the compiled distribution data set. Adequacy of the SPA and SCI networks was considered better than that of the BSPA network, but still very limited. Less than 40% of all *Zostera* sightings occurred in SPAs or SCIs. Even if both types of Natura 2000 sites were combined into one network with BSPAs, adequacy would still be limited to 40% coverage of known *Zostera* habitats.

Charophyte distribution. A total of 23 Charophyte species was found across the Baltic Sea. Of these, 19 species were present in the BSPA network and 20 species each in the SCI, SPA and BSPA/N2000 networks (**Table 22**). All Contracting States, except Russia, protect nearly all Charophyte species in their marine areas. It can therefore be concluded that all four assessed networks are reasonably adequate with respect to the protection of Charophyte species. However, it must be pointed out that the available data is very coarse in resolution, and based on a variety of literature dating from 1981 to 2002. Data conformity is thus unlikely. Furthermore, data for Poland, Russia, Lithuania, Latvia, and southern Sweden was very scarce.

Table 22. Richness of Charophyte species in the BSAP, SCI, SPA and BSPA/N2000 networks of Contracting States and the Baltic Sea. The percentage of all species of a region present within the MPAs is given in parentheses. (Richness=number of species) (Charophyte distribution maps are based on Shubert & Blindow (2003) and include data gathered between 1981 and 2002.)

	Species rich-ness	Species richness in MPAs (% of total)							
		BSPA		SCI		SPA		BSPA/N2000	
Denmark	6	5	(83%)	5	(83%)	5	(83%)	5	(83%)
Estonia	7	7	(100%)	7	(100%)	7	(100%)	7	(100%)
Finland	14	12	(86%)	14	(100%)	14	(100%)	14	(100%)
Germany	10	9	(90%)	10	(100%)	10	(100%)	10	(100%)
Latvia	6	6	(100%)	6	(100%)	5	(83%)	6	(100%)
Lithuania	7	7	(100%)	7	(100%)	7	(100%)	7	(100%)
Poland	5	5	(100%)	5	(100%)	5	(100%)	5	(100%)
Russia	9	0	(0%)	n/a		n/a		3	(33%)
Sweden	13	12	(92%)	13	(100%)	12	(92%)	13	(100%)
Baltic Sea	**23**	**19**	**(83%)**	**20**	**(87%)**	**20**	**(87%)**	**20**	**(87%)**

Conclusion

The assessment of adequacy revealed that the network of BSPAs was by far the most adequate in terms of the size of sites, while the network of Natura 2000 sites failed to conform to the given HELCOM selection criteria (there are no such minimum size requirements for Natura 2000 sites). Furthermore, it was found that the quality of all assessed networks could not be described as adequate with respect to eutrophication status, shipping traffic and fishing intensity. However it must be noted that the value of this conclusion is severely limited due to the coarse resolution of the data sets provided and the absence of additional information which would have facilitated more detailed analyses.

The eutrophication map, for example, was derived from interpolation of a restricted set of point measurements, providing very limited data, especially in the case of offshore areas. The data on shipping traffic provides information on relative ship traffic density, however the aggregated numbers of ships do not represent true values. Slow-moving ships in particular were counted repeatedly in the same area, leading to the false results. Moreover, only AIS-equipped ships were included in the data set. Similarly, the data on fish landings/catches represent cumulative values for ICES squares. These were used to calculate theoretical quantities of landings/catches for certain areas. Due to the large size of ICES squares the calculated totals may not represent the actual amount of fish extracted from a particular area. Furthermore, no management measures were considered, which may have revealed an area as a low–take or no-take zone. Overall, more precise spatial data would be needed to provide more reliable insights on the quality of the MPA networks.

The same holds true for the assessment of adequacy in terms of the protection afforded to indicator species and biotopes. While the BSPA network was assessed as inadequate because not all indicator species and biotopes were protected, a more in-depth evaluation would require information on the distribution of these species and biotopes in the Baltic Sea. Such information was provided for Charophyte species and *Zostera marina* and *Z. noltii*. It was found that adequacy in terms of protection of *Zostera* habitats was very limited for all networks. On the other hand, Charophyte species were found to be reasonably well protected.

Although spatial information was provided, each of these data sets has its limitations, and this should be kept in mind when interpreting the findings. The data were compiled from various sources covering very diverse time frames and applying different collection methods. However the most conspicuous drawback is that the data is not spatially inclusive and comprehensive. The assessment of adequacy in terms of coverage of IBAs provided the most reliable findings due to the high data quality. It was found that the combined BSPA/N2000 network was the most adequate of all assessed networks.

Although data were available and processed, adequacy in terms of the protection of grey seal habitats could not be properly assessed on the basis of the data provided.

1.4.2 Representativity

The aim of a network of MPAs is to contribute to the protection of all ecosystems in the region. It requires adequate representation in the network of the full range of species, habitats, landscapes, ecological processes and environmental gradients to be found in the region. The representation of all biogeographic regions or ecological landscapes is thereby a prerequisite for the protection of biodiversity, since species assemblages will be distinct in each region (Airamé et al. 2003, Roberts et al. 2003, Day & Roff 2000). Furthermore, the representation and protection of an adequate proportion of all broad-scale features ensures the protection of unknown biodiversity. Particularly in large target regions, where complete knowledge of all biological features, abundance and distribution of species at their different life stages is not feasible, the representative protection of all occurring landscape types is essential and the only means to ensure the protection of the entire ecosystem. The number of representations considered to be adequate therefore depends on the entire target area and the aim of protection.

Grey seals

It has been suggested that the minimum total area of each habitat set aside for protection should be related to its relative prevalence in the region, so that a similar percentage of each feature is protected. However, some features, such as very sensitive or rare habitats, and species that rely on self replenishment may need more protection than common or widespread features. Additionally, the time required for recovery of a species or habitat might play an important role in the protection of sensitive features on a broader scale. To provide guidelines and comparable principles for the adequate representation of features in a network, several authors have suggested a range of values to determine how much of a habitat or sea area should be protected. In summary, many marine studies and international conventions have suggested that ecologically functional networks of marine protected areas should cover at least 20% of each habitat in a region to secure long-term viable populations and protection of the ecosystem (reviewed in Piekänen & Korpien 2008). However, it is proposed that regionally rare, sensitive and threatened habitats and species may need a larger protection ratio.

Methodology

The assessment on representativity of the networks of MPAs in Baltic Sea is divided into three distinct analyses: representation of indicator species and biotopes, benthic marine landscape representation, and geographical representation.

The analysis of indicator species and biotopes could only be performed for the network of BSPAs, as no information was available on species and habitats in Natura 2000 areas. Assessment of the BSPA network reviewed whether all indicator species and indicator biotopes were present, based on the information given in the BSPA database.

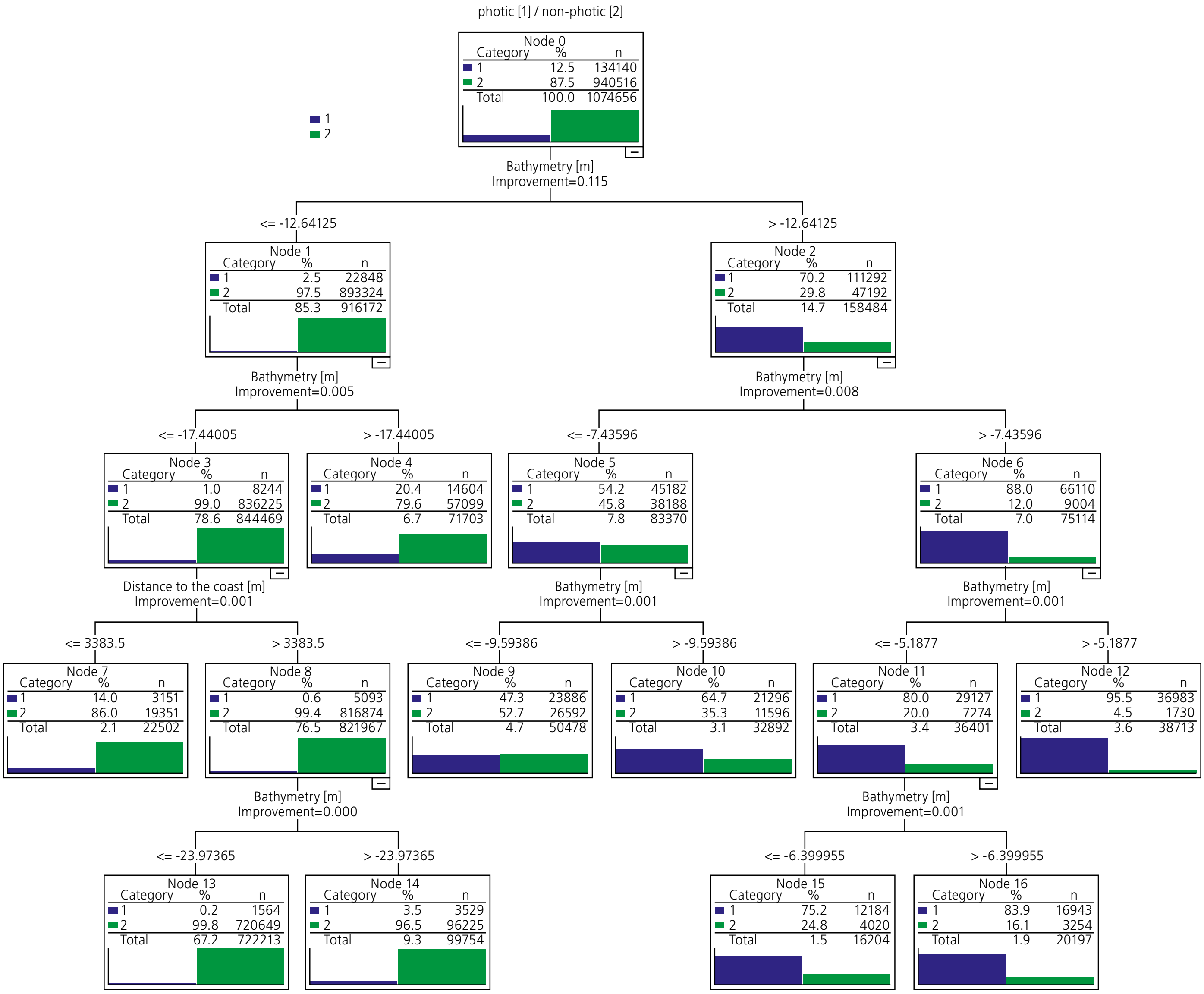

Figure 24. Decision tree for the incidence of photic/non-photic zones based on bathymetry data and the distance to the coast using Classification and Regression Trees (CART).

For the representativity analysis of benthic marine landscapes, GIS intersection methods were used to determine the area percentage of each landscape type in BSPAs, SCIs and SPAs. Following the guidelines of international conventions and aiming towards consistency with the Balance project, a three-level classification scheme for the proportionate representation of benthic marine landscapes was applied: <20% protection was considered inadequate; 20-60% protection as questionable (depending on the feature), and >60% representation as normal condition (see Piekäinen and Korpinen 2008 for a literature review on representation values).

The geographical representation of protected areas in all three networks was assessed with respect to three criteria: (1) the proportion of each country’s MPA within territorial waters (TW, including inner waters) and the exclusive economic zones (EEZ, outside territorial waters); (2) the proportion of each country’s MPA in the Baltic Sea basins, with the latter used as an additional proxy for biogeographic regions; and (3) the proportion of each country’s MPA in inshore and offshore areas. An offshore index was developed for the latter using data on the distance from the coast, bathymetry and photic level (photic or non-photic) and the

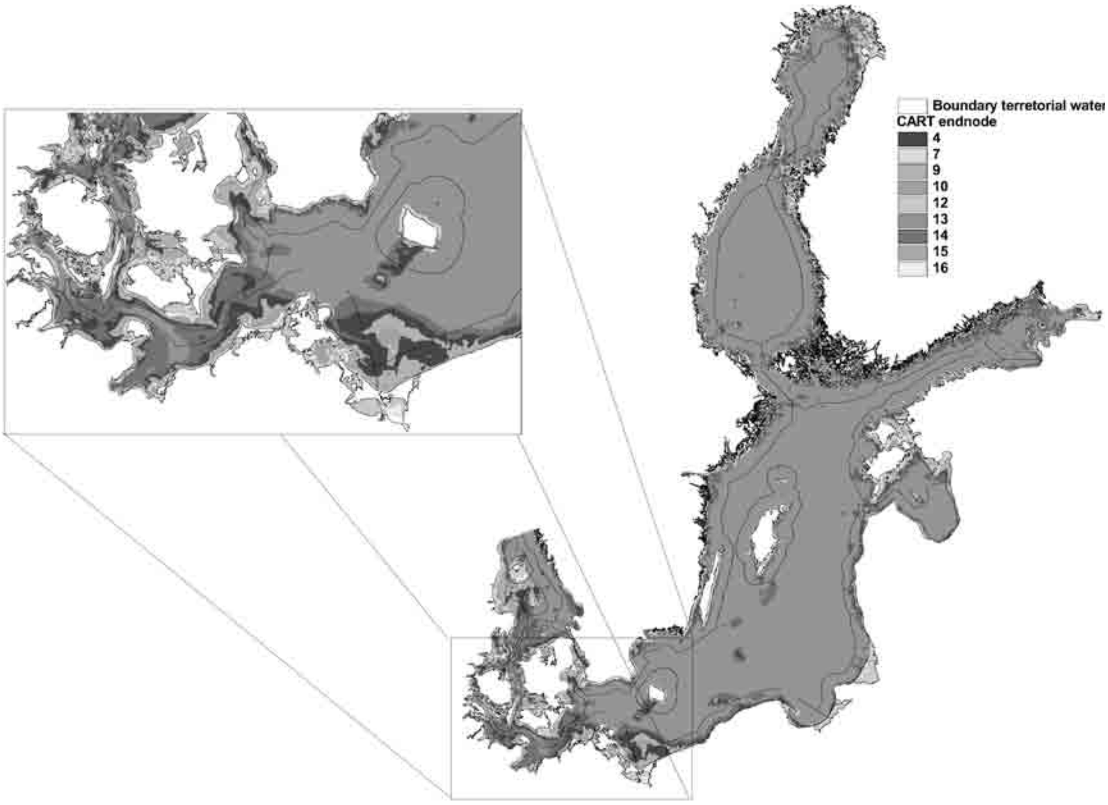

Figure 25. End nodes from the decision tree calculated for the incidence of photic/non-photic zones mapped for the entire Baltic Sea area.

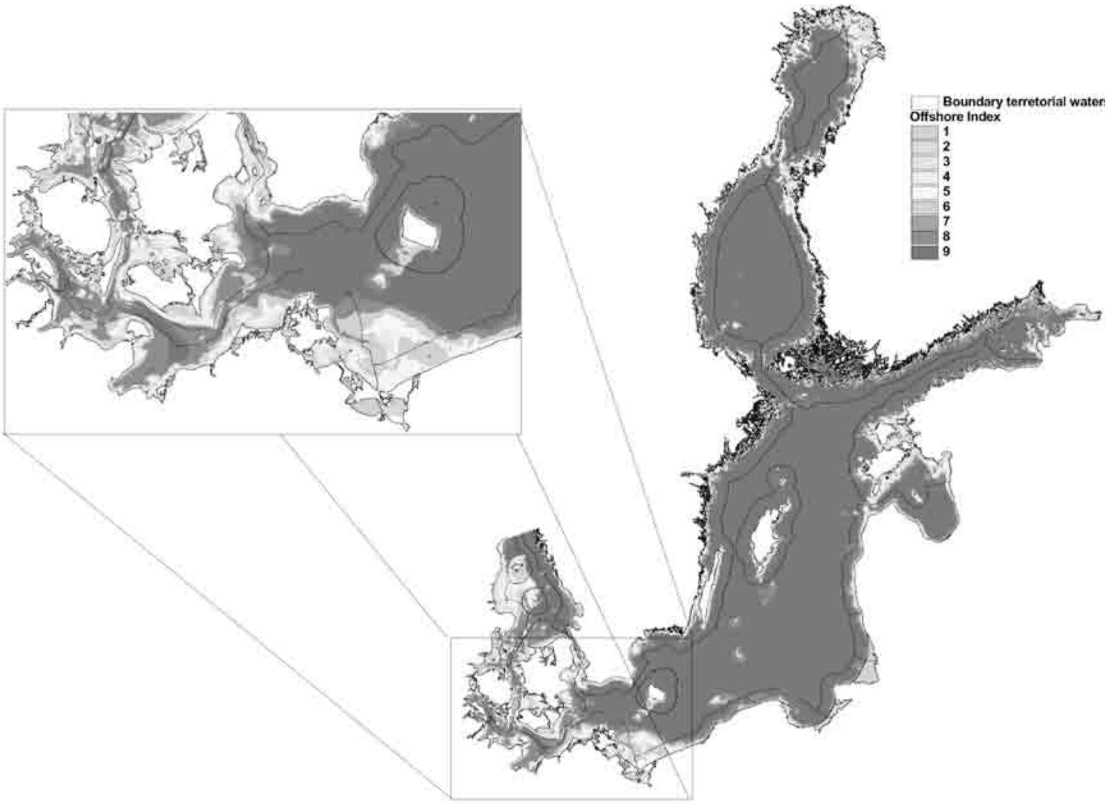

Figure 26. Spatial distribution of the offshore index in the Baltic Sea area.

decision tree algorithm Classification and Regression Trees (CART).

Offshore index. CART was applied to classify the Baltic Sea according to the statistical association between the spatial distribution of photic / non photic zones as well as bathymetry and the distance to the coast. The map of photic and non-photic zones was provided by the DHI and the International Council for the Exploration of the Sea (ICES) (resolution 200 x 200 m²).The map of bathymetry had a resolution 617.333 x 617.333 m², and the distance grid for the Baltic Sea coast was calculated from the available coastline geodata based on a distance grid (resolution 617.333 x 617.333 m²).

To calculate the offshore index all three raster data layers were first intersected and then exported into one XYZ table. CART was then applied to classify the Baltic Sea according to the statistical association between the spatial distribution of photic / non photic zones as well as bathymetry and the distance to the coast. Decision tree models such as CART are classification algorithms that partition a given data set (root node) into subclasses (sub nodes) via a series of binary splits. The terminal nodes of a decision tree are therefore called end nodes. The goal of the decision tree analysis is to compute explanation schemes for a defined target variable (in this case photic / non photic zones) from a set of meaningful predictor variables (bathymetry, distance to the coast). Splitting based on the features of the predicting variables. CART consequently chooses those predicting variables for splitting that optimise homogeneity in relation to the target variable. In case of a nominally-scaled target variable (as in this case) optimal homogeneity means that all cases in the node belong to only one category. The trees are developed until either only one object remains in the sub nodes or until user-specified restrictions are satisfied.

In terms of the analyses performed here the number of grid cells in the end nodes was restricted to 1% of all cases (10,747 grid cells). Furthermore a minimum improvement of 0.01% was set as a threshold for performing a split. The results of the CART analyses are summarised in **Figures 24-26**. **Figure 24** shows that except for one split, bathymetry was selected to subdivide the root node into sub nodes. The calculated CART tree was developed into three tree levels, resulting in a total nine end nodes. Each of these end nodes corresponded to a unique set of decision rules and could be applied to the predictor data to map the spatial distribution of end nodes in the Baltic Sea.

Table 23. Description of the offshore index based on the probability of finding photic/non-photic zones.

CART endnode	Probability (photic)	Offshore index
12	.955	1
16	.839	2
15	.752	3
10	.647	4
9	.473	5
4	.204	6
7	.140	7
14	.035	8
13	.002	9

Figure 25 shows that most of the area was classified based on end node 13, accounting for 67% of the Baltic Sea. The remaining 33% of the Baltic Sea was spatially differentiated to a high degree. This held true particularly for the German and Danish segments. The CART tree revealed that each end node could be described using the probability of having either photic or non photic conditions. The nine end nodes could therefore be transferred into an ordinal scaled index, ranging from 1 (according to end node 12 with 95.5% photic probability) to 9 (according to end node 13 with 0.2% photic probability). We define this index as an offshore index where high index values represent for high offshore conditions (**Table 23**). The final result of the CART analysis can be seen in **Figure 26**. The derived map was intersected with all MPA networks and for each MPA the median index value was calculated to characterise the offshore properties of all protected areas.

Results

Indicator species. Apart from *Zostera noltii* and *Gavia immer* all indicator species were found to be represented in the Baltic Sea wide BSPA network (**Table 24**). The same held true for the Baltic Proper basin. In the other basins, however,

Table 24. **Representation of indicator species in the Baltic Sea and basin-wide BSPA networks as reported in the HELCOM BSPA database. For information on HELCOM regions where the species are present or threatened see HELCOM 2007c. (Status: July 2009)**

Indicator species		Number of BSPAs where the species is present							
		Baltic Proper	Belt Sea	Gulf of Bothnia	Gulf of Finland	Gulf of Riga	Kat-tegat	The Sound	Baltic Sea
Algae	*Chara spp.*	4		8	6				**16**
	Fucus serratus	2							**2**
	Fucus vesiculosus	4		3	5	4			**13**
	Furcellaria lumbricalis	5		3	3	4			**12**
Vascular plant	*Zostera marina*	2		2			2		**4**
	Zostera noltii								
Fish	*Alosa fallax*	8			2		2		**10**
	Anguilla anguilla	3		2		2			**5**
	Gadus morhua	4		2					**5**
	Lampetra fluviatilis	8	2	4	2	4			**16**
	Salmo salar	8		3	4	2	2		**15**
Birds	*Gavia arctica*	10	3	12	4	4	2		**30**
	Gavia immer								
	Gavia stellata	11	3	13	4	4	2		**32**
	Mergus serrator	9	6	11	6	3	2		**32**
	Sterna albifrons	15	9	6	2	3	5	2	**36**
	Tadorna tadorna	6		11	5	3			**22**
Mammals	*Halichoerus grypus*	15		10	6		4	2	**33**
	Phoca vitulina	3	5				10	2	**17**
	Phoca hispida botnica	4		7					**10**
	Phocoena phocoena	8	7				3		**16**
Number of indicator species represented		**19**	**7**	**15**	**12**	**10**	**10**	**3**	**19**

additional indicator species were not represented. In the Gulf of Bothnia six species were not represented, in the Gulf of Finland nine, in the Gulf of Riga and the Kattegat eleven each and in the Belt Sea 14. The Sound was the basin with the smallest number of indicator species represented. Only *Sterna albifrons, Halichoerus grypus* and *Phoca vitulina* were reported in the BSPAs of this basin. Overall, the indicator species represented in the largest number of basins was *S. albifrons,* followed by three other bird species *Gavia arctica, G. stellata* and *Mergus serrator.* The species with the third highest level of representation were two fish species and the mammal *H. grypus*. The other species were represented in two to four basins, apart from *Fucus serratus*, which was reported only in the Baltic Proper. *F. serratus* was also represented only in one country (Germany), while *S. albifrons* was the only species represented in at least one BSPA for each Contracting State (**Table 25**). The Contracting State with the largest number of indicator species in its BSPAs was Lithuania, where 18 species were present. The Contracting States with the smallest numbers of indicator species were Russia and Denmark, with five indicator species each.

In summary, the bird species and *H. grypus* were most represented in the network of BSPAs, regardless of the geographical scale (countries or basins) evaluated. However is must be noted that the natural distribution and abundance of the species were not taken into account. Further, some of the defined indicator species might simply not have been native to some of the basins or marine areas of the Contracting States. Hence it was difficult to establish whether or not the given numbers of representation are adequate. Future assessments should therefore include data on the natural distribution of the indicator species considered.

Table 25. **Representation of indicator species in the BSPA networks of the Contracting States as reported in the HELCOM BSPA database. For information on HELCOM regions where the species are present or threatened see HELCOM 2007c. (Status: July 2009)**

Indicator species		**Number of BSPAs where the species is present**									
		Denmark	**Estonia**	**Finland**	**Germany**	**Latvia**	**Lithuania**	**Poland**	**Russia**	**Sweden**	**Baltic Sea**
Algae	*Chara spp.*			8			2			8	**16**
	Fucus serratus				2						**2**
	Fucus vesiculosus			6		4	2			4	**13**
	Furcellaria lumbricalis			4	2	5	2			3	**12**
Vascular plant	*Zostera marina*			2			2			2	**4**
	Zostera noltii										
Fish	*Alosa fallax*	2	2		2	2	3	3	2		**10**
	Anguilla anguilla					2	3			2	**5**
	Gadus morhua						3			3	**5**
	Lampetra fluviatilis		3	3	2	4	4	4		2	**16**
	Salmo salar		2	4		2	4	4		4	**15**
Birds	*Gavia arctica*			10	4	5	4	3	2	8	**30**
	Gavia immer										
	Gavia stellata		2	12	4	5	4	4	2	6	**32**
	Mergus serrator	2	4	13	5	3	5	3		4	**32**
	Sterna albifrons	8	4	5	5	3	5	5	2	7	**36**
	Tadorna tadorna			14		3	5	2		2	**22**
Mammals	*Halichoerus grypus*	5	5	10	2		3	5	2	8	**33**
	Phoca vitulina	10			2		2			6	**17**
	Phoca hispida botnica		3	6			2			2	**10**
	Phocoena phocoena				8		2	4		5	**16**
Number of indicator species represented		**5**	**8**	**13**	**11**	**11**	**18**	**10**	**5**	**17**	**19**

Table 26. **Representation of indicator biotopes in the Baltic Sea and basin-wide BSPA networks as reported in the HELCOM BSPA database. For more information on indicator biotopes including their occurrence in HELCOM regions see HELCOM 2007c. (Status: July 2009)**

Indicator biotope	**Number of BSPAs where the biotope present**							
	Baltic Proper	**Belt Sea**	**Gulf of Bothnia**	**Gulf of Finland**	**Gulf of Riga**	**Kattegat**	**The Sound**	**Baltic Sea**
Bubbling reefs						8		**8**
Estuaries	8		5	4	3	4	2	**21**
Lagoons	17	10	19	6	3	6	2	**57**
Macrophytes	4		2	2				**6**
Reefs	17	15	10	7	3	13	2	**61**
Sandbanks	16	13	11	6	3	11	3	**57**
Shallow inlets & bays	11	9	8	3		2		**29**
Indicator biotopes represented	**6**	**4**	**6**	**6**	**4**	**6**	**4**	**7**

Indicator biotopes. The assessment of representation of indicator biotopes revealed that they were all present across the entire BSPA network (**Table 26**). The indicator biotope present in the smallest number of basins were 'Bubbling reefs' (present in the Kattegat only) and 'Macrophytes' (present in the Baltic Proper, the Gulf of Bothnia and the Gulf of Finland). These two biotopes were also present in the smallest number of countries (**Table 27**). 'Shallow inlets & bays' were present in five basins and the remaining four biotopes occurred in all basins. The latter also held true for 'Lagoons' and 'Sandbanks' in the marine areas of the Contracting States. 'Reefs' and 'Estuaries' were only absent in one and two countries, respectively.

Overall, none of the basin-wide BSPA networks or individual BSPA networks of the Contracting States (except for Sweden) represented all indicator biotopes. As for the indicator species, it must be noted that the natural distribution of the biotopes was not taken into account. Some of the defined indicator biotopes might simply not have been present in particular basins or marine areas of the Contracting States. It was therefore difficult to establish whether or not the given numbers of representation were adequate.

Benthic marine landscape representation. **Table 28** shows that almost all landscape types in the Baltic Sea were represented in the analysed networks of protected areas. Only three landscape types were not represented in the BSPA network and one each in the SCI, SPA, and BSPA/N2000 networks. However, most of the landscapes were found to be inadequately represented, accounting for less than 20% of the total area of MPAs. Just three landscape types in the SCI and BSPA/N2000 networks and two in the SPA network were considered to be represented at normal levels (**Table 27** and **Figures 27**).

Table 27. Representation of indicator biotopes in the BSPA networks of the Contracting States as reported in the HELCOM BSPA database. For more information on indicator biotopes including their occurrence in HELCOM regions see HELCOM 2007c. (Status: July 2009)

Indicator biotope	Number of BSPAs where the biotope present								
	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Bubbling reefs	7								2
Estuaries	2	2	7		3	2	5		6
Lagoons	9	5	18	6	3	3	5	2	14
Macrophytes			2	2			2		3
Reefs	16	5	11	11	4	2	2		17
Sandbanks	12	5	11	10	3	2	5	2	15
Shallow inlets & bays	6	5	5	5			5	2	7
Indicator biotopes represented	**6**	**5**	**6**	**5**	**4**	**4**	**6**	**3**	**7**

Table 28. Baltic Sea -wide benthic marine landscape representation. Number of marine landscape types not represented, inadequately represented, questionable and represented at normal condition in the BSPA, SCI, SPA and BSPA/N2000 networks. (Status: July 2009)

	Representation: number of landscape types			
	not represented (0%)	inadequate (<20%)	questionable (20-60%)	normal (>60%)
BSPA	3	45	12	0
SCI	1	40	16	3
SPA	1	42	15	2
BSPA/N2000	1	37	19	3

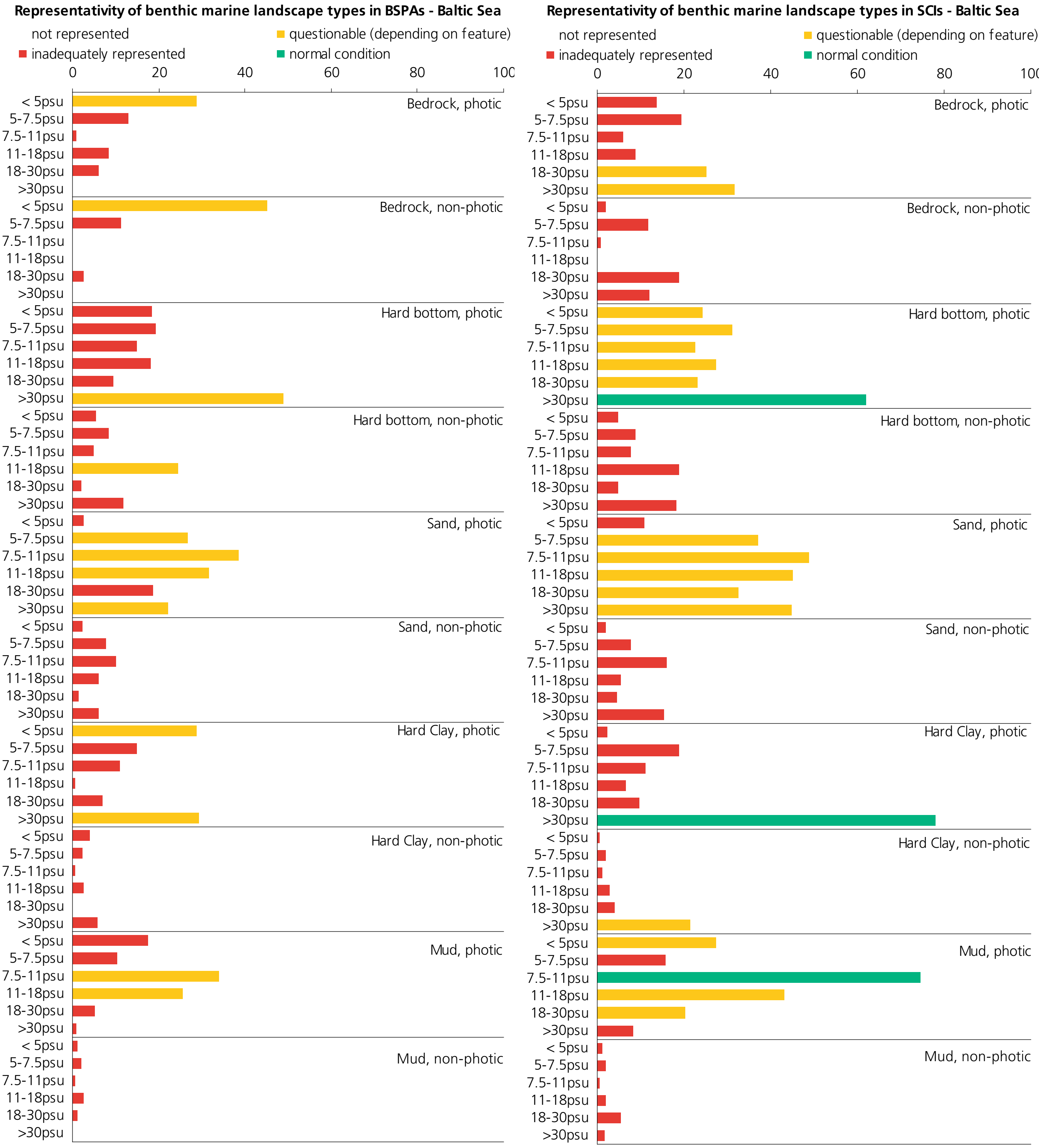

Figure 27. Benthic marine landscape representation in BSPAs, SCIs and SPAs. The table shows the percentage of each landscape type present in BSPAs, SCIs and SPAs. The categories were defined as follows: normal condition >60%, questionable 20-60%, inadequate <20% and not represented 0%. Continues.

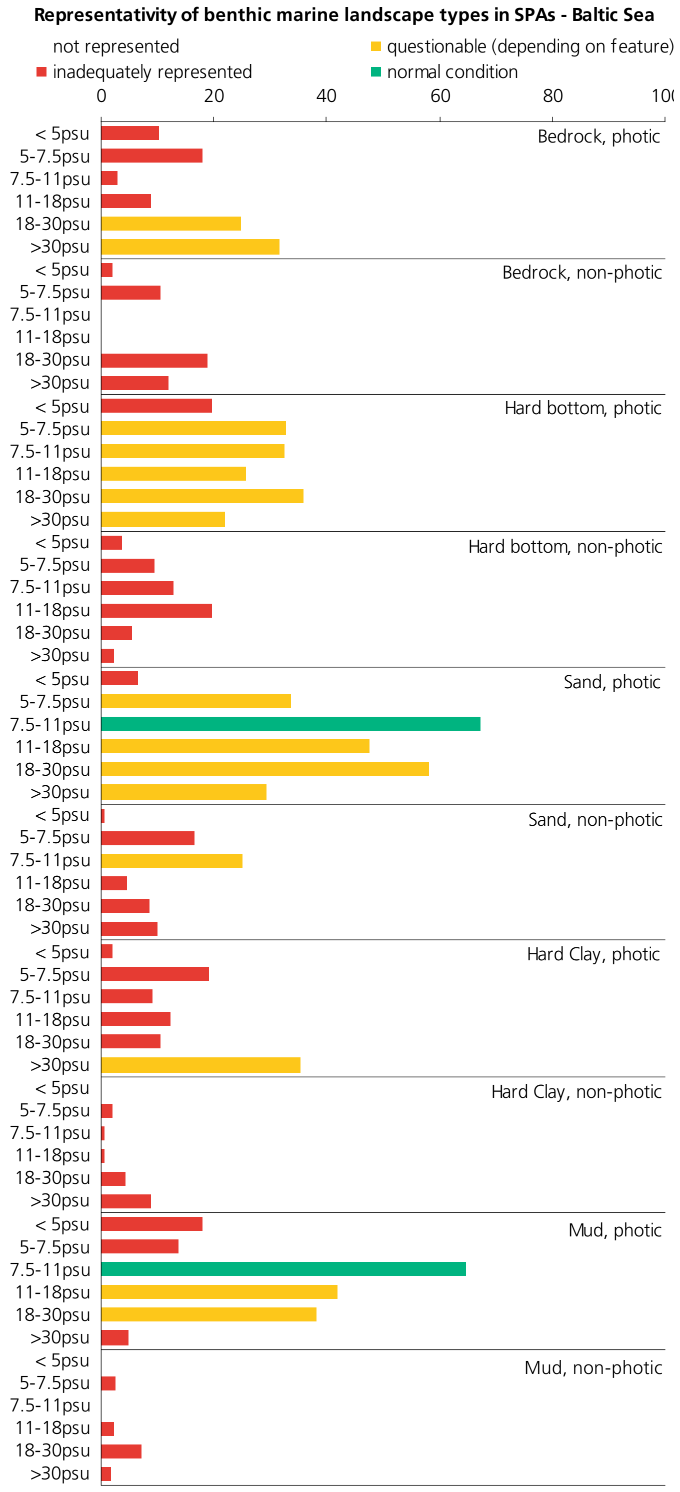
Representativity of benthic marine landscape types in SPAs - Baltic Sea

Figure 27. Continued.

Individual analysis of the basin-wide networks reveals certain similarities. Several landscape types present in the Baltic Proper, Gulf of Finland, Gulf of Riga, Kattegat and the Sound were not represented in the respective MPA networks (**Figure 28a, Table 29**). The majority of the landscapes represented in all basin wide-networks was inadequately represented. Only the Belt Sea possessed most landscape types represented at rates exceeding 20-60%, and the Gulf of Riga even at normal condition presented rates above 60%. We can therefore conclude that only the Gulf of Riga had a majority of its landscape types adequately represented. This was not the case for any of the networks in the marine areas of the Contracting States, although Germany held about one third of the landscape types represented at a normal condition (**Figure 28b, Table 30**).

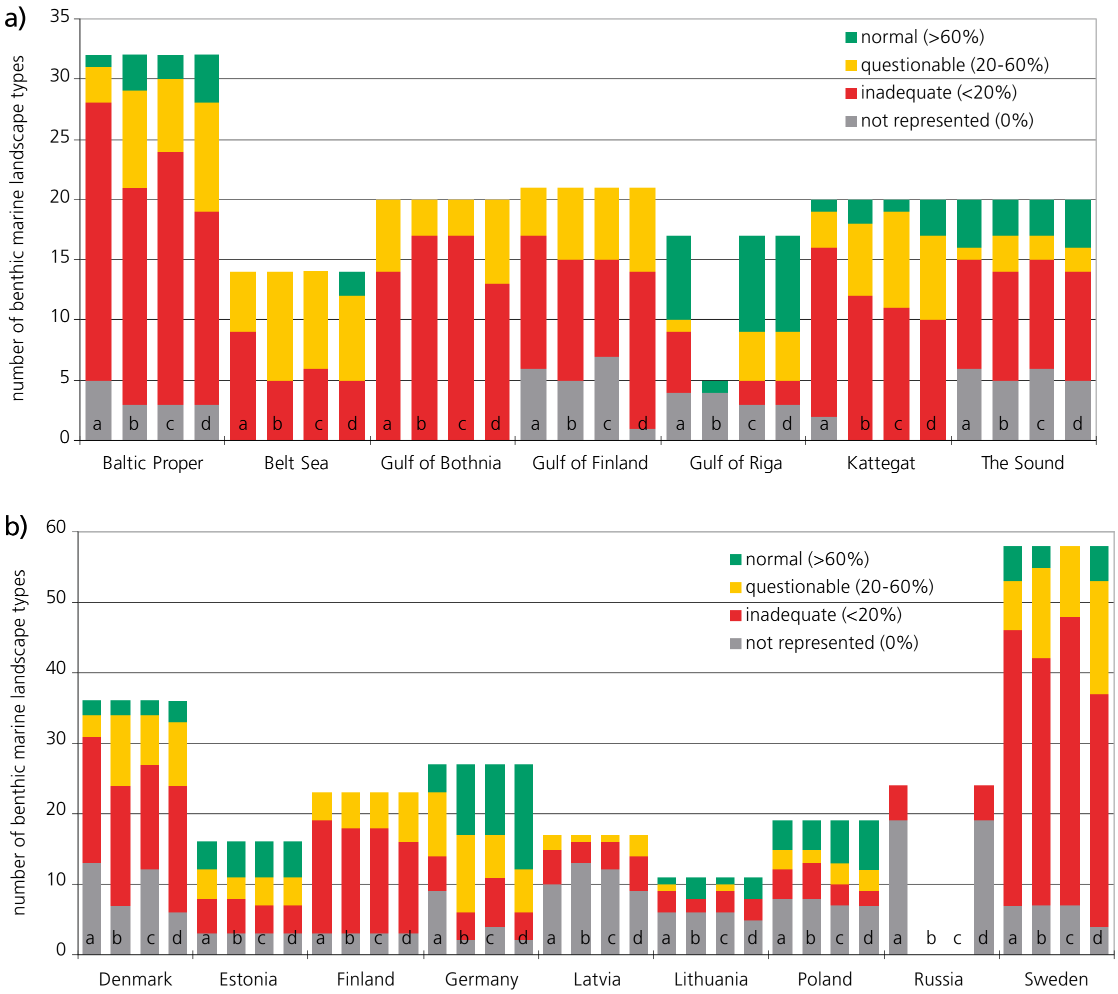

Figure 28. Benthic marine landscape representation in the BSPA [a], SCI [b], SPA [c] and BSPA/N2000 [d] networks of each a) basin and b) Contracting State.

Table 29. Benthic marine landscape representation in the MPA networks per Baltic Sea basins. Number of marine landscape types not represented, inadequately represented, questionable and represented at normal condition in the BSPA, SCI, SPA and BSPA/N2000 networks. (Status: July 2009)

	Representation: number of landscape types															
	not represented (0%)				inadequate (<20%)				questionable (20-60%)				normal (>60%)			
	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000
Baltic Proper	5	3	3	3	23	18	21	16	3	8	6	9	1	3	2	4
Belt Sea					9	5	6	5	5	9	8	7				2
Gulf of Bothnia					14	17	17	13	6	3	3	7				
Gulf of Finland	6	5	7	1	11	10	8	13	4	6	6	7				
Gulf of Riga	4	4	3	3	5		2	2	1		4	4	7	1	8	8
Kattegat	2				14	12	11	10	3	6	8	7	1	2	1	3
The Sound	6	5	6	5	9	9	9	9	1	3	2	2	4	3	3	4

Table 30. **Benthic marine landscape representation in the MPA networks per Contracting States. Number of marine landscape types not represented, inadequately represented, questionable and represented at normal condition in the BSPA, SCI, SPA and BSPA/N2000 networks. (Status: July 2009)**

	Representation: number of landscape types															
	not represented (0%)				inadequate (<20%)				questionable (20-60%)				normal (>60%)			
	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000
Denmark	13	7	12	6	18	17	15	18	3	10	7	9	2	2	2	3
Estonia	3	3	3	3	5	5	4	4	4	3	4	4	4	5	5	5
Finland	3	3	3	3	16	15	15	13	4	5	5	7				
Germany	9	2	4	2	5	4	7	4	9	11	6	6	4	10	10	15
Latvia	10	13	12	9	5	3	4	5	2	1	1	3				
Lithuania	6	6	6	5	3	2	3	3	1		1		1	3	1	3
Poland	8	8	7	7	4	5	3	2	3	2	3	3	4	4	6	7
Russia	19	n/a	n/a	19	5	n/a	n/a	5		n/a	n/a			n/a	n/a	
Sweden	7	7	7	4	39	35	41	33	7	13	10	16	5	3		5

Table 31a. **Geographical distribution of MPAs in the TW and EEZ areas of the basins and the Baltic Sea. The percentage distribution of each MPA network in the TW and EEZ within the identified zone is given. (Status: July 2009)**

	% of total MPA							
	BSPA		BSPA/N2000		SCI		SPA	
	TW	EEZ	TW	EEZ	TW	EEZ	TW	EEZ
Baltic Proper	62	38	69	31	66	34	63	37
Belt Sea	88	12	93	7	92	8	100	
Gulf of Bothnian	100		96	4	95	5	100	
Gulf of Finland	100		98	2	100		100	
Gulf of Riga	100		100		100		100	
Kattegat	85	15	84	16	82	18	88	12
The Sound	100		100		100		100	
Baltic Sea	**84**	**16**	**84**	**16**	**83**	**17**	**83**	**17**

Table 31b. **Geographical distribution of MPAs in the TW and EEZ areas of the basins and the Baltic Sea. The protected marine area of each basin separated into TW and EEZ is provided as an area (km²) and percentage of the total protected area. The use of data sets from various resources may have resulted in inconsistencies in administrative borders and MPA geometries, causing slight deviations in the areas calculated. (Status: July 2009)**

	Protected marine area [km^2] (% of marine area protected)											
	BSPA						SCI					
	TW		EEZ		Total		TW		EEZ		Total	
Baltic Proper	5 270	(6.1)	3 285	(2.7)	8 554	(4.1)	8 448	(9.8)	4 261	(3.5)	12 710	(6.1)
Belt Sea	2 571	(15.5)	359	(18.5)	2 929	(15.8)	4 083	(24.7)	372	(19.2)	4 455	(24.1)
Gulf of Bothnian	5 086	(7.3)	0	(0)	5 086	(4.4)	4 942	(7.1)	251	(0.6)	5 194	(4.5)
Gulf of Finland	2 625	(10.0)	2	(0.1)	2 627	(8.9)	3 006	(11.5)	1	(0)	3 006	(10.2)
Gulf of Riga	2 604	(13.9)	0	(0)	2 604	(13.9)	2 767	(14.7)	0	(0)	2 767	(14.7)
Kattegat	1 570	(9.1)	276	(4.7)	1 845	(7.9)	2 184	(12.6)	470	(8.0)	2 654	(11.4)
The Sound	319	(14.1)	0	(0)	319	(14.0)	374	(16.6)	0	(0)	374	(16.4)
Baltic Sea	**20 046**	**(8.5)**	**3 921**	**(2.2)**	**23 967**	**(5.8)**	**25 870**	**(10.9)**	**5 355**	**(3.0)**	**31 225**	**(7.5)**

Geographical distribution. The geographical distribution of BSPAs and Natura 2000 sites with respect to number of sites and location in each Contracting State is discussed in detail in Chapter 1.3. As such it will only be referred to in terms of the distribution of protected areas in the TW and the EEZ as well as in relation to the offshore index.

Baltic Sea -wide it was found that more than 80% of each network was located within the TW zone (**Table 31a**). A similar situation emerged on investigation of the basin-wide networks. The location of protected areas in the Baltic Proper was found to be more evenly distributed among the TW and EEZ, although skewed in favour of the TW, where more the 60% of each network was located. In the Gulf of Riga and The Sound all networks were located entirely within the TW, and it should be noted that only a very small proportion of these basins make up the EEZ. The same could be said of the Gulf Finland, where only 2% of the combined BSPA/N2000 network was located within the EEZ - all other networks had less than 1% in the EEZ. In contrast to the Gulf of Riga and The Sound, however, a larger total area resided in the EEZ. The EEZs in the Belt Sea, the Gulf of Bothnia and the Kattegat were also very weakly protected. For more details on the geographical distribution of MPA networks in the basins see **Table 31b**.

Overall, the same could be deduced for the marine areas of the Contracting States. Apart from the


Waves at Bothnian Bay National Park

Table 31b. Continued.

	Protected marine area [km^2] (% of marine area protected)											
	SPA						BSPA/N2000					
	TW		EEZ		Total		TW		EEZ		Total	
Baltic Proper	10 026	(11.6)	5 847	(4.8)	15 873	(7.7)	13 552	(15.7)	5 980	(4.9)	19 532	(9.4)
Belt Sea	4 388	(26.5)	1	(0.1)	4 389	(23.7)	4 737	(28.6)	372	(19.2)	5 108	(27.6)
Gulf of Bothnian	4 148	(5.9)	0	(0)	4 148	(3.6)	7 122	(10.2)	263	(0.6)	7 385	(6.5)
Gulf of Finland	2 956	(11.3)	1	(0.0)	2 956	(10.0)	3 969	(15.2)	74	(2.2)	4 043	(13.7)
Gulf of Riga	5 162	(27.5)	0.2	(8.0)	5 162	(27.5)	5 500	(29.3)	0.2	(8.0)	5 500	(29.3)
Kattegat	3 950	(22.8)	545	(9.2)	4 495	(19.4)	4 334	(25.0)	839	(14.2)	5 173	(22.3)
The Sound	352	(15.6)	0	(0)	352	(15.4)	393	(17.4)	0	(0)	393	(17.2)
Baltic Sea	**31 044**	**(13.1)**	**6 395**	**(3.6)**	**37 439**	**(9.0)**	**39 609**	**(16.7)**	**7 533**	**(4.3)**	**47 142**	**(11.4)**

Table 32a. Geographical distribution of MPAs in the TW and EEZ areas of the Contracting States. The table shows the percentage of each MPA network located in the TW and EEZ. (Status: July 2009)

	% of total MPA							
	BSPA		BSPA/N2000		SCI		SPA	
	TW	EEZ	TW	EEZ	TW	EEZ	TW	EEZ
Denmark	99	1	94	6	98	2	95	5
Estonia	100		99	1	100		99	1
Finland	100		99	1	100		100	
Germany	46	54	60	40	61	39	60	40
Latvia	97	3	98	2	100		100	
Lithuania	100		100		100		100	
Poland	100		77	23	61	39	77	23
Russia	100		100		n/a		n/a	
Sweden	75	25	70	30	69	31	48	52

Table 32b. Geographical distribution of MPAs in the TW and EEZ areas of Contracting States. The protected marine portion of each Contracting States' marine area separated into TW and EEZ is provided as an area (km²) and percentage of the total protected area. (Status: July 2009)

	Protected marine area [km²] (% of marine area protected)											
	BSPA						SCI					
	TW		EEZ		Total		TW		EEZ		Total	
Denmark	2 633	(8.2)	26	(0.2)	2 659	(5.9)	5 252	(16.3)	118	(0.9)	5 370	(11.8)
Estonia	2 777	(11.2)	0	(0.0)	2 777	(7.6)	3 678	(14.9)	0	(0.0)	3 678	(10.1)
Finland	5 509	(10.6)	2	(0.0)	5 512	(6.8)	6 360	(12.3)	1	(0.0)	6 360	(7.9)
Germany	2 092	(19.4)	2 469	(54.5)	4 561	(29.7)	2 768	(25.6)	1 801	(39.8)	4 569	(29.8)
Latvia	840	(6.7)	24	(0.1)	863	(3.0)	559	(4.4)	0	(0.0)	559	(1.9)
Lithuania	363	(15.9)	0	(0)	363	(5.6)	685	(30.1)	2	(0)	686	(10.5)
Poland	1 299	(12.9)	0	(0)	1 299	(4.4)	2 649	(26.3)	1 668	(9)	4 318	(14.6)
Russia	246	(1.5)	0	(0)	246	(1.0)	n/a		n/a		n/a	
Sweden	4 287	(5.6)	1 400	(2.0)	5 687	(3.9)	3 919	(5.2)	1 766	(2.5)	5 685	(3.9)
Baltic Sea	**20 046**	**(8.5)**	**3 921**	**(2.2)**	**23 967**	**(5.8)**	**25 870**	**(10.9)**	**5 355**	**(3.0)**	**31 225**	**(7.5)**

networks in Germany, Sweden and the SCI, SPA and BSPA/N2000 networks in Poland, protection was strongly skewed in favour of the TW. Estonia, Finland, Lithuania and Russia all positioned their BSPAs and Natura 2000 sites within their TW (**Table 32a**). For more details on the geographical distribution of the MPA networks in the Contracting States see **Table 32b**.

By and large, it was found that all networks needed to be expanded by situating sites in the EEZ to ensure adequate geographical representation.

The application of an offshore index to analyse the geographical representation of the networks of protected areas revealed an analogously strong imbalance. Very few sites of the SCI and SPA networks were found to have a high offshore index, indicating that only a very small fraction of these networks was located in areas with high offshore-conditions (**Figure 29, Table 33**). More than half of all SCIs and SPAs exhibited an average offshore index of three or less. The geographical representation of the BSPA network was better, with 20% of all sites having an offshore index of one, while 6 to 15% of sites registered offshore indices ranging between two and nine. Basin-wide the best overall geographical representation was found for the Baltic Proper and The Gulf of Bothnia, and country-wise in the marine area of Sweden (**Tables 34** and **35**).

Conclusion

The assessment of representativity in Baltic Sea MPA networks revealed that full representation of all indicator species and biotopes in the BSPA network was not provided. However, in terms of the assessment of adequacy, it should be borne in mind that the natural distribution of the species and biotopes was taken into account. It was therefore difficult to determine whether or not the representation of the species and biotopes in the network was adequate. The analysis of benthic marine landscape representativity revealed that most landscapes were inadequately represented with less than 20% of the total area lying within MPAs. Threshold values for landscape representativity were derived from the Habitats Directive laid down by Boillot et al. (1997), and offered a numerical mechanism for evaluating sufficient or insufficient levels of representation for landscapes. However, the appropriate level of habitat protection is rather habitat-specific and depends on the degree of endangerment and the protection objective. For example, protection of a highly mobile species requires conservation of a larger area of their habitat (Roberts and Hawkins 2000).

With respect to the geographical distribution of MPAs it was found that more than 80% of each network was located in the TW zone, resulting in severe under-representation in the EEZ. Only the German and Swedish networks as well as the SCI, SPA and BSPA/N2000 networks in Poland protect an adequate amount of their EEZ area. More and better available information for this area could explain the bias towards MPAs in the TW. Furthermore, the Baltic Sea probably holds a larger

Table 32b. Continued.

	Protected marine area [km^2] (% of marine area protected)											
	SPA						BSPA/N2000					
	TW		EEZ		Total		TW		EEZ		Total	
Denmark	6 899	(21.4)	368	(2.8)	7 267	(16.0)	7 486	(23.2)	487	(3.7)	7 973	(17.6)
Estonia	6 399	(25.9)	43	(0.4)	6 442	(17.7)	6 490	(26.2)	43	(0.4)	6 533	(18.0)
Finland	6 295	(12.2)	1	(0.0)	6 295	(7.8)	7 030	(13.6)	86	(0.3)	7 115	(8.8)
Germany	2 956	(27.4)	2 005	(44.3)	4 961	(32.4)	3 749	(34.7)	2 471	(54.6)	6 220	(40.6)
Latvia	519	(4.1)	0	(0.0)	519	(1.8)	1 148	(9.1)	24	(0.1)	1 171	(4.1)
Lithuania	366	(16.1)	0	(0)	366	(5.6)	691	(30.4)	2	(0)	693	(10.6)
Poland	5 477	(54.4)	1 668	(9)	7 145	(24.2)	5 692	(56.5)	1 668	(9)	7 360	(24.9)
Russia	n/a		n/a		n/a		994	(6.0)	0	(0)	994	(4.2)
Sweden	2 134	(2.8)	2 310	(3.2)	4 444	(3.0)	6 331	(8.3)	2 753	(3.9)	9 084	(6.2)
Baltic Sea	**31 044**	**(13.1)**	**6 395**	**(3.6)**	**37 439**	**(9.0)**	**39 609**	**(16.7)**	**7 533**	**(4.3)**	**47 142**	**(11.4)**

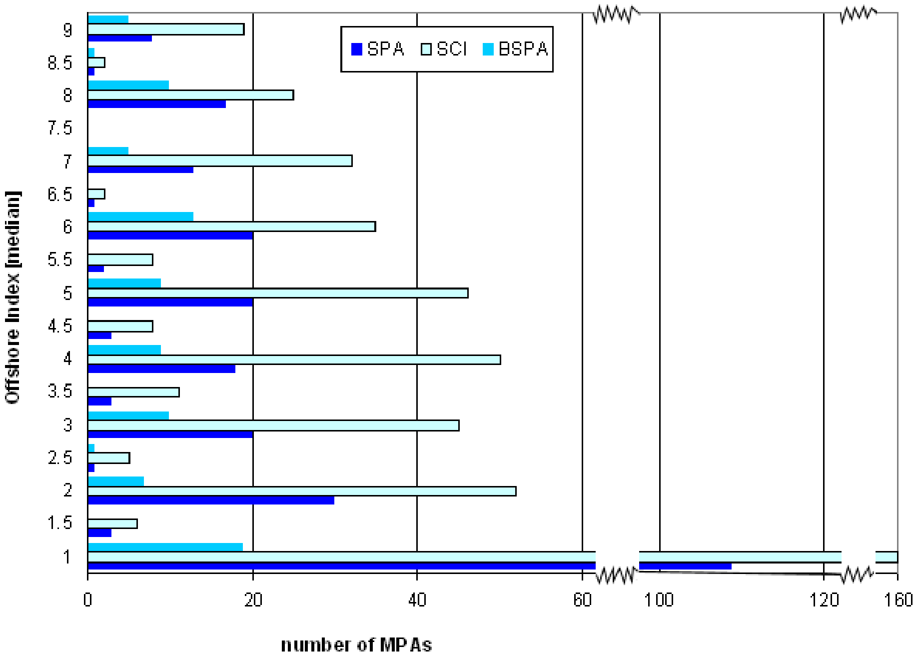

Figure 29. Number of MPAs with a calculated median Offshore Index in the Baltic Sea.

variety of species and biotopes in the TW, which are in greater need of protection than those in the EEZ. The most important biotopes in the EEZ are located in shallow areas, while MPAs have mostly been established to protect marine mammals such harbour porpoises. The application of an offshore index to analyse the geographical representation of the networks of protected areas revealed an analogously strong imbalance. Very few MPAs were found to have a high offshore index indicating that only a very small fraction of the networks was located in areas with high offshore conditions.

Table 33. **Offshore indices and the number of MPAs (calculated median) in the Baltic Sea. The percentage of the total number of MPAs at a given offshore index is provided in parentheses. The percentage of Baltic Sea area for each integral index is also shown. As no individual sites were distinguished for the combined BSPA/N2000 network, the numbers of grid cells (617.3 x 617.3 m) of a given offshore index within the network as well as the percentage of the total number of grid cells coinciding with the network are indicated. (Status: July 2009)**

OI (offshore index)	% of total Baltic Sea area	number of MPAs at OI (% of total no. of MPAs)							
		BSPAs		SCIs		SPAs		BSPA/N2000	
1	10%	19	(21%)	160	(32%)	109	(41%)	23393	(19%)
1.5				6	(1%)	3	(1%)		
2	2%	7	(8%)	52	(10%)	30	(11%)	8808	(7%)
2.5		1	(1%)	5	(1%)	1	(0%)		
3	2%	10	(11%)	45	(9%)	20	(7%)	6936	(6%)
3.5				11	(2%)	3	(1%)		
4	6%	9	(10%)	50	(10%)	18	(7%)	12301	(10%)
4.5				8	(2%)	3	(1%)		
5	12%	9	(10%)	46	(9%)	20	(7%)	15813	(13%)
5.5				8	(2%)	2	(1%)		
6	21%	13	(15%)	35	(7%)	20	(7%)	18213	(15%)
6.5				2	(0%)	1	(0%)		
7	1%	5	(6%)	32	(6%)	13	(5%)	3613	(3%)
7.5									
8	23%	10	(11%)	25	(5%)	17	(6%)	17800	(15%)
8.5		1	(1%)	2	(0%)	1	(0%)		
9	22%	5	(6%)	19	(4%)	8	(3%)	14458	(12%)

Table 34. **Offshore indices and the number of MPAs (calculated median) in each basin. (Status: July 2009)**

OI (off-shore index)	Number of MPAs at OI																				
	Baltic Proper			Belt Sea			Gulf of Bothnian			Gulf of Finland			Gulf of Riga			Kattegat			The Sound		
	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA
1	8	66	39	2	15	9	4	40	33	1	5	6	1	18	9	3	12	9	2	9	5
1.5		1	1					3	1					1	1		1				
2		11	11	2	7	3	3	28	10			1	1	4	2	2	2	4			
2.5		2		1	1	1		1									1				
3	1	11	5	1	5	4	6	27	10		1		2	2	1						
3.5		5	2		2			4	1												
4	3	23	8	1	5	3	4	16	3		1			1	1	1	5	4	1	1	1
4.5		3	1					3	1		2	1									
5	5	20	7	4	7	6		8	4		5	2					4	1			
5.5		2	1					5	1								1				
6	5	19	10	1	3	1	2	10	5	3	4	3			1	2	4	2			
6.5								2	1												
7	1	9	5		1		2	18	5	2	2	2				1	2	1	1	1	1
7.5																					
8	5	7	6	2	2		1	9	7	2	3	4				2	4	1			
8.5		1	1													1	1				
9	3	9	4	1	1			5	2		2					1	5	2			

Table 35. Offshore indices and the number of MPAs (calculated median) in each Contracting States' marine area. (Status: July 2009)

Off-shore index	Number of MPAs [median]														
	Denmark			Estonia			Finland			Germany			Latvia		
	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA
1	4	21	16	2	23	14	5	35	36	3	16	5		3	2
1.5		1			1	1		2	1						
2	3	4	5		3	2	3	10	6		4	1	1	2	1
2.5		2								1		1			
3	1	1	3	1	2		5	7	5		4	1	2	2	1
3.5		2						1						1	1
4	1	5	4		2	1	1	5	1		3				
4.5					2	1		2	1						
5	1	9	3		3	3		7	1	3	3	3			
5.5		1						2							
6	1	6	1	1	2	2	2	5	4	2		2			
6.5								1	1						
7	1	2			1	1	3	15	5						
7.5															
8	2	3				1	3	12	10	2	3		1	1	1
8.5															
9	2	3	1		1			2	1	1	2				

Table 35. Continued.

Off-shore index	Number of MPAs [median]											
	Lithuania			Poland			Russia			Sweden		
	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA	BSPA	SCI	SPA
1	1	5	3	1	5	5	1	n/a	n/a	2	52	28
1.5								n/a	n/a		2	1
2					1	2		n/a	n/a		28	13
2.5								n/a	n/a		3	
3								n/a	n/a	1	29	10
3.5								n/a	n/a		7	2
4	1			1	1			n/a	n/a	5	34	12
4.5								n/a	n/a		4	1
5		1	1	1			1	n/a	n/a	3	22	8
5.5								n/a	n/a		5	2
6	2	1	1	1	2	2		n/a	n/a	4	19	8
6.5								n/a	n/a		1	
7		1						n/a	n/a	1	13	7
7.5								n/a	n/a			
8					1	2		n/a	n/a	2	5	3
8.5								n/a	n/a	1	2	1
9								n/a	n/a	2	11	6

1.4.3 Replication

To ensure the natural variation of all features within species or habitats and landscape types, and to minimise the effects of damaging events and long-term changes, adequate replication of all protected features is needed. Replication enhances the resilience of ecosystems, increases representation and connectivity by adding to the number of possible connections between sites (see Chapter 1.4.4). Replication can thus be considered to be an insurance factor for a sustainable long-term ecologically-coherent network of MPAs. An appropriate number of replicates should be determined on a case-by-case basis and depends on the features addressed. The same holds true for an appropriate size of replicates, which in turn depends on the requirements of the habitat or species assessed.

A network may be studied in terms of between-site and in-site replication, with the latter examining the number of replicates of a certain feature found in a single MPA. Between-site replication provides information on entire networks, such as how many areas exhibit a certain feature, independent of the number of features in each area. A feature that is present twice has a replication number of one, a feature that is present three times has a replication number of two, and so on.

Methodology

Since it was not possible to assess the replication of all features within the network of MPAs in the course of this project, analysis focused on the replication of indicator species and biotopes, as well as benthic marine landscape types. Furthermore, it was not feasible assess the requirements of each species or habitat on a case-by-case basis to determine adequate size and quantity of replications. Therefore a theoretical minimum of adequate replicates was set at three. The minimum size for a landscape patch to be considered a replicate was agreed at 24 ha (Piekäinen and Korpinen 2008).

The replication of indicator species and biotopes was assessed on behalf of existing features only as listed in the BSPA database. The quantity of replicates was thereby provided for three geographical scales: the Baltic Sea, the Baltic Sea basins and the marine areas of the Contracting States. It is important to note that eight BSPAs did not provide information on protected or existing species, while, three BSPAs provided no information on habitats,

Black carrageen (*Furcellaria lumbricalis*)

Table 36. Between-site replication of indicator species in the BSPA network of the basins and the Baltic Sea. The table shows the number of BSPAs in which an indicator species is protected as well as the number of Basins where replication was found to be adequate. A minimum of three replicates is considered adequate. (Status: July 2009)

Indicator species		No. of BSPAs where present or protected							No. of basins where adequately replicated	Baltic Sea wide replication
		Baltic Proper	Belt Sea	Gulf of Bothnia	Gulf of Finland	Gulf of Riga	Kat-tegat	The Sound		
Algae	*Chara* spp.	3		7	5				**3**	**15**
	Fucus serratus	1								**1**
	Fucus vesiculosus	3		2	4	3			**3**	**12**
	Furcellaria lumbricalis	4		2	2	3			**2**	**11**
Vascular plant	*Zostera marina*	1		1			1			**3**
	Zostera noltii									
Fish	*Alosa fallax*	7			1		1		**1**	**9**
	Anguilla anguilla	2		1		1				**4**
	Gadus morhua	3		1					**1**	**4**
	Lampetra fluviatilis	7	1	3	1	3			**3**	**15**
	Salmo salar	7		2	3	1	1		**2**	**14**
Birds	*Gavia arctica*	9	2	11	3	3	1		**4**	**29**
	Gavia immer									
	Gavia stellata	10	2	12	3	3	1		**4**	**31**
	Mergus serrator	8	5	10	5	2	1		**4**	**31**
	Sterna albifrons	14	8	5	1	2	4	1	**4**	**35**
	Tadorna tadorna	5		10	4	2			**3**	**21**
Mammals	*Halichoerus grypus*	14		9	5		3	1	**4**	**32**
	Phoca vitulina	2	4				9	1	**2**	**16**
	Phoca hispida botnica	3		6					**2**	**9**
	Phocoena phocoena	7	6				2		**2**	**15**
Number of indicator species adequately replicated		**15**	**4**	**9**	**8**	**5**	**3**			**18**

25 had no information on biotopes and 78 offered no details on biotope complexes.

The replication of landscape types was assessed for the BSPA network, the SCI and SPA networks and the combined BSPA/N2000 network. In terms of indicator species and biotopes, between-site replication of landscape types was determined at the three geographical scales mentioned above. Within-site replication was assessed on a Baltic Sea -wide scale only.

Results

Indicator species. Baltic Sea -wide, between-site replication of indicator species in the BSPA network varies widely. While some indicators were reported to be present or protected in a total of 36 BSPAs (replication number = 35) others were found in less than five BSPAs (**Table 36**). Two indicators, *Zostera noltii* and *Gavia immer* were completely absent from the network. On the whole, 18 of the 19 occurring indicator species were adequately replicated in the Baltic Sea -wide BSPA network. An analysis of the basin-specific BSPA networks showed that all but two basins provided adequate replication for at least 50% of the occurring indicator species. While the Kattegat exhibited an adequate number of replications for three of the ten occurring species, the three indicator species present in the Sound were all replicated only once. In the Baltic Proper and the Gulf of Bothnia the similar proportions of present indicator species were adequately protected with 15 out of 19 and nine out of 15 species, respectively. The Belt Sea adequately replicates four out of seven, the Gulf of Finland eight out of twelve and the Gulf of Riga five out of ten indicator species (**Table 36**). The only species adequately replicated in all basins where they occur are *Chara* sp.)[7] and *Phocoena phocoena*.

Individual assessment of the BSPA networks in the HELCOM countries revealed that five indica-

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[7] Contemplating the six occurring *Chara* species separately, however, only *Chara aspera* is adequately replicated in the Gulf of Bothnia. Baltic Sea wide *C. aspera* and *C. baltica* are adequately replicated.

tor species were inadequately replicated in all of the states where they occurred. These included *Fucus serratus, Zostera marina*, and the three fish species *Alosa fallax, Anguilla anguilla* and *Gadus morhua* (**Table 37**). The remaining 14 indicator species were adequately replicated in at least some of the countries were they were present, but none was adequately replicated in all states. Four out of nine countries had an adequate number of replications for more than 50% of the present indicator species. These were Denmark, with three out of five indicator species adequately replicated, Finland, with eleven out of 13, Poland with six out of ten, and Sweden with ten out of 17. Estonia, Germany, Latvia and Lithuania showed adequate replications for at least some of the present indicator species their BSPA networks, while for Russia all of the five indicator species occurring in its marine area were inadequately replicated.

Indicator biotopes. As was the case for indicator species, the replication of indicator biotopes could only be assessed for the BSPA network. Baltic Sea -wide, all seven indicator biotopes were adequately replicated, with 'Macrophytes' occurring in five BSPAs, 'Bubbling Reefs' in seven, 'Estuaries' in 20, 'Shallow Inlets & Bays' in 28, 'Lagoons' and 'Sandbanks' in 56, and 'Reefs' present in up to 60 BSPAs (**Table 38**). While adequate replication was observed for all indicator biotopes on a Baltic Sea -wide scale, adequate basin-specific replication was not provided for all biotopes at the time (**Table 36**). Neither the BSPA network in the Gulf of Bothnia nor the Kattegat provided an adequate number of replications for one out of six present biotope indicators, while the Gulf of Finland lacked adequate replication for 'Macrophytes' and 'Shallow Inlets & Bays'. Both the Gulf of Riga and The Sound inadequately replicated all four present indicator biotopes. Only the BSPA networks in

Table 37. Between-site replication of indicator species in the BSPA network of Contracting States. The table shows the number of BSPAs in which an indicator species is protected as well as the number of Countries where replication was found to be adequate. A minimum of three replicates is considered adequate. (Status: July 2009)

Indicator species		No. of BSPAs where present or protected									No. of Contracting States where adequately replicated
		Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	
Algae	*Chara spp.*			7			1			7	**2**
	Fucus serratus				1						
	Fucus vesiculosus			5		3	1			3	**3**
	Furcellaria lumbricalis			3	1	4	1			2	**2**
Vascular plant	*Zostera marina*			1			1			1	
	Zostera noltii										
Fish	*Alosa fallax*	1	1		1	1	2	2	1		
	Anguilla anguilla					1	2			1	
	Gadus morhua						2			2	
	Lampetra fluviatilis		2	2	1	3	3	3		1	**3**
	Salmo salar		1	3		1	3	3		3	**4**
Birds	*Gavia arctica*			9	3	4	3	2	1	7	**5**
	Gavia immer										
	Gavia stellata		1	11	3	4	3	3	1	5	**6**
	Mergus serrator	1	3	12	4	2	4	2		3	**5**
	Sterna albifrons	7	3	4	4	2	4	4	1	6	**7**
	Tadorna tadorna			13		2	4	1		1	**2**
Mammals	*Halichoerus grypus*	4	4	9	1		2	4	1	7	**5**
	Phoca vitulina	9			1		1			5	**2**
	Phoca hispida botnica		2	5			1			1	**1**
	Phocoena phocoena				7		1	3		4	**3**
Number of indicator species adequately replicated		**3**	**3**	**11**	**5**	**5**	**7**	**6**	**0**	**10**	

Table 38. **Between-site replication of indicator biotopes in the BSPA network of the basins and the entire Baltic Sea. The table shows the number of BSPAs in which an indicator biotope is protected as well as the number of Basins where replication was found to be adequate. A minimum of three replicates is considered adequate. (Status: July 2009)**

Indicator biotopes	No. of BSPAs where present or protected							No. of basins where adequately replicated	Baltic Sea wide replication
	Baltic Proper	Belt Sea	Gulf of Bothnia	Gulf of Finland	Gulf of Riga	Katte-gat	The Sound		
Bubbling reefs						7		**1**	**7**
Estuaries	7		4	3	2	3	1	**4**	**20**
Lagoons	16	9	18	5	2	5	1	**5**	**56**
Macrophytes	3		1	1				**1**	**5**
Reefs	16	14	9	6	2	12	1	**5**	**60**
Sandbanks	15	12	10	5	2	10	2	**5**	**56**
Shallow inlets & bays	10	8	7	2		1		**3**	**28**
Indicator biotopes adequately replicated	**6**	**4**	**5**	**4**	**0**	**5**	**0**		**7**

Table 39. **Between-site replication of indicator biotopes in the BSPA network of Contracting States. The table shows BSPAs in which an indicator species is protected as well as the number of Countries where replication was found to be adequate. A minimum of three replicates is considered adequate. (Status: July 2009)**

Indicator biotopes	No. of BSPAs where present or protected									No. of Contracting States where adequately replicated
	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	
Bubbling reefs	6								1	**1**
Estuaries	1	1	6		2	1	4		5	**3**
Lagoons	8	4	17	5	2	2	4	1	13	**6**
Macrophytes			1	1			1		2	
Reefs	15	4	10	10	3	1	1		16	**6**
Sandbanks	11	4	10	9	2	1	4	1	14	**6**
Shallow inlets & bays	5	4	4	4			4	1	6	**6**
Indicator biotopes adequately replicated	**5**	**4**	**5**	**4**	**1**		**4**		**5**	

the two remaining basins, the Baltic Proper and the Belt Sea, provided adequate replication for all biotope indicators occurring.

Assessment of the BSPA networks in the countries found that all indicator biotopes but 'Macrophytes' were adequately replicated in at last some of the countries where they occurred (**Table 39**). Denmark, Estonia, Finland, and Germany should to increase the coverage of one of the present indicator biotopes to reach adequate replication, while Poland and Sweden needed to do the same for two indicator biotopes and Latvia for three. Russia and Lithuania did not provide adequate replication for any of the indicator biotopes present in their BSPA networks.

The information in the BSPA database provided by the countries showed that the number of replications should have been increased for most of the indicator biotopes to ensure adequate replication at the three defined spatial scales. 'Macrophytes' were the biotope type most in need of increased replication.

Benthic marine landscape types. The number of Baltic Sea -wide between-site and in-site replications of benthic marine landscape types

Table 40. **Between-site replications of benthic marine landscapes in the BSPA, SCI and SPA networks. Between-site replication indicates the number of protected areas with at least one patch of the landscape type. The tables show the number of Baltic Sea wide replications for the combined BSPA/N2000 network is given. A minimum of three replicates is considered adequate. Landscape types not present are marked with "-". (Status: July 2009)**

Benthic marine landscape			Between-site replication			total no of replicates
Substrate	**Light**	**Salinity**	**BSPA**	**SCI**	**SPA**	**BSPA/ N2000**
Bedrock	Photic	< 5psu	4	6	3	28
		5-7.5psu	16	55	34	256
		7.5-11psu	1	3	2	5
		11-18psu	0	0	0	0
		18-30psu	0	2	2	7
		>30psu	-	1	1	3
	Non-photic	< 5psu	2	1	1	17
		5-7.5psu	14	35	26	250
		7.5-11psu	0	2	0	3
		11-18psu	-	-	-	
		18-30psu	0	1	1	1
		>30psu	-	1	1	2
Hard bottom comp.	Photic	< 5psu	9	64	29	180
		5-7.5psu	21	93	71	312
		7.5-11psu	8	33	17	68
		11-18psu	13	30	20	111
		18-30psu	7	32	19	166
		>30psu	6	9	4	18
	Non-photic	< 5psu	10	32	12	161
		5-7.5psu	21	47	35	219
		7.5-11psu	5	11	6	49
		11-18psu	10	20	10	51
		18-30psu	4	17	12	59
		>30psu	4	9	1	39
Sand	Photic	< 5psu	6	27	15	69
		5-7.5psu	22	63	44	147
		7.5-11psu	9	35	17	79
		11-18psu	10	28	20	77
		18-30psu	9	38	31	123
		>30psu	5	10	6	30
	Non-photic	< 5psu	2	11	5	31
		5-7.5psu	21	34	28	127
		7.5-11psu	9	18	10	40
		11-18psu	10	18	12	60
		18-30psu	6	17	12	87
		>30psu	7	15	5	47

Benthic marine landscape			Between-site replication			total no of replicates
Substrate	**Light**	**Salinity**	**BSPA**	**SCI**	**SPA**	**BSPA/ N2000**
Hard clay	Photic	< 5psu	1	5	3	33
		5-7.5psu	15	54	34	237
		7.5-11psu	1	1	0	2
		11-18psu		0	1	2
		18-30psu	1	2	3	7
		>30psu	2	4	2	7
	Non-photic	< 5psu	3	6	3	30
		5-7.5psu	19	46	34	193
		7.5-11psu	1	2	3	24
		11-18psu	2	3	3	9
		18-30psu	-	0	0	3
		>30psu	2	5	1	43
Mud	Photic	< 5psu	4	28	9	84
		5-7.5psu	17	57	35	173
		7.5-11psu	2	12	7	26
		11-18psu	8	11	14	58
		18-30psu	5	23	19	101
		>30psu	1	2	1	3
	Non-photic	< 5psu	4	20	6	51
		5-7.5psu	17	46	29	162
		7.5-11psu	3	4	2	28
		11-18psu	11	17	10	38
		18-30psu	6	21	16	60
		>30psu	3	10	5	22
No. of landscape types adequately replicated			**39**	**46**	**43**	**54**

in the BSPA, SCI and SPA networks is shown in **Tables 40** and **41**. These tables also show the number of landscape replicates in the combined BSPA/N2000 network. It was not possible to differentiate between within-site and between-site replication for the BSPA/N2000 because no individual areas were delineated. Between-site replication for landscape-specific replication analysis was defined as the number of protected areas (BSPAs, SCIs or SPAs) containing at least one patch of the addressed landscape type minus one (two sites = one replicate). Within-site replication defines the number of minimum-size landscape patches within the same protected area minus one (two patches = one replicate).

In summary, the following overall observations were made concerning Baltic Sea wide between-site replication of landscapes (**Table 40**):

- 16 out of 55 landscape types were not sufficiently replicated in the BSPA network. Five landscape types were not at all represented or

Table 41. **Within-site replications of benthic marine landscapes in the BSPA, SCI and SPA networks. The table shows the total number of protected areas with replicates of the landscape type (i.e. at least two patches = one replicate) for within-site replication as well as the number of areas with adequate within-site replication. A minimum of three replicates is considered adequate. Landscape types not present are marked with "-". (Status: July 2009)**

Benthic marine landscape			Total no. of MPAs with within-site replicates			No. of MPAs with adequate within-site replication		
Substrate	Light	Salinity	BSPA	SCI	SPA	BSPA	SCI	SPA
Bedrock	Photic	< 5psu	5	6	4	2	1	1
		5-7.5psu	17	56	35	14	17	15
		7.5-11psu	2	5	3	0	0	0
		11-18psu	1	1	1	0	0	0
		18-30psu	1	3	3	0	2	2
		>30psu	-	2	2	-	1	1
	Non-photic	< 5psu	3	2	2	1	0	0
		5-7.5psu	15	36	27	13	21	17
		7.5-11psu	1	3	1	0	0	0
		11-18psu	-	-	-	-	-	-
		18-30psu	1	2	2	0	0	0
		>30psu	-	2	2	-	0	0
Hard bottom comp.	Photic	< 5psu	10	65	30	6	11	7
		5-7.5psu	22	94	72	10	18	15
		7.5-11psu	9	34	18	3	6	5
		11-18psu	14	31	21	4	14	16
		18-30psu	8	33	20	3	12	12
		>30psu	7	10	5	1	3	2
	Non-photic	< 5psu	11	33	13	6	8	6
		5-7.5psu	22	48	36	12	18	16
		7.5-11psu	6	12	7	2	2	3
		11-18psu	11	21	11	4	6	5
		18-30psu	5	18	13	1	6	7
		>30psu	5	10	2	2	3	1
Sand	Photic	< 5psu	7	28	16	1	4	2
		5-7.5psu	23	64	45	7	13	12
		7.5-11psu	10	36	18	3	7	6
		11-18psu	11	29	21	4	8	9
		18-30psu	10	39	32	5	11	12
		>30psu	6	11	7	2	4	2
	Non-photic	< 5psu	3	12	6	2	4	4
		5-7.5psu	22	35	29	8	13	12
		7.5-11psu	10	19	11	2	7	6
		11-18psu	11	19	13	5	8	4
		18-30psu	7	18	13	2	5	8
		>30psu	8	16	6	2	6	3
Hard clay	Photic	< 5psu	2	6	4	1	2	1
		5-7.5psu	16	55	35	9	16	14
		7.5-11psu	2	2	1	0	0	0
		11-18psu	-	1	2	-	0	0
		18-30psu	2	3	4	0	0	0
		>30psu	3	5	3	0	1	0
	Non-photic	< 5psu	4	7	4	1	0	0
		5-7.5psu	20	47	35	8	19	15
		7.5-11psu	2	3	4	1	1	0
		11-18psu	3	4	4	0	1	2
		18-30psu	-	1	1	-	1	1
		>30psu	3	6	2	2	4	2
Mud	Photic	< 5psu	5	29	10	2	10	4
		5-7.5psu	18	58	36	7	11	10
		7.5-11psu	3	13	8	2	4	3
		11-18psu	9	12	15	5	8	6
		18-30psu	6	24	20	3	10	11
		>30psu	2	3	2	0	0	0
	Non-photic	< 5psu	5	21	7	2	4	1
		5-7.5psu	18	47	30	11	14	12
		7.5-11psu	4	5	3	1	1	0
		11-18psu	12	18	11	5	6	5
		18-30psu	7	22	17	1	7	7
		>30psu	4	11	6	1	3	2

patches where smaller than 24 ha. Out of the 39 sufficiently replicated landscape types, 16 had a replicate number of ten or more.

- 13 out of 59 landscape types were not sufficiently replicated in the SCI network. One landscape type was either not at all represented or patches were smaller than 24 ha. Out of the 46 sufficiently replicated landscape types, 36 had a replicate number of ten or more.
- 16 out of 59 landscape types were not adequately replicated in the SPA network. One landscape types was either not at all represented or patches were smaller than 24 ha. Out of the 43 sufficiently replicated landscape types, 28 had a replicate number of ten or more.

Thus the SCI network provided adequate replication for the highest number of landscape types, as well as the largest number of replications.

For Baltic Sea -wide within-site replications the following observations were made (**Table 41**):

- Ten out of 55 landscape types were not adequately replicated in any of the BSPAs. Five landscape types were adequately replicated in more than ten BSPAs.
- Eleven out of 59 landscape types were not adequately replicated in any of the SCIs. 16 landscape types were adequately replicated in more than ten SCIs.
- 14 out of 59 landscape types were not adequately replicated in any of the SPAs. 14 landscape types were adequately replicated in more than ten SPAs.

While many of the protected areas exhibited replicates of landscape patches, only few provided an adequate number of replicates. In particular those landscape types which were inadequately replicated in all protected areas, should be considered in future designations of protected areas. These are 'photic bedrock habitats at 7.5-11 psu and 11-18 psu', as well as 'non-photic bedrock habitats at 7.5-11 psu, 11-18 psu, 18-30 psu and > 30 psu'; 'photic hard clay at 7.5-11 psu, 11-18 psu and 18-30 psu'; and 'photic mud at > 30 psu'. The network with the largest number of protected areas providing adequate replication of landscape types was the SCI network.

Baltic Sea -wide landscape replicates in the combined BSPA/N2000 network was found to be adequate in all but five cases, while 45 landscape types had replication numbers of more than ten.

Between-site replication for landscape types on the scale of basins is shown in **Table 42**. Only one basin, the Sound, did not provide adequate replication for at least one of the present landscape types within the network of BSPAs. Furthermore, the Sound, followed by the Gulf of Riga had the worst records in terms of between-site replication of landscape types in the networks of SCIs and SPAs. With regard to the BSPA network all other basins but the Belt Sea, adequately replicated more than ten landscape types within all three networks. The same finding held true for the total number of replicates in the combined BSPA/N2000 basin-wide networks.

Between-site replication of landscape types in each Contracting States' networks of BSPAs, SCIs and SPAs is shown in **Table 43**. Three countries adequately replicated more than ten landscape types in their BSPA and SPA networks. These Contracting States were Denmark, Finland, and Sweden. In terms of the SCI network these three countries were joined by Germany. The only countries that did not provide adequate replications of any landscape type in the network of BSPAs were Poland and Russia. The combined BSPA/N2000 network provided more than ten adequately replicated landscape types in six countries.

Conclusion

Based on the information provided, it was observed that there was a need for enhanced replication for most of the chosen indicator species. While the final number of replicates depends on the occurrence and distribution of the species, the theoretical minimum target of three replicates should at least be achieved. Where possible, a more precise number should be determined based on the species and on case-by-case evaluations. Of all species present in the BSPA network, special attention should be paid to *Fucus serratus, Zostera marina*, and the three fish

Table 42. Between-site replication of benthic marine landscape types in basin wide networks of BSPAs, SCIs and SPAs. The table shows the total number of landscape types (minimum patch size = 24 ha) in at least one MPA as well as the number of landscape types adequately represented in each basin-wide MPA network. A minimum of three replicates is considered adequate. (Status: July 2009)

Basins	Total no. of landscape types present in MPA network				No. of landscape types adequately replicated between-sites			
	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000
Baltic Proper	25	29	28	29	14	19	16	28
Belt Sea	13	14	14	14	6	12	12	14
Gulf of Bothnia	20	20	20	20	14	19	17	20
Gulf of Finland	12	13	13	18	10	10	10	15
Gulf of Riga	13	13	13	13	2	4	4	11
Kattegatt	17	20	20	20	10	12	10	18
The Sound	12	11	10	13	0	2	1	5

Table 43. Between-site replication of benthic marine landscape types in each Contracting States' networks of BSPAs, SCIs and SPAs. The table shows the total number of landscape types (minimum patch size = 24 ha) found in at least one MPA as well as the number of landscape types adequately represented in each marine Contracting States' MPA network. A minimum of three replicates is considered adequate. (Status: July 2009)

State	Total no. of landscape types present in the MPA network				No. of landscape types adequately replicated between-sites			
	BSPA	SCI	SPA	BSPA/ N2000	BSPA	SCI	SPA	BSPA/ N2000
Denmark	23	29	24	30	11	17	13	19
Estonia	13	13	13	13	3	8	8	11
Finland	19	19	19	19	14	15	14	17
Germany	17	25	23	25	6	11	6	16
Latvia	6	4	4	6	2	2	1	2
Lithuania	3	4	3	4	1	1	1	2
Poland	11	12	12	12	0	3	5	6
Russia	3	n/a	n/a	17	0	n/a	n/a	12
Sweden	49	51	47	52	12	33	23	42

species *Alosa fallax, Anguilla anguilla* and *Gadus morhua*, since they were most underrepresented. The one indicator biotope type that is in most need of increased replication is 'Macrophytes'.

In general, the number of replications should be increased for most of the indicator biotopes to ensure adequate replication levels. Nevertheless, it should be noted that Baltic-wide distribution maps of the indicator species and biotopes are essential for an in depth evaluation of the results. For benthic marine landscape type replication it was found that many, but not all, were adequately replicated across and within the MPAs. Thus it was concluded that the SCI network provided adequate replication for the highest number of landscape types. Those landscape types which were not adequately replicated should be accounted for in future BSPA designations.

1.4.4 Connectivity

The marine environment represents a highly mobile milieu. While some species living in the sea disperse and migrate by active movement others drift, float or raft with the moving water masses or on objects in the water. Dispersal strategies therefore differ not only between species but also within species at different life stages. One single species might need a wide range of habitats, which cannot be covered by a single MPA. Hence connectivity among protected areas is of vital importance. It provides corridors for migrating species, linkages between diverse habitats occupied by species at different life stages, and allows for genetic interchange between populations. It is thus essential to promote connectivity within and among MPAs.

Evaluating the connectivity of a network of MPAs is somewhat problematic as MPAs aim to protect a variety of species, which however have a wide range of dispersal strategies and dispersal distances. A network might provide connectivity for long-range species but not for short-range species. To fully evaluate the connectivity of a network, the assessment would have to be based on all features for which the network is established. Furthermore, direction and strength of currents as well as availability of floating objects should be taken into account. In a broad-scale assessment such as presented here, such an approach is not feasible. This connectivity assessment therefore considers only the distance between sites, and is based on benthic marine landscapes (Piekäinen and Korpinen 2008).

Methodology

Using the methodology applied in the Balance project, a two-pronged approach was chosen to assess the connectivity of the three different networks. The first approach represents a theoretical model. A set of five widespread marine landscape types, representing different combinations of substrate, salinity and photic depth was chosen, and the connectivity between the patches assessed. The chosen landscape types are 'hard bottom complex, non-photic, 5-7 psu', 'sand, photic, 7.5-11 psu', 'sand, non-photic, 11-18 psu', 'mud, photic, 0-5 psu' and 'mud, non-photic, 18-30 psu'. The map of selected landscapes was then clipped with the maps of networks, selecting only those landscapes occurring within BSPAs, SCIs, SPAs or the combined BSPA/N2000 network.

As with the assessment of representativity, a minimum size of 24 ha was pre-set for a landscape patch to be taken into account. The connectivity analyses were performed on the basis of theoretical and species-specific connection distances. In terms of the theoretical approach, 25 km and 50 km border to border distances between landscape patches were applied. These numbers were based on the scientific recommendations repeatedly suggested as theoretical dispersal distances if a network is not targeted to a certain species, or if spatial information on habitat or species distribution is unavailable (Botsford et al. 2001, Shanks et al. 2003, Palumbi 2003, Halpern et al. 2006). A detailed review can be found in Piekäinen and Korpinen (2008).

The second approach involves a species-specific connectivity analysis of the networks, in which a set of five species was chosen: *Macoma baltica, Psetta maxima, Furcellaria lumbricalis, Idotea baltica* and *Fucus vesiculosus*. These species are common and widespread in the Baltic Sea and display different dispersal strategies and distances (**Table 44**).

Based on the species habitats, suitable landscape types were selected for each species and combined to define the potential geographical distribution of the chosen species. Once more, only those landscapes occurring within the protected areas were selected. However, in contrast to the first approach, no minimum size was prescribed for a patch to be taken into account. The dispersal distance of each species as defined in the literature (**Table 44**) determined the maximum straight-line distance between the patches of potential habitats considered to ensure connectivity.

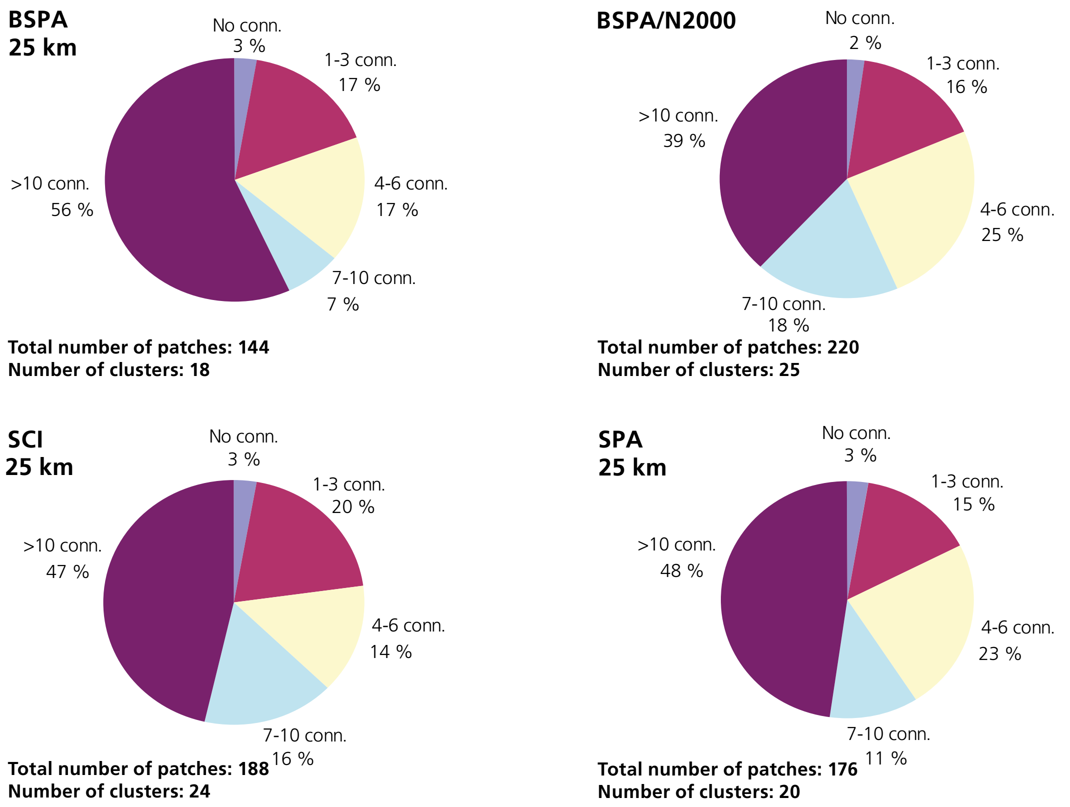
Two types of connectivity measures were derived for both approaches. On the one hand, a neighbourhood analysis was carried out for each landscape patch (or potential habitat patch in the species-specific approach). 25 km and 50 km search radii were used for the theoretical landscape approach, while species-specific dispersal distances were applied for the species-specific approach. The number of neighbours within the search radius defined the number of connections. The second connectivity measure provided information on how many self-contained clusters were formed in connected MPAs. The selected landscape patches or potential habitat patches were therefore expanded in all directions by half the respective dispersal distance. All patches

Table 44. Species selected for the analysis of connectivity at the benthic marine landscape level. The table shows the substrates, salinity class and photic depth chosen as their potential habitats as well as the species-specific dispersal distances (estimates, based on genetic and behavioural studies). Source: Piekäinen & Korpinen 2008, p. 63 and references therein.

Species	Substrate	Salinity	Photic depth	Dispersal distance	Notes and references
Macoma baltica (Baltic tellin)	Sand and mud[1]	> 5 psu	Non-photic and photic	100 km[2]	Tolerates salinity of 4 psu[3]. Distribution whole Baltic Sea, except the Bothnian Bay.
Psetta maxima (turbot) spawning and nursery grounds	Bedrock, hard bottom complex and sand[4]	> 5 psu	Photic	25 km[5]	Spawning and nursery grounds are not found north from the Finnish south coast.
Furcellaria lumbricalis (Black carrageen)	Bedrock, hard bottom complex and sand	> 5 psu	Photic	25 km[6]	Distribution whole Baltic Sea, except the Bothnian Bay.
Idotea baltica (Baltic isopod)	Bedrock, hard bottom complex and sand	> 5 psu	Photic	25 km[7]	Distribution whole Baltic Sea, except the Bothnian Bay.
Fucus vesiculosus (Bladder wrack)	Bedrock, hard bottom complex and sand	> 5 psu	Photic	1 km[8]	Distribution whole Baltic Sea, except the Bothnian Bay.

[1] MarLIN, [2]larval settling time 1-6 months, Marlin, [3]Laine & Seppänen 2001, [4]Iglesias et al. 2003, Sparrevohn & Sottrup 2003, Stankus 2006, [5]based on genetical studies, Florin & Höglund 2006, [6]Fletcher & Callow 1992, Norton 1992, [7]based on measurements by Alexander & Chen 1990, [8]according to Gaylord et al. 2002: a fraction of algal propagules can drift distances of several kilometres.

Non-photic hard bottom complex 5-7.5 psu, 25 km dispersal distance



Non-photic hard bottom complex 5-7.5 psu, 50 km dispersal distance

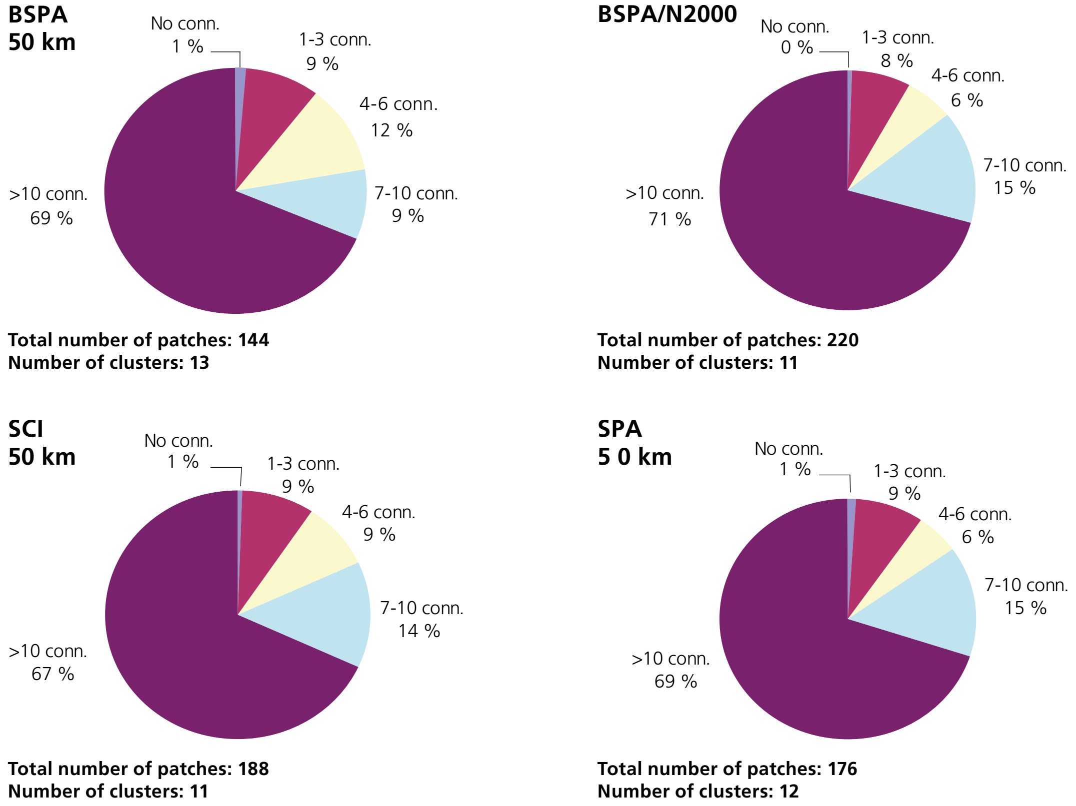
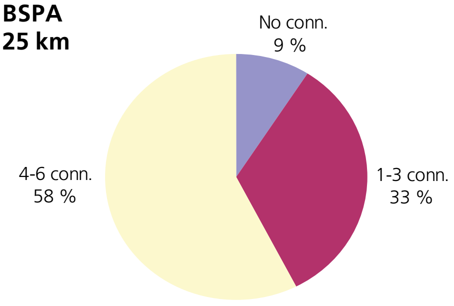


Figure 30. Number of connections between patches (min. size 24 ha) of five benthic marine landscape types at a theoretical dispersal distance of 25 and 50 km in the BSPA, SCI, SPA and BSPA/N2000 networks of the Baltic Sea.

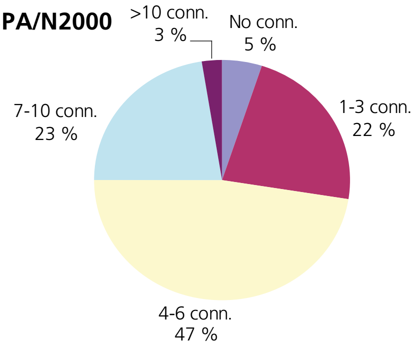
Photic sand 7.5-11 psu, 25 km dispersal distance

BSPA
25 km



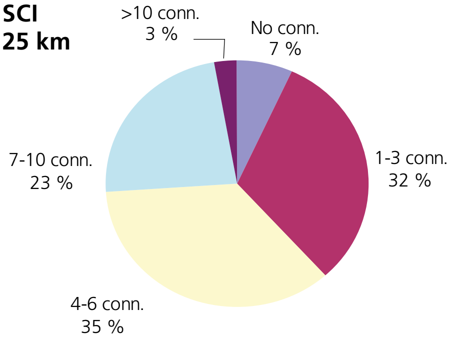
Total number of patches: 33
Number of clusters: 10

BSPA/N2000



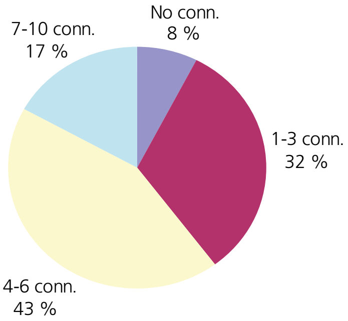
Total number of patches: 80
Number of clusters: 14

SCI
25 km



Total number of patches: 73
Number of clusters: 16

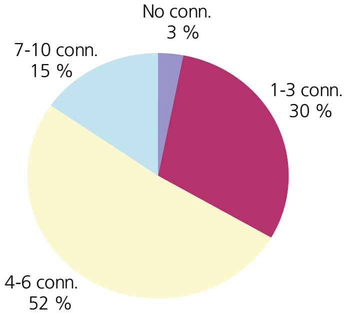
SPA
25 km



Total number of patches: 53
Number of clusters: 12

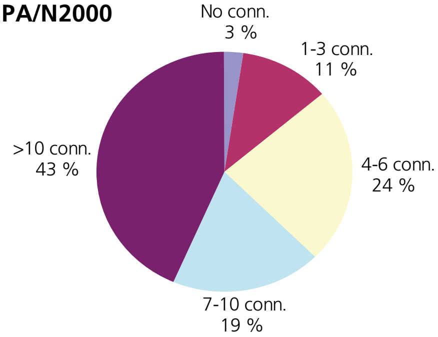
Photic sand 7.5-11 psu, 50 km dispersal distance

BSPA
50 km



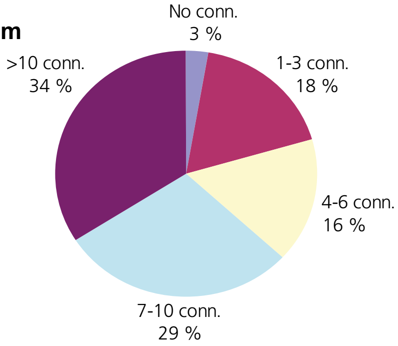
Total number of patches: 33
Number of clusters: 7

BSPA/N2000



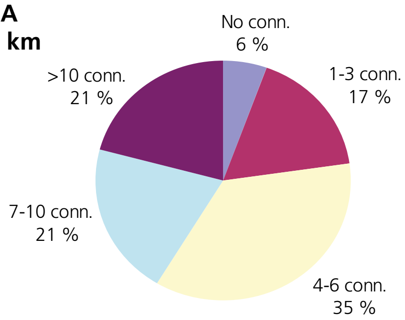
Total number of patches: 80
Number of clusters: 7

SCI
50 km



Total number of patches: 73
Number of clusters: 9

SPA
50 km

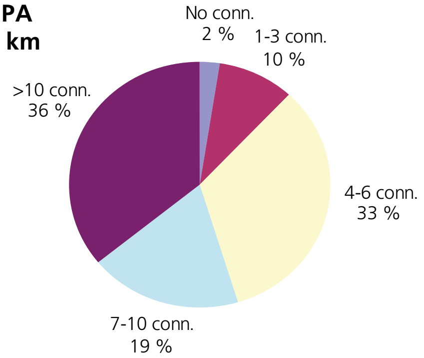


Total number of patches: 53
Number of clusters: 7

Figure 30. Continued

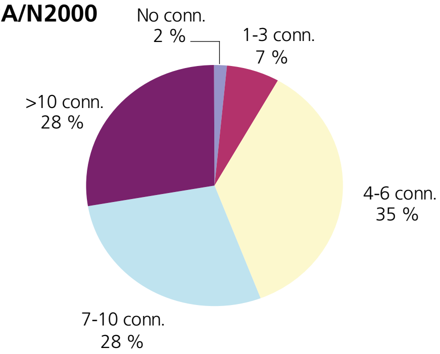
Non-photic sand 11-18 psu, 25 km dispersal distance

BSPA
25 km



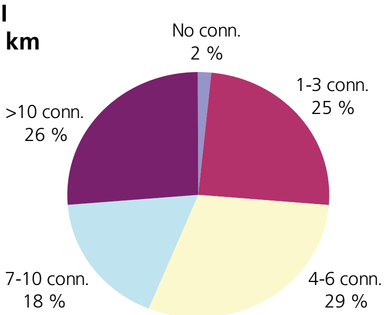
Total number of patches: 42
Number of clusters: 5

BSPA/N2000



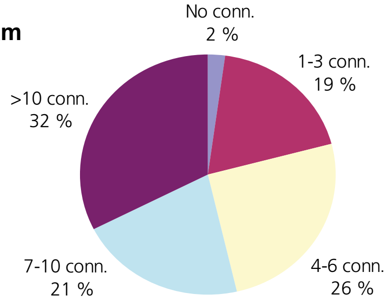
Total number of patches: 61
Number of clusters: 7

SCI
25 km



Total number of patches: 57
Number of clusters: 7

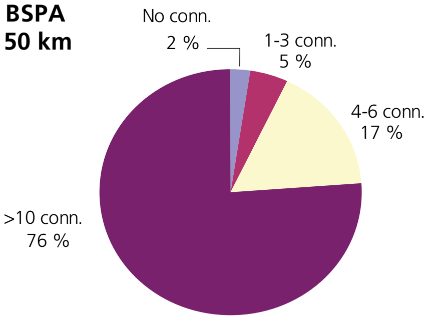
SPA
25 km



Total number of patches: 43
Number of clusters: 6

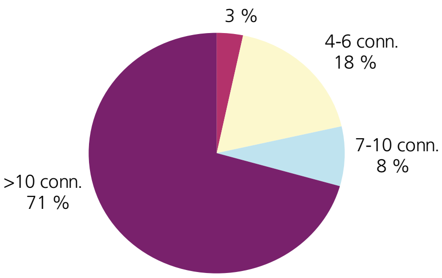
Non-photic sand 11-18 psu, 50 km dispersal distance

BSPA
50 km



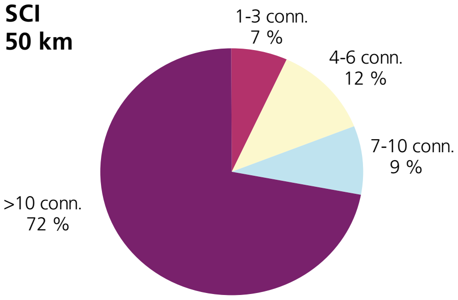
Total number of patches: 42
Number of clusters: 4

BSPA/N2000



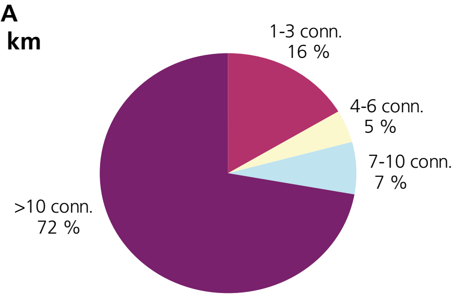
Total number of patches: 61
Number of clusters: 3

SCI
50 km



Total number of patches: 57
Number of clusters: 3

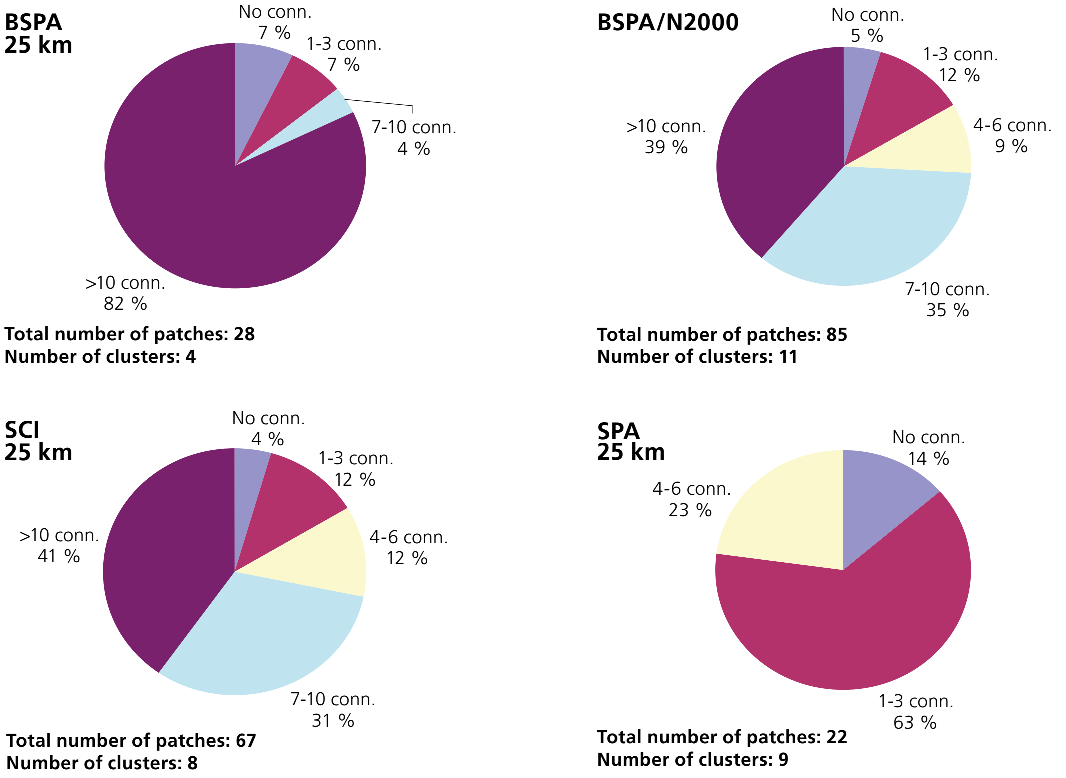
SPA
50 km



Total number of patches: 43
Number of clusters: 4

Figure 30. Continued

Photic mud < 5 psu, 25 km dispersal distance


BSPA 25 km

Total number of patches: 28
Number of clusters: 4

BSPA/N2000

Total number of patches: 85
Number of clusters: 11

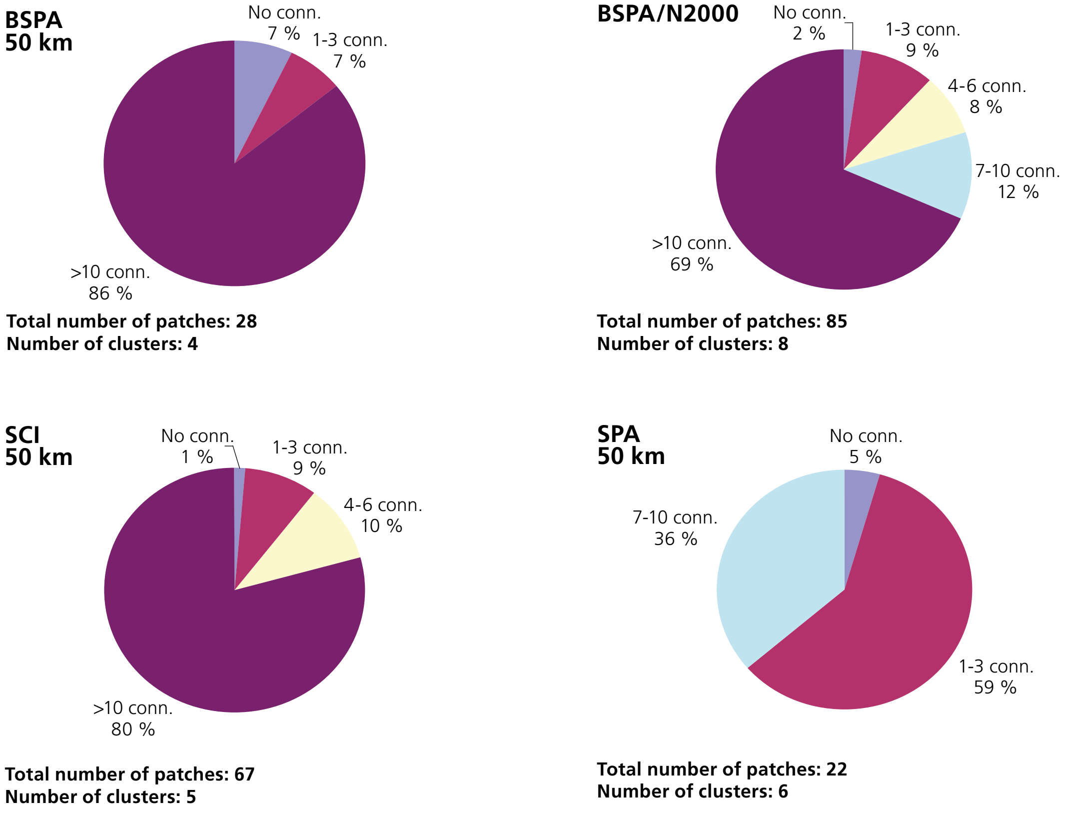
SCI 25 km

Total number of patches: 67
Number of clusters: 8

SPA 25 km

Total number of patches: 22
Number of clusters: 9

Photic mud < 5 psu, 50 km dispersal distance


BSPA 50 km

Total number of patches: 28
Number of clusters: 4

BSPA/N2000

Total number of patches: 85
Number of clusters: 8

SCI 50 km

Total number of patches: 67
Number of clusters: 5

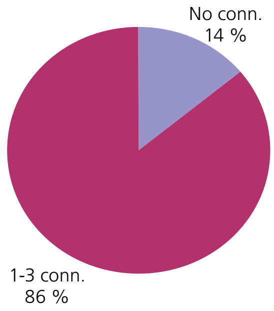
SPA 50 km

Total number of patches: 22
Number of clusters: 6

Figure 30. Continued

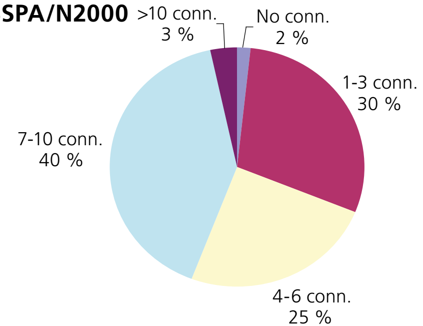
Non-photic mud 18-30 psu, 25 km dispersal distance

BSPA
25 km



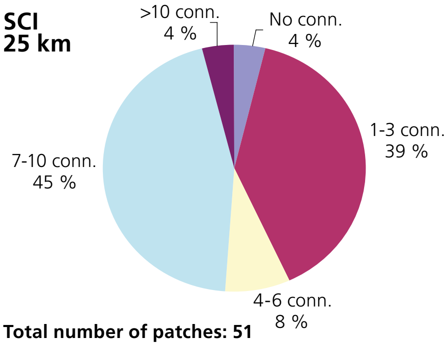
Total number of patches: 14
Number of clusters: 6

BSPA/N2000



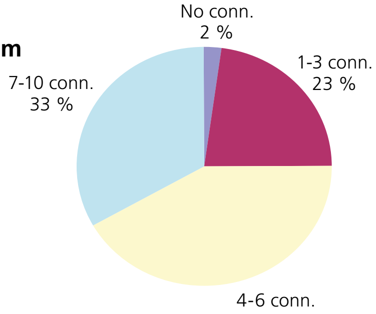
Total number of patches: 61
Number of clusters: 9

SCI
25 km



Total number of patches: 51
Number of clusters: 9

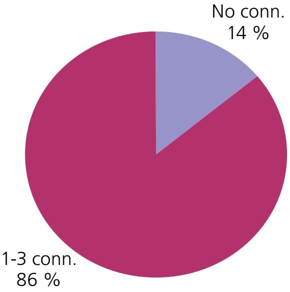
SPA
25 km



Total number of patches: 48
Number of clusters: 7

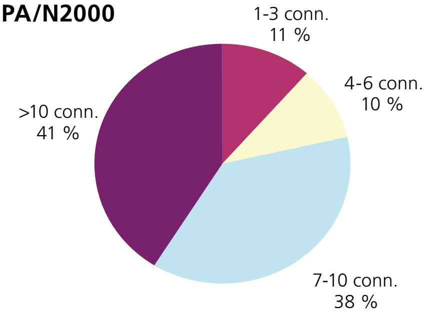
Non-photic mud 18-30 psu, 50 km dispersal distance

BSPA
50 km



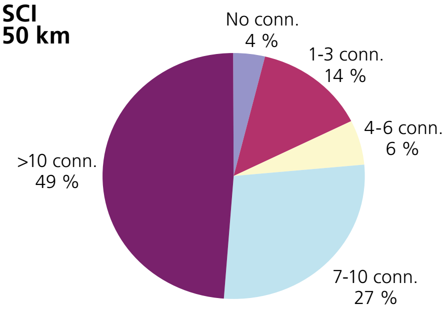
Total number of patches: 14
Number of clusters: 6

BSPA/N2000



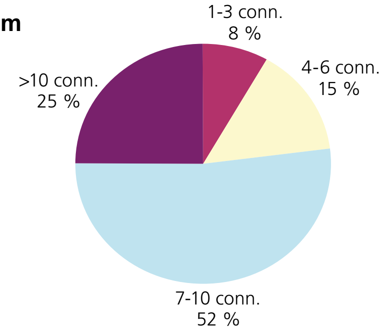
Total number of patches: 61
Number of clusters: 5

SCI
50 km



Total number of patches: 51
Number of clusters: 6

SPA
50 km



Total number of patches: 48
Number of clusters: 4

Figure 30. Continued

thus adjoined or overlapped each other to the value of the dispersal distances. The number of connecting patches or clusters was defined in this way.

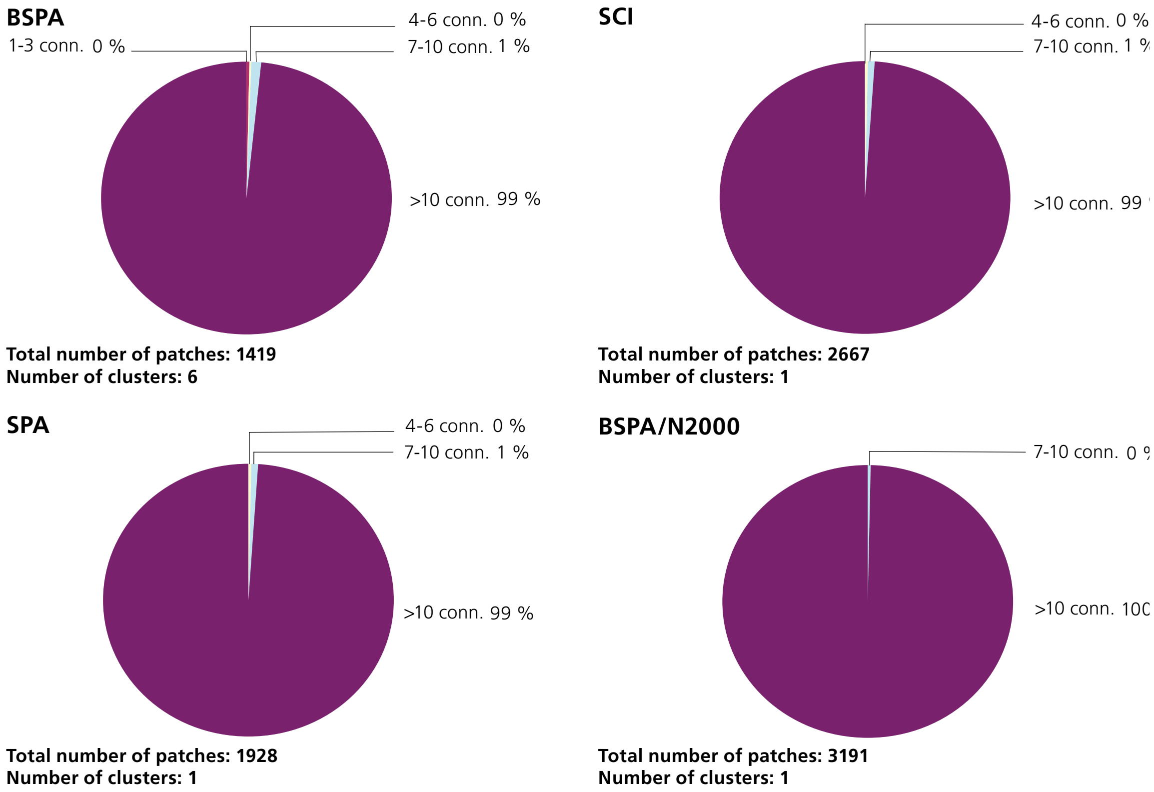
Results

The five benthic marine landscape types differ strongly, not only in terms of the number of connections but also in terms of the network types investigated (**Figure 30** and **Table 45**). The 'non-photic hard bottom complex at 5-7.5psu' has a large proportion of patches with more than ten connections each protected in the networks at both 25 and 50 km dispersal distances. The same was observed for 'non-photic sand at 11-18psu', however the findings were more pronounced at an

Table 45. Connectivity between the five selected benthic marine landscape types in the Baltic Sea. The table shows the size of landscape patches (min. size 24 ha) in the BSPA, SCI, SPA and BSPA/N2000 network for each connectivity category (no connections, 1-3 connections, 4-6 connections, 7-10 connections and >10 connections) with 25 and 50 km dispersal distances. The total number of patches and f clusters in each MPA network is provided. (Status: July 2009)

Landscape type	Dispersal distance [km]	MPA type	Number of landscape patches with the given number of connections					Total number of patches	Number of clusters
			No conn.	1-3 conn.	4-6 conn.	7-10 conn.	>10 conn.		
Hard bottom complex non-photic 5-7psu	25	BSPA	4	24	24	10	82	144	18
		SCI	5	38	27	31	87	188	24
		SPA	5	26	41	20	84	176	20
		BSPA/N2000	5	36	55	40	84	220	25
	50	BSPA	2	13	17	13	99	144	13
		SCI	1	17	16	26	128	188	11
		SPA	2	15	10	26	123	176	12
		BSPA/N2000	1	17	13	34	155	220	11
Sand photic 7.5-11psu	25	BSPA	3	11	19	0	0	33	10
		SCI	5	23	26	17	2	73	16
		SPA	4	17	23	9	0	53	12
		BSPA/N2000	4	18	38	18	2	80	14
	50	BSPA	1	10	17	5	0	33	7
		SCI	2	13	12	21	25	73	9
		SPA	3	9	19	11	11	53	7
		BSPA/N2000	2	9	19	15	35	80	7
Sand non-photic 11-18psu	25	BSPA	1	4	14	8	15	42	5
		SCI	1	14	17	10	15	57	7
		SPA	1	8	11	9	14	43	6
		BSPA/N2000	1	4	22	17	17	61	7
	50	BSPA	1	2	7	0	32	42	4
		SCI	0	4	7	5	41	57	3
		SPA	0	7	2	3	31	43	4
		BSPA/N2000	0	2	11	5	43	61	3
Mud photic <5psu	25	BSPA	2	2	0	1	23	28	4
		SCI	3	8	8	21	27	67	8
		SPA	3	14	5	0	0	22	9
		BSPA/N2000	4	10	8	30	33	85	11
	50	BSPA	2	2	0	0	24	28	4
		SCI	1	6	7	0	53	67	5
		SPA	1	13	0	8	0	22	6
		BSPA/N2000	2	8	7	10	58	85	8
Mud non-photic 18-30psu	25	BSPA	2	12	0	0	0	14	6
		SCI	2	20	4	23	2	51	9
		SPA	1	11	20	16	0	48	7
		BSPA/N2000	1	18	15	25	2	61	9
	50	BSPA	2	12	0	0	0	14	6
		SCI	2	7	3	14	25	51	6
		SPA	0	4	7	25	12	48	4
		BSPA/N2000	0	7	6	23	25	61	5

Macoma baltica, 100 km dispersal distance



Psetta maxima, 25 km dispersal distance

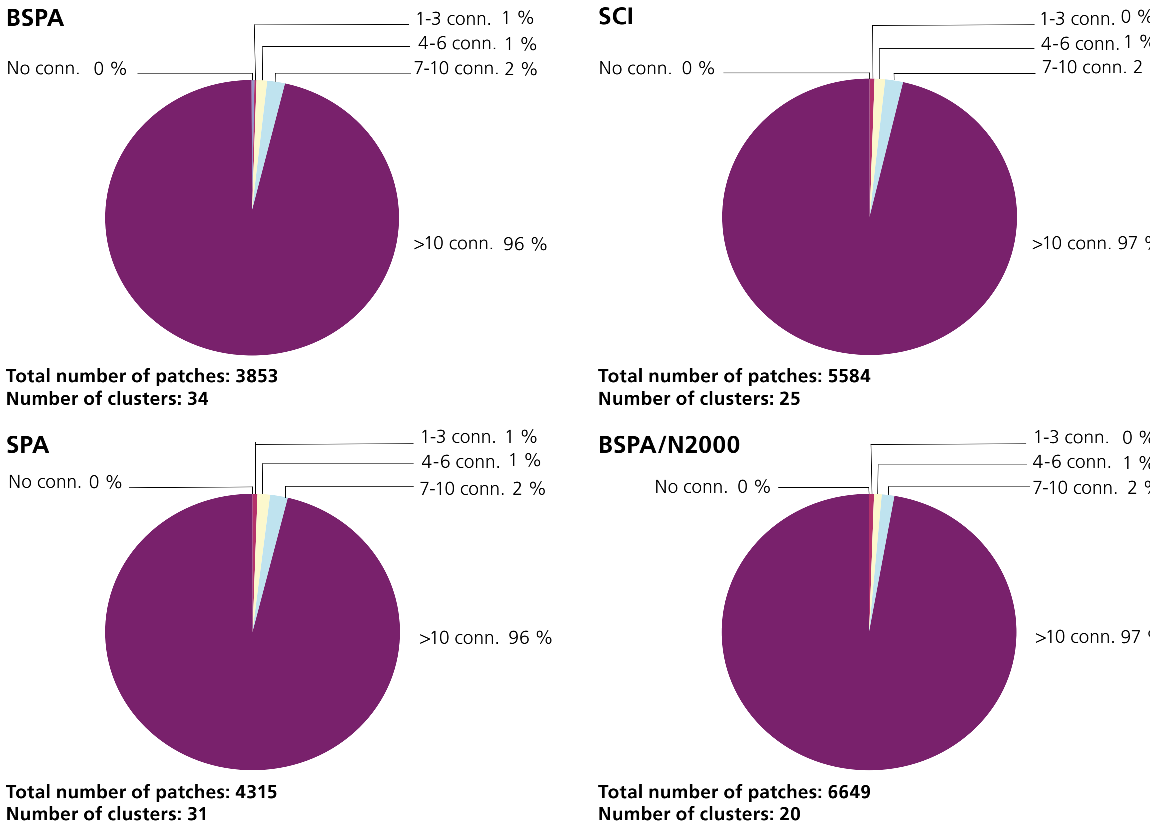
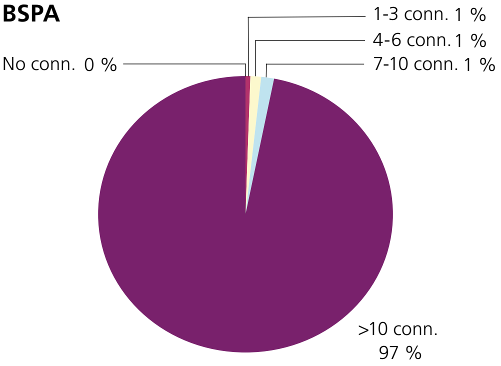


Figure 31. Number of connections between habitat patches of four species at a species-specific dispersal distance in the BSPA, SCI, SPA and BSPA/N2000 networks of the Baltic Sea.

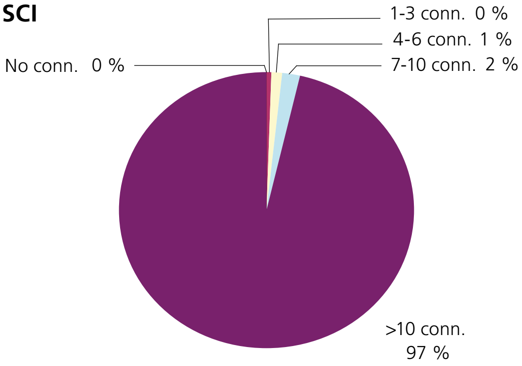
Furcellaria lumbricalis/ Idotea baltica, 25 km dispersal distance

BSPA



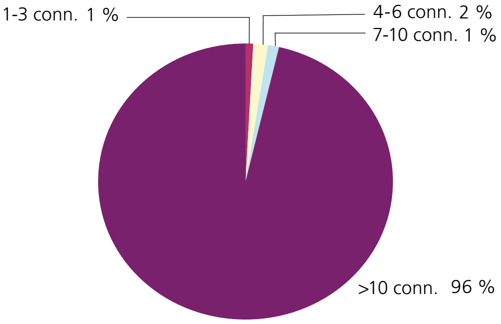
Total number of patches: 3565
Number of clusters: 35

SCI



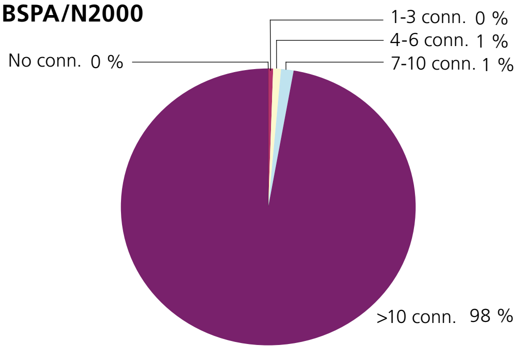
Total number of patches: 5101
Number of clusters: 29

SPA



Total number of patches: 4096
Number of clusters: 39

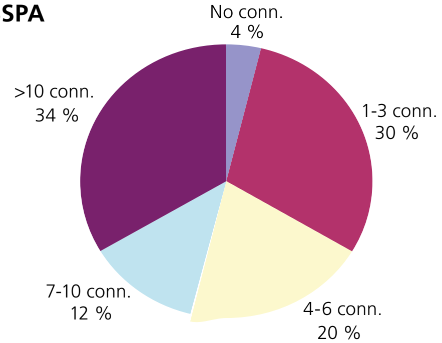
BSPA/N2000



Total number of patches: 6154
Number of clusters: 27

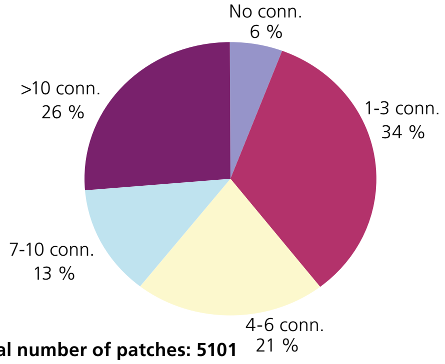
Fucus vesiculosus, 1 km dispersal distance

BSPA



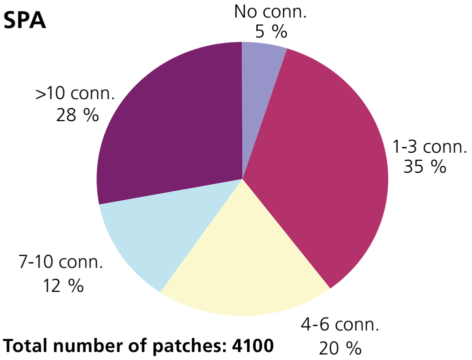
Total number of patches: 3565
Number of clusters: 415

SCI



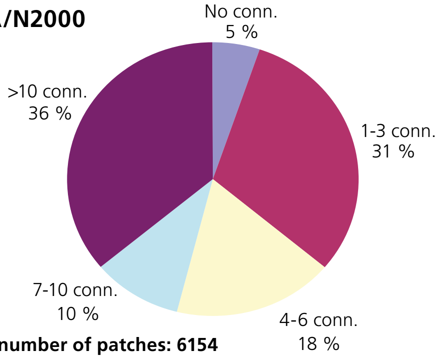
Total number of patches: 5101
Number of clusters: 790

SPA



Total number of patches: 4100
Number of clusters: 594

BSPA/N2000



Total number of patches: 6154
Number of clusters: 860

Figure 31. Continued

increased dispersal distance of 50 km. Only a very small proportion of patches exhibited fewer than three connections.

Furthermore, in terms of the allocation of connectivity, ‘photic mud at <5 psu’ was very similar to the two landscape types previously discussed. Only the SPA network did not provide an equal degree of connectivity between the patches, as most have a connectivity value of less than four. ‘Photic sand at 7.5-11 psu’ and ‘non-photic mud at 18-30 psu’ showed the lowest degree of connectivity among all networks, with the latter, however, improving at an increased dispersal distance of 50 km.

Overall, it was observed that the highest level of connectivity was provided by the BSPA network for the ‘photic mud at <5 psu’ landscape type, while the lowest degree was offered by ‘non-photic mud at 18-30 psu’ in the same network. This was not directly visible when comparing the number of clusters, because patches of both landscape types connect to four and six clusters respectively in the BSPA network. At the same time, however, the former landscape type was represented in the BSPA network by 28 patches, while the latter was scarcer with only 14 patches occurring in BSPAs. Generally, the number of clusters decreased with increased dispersal distances and the highest number of clusters were found in the best represented landscape types.

The species-specific analysis revealed good connectivity in all four networks for species with dispersal distances of 25 km and more. Best connectivity was thus provided for *Macoma baltica*, which had the largest dispersal distance of 100 km. In the SCI, SPA and BSPA/N2000 networks all potential habitat patches were connected and formed a single cluster (**Figure 31** and **Table 46**). In the BSPA network, the potential habitat patches connected to form six clusters. For *Psetta maxima*, *Furcellaria lumbricalis* and *Idotea baltica* the number of potential habitat clusters varied between 20 and 39 in the different networks. The BSPA/N2000 network provided the highest level of connectivity for these species. The habitats of *Fucus vesiculosus* were less well connected, based on a dispersal distance of just 1 km. Most of the patches were connected to less than four potential habitats. Here too the BSPA/N2000 network provided the best connection.

Conclusion

The assessment revealed the need for improved connectivity for many of the landscape types in all networks. For very scarce and dispersed landscape types, however, connectivity may not be gener-

Table 46. Connectivity between the potential habitat patches of the chosen species in the Baltic Sea. The table shows the number of habitat patches in the BSPA, SCI, SPA and BSPA/N2000 networks in each connectivity category (no connections, 1-3 connections, 4-6 connections, 7-10 connections and >10 connections) for the species-specific dispersal distance. The total number of patches and clusters in each MPA network is also provided. (Status: July 2009)

Species	Dispersal distance [km]	MPA type	Number of habitat patches with the given number of connections					Total number of patches	Number of clusters
			No conn.	1-3 conn.	4-6 conn.	7-10 conn.	>10 conn.		
Macoma baltica	100	BSPA		4	4	17	1394	1419	6
		SCI			4	23	2640	2667	1
		SPA			8	14	1906	1928	1
		BSPA/N2000				12	3179	3191	1
Psetta maxima	25	BSPA	6	20	35	80	3712	3853	34
		SCI	5	27	65	105	5382	5584	25
		SPA	5	22	61	80	4147	4315	31
		BSPA/N2000	3	26	62	102	6456	6649	20
Furcellaria lumbricalis/ Idotea baltica	25	BSPA	4	18	42	48	3453	3565	35
		SCI	5	24	58	92	4922	5101	29
		SPA		32	74	39	3951	4096	39
		BSPA/N2000	4	30	58	81	5981	6154	27
Fucus vesiculosus	1	BSPA	143	1053	729	442	1198	3565	415
		SCI	291	1726	1069	666	1349	5101	790
		SPA	207	1426	808	506	1153	4100	594
		BSPA/N2000	325	1899	1093	611	2226	6154	860

ated among all patches. A closer look at landscape type distribution and the species inhabiting these landscapes would be needed to evaluate the connectivity of the protected area networks more thoroughly. Certain landscape types, for example, might serve as stepping stones for dispersing species, thus providing connection between landscape patches otherwise far apart from each other.

The species-specific analysis revealed good connectivity in all four networks for species with dispersal distances of 25 km and more. The best degree of connectivity was therefore provided for the species with the largest dispersal distance of 100 km. The habitats of *Fucus vesiculosus*, which has a very short dispersal distance, were less well connected. The BSPA/N2000 network provided the best level of connection in all cases.

1.5 Discussion

Nowadays, the concept of ecological coherence is widely used and has been adopted in various fora, including the EC Habitats Directive (1992), the Convention on Biological Diversity (1992) and several regional sea organisations such as HELCOM and OSPAR. The term ecological coherence has not been formally defined and there are very few practical and theoretical examples of the assessment and analyses of the ecological coherence of a network of MPAs. Nevertheless, it is a major aim of HELCOM to establish an ecologically coherent network of well-managed marine protected areas in the Baltic Sea by 2010. As such, the HELCOM definition for ecological coherence is for the most part identical to that of the IUCN (International Union for Conservation of Nature) and OSPAR. The definition addresses the four assessment criteria of adequacy, replication, representativity and connectivity. In practice, these criteria take into account the size and shape of MPAs, the coverage of species, habitats and landscapes, the location of MPAs across biogeographic scales, as well as replication and between-site connections on different scales (HELCOM 2009).

To assess progress towards the 2010 target, the HELCOM BSPA database was updated using a comprehensive questionnaire that required the HELCOM Contracting States to scrutinize all the information available for their BSPAs. With the designation of new BSPAs and an adjustment of the geographical expansion of several sites, the area covered by designated and managed BSPAs was considerably augmented since the previous assessment in 2008.

In total, 10.3% of the HELCOM marine area is currently protected by BSPAs, compared to only 3.9% six years ago and 5.5% two years ago. The increase in the total area protected and the designation of several new sites are a positive development, but there are still several potential BSPAs that have not been nominated by Contracting States. A total of 40 BSPAs still remain either recommended by HELCOM Recommendation 15/5 or proposed by Hägerhall and Skov (1998). Furthermore, a large area in the Baltic Sea protected by Natura 2000 sites under the Habitats or Birds Directive has still not been assigned to HELCOM. This in spite of agreement by the Contracting States to, where appropriate, designate by 2009 already existing Natura 2000 sites as HELCOM BSPAs. While some countries quickly moved forward, designating more and more of their Natura 2000 sites as BSPAs, others still have to catch up, and some plan to do so in the near future. However, it should be noted that more than 80% of the approximately one thousand Natura 2000 sites are smaller than the HELCOM minimum recommended size of 3000 ha for marine sites (HELCOM 2009). Natura 2000 sites should thus be expanded by annexing additional adjacent areas or several Natura 2000 sites should be combined into larger BSPAs. The latter option seems feasible, because several Natura 2000 sites share the same borders or even overlap due to the distinction made between Site of Community Interest (SCIs) designated under the Habitats Directive and Special Protected Areas (SPAs) designated under the Birds Directive.

Since more than 75% of the BSPAs (based on the 89 assessed BSPAs designated by July 2009) are larger than 3000 ha as suggested by HELCOM, the current size distribution of BSPAs can be considered acceptable. Once the minimum size requirement is met, variations in the size and shape of BSPAs becomes beneficial in the drive towards ecological coherence based on the adequacy criteria. While small reserves are easier to plan and manage and the large edge-to-area ratios allow


Caspian tern (*Sterna caspia*)

for high spill-over rates, these zones will function best if there are essential linkages among the sites. Nevertheless, they harbour many non- or rarely-migrating species and serve to sustain ecosystem heterogeneity. Larger areas, better protecting rare and fragmented habitats, may retain pristine ecosystems, and are generally less vulnerable.

The analysis of the updated HELCOM GIS database revealed that the quantity of BSPAs varied considerably among the Contracting States, and so did the proportion of protected marine area. While Germany was in an unrivalled position with a protected marine area of nearly 30%, followed by Poland with 24% and Denmark with 22%, the other Contracting States designated between 3 and 7% of their marine area as BSPAs. However comparison of the aggregated marine BSPAs showed that Sweden protected the largest region. But since Sweden has a Baltic Sea marine area (EEZ + TW) considerably larger than the that of the other Contracting States, the protected area is proportionally quite small.

Not only does the extent of each country's EEZ differ considerably but so does its expansion into offshore and more coastal areas. Some states have much larger offshore areas than others, which in general are far less protected than near shore or coastal areas. Hence the protection effort required varies greatly among the Contracting States. Furthermore, it is important to note that HELCOM has not yet agreed on any target for the proportion of Baltic Sea Marine area that should be covered by BSPAs. However, the World Summit on Sustainable Development, and subsequently the Convention on Biological Diversity, have recommended a global target of 10% of all marine ecological regions to be effectively conserved by 2012 (HELCOM 2009). Combining the marine protected areas of BSPAs and Natura 2000 sites plus Russian Ramsar sites and the five Finnish BSPAs which are still in the designation process, the 2010 target of 10% protection would be met with protection for 12.3% of the marine Helsinki Convention Area. Nonetheless, this does not hold true for all Contracting States if their marine areas are independently analysed. Finland, Latvia, Russia and Sweden would fail to reach the desired 10% protection limit for their marine environment. While Finland protects more than 10% of its TW, the latter three countries have not reached the 2010 target for their TWs. On the whole, however, more than 18% of all TWs in the Baltic Sea is protected by 84% of all BSPAs and Natura 2000 sites. By contrast, protection of the EEZs by a combined Natura 2000 - BSPA network remains deficient, with only about 5% of the total EEZ area protected. Despite the decision taken to designate existing Natura 2000 sites (where appropriate) as HELCOM BSPA (HELCOM 2007a) by 2009, only 83% of the total marine Natura 2000 network has been nominated as BSPAs.

Apart from establishing an ecologically coherent network of BSPAs as a preliminary step, an additional goal of HELCOM is a well-managed MPA network. While all countries generally provided good feedback to the survey, several BSPAs still lack important information particularly regarding their management measures. As a result, it is not possible to fully assess the protection efficiency of the current network. No information on management status was provided for ten sites and for 14 sites no data on regulated activities were provided. Nonetheless, appropriate management measures are crucial for securing the long-term protection and efficiency of sites. At present, management plans exist for less than half of all BSPAs.

In addition to a lack of information about management measures, the updated database is still short on data about protected species and habitats or biotopes for several BSPAs. Based on the information provided, it can be observed that a more intense protection efforts should focus on threatened and/or declining species and habitats/biotopes listed in HELCOM 2007c. In particular the fish species listed therein lack protection, as only half of the 26 species are reported to be protected in BSPAs. With regard to the listed habitats/biotopes, at least two are in need of more protection measures as they are not represented in any BSPA: these are ‘shell gravel bottoms’ and ‘sea pens and burrowing megafauna communities’. For a further three habitats/biotopes no information was provided in the database.

The overall lack of information, especially on the distribution of underwater species and habitats as well as on ecological processes, made the evaluation of the ecological coherence of the network of MPAs in the Baltic Sea difficult. In practical terms, the assessment defines the extent to which ecological coherence has not been achieved rather than laying out whether or not it has been achieved. Because ecological coherence is a holistic concept that relies on many constituent parts, it is much easier to prove that a network is not ecologically

Rocky bottom, Skorv (*Saduria entomon*)

coherent than to provide evidence to support its ecological coherence.

At this point, it is not possible to measure the ecological coherence of the Baltic Sea, but the approach applied in this assessment provides valuable insights into the state of the network. As such, it can be observed that the network of BSPAs is by far most adequate in terms of the size of sites, while the network of Natura 2000 sites is inconsistent with the given HELCOM recommendation. The quality of all assessed networks can be described as inadequate with respect to eutrophication status, shipping traffic and fishing intensity. Nonetheless, it must be remembered that the value of this conclusion is severely limited due to the coarse resolution of the data sets provided. More precise spatial data would be needed to provide more reliable information on the quality of the MPA networks. The same holds true for the adequacy assessment in terms of the protection of indicator species and biotopes.

While the BSPA network was found to be inadequate because not all indicator species and biotopes were protected, a more in-depth evaluation would require information on the distribution of the species and biotopes assessed. Such information was provided for charophyte species and *Zostera marina* and *Z. noltii*. It was found that adequacy in terms of protection of *Zostera* habitats is limited within all networks. On the other hand, Charophyte species were reasonably well protected. Although spatial information was provided, each of these data sets has its limitations, which should be kept noted when interpreting the results.

The assessment of adequacy in terms of the coverage of IBAs revealed that the combined BSPA/N2000 network is most adequate, protecting about 60% of the IBA area in the Baltic Sea. The BSPA network alone protects only half of that.

Representativity was assessed with respect to indicator species and biotopes, marine landscapes and geographical distribution. It was found that full representation of all indicator species and biotopes in the BSPA network was not provided. However, in terms of adequacy, observe that the natural distribution of the species and biotopes was been taken into account. Consequently, it is not possible to determine whether or not the representation of the species and biotopes present in the net work is adequate.

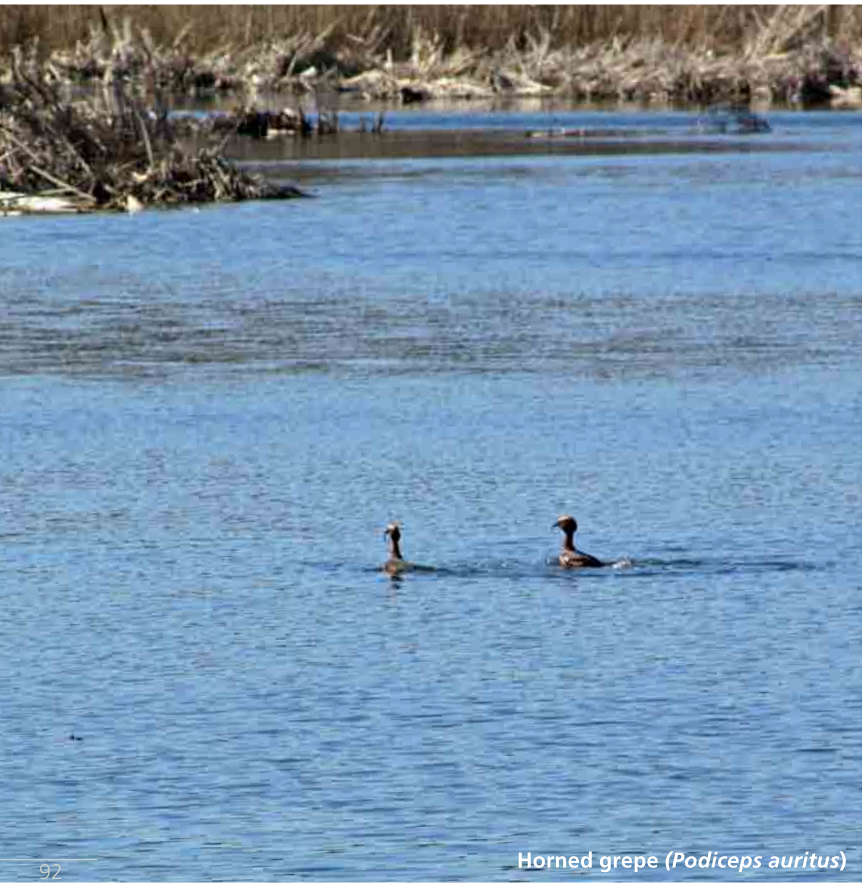
Analysis of the second aspect, the benthic marine landscape representation, revealed that most of the landscapes were inadequately represented, accounting for less than 20% of the total area of MPAs. This lower value of landscape representation was derived from the Balance project (Piekäinen and Korpinen 2007). However, the optimal level of habitat protections always depends on the aim and perspective of protection. For example, protection of a highly mobile species requires conservation of a larger area (Roberts and Hawkins 2000).

Analysis of the geographical distribution of MPAs revealed that more than 80% of each network was located in the TW zone, proving the EEZ to be severely underrepresented. Only the German and Swedish networks as well as the SCI, SPA and BSPA/N2000 networks in Poland provide adequate geographical distribution in their respective EEZs. The application of an offshore index to analyse the geographical representation of the networks of protected areas revealed an analogously strong imbalance. Very few MPAs were found to have a high offshore index indicating that only a very small fraction of the networks was located in areas with high offshore-conditions.

Since it was not possible to assess the replication of all features within the network of MPAs, the replication of indicator species and biotopes, as well as benthic marine landscape types was defined. The information provided showed the need for enhanced replication for most of the chosen indicator species. While the final number of replicates depends on the occurrence and distribution of the species, sites should target the theoretical minimum of three replicates. Where possible, a more precise number should be prescribed based on the species and on case-by-case evaluations.

Of all the species present within the BSPA network, special attention should be paid to *Fucus serratus, Zostera marina*, and the three fish species *Alosa fallax, Anguilla anguilla* and *Gadus morhua,* since they were severely underrepresented. The one indicator biotope type that is in most dire need of increased replication is 'Macrophytes'. By and large, the number of replications should be increased for most of the indicator biotopes to ensure adequate replication. For benthic marine landscape type replication it was found that many, but not all, were adequately replicated among and within MPAs. It can therefore be said that the SCI network provided adequate replication for the highest number of landscape types. Those landscape types which were not adequately replicated should be included in future BSPA designations.

Connectivity was assessed for a set of five landscape types, on the basis of a theoretical approach, and for five species. The assessment revealed the need for improved connectivity for many of the landscape types in all networks. For very scarce and dispersed landscape types, however, connectivity may not be achieved among all patches. Future analysis should take a closer look at landscape type distribution and the species inhabiting the landscapes to evaluate the connectivity of the protected area networks more thoroughly. For example, certain landscape types might serve as stepping stones for dispersing species, thus providing connection between landscape patches far apart from each other.



Horned grepe *(Podiceps auritus)*

The species-specific analysis revealed good levels of connectivity in all four networks for species with dispersal distances of 25 km and more. The best connectivity was thus provided for the species with the largest dispersal distance of 100 km. The habitats of *Fucus vesiculosus*, which has a very short dispersal distance, are less effectively connected. In all cases, the BSPA/N2000 network is provided the best degree of connection.

Overall, the assessment of the ecological coherence of the BSPA network provides evidence of positive developments during the past few years. However, the network cannot yet be considered ecologically coherent. Consequently, the Contracting States should invest greater effort into meeting the set targets. While EU Member States are obliged to designate, protect and manage Natura 2000 sites, and the European Court of Justice may punish non-compliant Member States, HELCOM has no direct legal power. Nevertheless, HELCOM Contracting States committed to taking any necessary legislative action at a national level following the guidelines provided by HELCOM Recommendation 15/5 (HELCOM 1994). If these HELCOM Guidelines on the designation and management of BSPAs were fully complied with, marine conservation would no doubt be more effective.

Furthermore, the procedures for the collection of data in the Baltic Sea as well as for the provision of data should be improved and standardised to provide a better basis for future assessments. It is hoped that the development of a common approach to EU maritime spatial planning and the implementation of the EU Marine Strategy Framework Directive will improve the availability and quality of research data. Finally, new criteria and strategies for the assessment of ecological coherence should be developed. These future proceedings alongside compliance with the HELCOM Recommendations and the Baltic Sea Action Plan should lead to further improvements in adequacy, representativity, replication and connectivity, thus providing the basis for a well-managed and ecologically coherent network of marine protected areas in the Baltic Sea region.

2 Selecting an efficient and representative network of BSPAs

2.1 Introduction – Systematic site selection

Until recently, most efforts to establish marine protected areas focused on areas with scenic and recreational value, or on ways to conserve individual species or habitats. In many cases these represented national approaches, and often led to the creation of *ad hoc* near-shore networks with substantial redundancy and many shortcomings (Fischer & Church 2005). As environmental degradation increases and more species become threatened or decline, there has been a growing interest towards designing more comprehensive, ecologically coherent networks of MPAs. Today it is widely accepted that only ecologically coherent networks can adequately satisfy the conservation needs of marine eco-regions governed by MPAs. However, well-managed MPA networks should also adequately take account of social and economic considerations. This approach is also supported by many international agreements (such as CBD COP7 2004, UN WSSD 2002) and EU directives (such as EU Marine Strategy Framework Directive, EU 2008). The Baltic Sea represented one of the vanguards of this thinking, when in 2003 HELCOM decided to implement an ecosystem approach to the management of human activities and the sustainable use of resources. In addition, the 2003 HELCOM/OSPAR Joint Work Programme (JWP) on MPAs called for the establishment of a well-managed and ecologically coherent network of BSPAs and OSPAR MPAs by 2010.

The ecological coherence analyses concluded that there had been positive developments in recent years and that HELCOM countries now protect over 10% of the Baltic Sea area - thus reaching the 10% target set by the seventh Conference of the Parties of the Convention on Biological Diversity in 2004 (CBD COP7). In spite of these gains, the network cannot yet be considered to be adequate or ecologically coherent from several perspectives. One reason for this conclusion is the fact that since 2003 all HELCOM countries have designated their new BSPAs on a national basis. A more systematic approach is needed to develop a comprehensive regional network covering the full range of Baltic Sea biodiversity and to ensure that responsibility is equitably shared among HELCOM countries on the basis of their respective ecological needs. There is a clear need for the designation of new sites, particularly in offshore areas. As our limited marine areas face increasing competing demands, it may be necessary to adopt a more systematic approach to marine conservation and site selection. This process must be seen as an important aspect of the implementation of the ecosystem approach and the fulfilment of the JWP.

Programmes and measures for marine conservation involve finding effective sets of protected areas and meeting quantitative targets, for example protecting 30% of the range of each species as cheaply as possible (Carwardine et al. 2009). This is referred to as the *minimum-set problem* where the goal is to achieve some minimum representation of biodiversity features with the lowest possible cost (Possingham et al. 2006). To a large extent, such systematic conservation planning follows the same criteria as those set out for an ecologically coherent network of MPAs and its design (see inter alia Lötter et al. 2008). Systematic site selection has the advantage that the outcome remains intersubjectively-revisable, thereby ensuring better transparency and defensibility of the process (Leslie et al. 2003). Another compelling benefit of this tool is that it provides different options for discussion depending on the preconditions used. Additionally, a wide variety of computer-based models have been developed in recent years to facilitate optimal site selection, (Fischer & Church 2005, Sarkar 2006).

The aim of this report is to introduce and discuss the possibilities of using a systematic tool such as Marxan to efficiently design and complement the existing Baltic Sea Marine Protected Areas network. The computer-based decision support tool *Marxan* (version 1.8.10, Game & Grantham 2008) and the Marxan interface *Zonae Cogito* (version 1.22, Watts et al. 2009) were used to identify a set of representative networks of BSPAs in the Baltic Sea. The EU-funded Balance project was the first to use Marxan for the Baltic Sea area in 2007 (Liman et al. 2008). One of the findings of the analysis was that the exercise should be repeated for the Baltic Sea as new information became available. Due to time constraints, these HELCOM 2010 Marxan analyses largely make use of experiences and expert recommendations compiled by the EU-funded Balance project, while adding new and updated information (data), where available, and incorporating any recent political objectives/commitments, where applicable.

2.1.1 Marxan: a tool for site selection

Marxan is software that delivers decision support for MPA selection and network design (Possingham et al. 2000, Possingham et al. 2008) by identifying efficient and comprehensive “portfolios” of suitable planning areas that satisfy a number of ecological, social and economic objectives. Marxan aims to achieve the user-defined biodiversity targets in the most cost-efficient manner with minimum cost. Cost can be a monetary value but it can also be measured using any other relative social, economic or ecological variable.

Marxan allows the user to define and vary many aspects of the problem such as the number and types of conservation features included in the analysis, the target for each conservation feature, the importance of meeting targets for these conservation features, the status of planning units and the cost of each planning unit in the proposed MPA network. The evaluation of multiple scenarios is one of the major strengths of Marxan. One of the most useful outputs from the decision support software is the information provided about planning unit selection frequency. This output shows how often each planning unit is selected for the network and shows those networks that solve the “problem” optimally. Marxan also provides a ‘best scenario’ output, which identifies the planning units that meet all conservation targets at the lowest cost.

Marxan has been used successfully by planning teams across the world, including the Baltic Sea (Liman et al. 2008). The Marxan software can be freely downloaded at http://www.ecology.uq.edu.au and was the main tool used for the HELCOM 2010 site selection analysis. The software Zonae Cogito (Watts et al. 2009), a decision support and database management system designed to supplement Marxan, was also used in the HELCOM analyses. This software, which incorporates open-source

GIS software components, was used to prepare the Marxan input files, execute some of the actual calculations and to analyse results.

2.2 Methodology

The overall aim of the analyses was to identify selected networks that comprehensively protect species, habitats and nature types of the marine and coastal ecosystems of the Baltic Sea area as required by HELCOM Recommendation 15/5 (1994) and the HELCOM Baltic Sea Action Plan (BSAP) (HELCOM 2007). Conservation objectives were also defined taking into account the EU Habitats (1992) and Birds (1979) Directives as well as other international recommendations.

A suitable network should represent adequate quantities of the entire range of species, habitats and ecological processes in the Baltic marine area and should also ensure sufficient representation in each of the sub-basins where they occur. To minimize conflicting interests, major human activities and their impacts should also be taken into account.

2.2.1 Conservation features

A conservation feature is a measurable and spatially defined component of biodiversity to be conserved within the protected areas network. Conservation features may be of different scales; they may represent species, communities, habitats, and so on. In Marxan each conservation feature is given a conservation target indicating how much of the respective feature should be represented in the network. The quantity may be given as percentages, areas (for instance in ha) or occurrences.

Site selection processes generally use biodiversity surrogates to capture all components of biodiversity (e.g. all species or entire ecosystems) since there are often insufficient temporal or budgetary resources available to conduct adequate surveys (Sarkar et al. 2006). In Marxan these surrogates are called *coarse filter features*. Coarse filter features cover most or all of the planning area and usually do not consider any single species. In addition to these broader scale features, so-called *fine filter features* are usually included. These are data for selected species or habitats which are not adequately represented by the coarse filter features such as rare, threatened or endangered species or keystone species (Beck et al. 2003).

Ideally, one would be able to select the most relevant features for both coarse and fine filter features based on expert consultations, literature reviews and relevant political frameworks. In this analysis, due to time constraints, it was necessary to base the analyses mainly on work already completed as part of the Balance project and to use other available data. The data and methods used in this analysis are described in the following sub-chapters

Coarse filter features

The Balance project mapped *benthic marine landscapes* of the Baltic Sea (Al-Hamdani & Reker 2007) and used this dataset as the main conservation feature for the Balance Marxan analyses. This data layer also constituted the most comprehensive conservation feature used in this analysis. The modelled data is based on bottom substrate, photic depth and salinity (**Table 47, Figure 10**). Altogether 60 benthic marine landscapes were identified in the Baltic Sea, which could be seen as a surrogate for broad-scale variation in the biodiversity of the Baltic Sea region. Some of these benthic habitats are widespread in the region while others cover only very limited areas. In summary, eight of the 60 benthic marine landscapes identified cover the majority of the seabed while 40 benthic habitats cover less than 1% each. The most abundant benthic marine landscapes include non-photic mud, non-photic hard clay, non-photic sand and non-photic hard bottom complexes.

Table 47. Surface sediment, sea floor salinity and depth zonation used to model the 60 benthic marine landscapes (Al-Hamdani & Reker 2007).

Surface sediment	Bedrock
	Hard bottom complex
	Sand (fine to coarse sand)
	Hard clay
	Mud
Sea floor salinity	Oligohaline 0-5 psu
	Oligohaline 5-7.5 psu
	Mesohaline 7.5-11 psu
	Mesohaline 11-18 psu
	Polyhaline 18-30 psu
	Euhaline >30 psu
Depth zonation	Euphotic zone, photic depth (defined as 1% surface irradiance reaches the seafloor)
	Non photic zone, below the photic depth

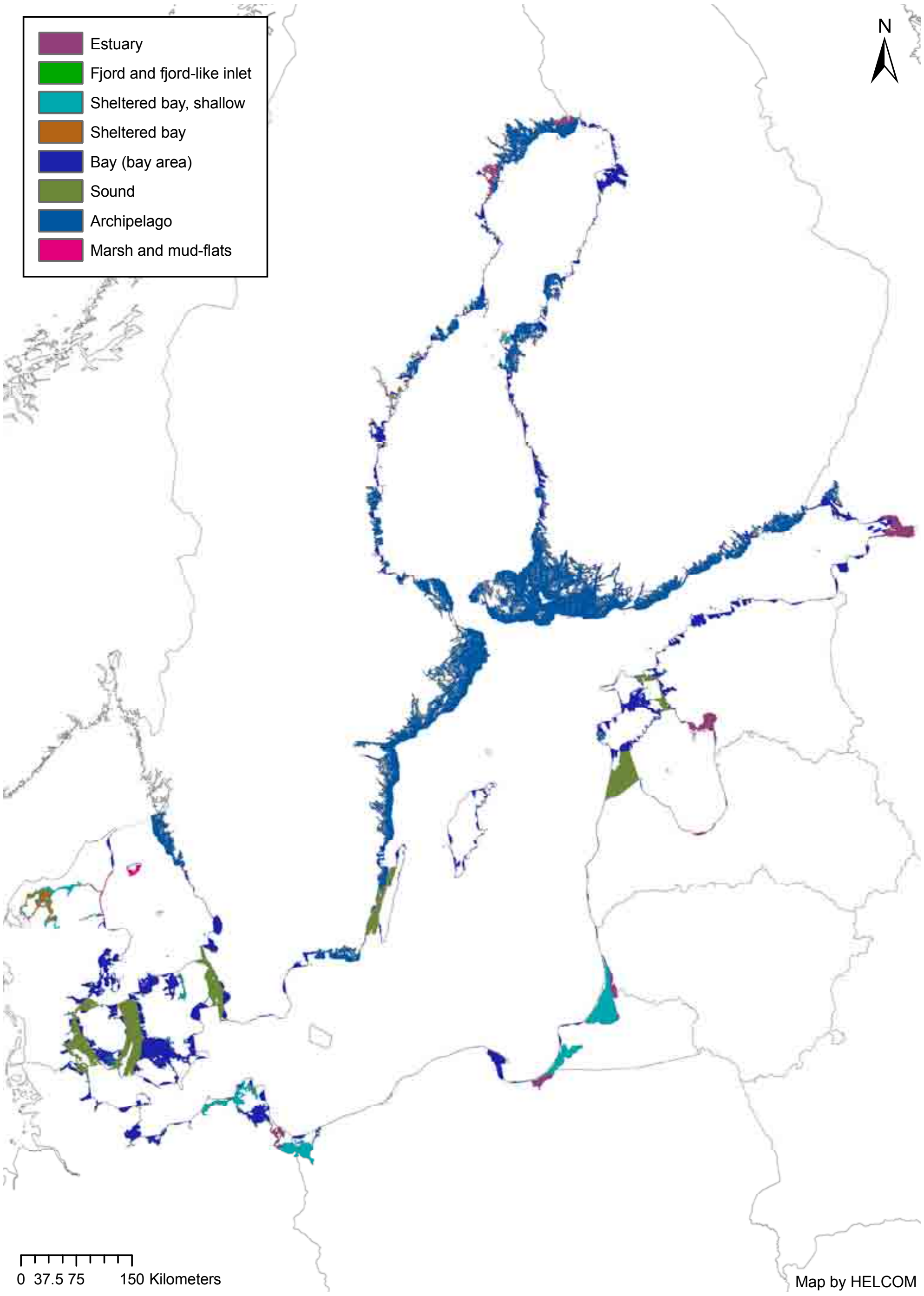


Figure 33. Coastal physiographic features based on a modelled data set by Al-Hamdani & Reker (2007) and modified using additional data from the EEA Corine Land Cover dataset. Note: These features are different from the natural habitat types shown in Annex I, EC Habitats Directive.

Coastal physiographic features, also modelled in the Balance project, were used as another surrogate for broad scale biodiversity (Al-Hamdani & Reker 2007). This data set indicated different environments in the transitional zone from land to sea and illustrated the physiographic complexity of the near-shore environment including estuaries, lagoons and lagoon-like bays, sounds, archipelagos and estuaries. For the HELCOM Marxan analyses, the data set was modified using additional records on bays, estuaries, marshes and mud-flats from the EEA Corine Land Cover data set[8] (**Figure 33**).

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[8] The data was downloaded from the web page of the European Environment Agency (EEA): http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-coastline (Last accessed 10 March 2010). The EEA classification and map is not at consistent with/does not reflect natural habitat types of Annex I, Habitats Directive.

Table 48. Data layers used as fine filter features and their origin.

Charophyte richness	Number of Charophyte species (0 to 8 species) per 20x20 km squares. Data based on Schubert & Blindow (2003).
Grey seal haul-outs	Central coordinates of grey seal (*Halichoerus grypus*) haul-out and breeding sites in the Baltic Sea. Data collected by the German Federal Agency for nature Conservation (BfN) from the HELCOM Seal Expert Group members (Maschner 2009).
Important Bird Areas	Areas identified by BirdLife International (2000) as "important coastal and marine bird areas in the Baltic Sea". The data includes wintering, feeding and breeding areas. The influence of existing and approved wind farms on the quality of the bird area was taken into account by giving the wind farms a five kilometre impact distance and this was used to cut the bird areas layer.
***Mytilus* densities**	Modelled in the EU-funded Mopodeco –project in 2009. The data is based on the mean carrying capacity for *Mytilus trossulus* during the period 2000-2007. The data was treated as "higher" and "lower" densities and separate targets were given to each. Higher densities were used as a surrogate for mussel reefs.
***Zostera* distribution**	Spatial data received from national contact points in Denmark, Germany and Estonia including *Zostera marina* and *Z. noltii*. The dataset was amended with lower quality data based on Boström et al (2003). The lower quality *Zostera* points were given a 2 kilometre buffer to increase the probability of including actual *Zostera* locations in the network.

Fine filter features

To ensure that the Baltic Sea biodiversity is well represented in the selected protected areas network, as much relevant data as possible was compiled to support the coarse filter features. The complete list of data layers used as fine filter features is detailed in **Table 48** (**Figure 34**).

a)

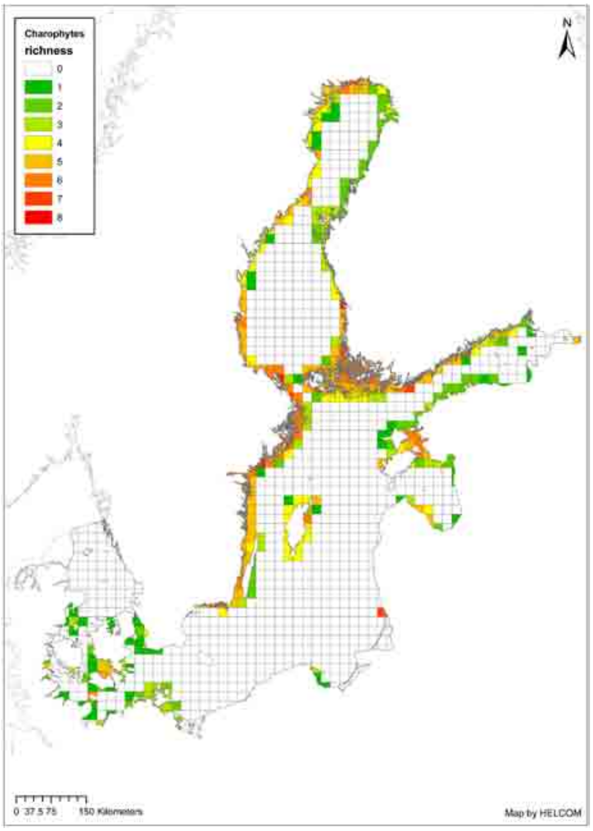

Figure 34. a) Charophyte richness map. Richness = number of species.

b)

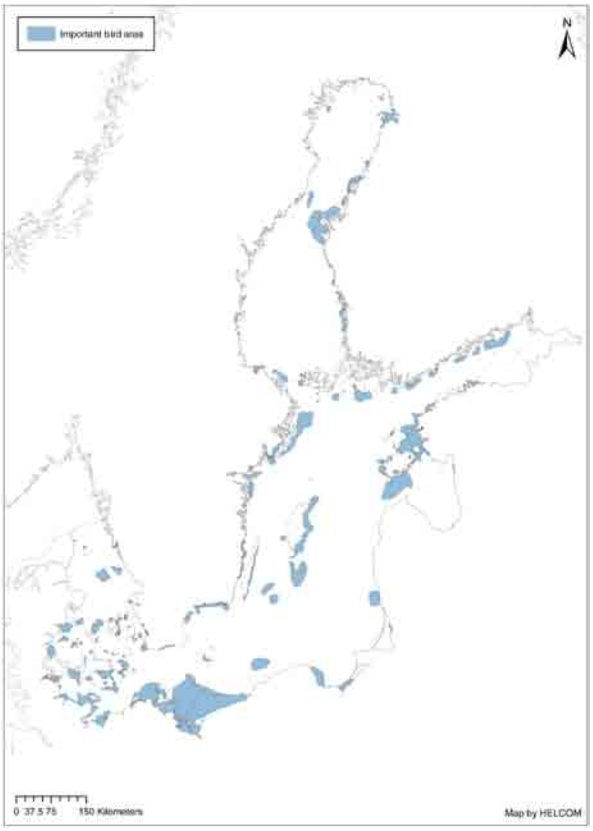

Figure 34. b) map of the Important Bird Areas.

c)

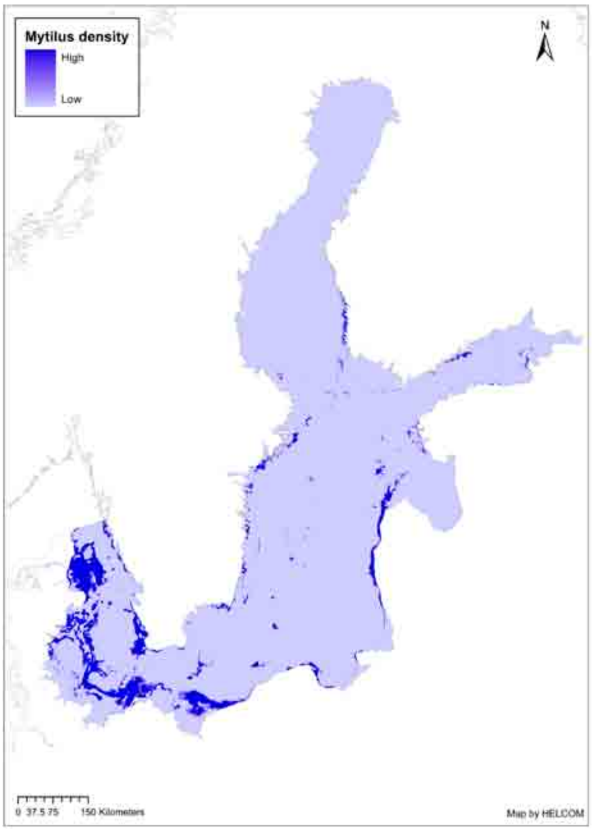

Figure 34. c) *Mytilus* densities map.

d)

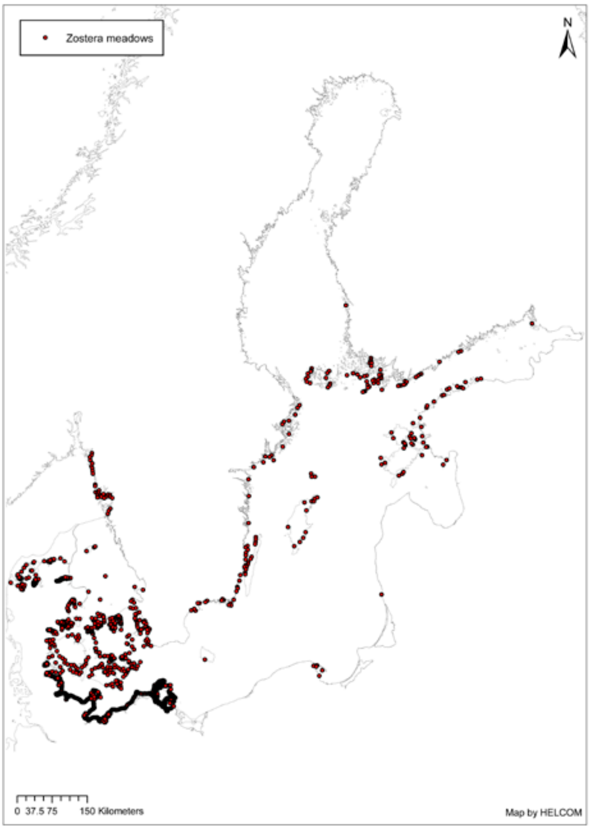

Figure 34. d) Map of *Zostera* meadows.

2.2.2 Study area, stratification and existing marine protected areas

The study area for the Marxan analyses was defined as the HELCOM marine area, including the Baltic Sea and the Kattegat. As such, the data used were adapted to include data only from that area. The study area was also divided into sub-regions a) according to the HELCOM sub-basins Bothnian Bay, Bothnian Sea, Gulf of Finland, Baltic Proper, Gulf of Riga and Kattegat and b) the exclusive economic zones (EEZ) of the nine HELCOM countries (**Figure 9**). The study area was segmented to allow for stratification of the analyses, meaning that it would then have been possible to set a minimum conservation requirement (12%, 20% or 30%) for each sub-region. This was done to ensure that site selection would not be biased by the availability of more data from some sub-regions compared to others, and to maintain equity among the countries, e.g. it would not be fair if one country had to protect 50% of its EEZ while another only protected 5%.

At present the Baltic Sea Protected Areas together with marine Natura 2000 sites cover slightly more than 12% of the Baltic Sea. These existing MPAs were *locked in* to the analyses meaning that the networks proposed by Marxan would include the existing areas, as well as suggestions for additional cost-efficient areas. For comparison, analyses were also carried out without locking in the existing BSPAs and marine Natura 2000 sites – with results proposing the most cost-efficient networks based only on the input data on conservation features and socio-economic costs.

2.2.3 Setting the conservation targets

The conservation targets used in the Marxan analyses were set to reflect both existing political agreements and scientific recommendations. Each conservation feature was given lower and higher conservation targets reflecting minimum as well as more ambitious conservation goals. Ideally, setting targets for each conservation feature should be based on assessments or at least on expert consultations (Lieberknecht et al. 2008). In the case of the HELCOM 2010 Marxan analyses, time constraints did not allow for conducting extensive expert hearing rounds. Target setting

Long-tailed duck (*Clangula hyemalis*)

was therefore based on the work carried out in the Balance project while additional guidance came from scientific literature, existing international legislation (e.g. EU directives) and other agreements which require certain proportions of important features and/or areas to be protected, such as the CBD 10% international target (CBD 2004). The work also referenced the World Parks Congress recommendation that "marine protected area networks should be extensive and include strictly protected areas that amount to at least 20-30% of each habitat" (IUCN 2003).

A number of scientific studies attempt to define how much sea area should be protected in order to allow fish stocks to grow. MPA sizes ranging from 10-50% of the total area have been suggested as being efficient for conservation and/or fisheries management (e.g. Rodwell and Roberts 2004, Roberts and Hawkins 2000). Other scientific studies have concluded that at least 30-50% (Airamé et al. 2003) or 20-50% (Saldek Nowlis & Friedlander 2005) of each habitat type should be protected to ensure viable populations.

Like the Balance analyses, the conservation targets used in the 2010 HELCOM Marxan analyses make use of the recommendations and political agreements mentioned above. Nevertheless, with respect to benthic marine landscapes, HELCOM decided not to use uniform targets for all marine landscapes as the Balance analyses do (Liman et al. 2008). This apart, it was felt that the study should favour ecologically important and/or rare benthic marine landscapes, to avoid Marxan choosing huge areas of deep sea mud from areas heavily influenced by oxygen deficiency (< 2 mgO/l), mainly in Kattegat and the western Baltic Sea. For example, the soft substrates in the non-photic zones are among the most common landscapes covering very large areas of the Baltic seabed, and for which there is generally less interest in conservation. Even if only 10% of such areas were protected they would altogether constitute over 1.3 million hectares.


Matsalu salt marshes, Estonia

One way of dealing with this type of data is to use proportional targets based on the overall prevalence of the conservation feature (Ardron 2007, Lieberknecht et al. 2008). It was decided to use this approach as a starting point for defining targets for benthic marine landscapes. The ecological significance of each benthic marine landscape was also considered and the targets were set based on both of these considerations. To arrive at a manageable number of benthic marine landscapes, salinity classes were not considered separately for their ecological significance. The targets given for the 10 selected benthic marine landscapes are shown in **Table 49** (**Figure 32**).

Conservation targets for other conservation features are listed in **Table 50**. The lower conservation targets aim to reflect the bare minimum conservation effort required to fulfil the most basic obligations set by international agreements and scientific studies. Reaching these goals could be used as a starting point for expanding the comprehensiveness of the existing BSPA network. The higher conservation targets, on the other hand, reflect slightly more ambitious conservation goals and could be considered to be more long-term.

2.3 Scenarios

Marxan outcomes were calculated for 16 different scenarios. These scenarios were analysed on the basis of different minimum sub-regional coverage levels (12, 20 and 30%) and according to the con-

Table 49. Conservation targets for benthic marine landscapes.

Benthic marine landscape	Light	Lower conservation target%	Higher conservation target%
Bedrock	Photic	25	30
	Aphotic	15	20
Hard bottom complex	Photic	20	25
	Aphotic	10	15
Sand	Photic	25	30
	Aphotic	15	20
Hard clay	Photic	15	20
	Aphotic	5	10
Mud	Photic	20	25
	Aphotic	5	10

Table 50. Conservation targets for other conservation features except benthic marine landscapes.

Conservation feature	Lower conservation target%	Higher conservation target%
Coastal physiographic features	20	60
Other important coastal features (marshes and mud-flats)	10	30
Important bird areas	10	30
Charophyte richness	20	20
Zostera distribution	20	60
Grey seal haul-outs	20	60
Mytilus density, higher	20	60
Mytilus density, lower	20	20

servation targets set for the conservation features (high or low). Each of these alternatives was then explored with and without locking the existing BSPAs and marine Natura 2000 sites (**Table 51**).

Table 51. List of all scenarios examined.

Minimum sub-regional coverage	Conservation target
Existing BSPAs and Natura 2000 sites locked in	
0%	Low
	High
12%	Low
	High
20%	Low
	High
30%	Low
	High
No existing BSPAs or Natura sites locked in	
0%	Low
12%	Low
	High
20%	Low
	High
30%	Low
	High

2.3.1 Suitability layer

Marxan tries to meet all the biodiversity conservation targets by minimising other conflicting uses. In the Marxan analysis, each planning unit is given a relative suitability value or “cost”. Therefore, cost parameters can be used to influence selection of planning units in certain areas, over other areas of equal size, e.g. to favour the selection of planning units in areas of high biological integrity, or to lower socio-economic cost. Most often cost is calculated either as a function of area, or as an economic cost; however the cost of each planning unit can also reflect an ecological issue where high cost sites should be avoided, all else being equal.

Threat can also be used as a surrogate for economic cost, and if the threat cannot be abated then making the cost threatened sites areas higher will mean that the chosen MPA network design is less likely to be influenced by these external forces. The cost of planning units can be increased in areas that are important for economic activities, such as fishing, relative to areas that are less important for fishing. In this way, it is possible to explore methods for meeting ecological targets while minimising impacts on ongoing human activities, and integrating socio-economic and political factors into conservation planning (Sarkar et al 2006).

In a preparatory meeting aimed at generating ideas on how to proceed with the HELCOM 2010 Marxan analyses, it was decided that the planning unit costs would be determined using threat and socio-economic data combined with a suitability (or cost) surface. The experiences of the Balance project were used for elaboration of the suitability layer. The data used in the HELCOM suitability surface includes data on the following pressures/economic activities: oil terminals, harbours, shipping accident risk areas, shipping traffic density, human population density, industries and urban areas (**Table 52, Figure 36**).

Because each Marxan planning unit can only have one cost value, it was necessary to calculate the intensities of the various data layers on pressures and activities. By using GIS tools multiple data layers were pooled using multi-criteria analysis. This meant that it was also necessary to perform various transformations, scaling, standardization and weighting of data (Ardron et al. 2008). For example, each activity and pressure was given a score of relative intensity as well as distance of influence. These figures were largely based on expert consultations performed in the Balance project (Liman et al. 2007).

2.4 Marxan settings

The HELCOM marine area was divided into nearly 44,000 hexagonal planning units, each 1,039 hectares in size. Marxan uses these planning units as building blocks for potential MPA networks. Before running Marxan each of the planning units can be given a unique status to determine variables such as whether or not the planning unit is locked into the selected network. In our analyses the existing BSPAs and Natura 2000 sites were locked in for about half of the analyses. In addition each planning unit was given values for individual suitability (e.g. cost) and the amount of each conservation feature found in it.

The major input parameters in Marxan are the number of iterations performed for each analysis, conservation feature penalty value and boundary length modifier. Each of these parameters was

Table 52. List of data sets used in the development of the suitability layer.

Pressure/Cost	Dataset used for HELCOM 2010 analysis
1. Oil terminals	Oil terminals (last updated 2009) Data source: HELCOM MARIS
2. Harbours	Harbours (last updated 2009) Data source: HELCOM MARIS
3. Shipping accident risk areas	Accident Risk Areas – split into 3 different layers: e.g. Moderate risk, high risk and very high risk areas. Data source: MARIS 2004
4. Shipping lanes	Average monthly shipping density on the Baltic Sea. Data source: extracted from AIS database, processed by Finnish Meteorological Institute for the ShipNoDeff project.
5. Human population density	5*5 km grid. Estimated population density for 2010 adjusted to match UN total figures. Original dataset: World v3 dataset, produced by Center for International Earth Science Information Network (CIESIN), Columbia University, United Nations Food and Agriculture Programme (FAO) and Centro Internacional de Agricultura Tropical (CIAT). Converted to raster by Gedas Vaitkus (Baltic GIS portal).
6. Industries	Industries in the catchment area (December 2009). Data source: HELCOM Pollution Load Compilation database (PLC-4).

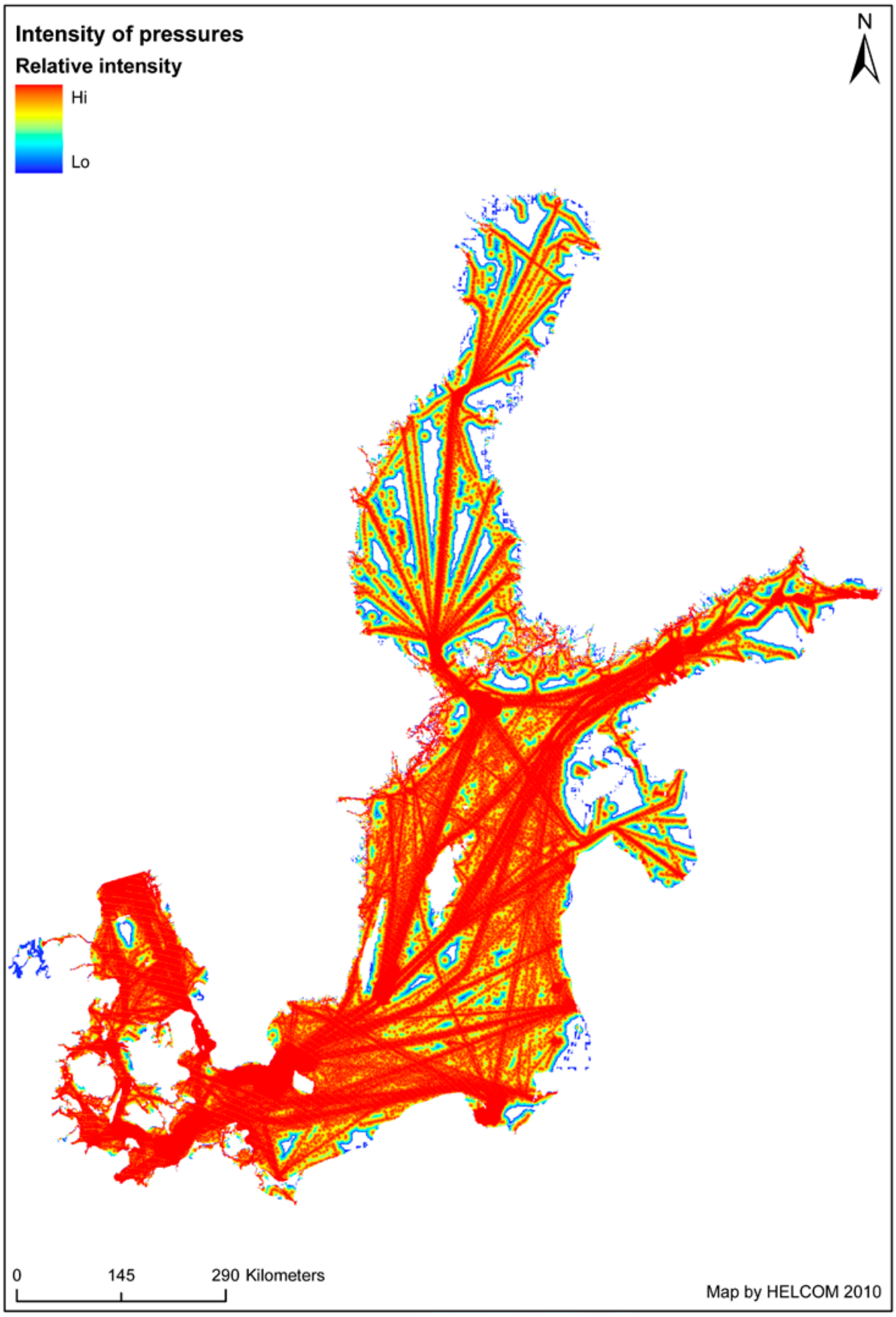

Figure 36. Map of the suitability surface summarising the cost of each grid cell based on a combination of the different data sets used.

separately determined for all scenarios using basic calibration. A wide range of values for each of these parameters was initially tested before conducting the actual analyses with those found to be most suitable.

Simulated annealing. Marxan uses an algorithm called simulated annealing to determine high quality and efficient solutions to large and complex problems (for more on simulated annealing see ***inter alia*** Ardron et al. 2008). The number of iterations determines how long the simulated annealing algorithm runs, meaning the number of times Marxan tries to build up an efficient network from the planning units. The greater the number of


Miller's thumb (*Cottus gobio*)

iterations, the more likely it is that the outcome will be efficient and will fulfil all conservation targets.

The number of iterations determines how long the simulated annealing algorithm runs, meaning the frequency with which planning units are swapped in and out of the proposed network. Usually at least hundreds of thousands to millions of iterations are needed. However, since large numbers of iterations can be time consuming, it has to be determined at what point the value of additional improvements is lost because of the extra computation time (Ball & Possingham 2000). An optimal number of iterations should result in outcomes with low total cost and which also produce equally good solutions with repeated computations. The number of iterations used for analysing the 16 scenarios varied from 4 to 6 million.

Conservation feature penalty value (or species penalty factor, SPF) is a weighting factor given to each conservation feature to determine the relative importance of reaching the targets set for that feature. This value can also be used to reflect the relative confidence of that data set or its spatial completeness, compared to others (Ardron 2007, Lieberknecht et al. 2008). In the 2010 HELCOM analyses, lower penalties were assigned to *Charophyte* richness and lower quality *Zostera* distribution data sets because it was not beneficial influence the outcome of the analysis with these weaker data sets. The penalty factor values used in the HELCOM analyses varied from 2 to 15.

Boundary Length Modifier (BLM) is the relative cost of an MPA's perimeter determining the importance given to the boundary length relative to total cost of the selected network. The larger the BLM value, the larger (but fewer) sites that will be selected, whereas a low BLM value will allow Marxan to choose several smaller sites. The BLM values used in the HELCOM analyses varied from three to 15.

2.5 Results

A range of scenarios (listed in **Table 51**) with varying total network coverage and different levels of conservation ambitions was analysed. Clear trends emerge from the results of the analyses. Rather than giving an exact answer to the optimal area or precise locations for new sites, the results reflect the weakness of the current in providing adequate protection to Baltic Sea biodiversity in light of the overarching HELCOM conservation objective. The results should be seen as examples of how Marxan can be used to assess and plan for a coherent network.

Two main types of Marxan outcomes are usually considered in the review of the results. These include the so-called *best portfolio* and the *summed solution*. The best portfolio is the outcome selected during repeated runs of algorithms that meet all conservation targets in the most cost-efficient manner. There are often many other outcomes which are almost as efficient as the best outcome. On the other hand, the summed solution indicates the number of times each planning unit is selected for the network in the set of repeated, independent runs of the algorithm (in other words, the selection frequency). Planning units that are repeatedly chosen are more likely to represent areas that would offer an effective and efficient network design. Areas selected more than 50% of the time usually represent locations likely to be most useful in the development of optimal protected area network solutions that use a minimum of area at the lowest cost (Nicolson et al. 2008). Less frequently selected areas on the other hand, provide greater flexibility in the sense that optimal solutions can be produced from a wider variety of location options.

All conservation targets were met in all of the scenarios studied. Additionally, more than the minimum conservation target was captured for several features, notably in scenarios where the existing Baltic Sea Protected Areas and Natura 2000 sites were locked into the network. **Table 53** provides an overview of the overall coverage of the Baltic Sea by BSPAs and marine Natura 2000 sites (in%) of the different scenarios, based on the best outcomes. The results show that when selecting a possible protected area network with no existing protected areas locked in, Marxan gives slightly more space-efficient outcomes than outcomes based on existing protected areas. This is not to say that existing protected area networks should be disregarded, but rather the findings indicate that in identifying sites complementary to the existing network, systematic site selection tools should be applied to find the most efficient outcomes that adequately protect the full range of biodiversity.

The results of some of the scenario analyses will now be discussed in more detail. Selection frequency maps and the parameters used for all scenarios are provided in Annex V. In the *Selection frequency* maps shown in **Figures 37-39**, red and orange indicate areas with high selection frequency and low flexibility whereas yellow indicates areas that offer more flexibility (which tells us that many alternative areas can be equally efficient in meeting the same target). Blue areas were selected less than 25% of the time and therefore are of lower priority. Areas with low flexibility are crucial in efficiently meeting the set conservation targets. They often cover conservation features that exist only in a specific area or that abut on an existing protected area and are therefore cost-efficient to include in the network.

Table 53. An overview of all scenarios and the total area selected as the best outcomes for each analysis.

Minimum sub-regional coverage	Conservation target	Selected area (%) of the Baltic Sea
Existing BSPAs and Natura 2000 sites locked in		
0%	Low	14%
	High	24%
12%	Low	17%
	High	24%
20%	Low	24%
	High	27%
30%	Low	33%
	High	34%
No existing BSPAs or Natura sites locked in		
0%	Low	11%
	High	21%
12%	Low	14%
	High	21%
20%	Low	22%
	High	24%
30%	Low	31%
	High	33%

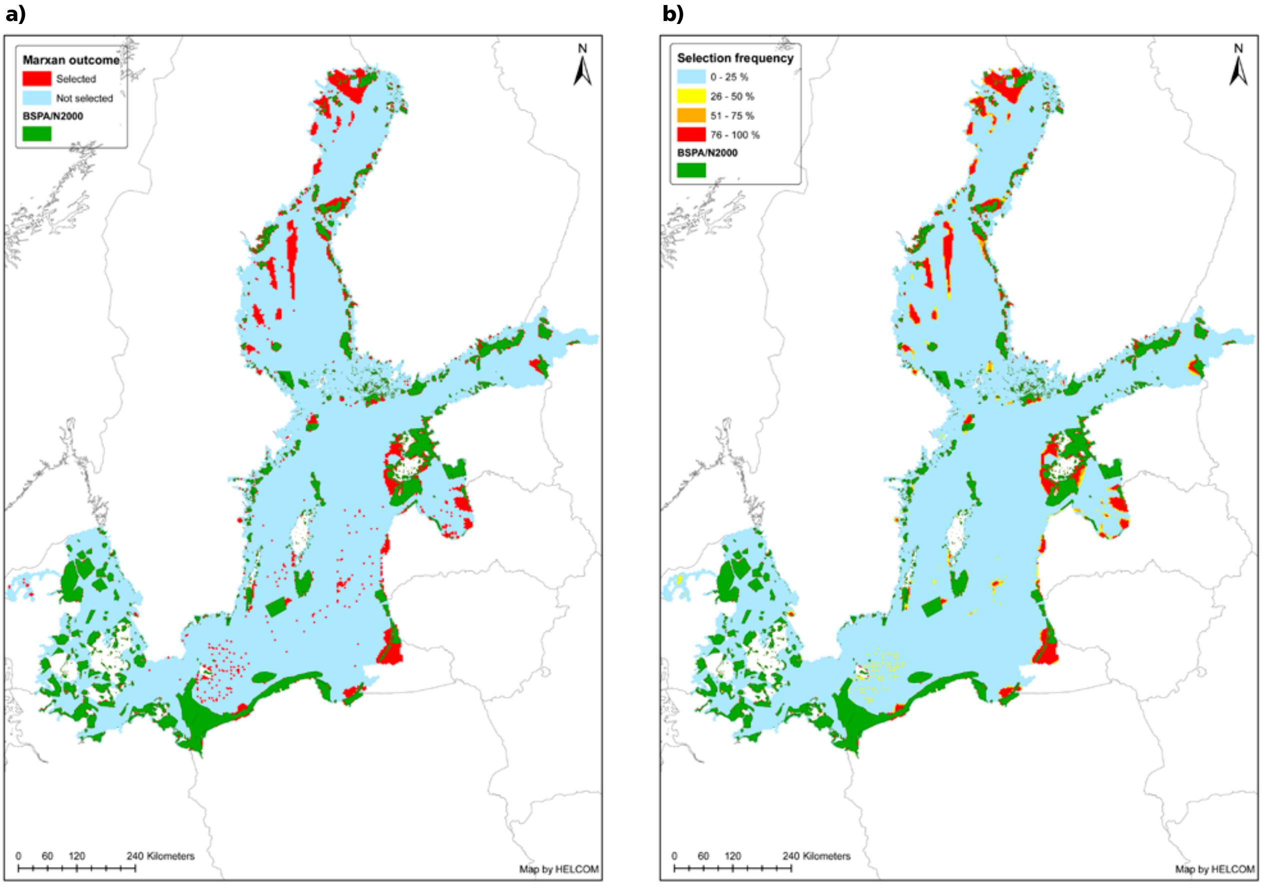

Figure 37. a) Best outcome of complementary sites with lower conservation targets, minimum 12% sub-regional coverage and existing BSPAs and marine Natura 2000 sites included; b) Selection frequency of different areas with lower conservation targets, minimum 12% sub-regional coverage and existing BSPAs and marine Natura 2000 sites included. For targets see Tables 49 and 50.

The results shown in **Figures 37a** and **b** and **Figures 38a** and **b** are based on two analyses where a minimum target of 12% conservation was set for each sub-basin and country's waters. The Figures demonstrate both the *Best outcome* map (**Figures 37a and 38a)** and the *Selection frequency* (**Figures 37b** and **38b**) for each planning unit. The two scenarios differ in that **Figure 37** shows sites selected based on low conservation targets for each conservation feature (minimum conservation ambition), whereas **Figure 38** is based on high conservation targets and is more justifiable in terms of adequate representation of important species/habitats.

Both figures show that the current network is not adequate in terms of fulfilling these targets. Even if the aim is to satisfy the minimum conservation ambition, protection should be provided for 5%, or about 21,000 km², larger than the current network, mainly in the northern Baltic Sea (**Figure 37a**). Should the long term objective be to reach the set of higher conservation targets, then the protected area would need to double that of the existing network - equivalent to approximately 24% of the entire Baltic Sea area (**Figure 38a**).

For comparison **Figure 39** shows the selection frequencies of minimum 20% and 30% sub-regional coverage with higher conservation targets for the different conservation features. To fulfil these targets, 26% and 34% of the Baltic Sea would have to be protected, respectively.

The results laid out in the first part of this report show that the current range of the area allocated for BSPAs varies significantly among the member countries. **Figures 37a** and **b** illustrate the current situation, and also proposes areas where there is a special need for additional protected areas to meet the target of at least 12% of each sub-basin and each country's waters protected. On the other hand **Figures 38 a** and **b** show that if the overall conservation aim is more ambitious, more BSPAs

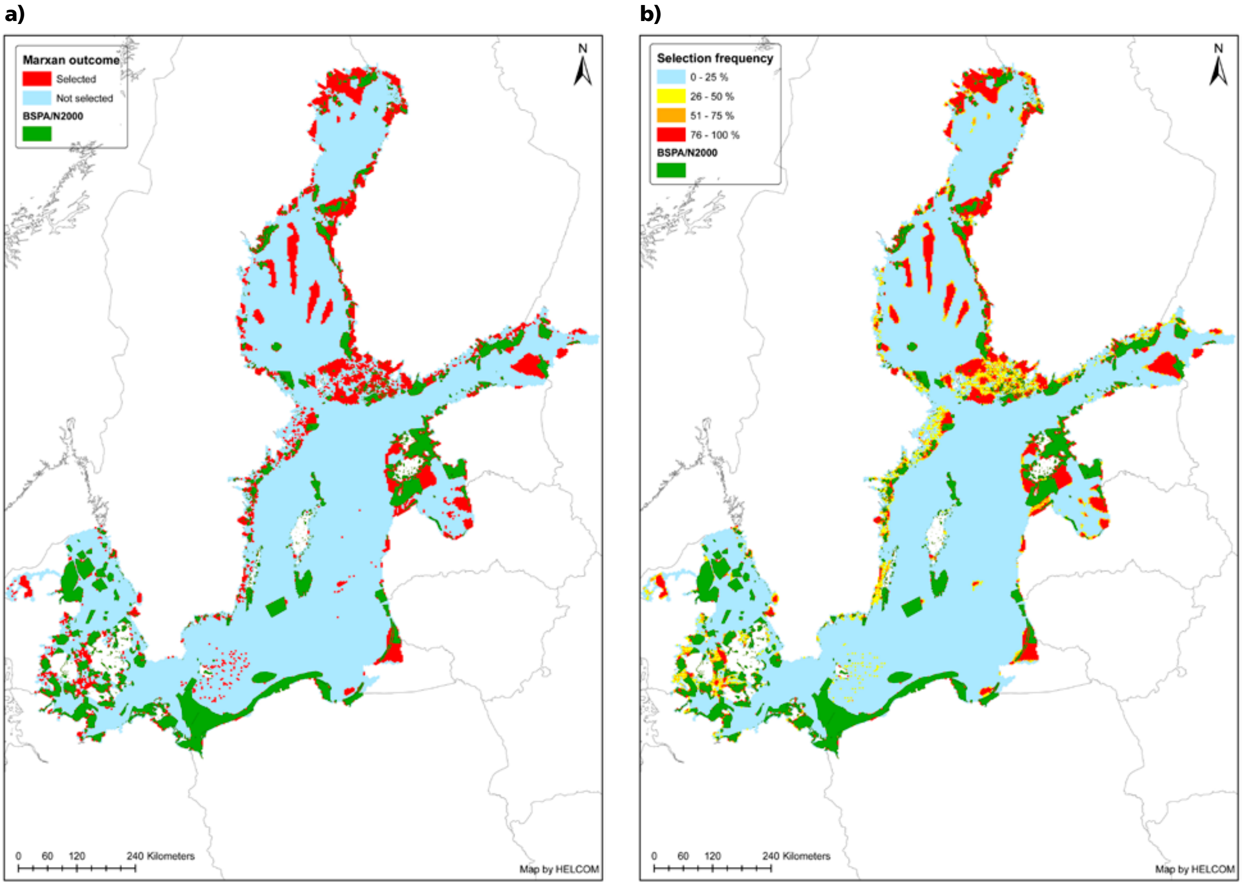

Figure 38. a) Best outcome of complementary sites with higher conservation targets, minimum 12% sub-regional coverage and existing BSPAs and marine Natura 2000 sites included; b) Selection frequency of different areas with higher conservation targets, minimum 12% sub-regional coverage and existing BSPAs and marine Natura 2000 sites included. For targets see Tables 49 and 50.

are needed in all areas, particularly in the northern parts of the Baltic Sea.

A comparison of the results presented in **Figures 38** and **39a**, shows that the supplementary area needed to reach high conservation targets with 20% minimum sub-regional coverage is not substantially greater than the area needed to fulfil similar ambitions conservation objectives with a 12% minimum sub-regional coverage. Although the results reflect the specific analytical criteria applied in this assessment and to the quality of input data, they do however, indicate where additional protected areas should be established to fulfil the agreed conservation objectives.

The outcomes depicted in the maps (**Figures 37** and **38**) show that the results are very much driven by a) the conservation feature data, which mainly cover coastal areas and b) the data on activities and pressures featured in the suitability layer, which produce high costs, above all to planning units in areas from which there is little biological data to choose. Consequently, few additional sites are proposed in open sea areas, except for in the outcome related to the scenario with *30% minimum sub-regional coverage, high conservation targets*, and which also includes proposals for larger areas in the offshore areas in the Baltic Proper (**Figure 39b**).

2.5.1 Data considerations

In interpreting the results of this exercise it is important to be aware of the limitations and quality of the data layers, which considerably influence the applicability of the results.

The suitability of each planning unit (i.e. the relative "cost" value) is an important factor determining the spatial selection of sites. Marxan tries to avoid areas indicating low suitability because of conflicting interests or threats to the location. The limited data available on species and habitat from the central Baltic

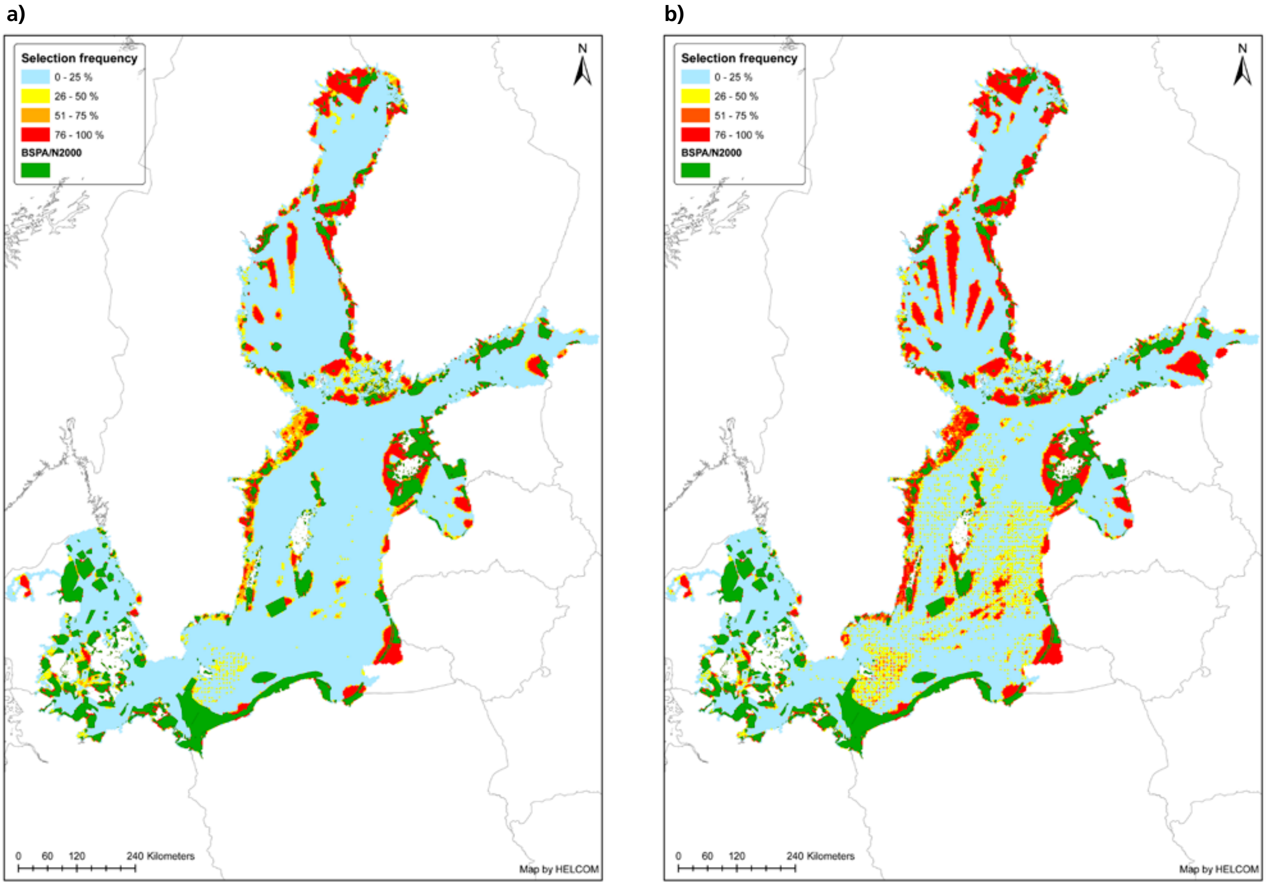

Figure 39. Selection frequencies of different areas with higher conservation targets, a) minimum 20% and b) minimum 30% of sub-regional coverage with existing BSPAs and marine Natura 2000 sites included. For targets, see Tables 49 and 50.

Sea and the fact that the non-photic soft sediments were not considered equally important compared to other benthic marine landscapes, coupled with the low suitability of that area meant that this area was not well-represented in many scenarios.

The availability of pelagic data layers at the start of the analyses would have yielded more comprehensive results. For instance, data on cod spawning grounds became accessible only at the very end of the analyses. A test run was performed with a minimum 12% conservation target for each sub-region and low and high conservation targets. The cod spawning grounds were also given lower (20%) and higher (60%) conservation targets. These test results (**Figure 40**) show that the total area proposed for conservation was approximately equal to the corresponding scenario (**Figures 37** and **38**) but the complementary sites were somewhat differently located.

These findings highlight the importance on accurate, good quality data for analysis both from near shore and off shore areas. Such data would also allow for use of a finer scale grid for coastal areas to provide accurate and more detailed inshore and near coastal planning.

It may also have been useful to stratify and compute all conservation feature data layers by sub-basin and country to take account of variables such as north-south variations and data quality. However this was not done due to time constraints and minimum conservation targets for each sub-region were instead applied.

The assignment of rather modest conservation targets to the deep soft-sediments may have resulted in the lower than expected representation of this benthic marine landscape in those parts of the Baltic Sea where oxygen depletion is not as severe a problem as in the central Baltic Sea. Data on oxygen depleted areas should have been considered and varying targets applied to those broad-scale benthic habitats not affected by oxygen depletion.

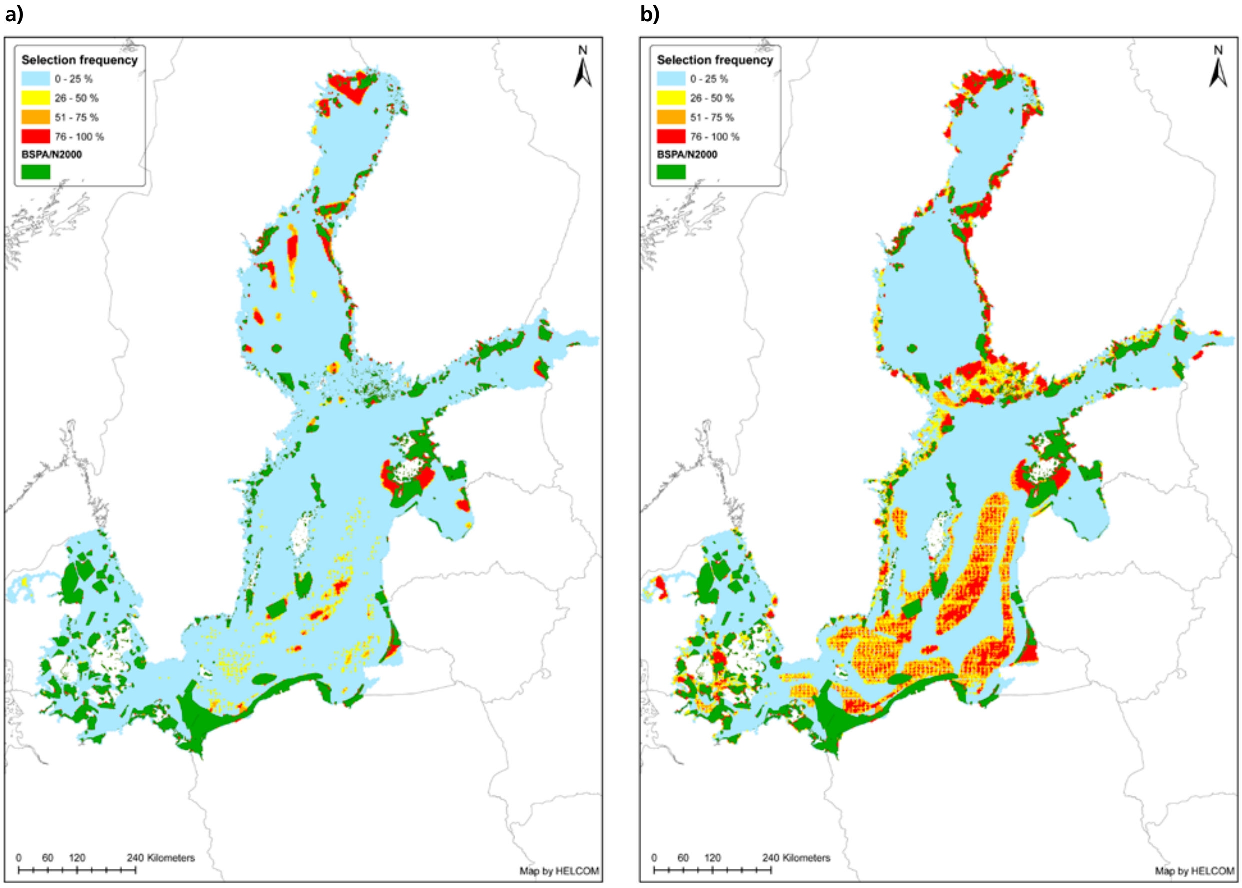

Figure 40. Selection frequencies of different areas with a) lower, and b) higher conservation targets with minimum 12% sub-regional coverage, existing BSPAs and marine Natura 2000 sites included and with the cod spawning area data layer. For targets, see the text and Tables 49 and 50.

In general, the availability and quality of biological data covering the entire Baltic Sea region was found to be relatively poor and should be improved to select a network that represents the full range of biodiversity and also enforces international political agreements. At present, good quality socio-economic data is much more easily available than biological data. This may explain a bias in Marxan towards selecting areas from the northernmost parts of the Baltic Sea where there are fewer activities and other pressures. This bias is illustrated by the best outcome for the low representation scenario, which has not been stratified by sub-basins or each country's waters, and which does not have existing BSPAs and marine Natura 2000 sites locked (**Figure 41**).

2.6 Discussion

The first part of this report concluded that the current network of Baltic Sea Protected Areas cannot be considered to be ecologically coherent in many respects and there is a need to designate more area for protection to ensure that the Baltic Sea ecosystem and its structures and functions are safeguarded. Experiences from the Balance project led HELCOM to decide that a systematic tool for planning a coherent network of BSPAs should be applied at the regional Baltic Sea level. It was recommended that a new Marxan analysis should be conducted using the latest available data, to generate a) a discussion on progress towards achieving the HELCOM objectives and b) the tabling of proposals for new sites to be included in the network towards fulfilment of those objectives.

The main objective and the starting point of the Marxan analysis was to identify solutions to complement the existing protected area network.
To determine the most cost-efficient network of MPAs, scenarios with no existing protected areas pre-selected were also considered. All the evaluated scenarios provided valuable information which

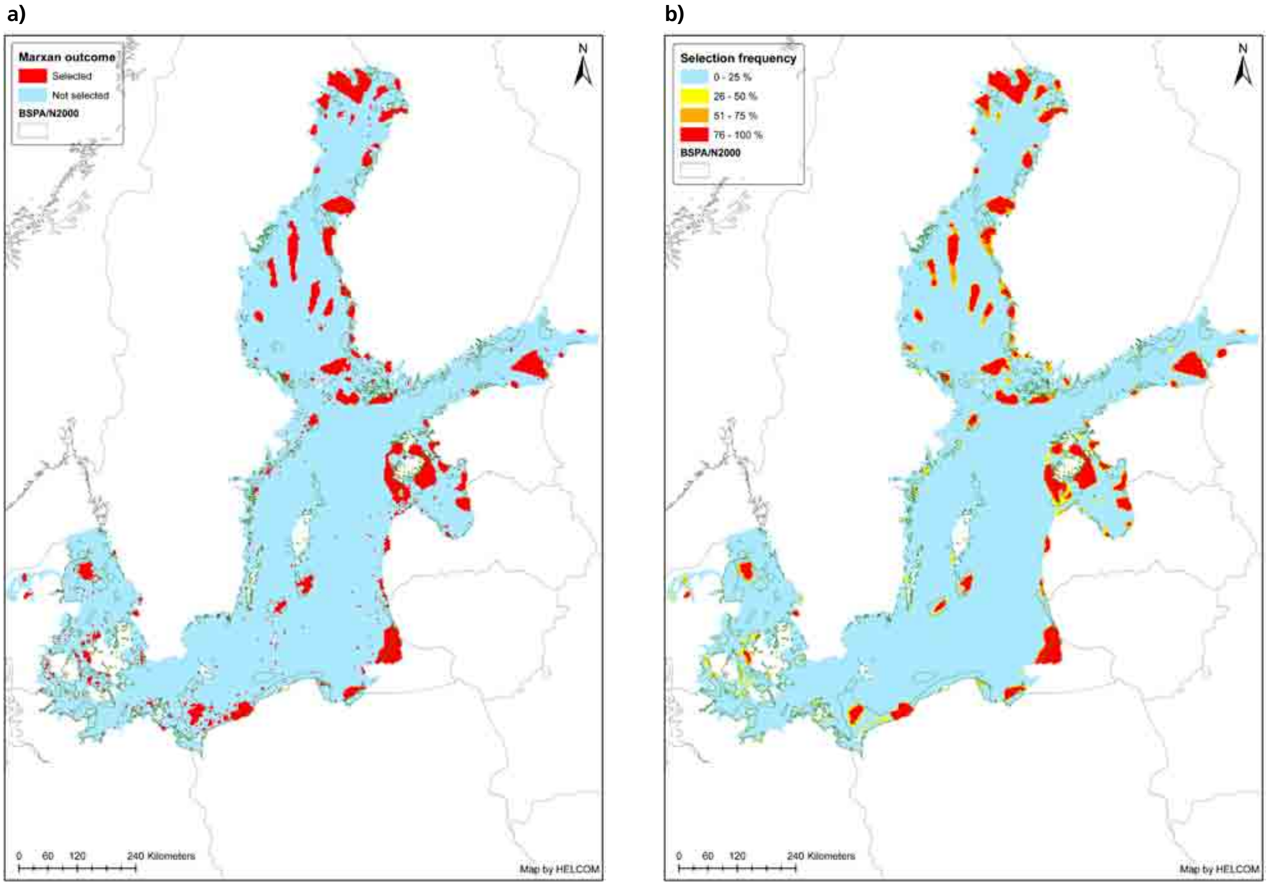

Figure 41. **a) Best outcome of the scenario showing 0% minimum sub-regional coverage with low conservation targets, no existing BSPAs and marine Natura 2000 sites locked and b) Selection frequency of the scenario showing 0% minimum sub-regional coverage with low conservation targets, no existing BSPAs and marine Natura 2000 sites locked.**

can guide the designation of new sites to develop an ecologically coherent network of BSPAs.

Rather than provide precise information on the size of the area to be protected, or precisely where additional areas should be located, the Marxan results provide general proposals to be considered depending on the breadth of conservation objectives. The results indicated that if the aim is to provide higher-level protection to the full range of biodiversity in the region, the networks of BSPAs and Natura 2000 sites should be expanded to at least twice their present size. This result is in line with recommendations from various scientific studies and some political frameworks. They are also consistent with the results of the Balance project, where the scenario of 20% conservation target and covering nearly 30% of the Baltic Sea was considered the most appropriate scenario (Liman et al. 2008). Even if the targets are less ambitious - a network covering at minimum 12% of each sub-basin and country's waters with lower conservation targets- more sites need to be designated as BSPAs.

The outcomes of the Marxan analysis also favoured the northernmost parts of the Baltic Sea, most notably when no existing BSPAs and marine Natura 2000 sites were locked into the analyses. This was largely due to the higher suitability of planning units in northern areas. A greater intensity of human activities in the southern Baltic Sea results in greater pressures to the environment and more competing interests (socio-economic costs) and thus increases the cost of establishing protected areas in the south. In contrast, from a biological point of view, most of the ecologically important features are found mainly in southern parts of the Baltic Sea. With better data it might be feasible to set varying targets for features based on their importance to the Baltic Sea. The lack of pelagic data for the analysis also meant that the results were inevitably skewed towards coastal areas.

Although the Marxan analysis provided general answers to initial questions, it is also clear that no precise locations can be proposed for additional new sites with the available data. The absence of Baltic-wide data sets that cover all basins and all EEZs in particular, results in regional imbalances and further challenges the identification of MPA locations. This challenge further emphasizes the importance of acquiring reliable data on Baltic Sea biodiversity and regional socio-economic activities.

In addition to more accurate data, stakeholder and expert consultations should also be conducted in the course of network design. It is highly recommended that the use of decision support tools such as Marxan be complemented by the inclusion of stakeholder and expert inputs into the planning process. There are many competing interests for the use of sea space and in an ideal situation MPA selection should be part of a broader maritime spatial planning process (Liman et al. 2008) that identifies the most suitable sites for nature conservation and other uses such as fishing, aquaculture, and tourism and so on. Marxan outcomes produce a variety of alternative solutions, each of which meet the conservation targets. This flexibility allows stakeholders and experts to guide the final selection of the areas appointed for conservation.

Management considerations are also important in determining the final boundaries. The development of management and zoning plans for protected areas should therefore be incorporated during the early stages of network design.

The HELCOM Baltic Sea Action Plan, several EU directives and other international agreements require the application of ecosystem based management to the protection and management of the marine environment. These instruments also underscore the importance of applying a regional approach to marine protection and resource management. A regional systematic approach to site selection supports the ecosystem approach and is also feasible in a multinational region such as the Baltic Sea. Using such an approach maximises the chance of creating a network that is representative and coherent, providing protection to the full range of biodiversity in the region while also considering socio-economic factors. An added benefit of this approach is that it can be repeated and can be revised fairly easily based on better information and access to new data. Ideally, the future nomination of marine protected areas should be integrated into an overarching maritime spatial planning and management process, combined with other management tools.

3. Conclusions and recommendations

In recent years there have been very encouraging developments in establishing BSPAs in the Baltic Sea and in achieving the 10% international target for regional coverage of BSPAs. In spite of these gains, the study found that neither the current network of Baltic Sea Protected Areas nor a common BSPA/Natura 2000 network could be considered ecologically coherent with respect to all four coherence criteria.

A major reason for this finding was the strong bias of the network towards near-shore and inshore areas. This fact influenced each of the applied coherence criteria. It should be kept in mind, however, that more than 80% of all Baltic Sea wide Natura 2000 sites are smaller than HELCOM minimum recommended size of 3000 ha for BSPAs, because no size limitations are prescribed for Natura 2000 sites. This is also one of the main reasons why all Natura 2000 sites have not been designated as BSPAs.

The main aim of the site selection analysis was to find solutions to complement the existing protected areas network. The results produced should be seen as examples of how systematic site selection can be used to assess and plan for a coherent network. They also indicate that if the aim is to provide more comprehensive protection for the full range of biodiversity in the basin, the network of BSPAs should be expanded to at least twice of its present size. This result is in line with recommendations from various scientific studies, some political frameworks. It is also consistent with the results of the Balance project, where the scenario of a 20% representation target covering nearly 30% of the Baltic Sea was considered the most appropriate outcome (Liman et al. 2008).

In interpreting the results of these analyses it is important to be aware of the limitations and quality of the data layers used. These factors considerably influenced the applicability of the results.

Bothnian Bay

Apart from certain aspects of the ecological coherence criteria, these deficiencies relate primarily to the limited availability and quality of data used. Additionally, incomplete entries were made in several aspects of the updated BSPA database.

While all countries generally provided good feedback on the survey, important information is still missing from a number of BSPAs. This was most evident in the case of questionnaire categories on protected species and biotope types, as well as management measures. As a result, it was not possible to fully assess the protection efficiency of the current network. In general, the study found that the availability and quality of biological data, relating to environmental quality and the distribution of underwater species and biotope types covering the entire Baltic Sea basin needs to be improved to ensure more accurate analyses in the future.

Apart from establishing an ecologically coherent network of BSPAs, one additional goal of HELCOM is to create a well-managed network. Proper management is a prerequisite for safeguarding the long-term conservation goals set for the individual sites, and also for the network as a whole. It was found that many of the existing Baltic Sea Protected Areas and Natura 2000 sites still lack management plans and/or measures. It was therefore not possible to fully assess the protection efficiency of the current network. However the fact that over 90% of BSPAs are also Natura 2000 sites indicates that conservation management in EU Member States will mainly be based on the requirements of the Birds and Habitats Directives. It can thus be inferred that the management of Natura 2000 sites does not sufficiently protect marine biodiversity in the Baltic Sea and does not take account of the Russian parts of the Baltic Sea. Furthermore, fishing is not prohibited or restricted in any of the protected areas. It is therefore of utmost importance to invest in the development of site-specific management measures reaching to achieve an ecologically coherent network of well-managed BSPAs.

The HELCOM Baltic Sea Action Plan and other international agreements require ecosystem-based management to be applied to protect the marine environment and to manage human activities. These instruments also underscore the importance of a systematic, regional approach to marine protection and resource management. A regional approach (encompassing the entire Baltic Sea area) maximises the chance of creating a network that is ecologically coherent, and protects to the full range of biodiversity in the region while also considering socio-economic factors.

The outcome of the assessment leads to the following proposals for further HELCOM work:
To secure the establishment of a network of BSPAs that fulfils all the criteria for ecological coherence (representativity, replication, adequacy and connectivity) and thereby provides sufficient protection to the entire ecosystem of the Baltic Sea it is necessary:

- that HELCOM HABITAT identifies additional potential BSPAs at the latest by the end of 2011 using the information provided in this assessment, and that Contracting States should designate appropriate new BSPAs at the latest at HELCOM HABITAT 14/2012;
- in doing so, to focus on providing protection to species and habitats identified in HELCOM as being threatened and/or declining. EU Member States should consider the obligations of the Birds- and Habitats Directives and their Annexes as well as the EU Marine Strategy Framework Directive, and in particular to designate new off-shore areas including the EEZ to ensure that BSPAs not only cover a total of at least 10% of the Baltic Sea area as a whole, but if scientifically justified, at least 10% of all its sub-basins[9] as well;
- to develop and apply by 2015, management plans and/or measures[10] for existing BSPAs, and that every new BSPA designation should be followed by establishment and implementation of a management plan and/or measures within five years.

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[9] As specified in the HELCOM Red List of marine and coastal biotopes and biotope complexes of the Baltic Sea, Belt Sea and Kattegat (BSEP No: 75).

[10] As defined in the HELCOM publication on Planning and Management of Baltic Sea Protected Areas: guidelines and tools from 2006 (BSEP No: 105).

Glossary

BALANCE (Baltic Sea Management - Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning): The BALANCE project aimed at developing marine management tools for the Baltic Sea based on spatial planning and cross-sectoral and transnational co-operation. It was co-funded by the EU Baltic Sea Region INTERREG III B Neighbourhood Programme and run between 2005 and 2007.

Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats): The convention came into force on 1st June 1982. Its goal is the conservation of wild flora and fauna and their natural habitats, as well as the monitoring and control of endangered and vulnerable species.

CBD (Convention on Biological Diversity): This treaty was tabled for signature at the Earth Summit in Rio de Janeiro on 5th June 1992 and entered into force on 29th December 1993. The aim of the convention is the overall protection of biodiversity (ecosystems, species and genetic diversity) as well as the sustainable use of its components.

EC Birds Directive (Directive on the Conservation of Wild Birds, 79/409/EEC): The Birds Directive came into force on 6th April 1979. The aim of the Directive is the conservation of all species of naturally occurring birds in the European territory of the Member States to which the Treaty applies, including the species' protection, management and control. The directive requires the establishment of Special Protection Areas (SPAs) for wild birds.

EC Habitats Directive (Directive on the conservation of natural habitats and of wild fauna and flora, 92/43/EEC): The Directive came into force on 21st May 1992. Its aim is the conservation of natural habitats and wild fauna and flora in the European territory of the Member States to which the Treaty applies. The Directive obliges Member States to identify Sites of Community Importance (SCI) for species and habitats that in a later step can be designated as Special Areas of Conservation (SACs) by the European Commission to ensure the favourable conservation status of European wild species and natural habitat types.

EC Marine Strategy Framework Directive (2008/56/EC, MSFD): The Directive came into force on 15th July 2008 and establishes a framework within which Member States of the European Union shall take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest. Strategies were to be developed and implemented to protect and preserve the marine environment, as well as to prevent and reduce inputs in the marine environment.

EU Water Framework Directive (2000/60/EC): The Directive was adopted on 23rd October 2000 and aims at the establishment of a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater.

Helsinki Convention (Convention on the Protection of the Marine Environment of the Baltic Sea Area): The Helsinki Convention was signed in 1974 and a new convention was signed in 1992 which entered into force on 17th January 2000. The aim of the Contracting Parties is to protect the marine environment of the Baltic Sea from all sources of pollution, and to restore and safeguard its ecological balance.

HELCOM (Helsinki Commission) is the governing body of the Helsinki Convention and works to protect the marine environment of the Baltic Sea through intergovernmental co-operation involving all Baltic Sea States and the European Community.

HELCOM Baltic Sea Action Plan (BSAP): This Action Plan is an ambitious programme to restore the good ecological status of the Baltic marine environment by 2021. It is based on ecological objectives for four key issues requiring action: eutrophication, hazardous substances, maritime activities and biodiversity.

HELCOM Recommendation 15/5 on BSPAs: The Recommendation was adopted on 10th March 1994 and recommends to the Contracting Parties of HELCOM to take all appropriate measures to establish a system of Coastal and Marine Baltic Sea Protected Areas (BSPA) in the framework of the Helsinki Convention. Contracting States initially proposed 62 as potential BSPAs.

Johannesburg Declaration: The UN WSSD (United Nations World Summit of Sustainable Development, in Johannesburg, South Africa, 2002) adopted among other issues a global target of 10% for all marine ecological regions to be effectively conserved by 2012.

Joint Work Programme (JWP) of HELCOM and OSPAR to complete by 2010 networks of Baltic Sea Protected Areas (BSPAs) and OSPAR Marine Protected Areas (agreed 2003).

Marxan A software designed to aid systematic conservation planning. With the use of stochastic optimisation routines (simulated annealing) it generates spatial protected areas systems that achieve particular biodiversity representation targets in an optimal way. The software is developed by Ian Ball and Hugh Possingham and it can be freely downloaded from the web-page of the University of Queensland.

Natura 2000 is the name for an EU-wide network of SACs (Special Areas of Conservation) and SCIs (Site of Community Importance) as well as SPAs (Special Protection Areas). Its legal foundations are the EC Habitats Directive and the EC Birds Directive.

OSPAR (Convention for the Protection of the Marine Environment of the North-East Atlantic): The "OSPAR Convention" was tabled for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris in 1992 and entered into force on 25th March 1998. The aim of the Contracting Parties is the prevention and elimination of pollution and the protection of the maritime area (of the biodiversity, resources and environmental quality) as defined in the convention, against the adverse effects of human activities.

Ramsar Convention (The Convention on Wetlands of International Importance): the convention was adopted by the participating nations on 2nd February 1971 and came into force on 21st December 1975. The aim of the convention is the conservation and sustainable utilisation of wetlands.

SAC (Special Area of Conservation): see EC Habitats Directive and Natura 2000 (thus far no marine SAC exists in the Baltic Sea).

SCI (Site of Community Importance): see EC Habitats Directive and Natura 2000.

SPA (Special Protection Area): see EC Birds Directive and Natura 2000.

Abbreviations

BfN	German Federal Agency for Nature Conservation
BSAP	Baltic Sea Action Plan
BSPA	Baltic Sea Protected Areas
BSPA/N2000	Natura 2000 - BSPA network
CART	Classification and Regression Trees
EEZ	Exclusive Economic Zone
ETRS_1989_LAEA	Lambert Azimuthal Equal Areas
FGFRI	Finish Game and Fisheries Research Institute
HEAT	HELCOM Eutrophication Assessment Tool
HELCOM	Helsinki Commission
AIS	Automatic Identification System for ships
IBA	Important Bird Area
ICES	International Council for the Exploration of the Sea
IDW	Inverse Distance Weighted method
IUCN	International Union for Conservation of Nature
JWP	Joint Work Programme of HELCOM and OSPAR to establish a coherent network of marine protected areas in the Northeast Atlantic and the Baltic Sea by 2010
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
OSPAR	Oslo-Paris Convention
SAC	Special Area of Conservation
SCI	Site of Community Importance
HELCOM SEAL	HELCOM Seal Expert Group
SPA	Special Protection Area
TW	Territorial Waters
UN WSSD	United Nations World Summit of Sustainable Development (Johannesburg 2002)

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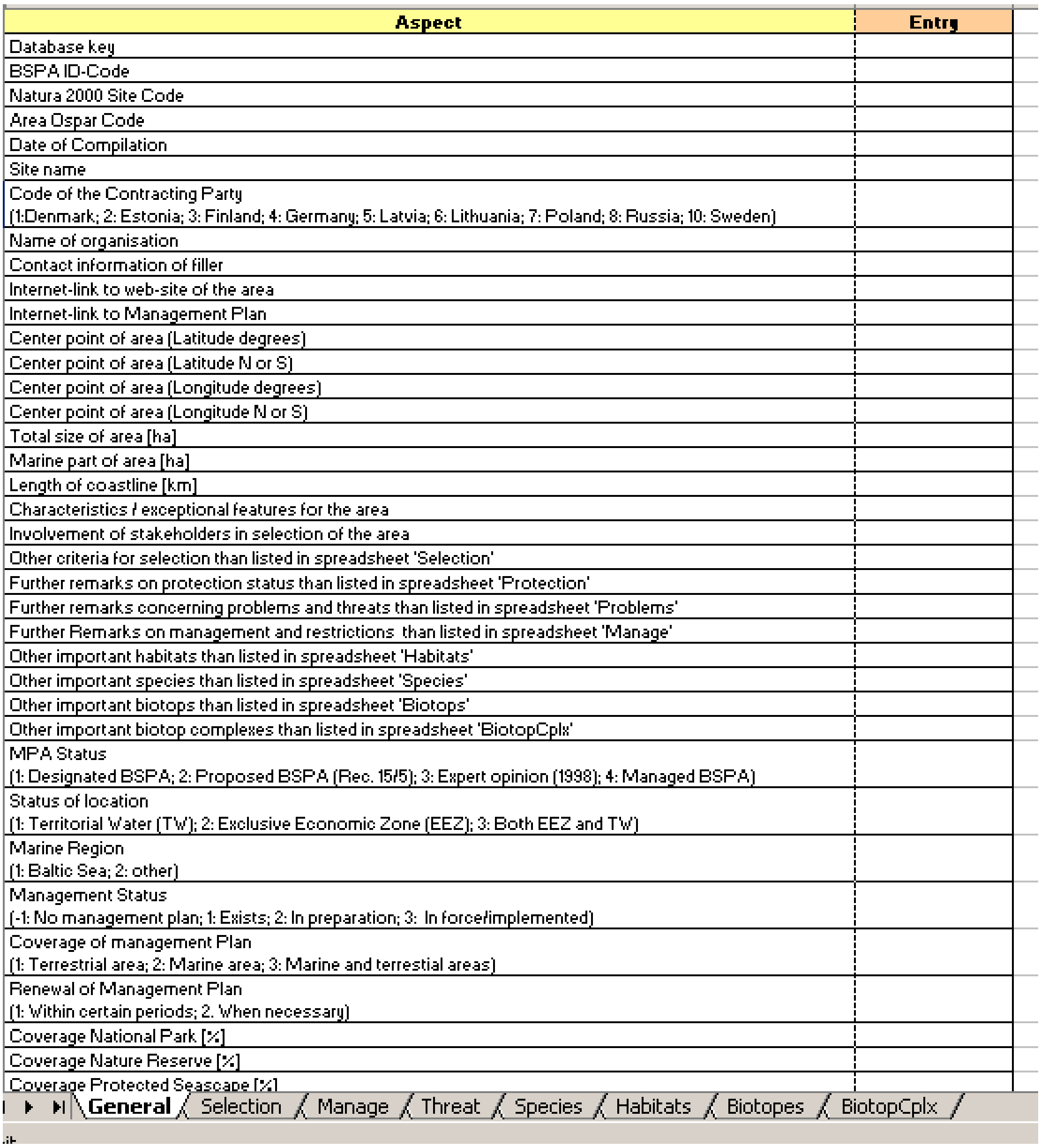
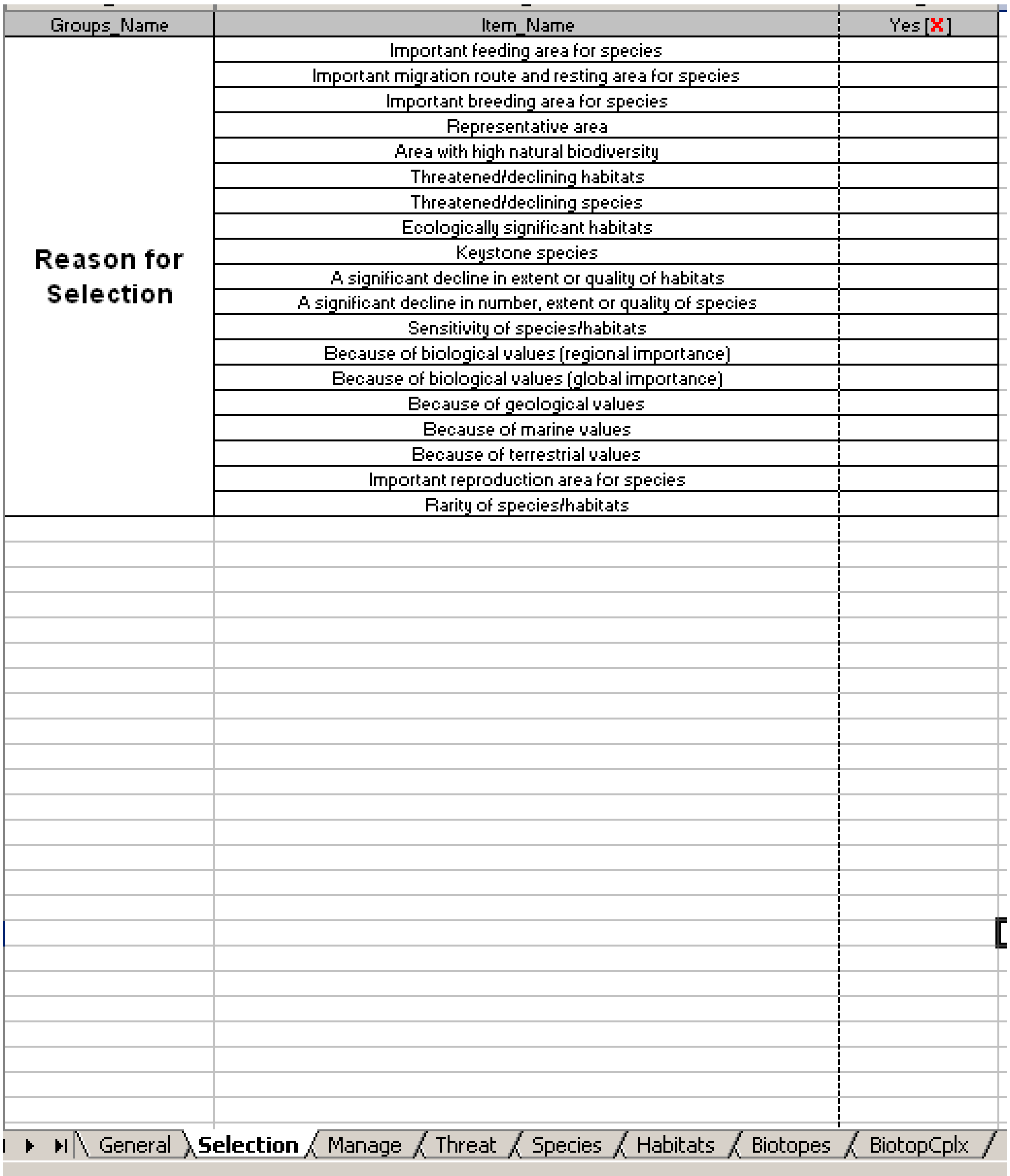
Annex I

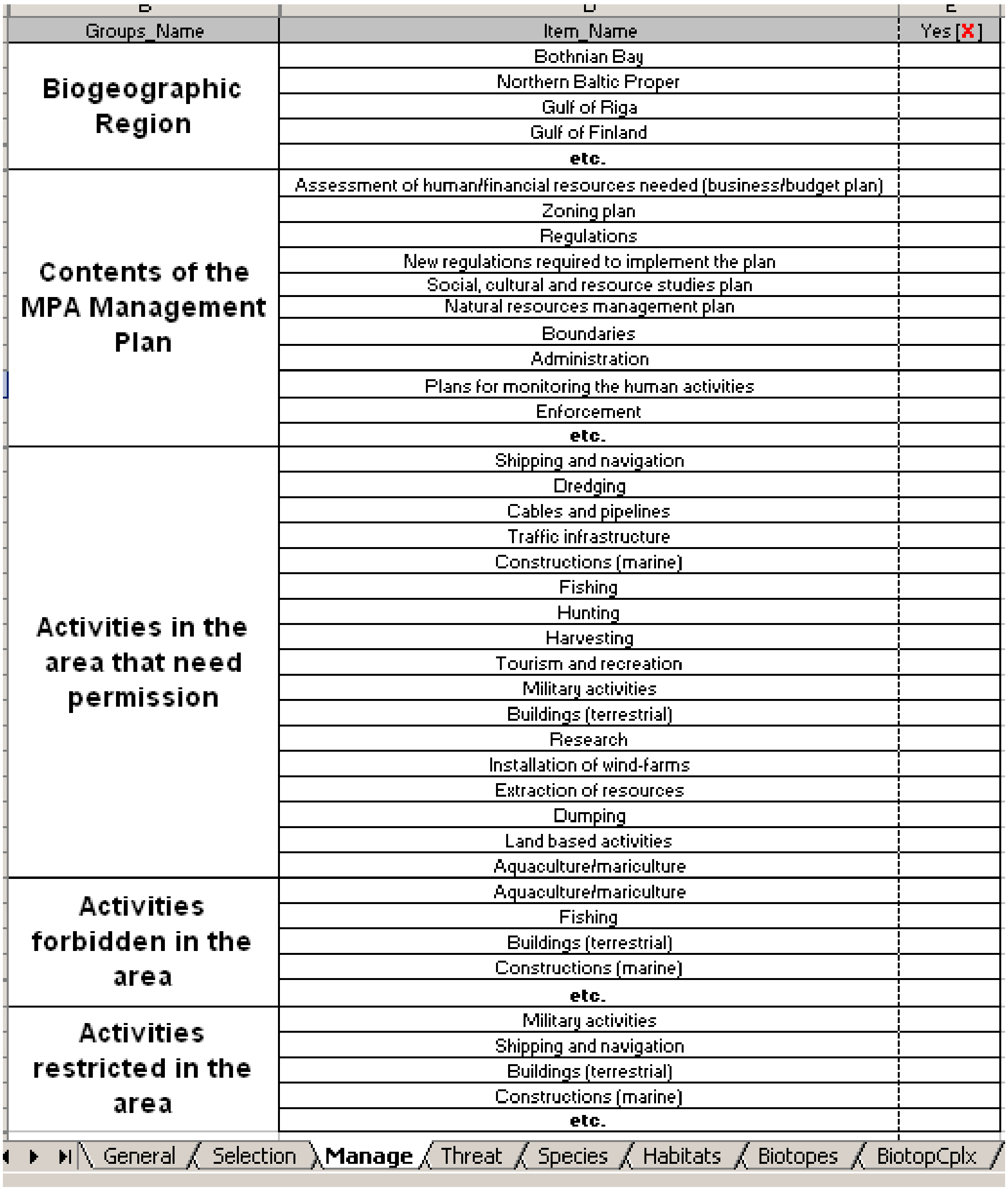
Questionnaire (empty) for update of the HELCOM database



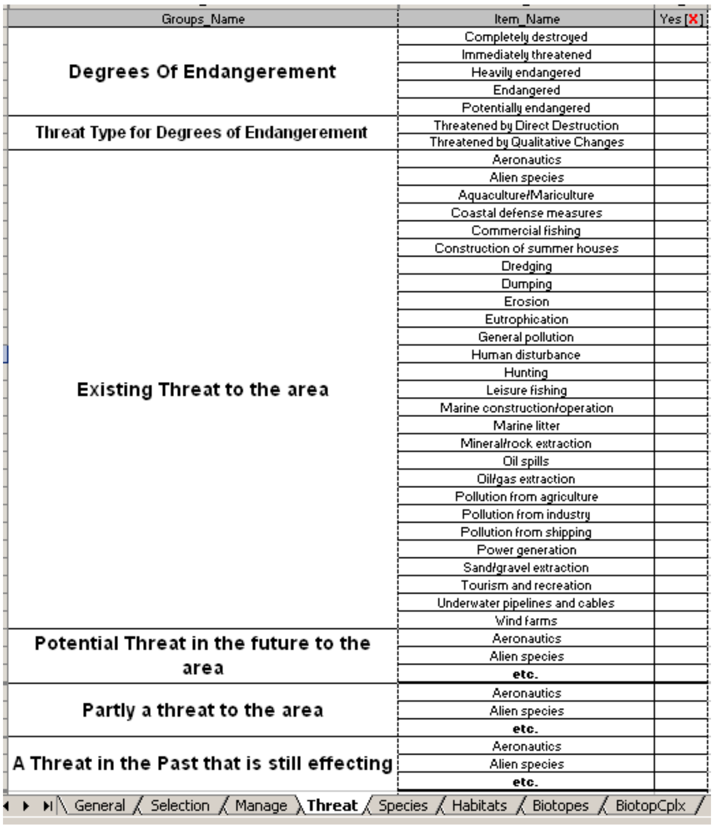
Aspect	Entry
Database key	
BSPA ID-Code	
Natura 2000 Site Code	
Area Ospar Code	
Date of Compilation	
Site name	
Code of the Contracting Party (1:Denmark; 2: Estonia; 3: Finland; 4: Germany; 5: Latvia; 6: Lithuania; 7: Poland; 8: Russia; 10: Sweden)	
Name of organisation	
Contact information of filler	
Internet-link to web-site of the area	
Internet-link to Management Plan	
Center point of area (Latitude degrees)	
Center point of area (Latitude N or S)	
Center point of area (Longitude degrees)	
Center point of area (Longitude N or S)	
Total size of area [ha]	
Marine part of area [ha]	
Length of coastline [km]	
Characteristics / exceptional features for the area	
Involvement of stakeholders in selection of the area	
Other criteria for selection than listed in spreadsheet 'Selection'	
Further remarks on protection status than listed in spreadsheet 'Protection'	
Further remarks concerning problems and threats than listed in spreadsheet 'Problems'	
Further Remarks on management and restrictions than listed in spreadsheet 'Manage'	
Other important habitats than listed in spreadsheet 'Habitats'	
Other important species than listed in spreadsheet 'Species'	
Other important biotops than listed in spreadsheet 'Biotops'	
Other important biotop complexes than listed in spreadsheet 'BiotopCplx'	
MPA Status (1: Designated BSPA; 2: Proposed BSPA (Rec. 15/5); 3: Expert opinion (1998); 4: Managed BSPA)	
Status of location (1: Territorial Water (TW); 2: Exclusive Economic Zone (EEZ); 3: Both EEZ and TW)	
Marine Region (1: Baltic Sea; 2: other)	
Management Status (-1: No management plan; 1: Exists; 2: In preparation; 3: In force/implemented)	
Coverage of management Plan (1: Terrestrial area; 2: Marine area; 3: Marine and terrestial areas)	
Renewal of Management Plan (1: Within certain periods; 2. When necessary)	
Coverage National Park [%]	
Coverage Nature Reserve [%]	
Coverage Protected Seascape [%]	



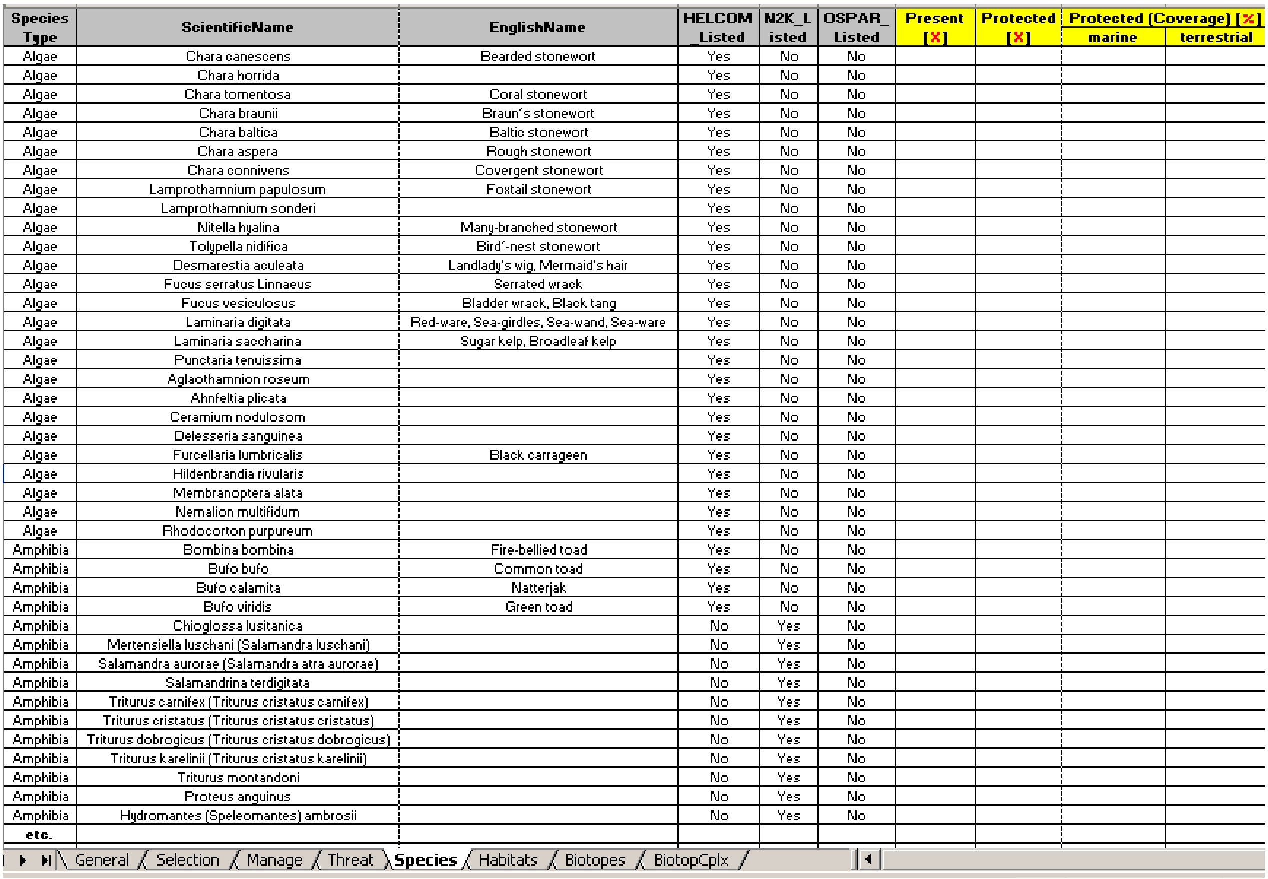
Groups_Name	Item_Name	Yes [X]
Reason for Selection	Important feeding area for species	
	Important migration route and resting area for species	
	Important breeding area for species	
	Representative area	
	Area with high natural biodiversity	
	Threatened/declining habitats	
	Threatened/declining species	
	Ecologically significant habitats	
	Keystone species	
	A significant decline in extent or quality of habitats	
	A significant decline in number, extent or quality of species	
	Sensitivity of species/habitats	
	Because of biological values (regional importance)	
	Because of biological values (global importance)	
	Because of geological values	
	Because of marine values	
	Because of terrestrial values	
	Important reproduction area for species	
	Rarity of species/habitats	



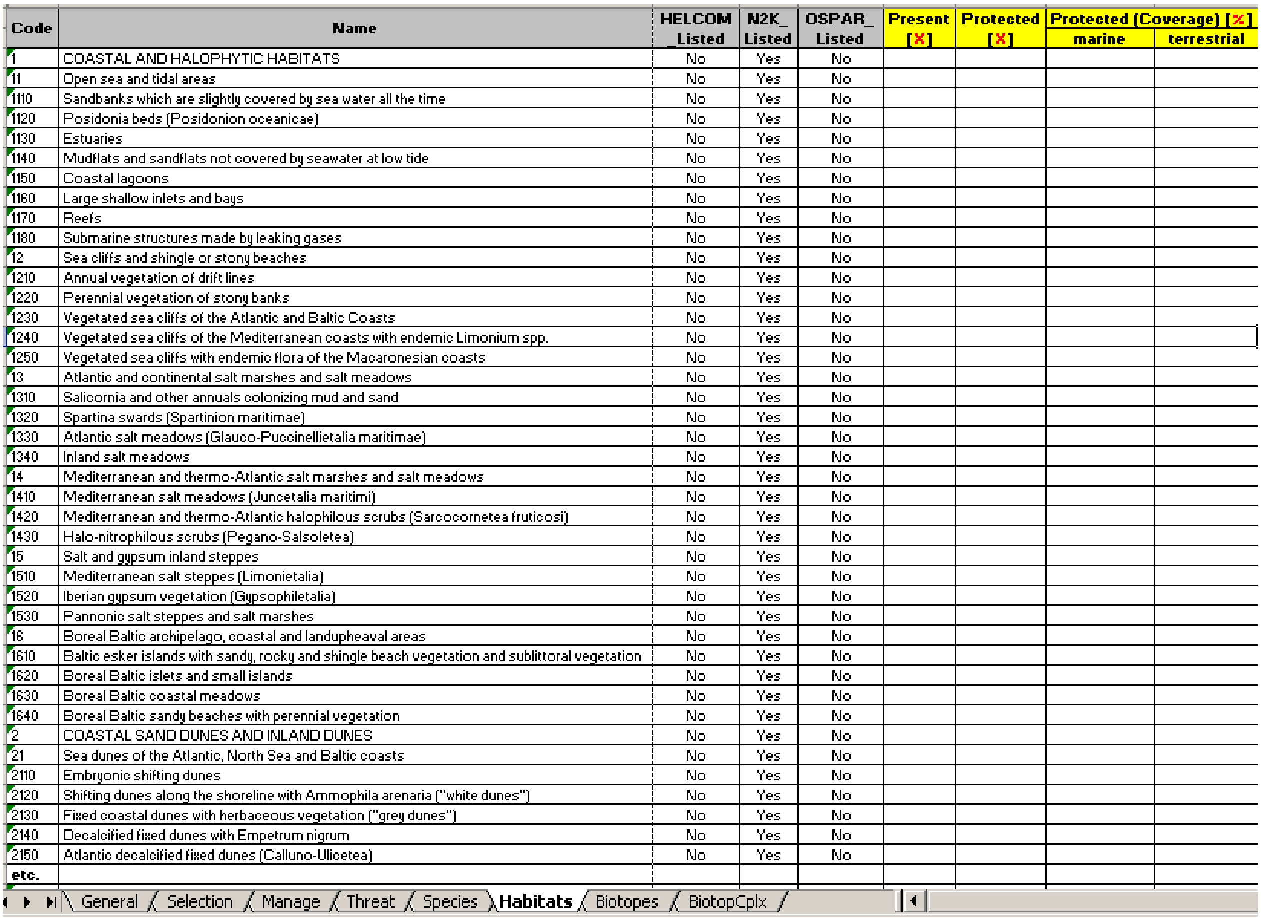
Groups_Name	Item_Name	Yes [X]
Biogeographic Region	Bothnian Bay	
	Northern Baltic Proper	
	Gulf of Riga	
	Gulf of Finland	
	etc.	
Contents of the MPA Management Plan	Assessment of human/financial resources needed (business/budget plan)	
	Zoning plan	
	Regulations	
	New regulations required to implement the plan	
	Social, cultural and resource studies plan	
	Natural resources management plan	
	Boundaries	
	Administration	
	Plans for monitoring the human activities	
	Enforcement	
	etc.	
Activities in the area that need permission	Shipping and navigation	
	Dredging	
	Cables and pipelines	
	Traffic infrastructure	
	Constructions (marine)	
	Fishing	
	Hunting	
	Harvesting	
	Tourism and recreation	
	Military activities	
	Buildings (terrestrial)	
	Research	
	Installation of wind-farms	
	Extraction of resources	
	Dumping	
	Land based activities	
	Aquaculture/mariculture	
Activities forbidden in the area	Aquaculture/mariculture	
	Fishing	
	Buildings (terrestrial)	
	Constructions (marine)	
	etc.	
Activities restricted in the area	Military activities	
	Shipping and navigation	
	Buildings (terrestrial)	
	Constructions (marine)	
	etc.	



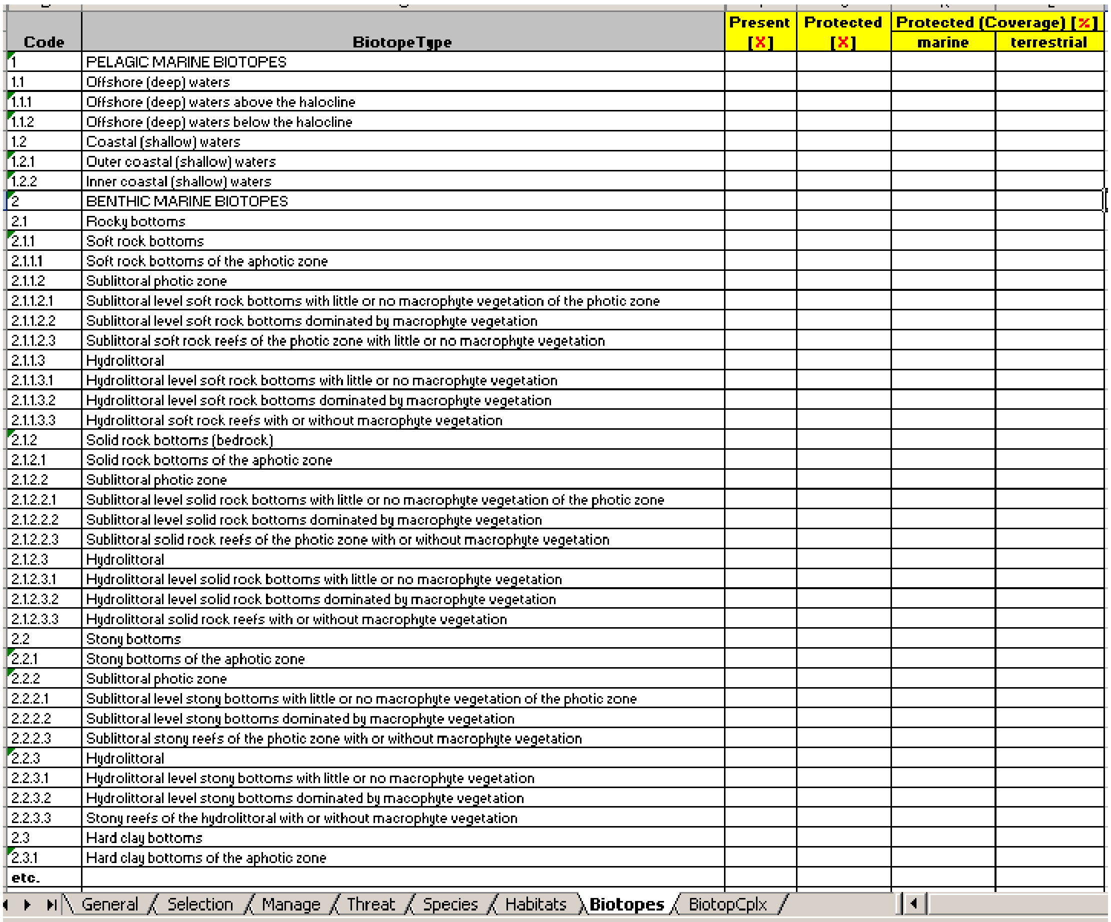
Groups_Name	Item_Name	Yes [X]
Degrees Of Endangerement	Completely destroyed	
	Immediately threatened	
	Heavily endangered	
	Endangered	
	Potentially endangered	
Threat Type for Degrees of Endangerement	Threatened by Direct Destruction	
	Threatened by Qualitative Changes	
Existing Threat to the area	Aeronautics	
	Alien species	
	Aquaculture/Mariculture	
	Coastal defense measures	
	Commercial fishing	
	Construction of summer houses	
	Dredging	
	Dumping	
	Erosion	
	Eutrophication	
	General pollution	
	Human disturbance	
	Hunting	
	Leisure fishing	
	Marine construction/operation	
	Marine litter	
	Mineral/rock extraction	
	Oil spills	
	Oil/gas extraction	
	Pollution from agriculture	
	Pollution from industry	
	Pollution from shipping	
	Power generation	
	Sand/gravel extraction	
	Tourism and recreation	
	Underwater pipelines and cables	
	Wind farms	
Potential Threat in the future to the area	Aeronautics	
	Alien species	
	etc.	
Partly a threat to the area	Aeronautics	
	Alien species	
	etc.	
A Threat in the Past that is still effecting	Aeronautics	
	Alien species	
	etc.	



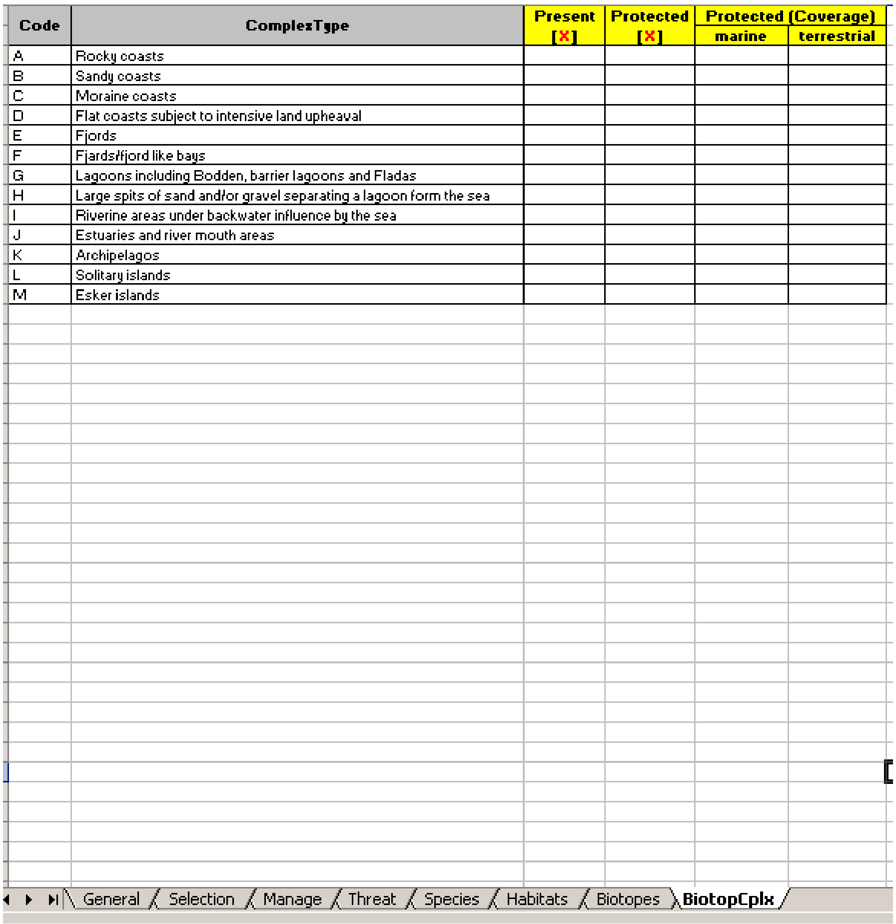
Species Type	ScientificName	EnglishName	HELCOM _Listed	N2K_Listed	OSPAR_ Listed	Present [X]	Protected [X]	Protected (Coverage) [X]	
								marine	terrestrial
Algae	Chara canescens	Bearded stonewort	Yes	No	No				
Algae	Chara horrida		Yes	No	No				
Algae	Chara tomentosa	Coral stonewort	Yes	No	No				
Algae	Chara braunii	Braun´s stonewort	Yes	No	No				
Algae	Chara baltica	Baltic stonewort	Yes	No	No				
Algae	Chara aspera	Rough stonewort	Yes	No	No				
Algae	Chara connivens	Covergent stonewort	Yes	No	No				
Algae	Lamprothamnium papulosum	Foxtail stonewort	Yes	No	No				
Algae	Lamprothamnium sonderi		Yes	No	No				
Algae	Nitella hyalina	Many-branched stonewort	Yes	No	No				
Algae	Tolypella nidifica	Bird´-nest stonewort	Yes	No	No				
Algae	Desmarestia aculeata	Landlady's wig, Mermaid's hair	Yes	No	No				
Algae	Fucus serratus Linnaeus	Serrated wrack	Yes	No	No				
Algae	Fucus vesiculosus	Bladder wrack, Black tang	Yes	No	No				
Algae	Laminaria digitata	Red-ware, Sea-girdles, Sea-wand, Sea-ware	Yes	No	No				
Algae	Laminaria saccharina	Sugar kelp, Broadleaf kelp	Yes	No	No				
Algae	Punctaria tenuissima		Yes	No	No				
Algae	Aglaothamnion roseum		Yes	No	No				
Algae	Ahnfeltia plicata		Yes	No	No				
Algae	Ceramium nodulosom		Yes	No	No				
Algae	Delesseria sanguinea		Yes	No	No				
Algae	Furcellaria lumbricalis	Black carrageen	Yes	No	No				
Algae	Hildenbrandia rivularis		Yes	No	No				
Algae	Membranoptera alata		Yes	No	No				
Algae	Nemalion multifidum		Yes	No	No				
Algae	Rhodocorton purpureum		Yes	No	No				
Amphibia	Bombina bombina	Fire-bellied toad	Yes	No	No				
Amphibia	Bufo bufo	Common toad	Yes	No	No				
Amphibia	Bufo calamita	Natterjak	Yes	No	No				
Amphibia	Bufo viridis	Green toad	Yes	No	No				
Amphibia	Chioglossa lusitanica		No	Yes	No				
Amphibia	Mertensiella luschani (Salamandra luschani)		No	Yes	No				
Amphibia	Salamandra aurorae (Salamandra atra aurorae)		No	Yes	No				
Amphibia	Salamandrina terdigitata		No	Yes	No				
Amphibia	Triturus carnifex (Triturus cristatus carnifex)		No	Yes	No				
Amphibia	Triturus cristatus (Triturus cristatus cristatus)		No	Yes	No				
Amphibia	Triturus dobrogicus (Triturus cristatus dobrogicus)		No	Yes	No				
Amphibia	Triturus karelinii (Triturus cristatus karelinii)		No	Yes	No				
Amphibia	Triturus montandoni		No	Yes	No				
Amphibia	Proteus anguinus		No	Yes	No				
Amphibia	Hydromantes (Speleomantes) ambrosii		No	Yes	No				
etc.									



Code	Name	HELCOM _Listed	N2K_ Listed	OSPAR_ Listed	Present [X]	Protected [X]	Protected (Coverage) [%] marine	terrestrial
1	COASTAL AND HALOPHYTIC HABITATS	No	Yes	No				
11	Open sea and tidal areas	No	Yes	No				
1110	Sandbanks which are slightly covered by sea water all the time	No	Yes	No				
1120	Posidonia beds (Posidonion oceanicae)	No	Yes	No				
1130	Estuaries	No	Yes	No				
1140	Mudflats and sandflats not covered by seawater at low tide	No	Yes	No				
1150	Coastal lagoons	No	Yes	No				
1160	Large shallow inlets and bays	No	Yes	No				
1170	Reefs	No	Yes	No				
1180	Submarine structures made by leaking gases	No	Yes	No				
12	Sea cliffs and shingle or stony beaches	No	Yes	No				
1210	Annual vegetation of drift lines	No	Yes	No				
1220	Perennial vegetation of stony banks	No	Yes	No				
1230	Vegetated sea cliffs of the Atlantic and Baltic Coasts	No	Yes	No				
1240	Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.	No	Yes	No				
1250	Vegetated sea cliffs with endemic flora of the Macaronesian coasts	No	Yes	No				
13	Atlantic and continental salt marshes and salt meadows	No	Yes	No				
1310	Salicornia and other annuals colonizing mud and sand	No	Yes	No				
1320	Spartina swards (Spartinion maritimae)	No	Yes	No				
1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	No	Yes	No				
1340	Inland salt meadows	No	Yes	No				
14	Mediterranean and thermo-Atlantic salt marshes and salt meadows	No	Yes	No				
1410	Mediterranean salt meadows (Juncetalia maritimi)	No	Yes	No				
1420	Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	No	Yes	No				
1430	Halo-nitrophilous scrubs (Pegano-Salsoletea)	No	Yes	No				
15	Salt and gypsum inland steppes	No	Yes	No				
1510	Mediterranean salt steppes (Limonietalia)	No	Yes	No				
1520	Iberian gypsum vegetation (Gypsophiletalia)	No	Yes	No				
1530	Pannonic salt steppes and salt marshes	No	Yes	No				
16	Boreal Baltic archipelago, coastal and landupheaval areas	No	Yes	No				
1610	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	No	Yes	No				
1620	Boreal Baltic islets and small islands	No	Yes	No				
1630	Boreal Baltic coastal meadows	No	Yes	No				
1640	Boreal Baltic sandy beaches with perennial vegetation	No	Yes	No				
2	COASTAL SAND DUNES AND INLAND DUNES	No	Yes	No				
21	Sea dunes of the Atlantic, North Sea and Baltic coasts	No	Yes	No				
2110	Embryonic shifting dunes	No	Yes	No				
2120	Shifting dunes along the shoreline with Ammophila arenaria ("white dunes")	No	Yes	No				
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	No	Yes	No				
2140	Decalcified fixed dunes with Empetrum nigrum	No	Yes	No				
2150	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	No	Yes	No				
etc.								



Code	BiotopeType	Present [X]	Protected [X]	Protected (Coverage) [%] marine	Protected (Coverage) [%] terrestrial
1	PELAGIC MARINE BIOTOPES				
1.1	Offshore (deep) waters				
1.1.1	Offshore (deep) waters above the halocline				
1.1.2	Offshore (deep) waters below the halocline				
1.2	Coastal (shallow) waters				
1.2.1	Outer coastal (shallow) waters				
1.2.2	Inner coastal (shallow) waters				
2	BENTHIC MARINE BIOTOPES				
2.1	Rocky bottoms				
2.1.1	Soft rock bottoms				
2.1.1.1	Soft rock bottoms of the aphotic zone				
2.1.1.2	Sublittoral photic zone				
2.1.1.2.1	Sublittoral level soft rock bottoms with little or no macrophyte vegetation of the photic zone				
2.1.1.2.2	Sublittoral level soft rock bottoms dominated by macrophyte vegetation				
2.1.1.2.3	Sublittoral soft rock reefs of the photic zone with little or no macrophyte vegetation				
2.1.1.3	Hydrolittoral				
2.1.1.3.1	Hydrolittoral level soft rock bottoms with little or no macrophyte vegetation				
2.1.1.3.2	Hydrolittoral level soft rock bottoms dominated by macrophyte vegetation				
2.1.1.3.3	Hydrolittoral soft rock reefs with or without macrophyte vegetation				
2.1.2	Solid rock bottoms (bedrock)				
2.1.2.1	Solid rock bottoms of the aphotic zone				
2.1.2.2	Sublittoral photic zone				
2.1.2.2.1	Sublittoral level solid rock bottoms with little or no macrophyte vegetation of the photic zone				
2.1.2.2.2	Sublittoral level solid rock bottoms dominated by macrophyte vegetation				
2.1.2.2.3	Sublittoral solid rock reefs of the photic zone with or without macrophyte vegetation				
2.1.2.3	Hydrolittoral				
2.1.2.3.1	Hydrolittoral level solid rock bottoms with little or no macrophyte vegetation				
2.1.2.3.2	Hydrolittoral level solid rock bottoms dominated by macrophyte vegetation				
2.1.2.3.3	Hydrolittoral solid rock reefs with or without macrophyte vegetation				
2.2	Stony bottoms				
2.2.1	Stony bottoms of the aphotic zone				
2.2.2	Sublittoral photic zone				
2.2.2.1	Sublittoral level stony bottoms with little or no macrophyte vegetation of the photic zone				
2.2.2.2	Sublittoral level stony bottoms dominated by macrophyte vegetation				
2.2.2.3	Sublittoral stony reefs of the photic zone with or without macrophyte vegetation				
2.2.3	Hydrolittoral				
2.2.3.1	Hydrolittoral level stony bottoms with little or no macrophyte vegetation				
2.2.3.2	Hydrolittoral level stony bottoms dominated by macophyte vegetation				
2.2.3.3	Stony reefs of the hydrolittoral with or without macrophyte vegetation				
2.3	Hard clay bottoms				
2.3.1	Hard clay bottoms of the aphotic zone				
etc.					



Code	ComplexType	Present [X]	Protected [X]	Protected (Coverage) marine	Protected (Coverage) terrestrial
A	Rocky coasts				
B	Sandy coasts				
C	Moraine coasts				
D	Flat coasts subject to intensive land upheaval				
E	Fjords				
F	Fjards/fjord like bays				
G	Lagoons including Bodden, barrier lagoons and Fladas				
H	Large spits of sand and/or gravel separating a lagoon form the sea				
I	Riverine areas under backwater influence by the sea				
J	Estuaries and river mouth areas				
K	Archipelagos				
L	Solitary islands				
M	Esker islands				

Annex II

Special case: Germany

Transfer of information from Natura 2000 Standard Data Forms to the BSPA database

Within the German EEZ some BSPAs overlap several Natura 2000 sites. To be able to precisely adopt information from the periodically required Natura 2000 reporting it was decided to replace the originally designated German BSPAs by sites based upon the Natura 2000 marine protected areas. The Natura 2000 areas were coded as "new" sub-sites with reference to overlapping BSPAs and the "old " BSPAs deleted from the BSPA DB.

Table 1 indicates which Natura 2000 sites provided information and replaced the listed BSPAs in the HELCOM BSPA database. In addition data from standard data forms four SCIs (marked with a cross in Table 1) were used for the analysis, as they spatially coincided with the indicated BSPA. They were, however, not included into the HELCOM BSPA database as sub-sites because they were not officially designated as BSPA.

Table 1. Managed and designated BSPAs within the German EEZ and spatially coinciding Natura 2000 sites, Sites of Community Importance (SCI, Habitats Directive) and Special Protected Areas (SPA, Birds Directive). The information from standard data forms of these Natura 2000 sites was transferred to the corresponding BSPAs.

BSPA ID	Name	Natura 2000 sites	
		SCI	SPA
2	Jasmund National Park	1447-302	
3	Vorpommersche Boddenlandschaft National Park	1541-301, 1544-302, 1542-302	1542-401
171	Walkyriengrund	1832-322	
172	Pommersche Bucht – Rönnebank Komplex	1249-301, 1251-301, 1652-301	1552-401
173	Flensburger Förde	1123-393	1123-491
174	Schlei	1423-394	1423-491
175	Eckernförder Bucht mit Flachgründen	1526-391	1525-491
176	Östliche Kieler Bucht	1528-391, 1631-392, 1532-391[1], 1629-391[1], 1631-391[1], 1631-393[1]	1530-491
177	Ostsee östlich Wagrien	1533-301, 1632-392, 1733-301	1633-491
178	Ostseeküste am Brodtener Ufer	1931-301[2]	
180	Kadetrinne	1332-301	
181	Fehmarn Belt	1339-301	

1 SCIs which spatially overlap with BSPAs but which have not been designated as BSPAs
2 Also protected as an SPA under the EC Birds Directive

For some BSPAs information was available within the BSPA DB. To avoid its loss it was decided to integrate any additional information to the new sub-site. Where several Natura 2000 sites were added as sub-sites replacing one BSPA the information was added to that sub-site which was stated as reference Natura 2000 site. In case of antagonisms and doubts it was referred to the information most up to date. Thus information from BSPA 172 was transferred to 229, from 173 to 210 from 174 to 212, and from 180 to 231.

Table 2 shows how information from the certain fields of the Standard Data Form (SDF) was transferred to the BSPA Questionnaire with Table 3 specifying the equivalent synonyms of codes in Category 6.1 'General Impacts and Activities' identified in the BSPA database as 'Threats Existing to the Area' or 'Partly a Threat to the Area'.

Table 2. List of the categories from the Natura 2000 Standard Data Form (SDF) from which information could be transferred to the HELCOM database and the equivalent categories and fields in the BSPA questionnaire.

SDF Category		BSPA Questionnaire	
		Category	Field
1.2	Site Code	General	N2K_SITE CODE
1.3 / 1.4	Compilation Data / Update	General	Date
1.6	Respondent	General	Contracting Party Value ID, Organisation Name, Contact Information
1.7	Site Name	General	Name
2.2	Area (ha)	General	Area Total Size
3.1	Habitat Types	Habitats[1]	protected
3.2 / 3.3	Species	Species[2]	protected
4.1	General Site Character: Habitat Classes		
	# Marine Areas, Sea Inlets	General	Area Marine Size
	# Other Site Characteristics	General / Selection[3]	Characteristics / Reason for Selection
4.2	Quality and Importance	Selection[3]	
4.3	Vulnerability	Threats	Existing Threat to the area
5.1	Relation of the Described site with other sites:		
	# designated at the international level: % Cover	General	% Coverage
6.1	General Impacts and Activities		
	# Within the Site: Intensity A	Threats	Existing Threat to the area
	# Within the Site: Intensity B/C	Threats	Partly a threat to the area
	# Around the Site	Threats	Partly a threat to the area

1 Codes in the SDF and the BSPA Questionnaire are identical

2 Species not listed were recorded in 'General: Other Important Species'

3 If the given information could not be matched with any of the isted options, it was recorded in 'General: Selection

Table 3. Codes given for the Standard Data Form (SDF) Category 6.1 'General Impacts and Activities' and the equivalent synonyms listed in the BSPA database as 'Threats Existing to the Area' or 'Partly a Threat to the Area'.

SDFCode	BSPA DB Synonym
100 – 190	Pollution from Agriculture
200	Aquaculture/ Mariculture
210 – 213	Commercial Fishing
220 – 221	Leisure Fishing
230	Hunting
240 – 290	Not applicable
300 – 302	Sand/ Gravel Extraction
310 – 390	Mineral/ Rock Extraction
400 – 409	Construction of Summer Houses
410 – 419	Pollution from Industry
420 – 424	General Pollution
430 – 490	Not applicable
500 – 504	Human Disturbance
505 – 506	Aeronautics
507 – 509	Human Disturbance
510 – 513	Underwater Pipelines and Cables
520	Pollution from Shipping
530 – 590	Not applicable
600 – 690	Tourism and Recreation
700 – 709	General Pollution
710 – 740	Human Disturbance
790	General Pollution
800 – 811	Marine Construction
820	Sand/ Gravel Extraction
830 – 853	Not applicable
860	Dumping
870 – 871	Coastal Defence Measures
890	Marine Construction
900	Erosion
910 – 953	Not applicable
954	Alien Species
960 – 990	Not applicable

Annex III

Recommendations for the improvement of the structure and the content of the HELCOM BSPA database

Proposals for deletion

Based on the results of the survey, we recommend excluding the categories “General” and “Biogeographic region”. Several aspects in the “General” category were completed for only a few BSPAs. These for example included questions which provided information on the percentage overlap of BSPAs with other types of marine protected areas. In particular information concerning area overlaps may not be comparable due to the use of different projections and due to the variable quality of the underlying data. Moreover, if required, this type of data can easily be derived as consistent and comparable information applying standard GIS procedures. The same applies also for the category “Biogeographic region”.

Proposals for harmonisation

With regard to “Threats” and “Activities” we propose matching the two lists provided in the database. The majority of the variables proposed exist in both lists, but some have been divided into multiple components in one or the other. The lists should therefore be harmonised to simplify finalisation of the database. Furthermore, the list of threats should be validated against the list provided in the Natura 2000 standard data forms allowing, users to extract the required information from the standard data forms where available.

Protected area status

Also, the only possible MPA status for BSPAs reported in the database should be ‘designated’. The distinction between managed and designated sites should be excluded because more detailed information on management status was provided. Moreover, several BSPAs were categorized as managed, though management measures were reported to be either non-existent or not in force, indicating a misunderstanding of the terminology used.

Proposed sites

Sites proposed under Recommendation 15/5 and expert opinion sites suggested by Hägerhall & Skov (1998) constitute a fixed set of advocated BSPAs to which no further sites could be added. Their listing in the database would be counterproductive because they were not officially nominated and thus provided no protection. Contracting States are not obliged to designate proposed and expert opinion sites but are merely recommended to do so. To determine designation status, shape files of proposed and expert opinion sites should be maintained in the GIS database for comparison.

Management plan

It is also recommended that the term ‘management plan’ be replaced by the broader expression ‘management measures’. The term ‘management plan’ is defined by the Habitats Directives as distinct policies specifically designed for each site. The plan should correspond to the ecological requirements of the natural habitat types and the abundant species within the specific site. ‘Management plans, which are detailed official documents, transcend other management types and take into account the specific characteristics of each site and all foreseen activities. The term ‘management measures’ is less strictly defined and may include a variety of official, regional and contractual activities.

The lists of species, habitats and biotopes

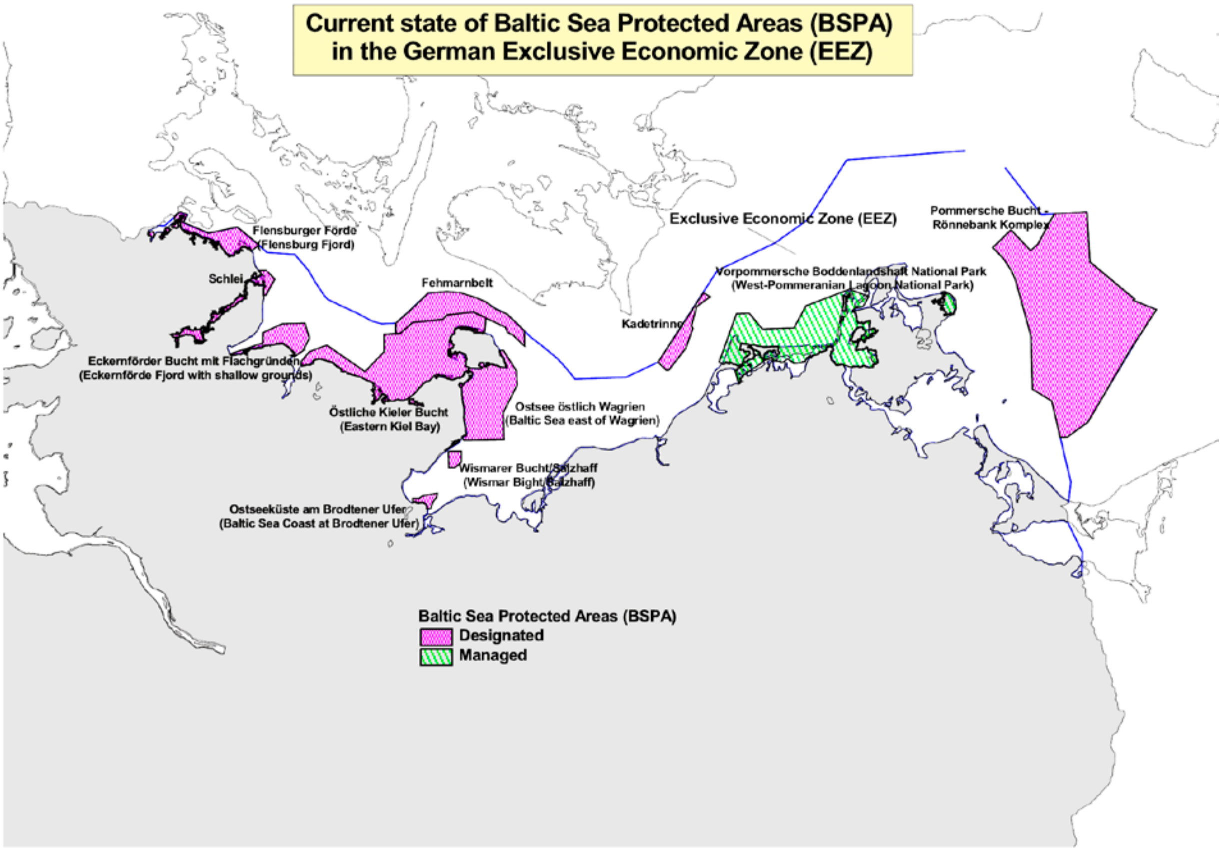
The list of species should be shortened to include marine, terrestrial and freshwater species occurring in the Baltic Sea region only. Furthermore only those species protected by management measures or legislation should be reported by Contracting States. An additional category should allow Contracting States to provide information about species which are prevalent for a BSPA but which do not need any specific protection.

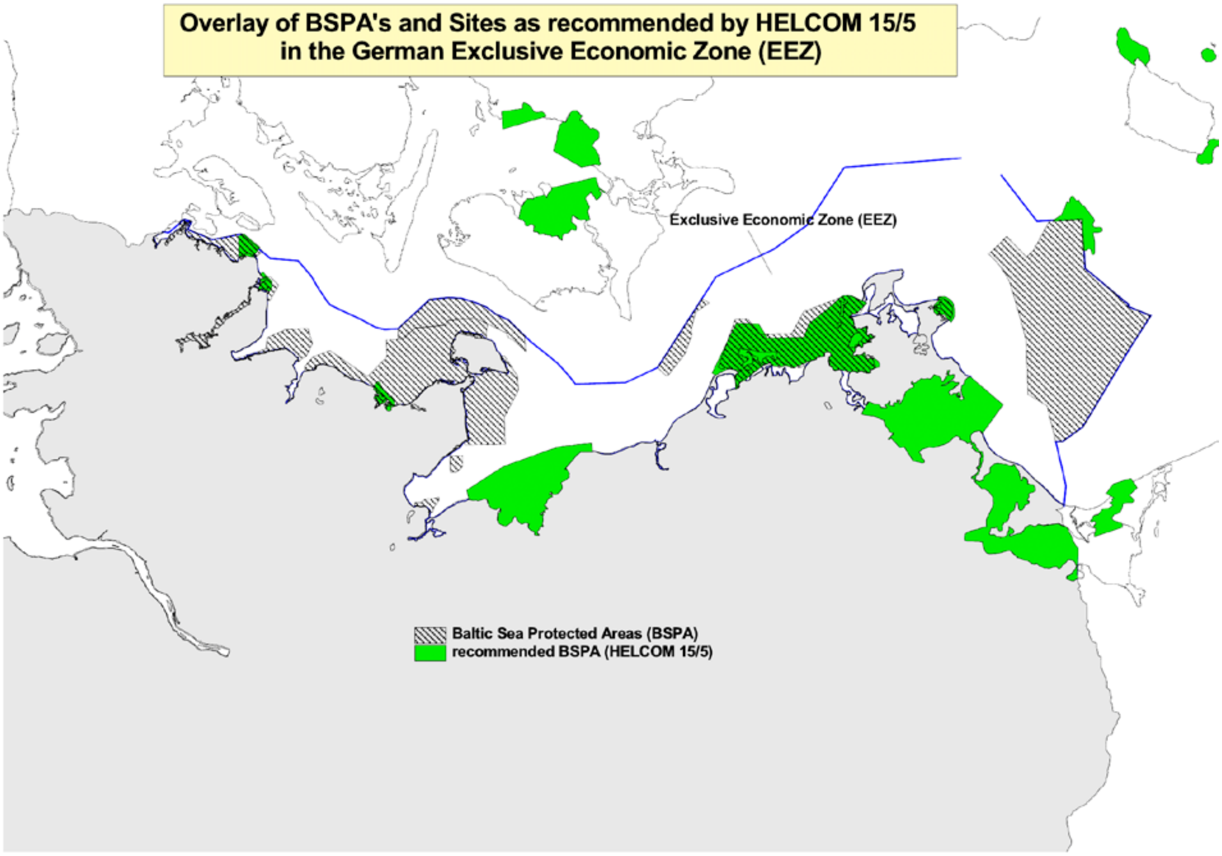
We also recommend including only one list of biotopes. At current, the lists of habitats, biotopes and biotope complexes have different data origins and consequently apply diverse terminologies. While some terms may explicitly refer to distinct biotopes, others may categorise and differentiate certain biotope types at distinct levels. Moreover, categorisations currently differ not only among the three lists, but also within individual lists. This results in highly inconsistent classifications, and since users may select check all classification levels, it also results in data replication. The list should include only marine, terrestrial and freshwater biotopes occurring in the Baltic Sea region and should be explicit and consistent in terminology. As stated in the BSAP habitat building biotopes in particular should be included (HELCOM (2007a).

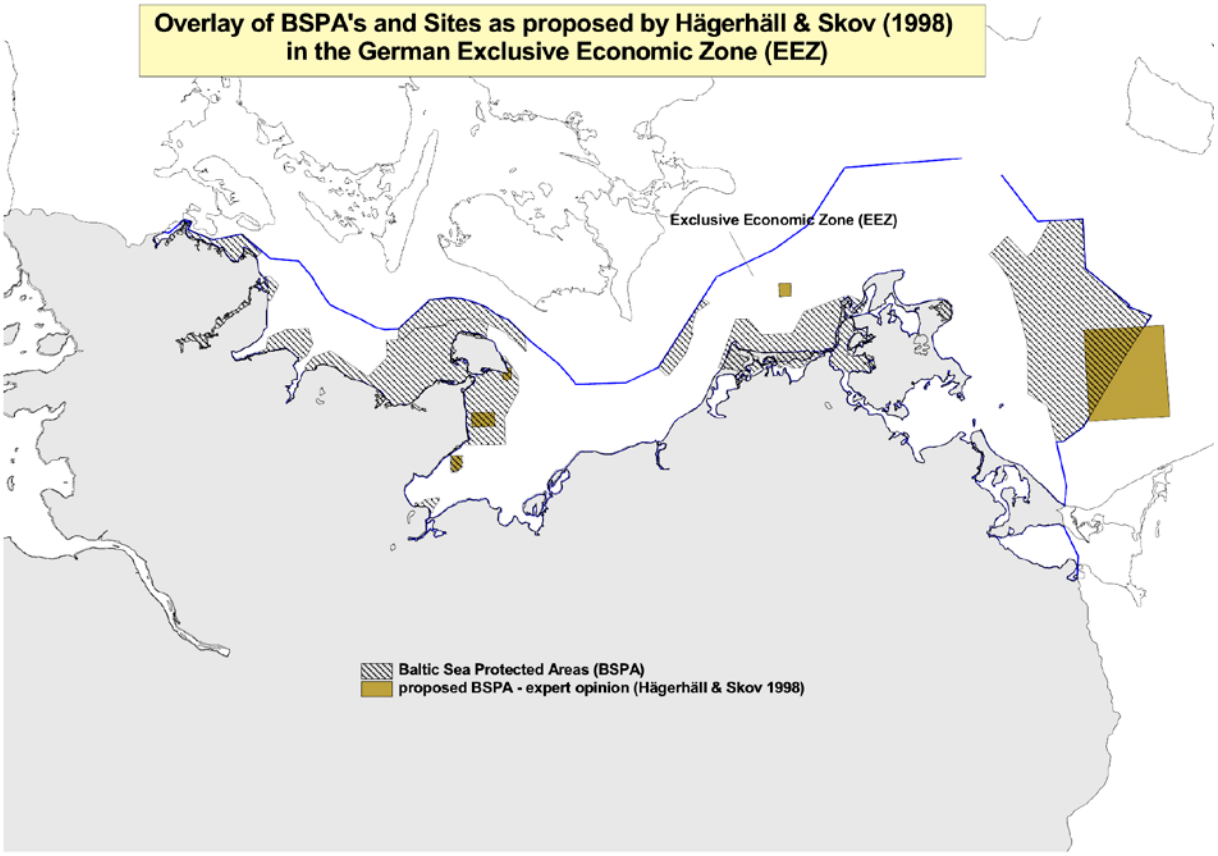
As for the species, it is also recommended here that the Contracting States should report only those biotopes protected by management measures and/ or legislation. A further category should be added to allow Contracting States to report on biotopes which are prevalent for a BSPA, but which do not need any specific protection.

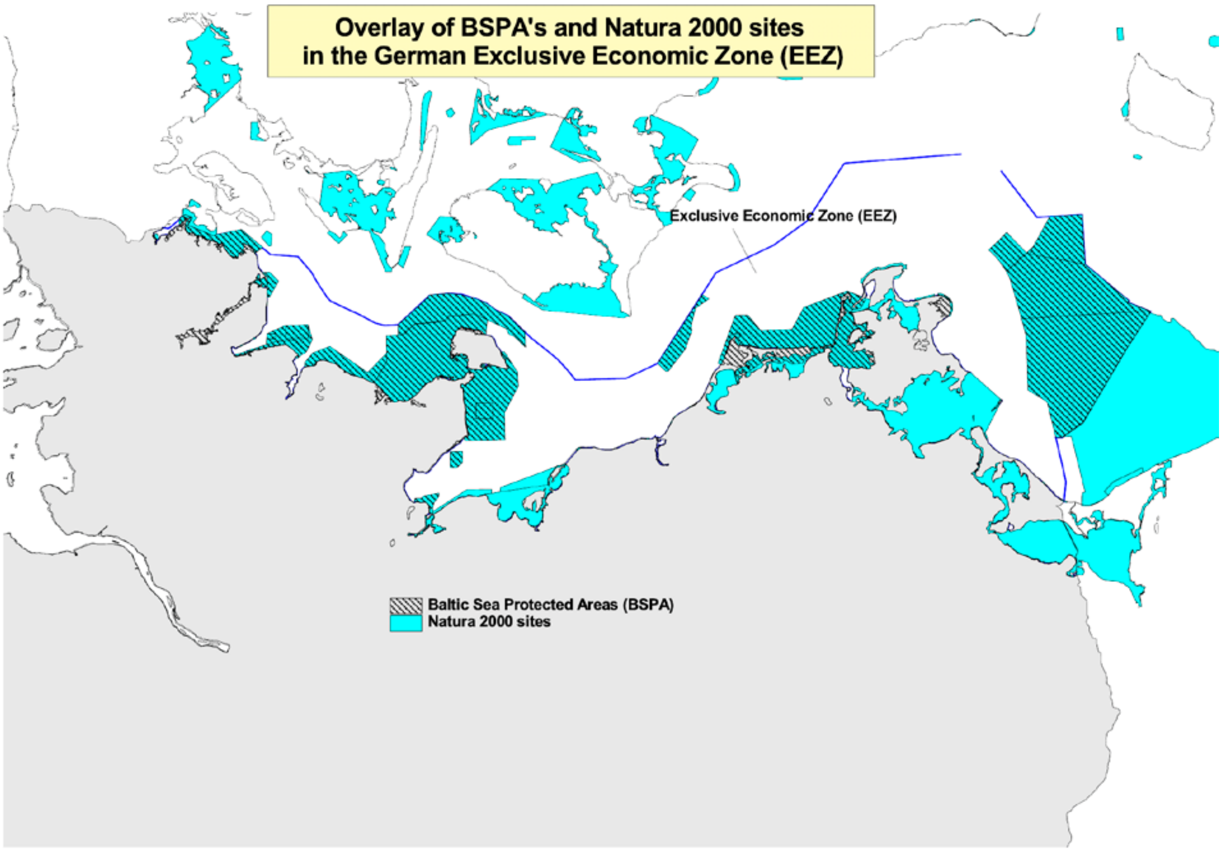
Annex IV

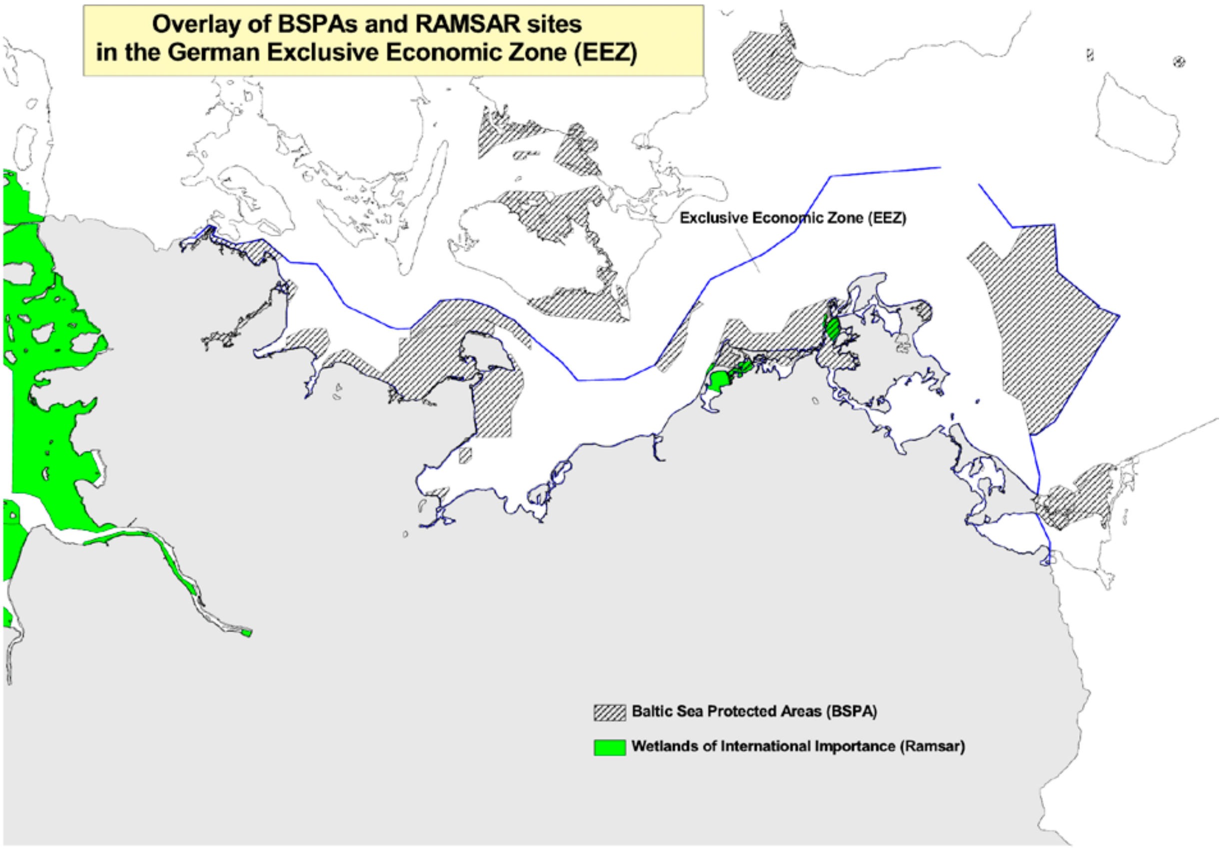
Set of maps used with the questionnaire. Example: Germany

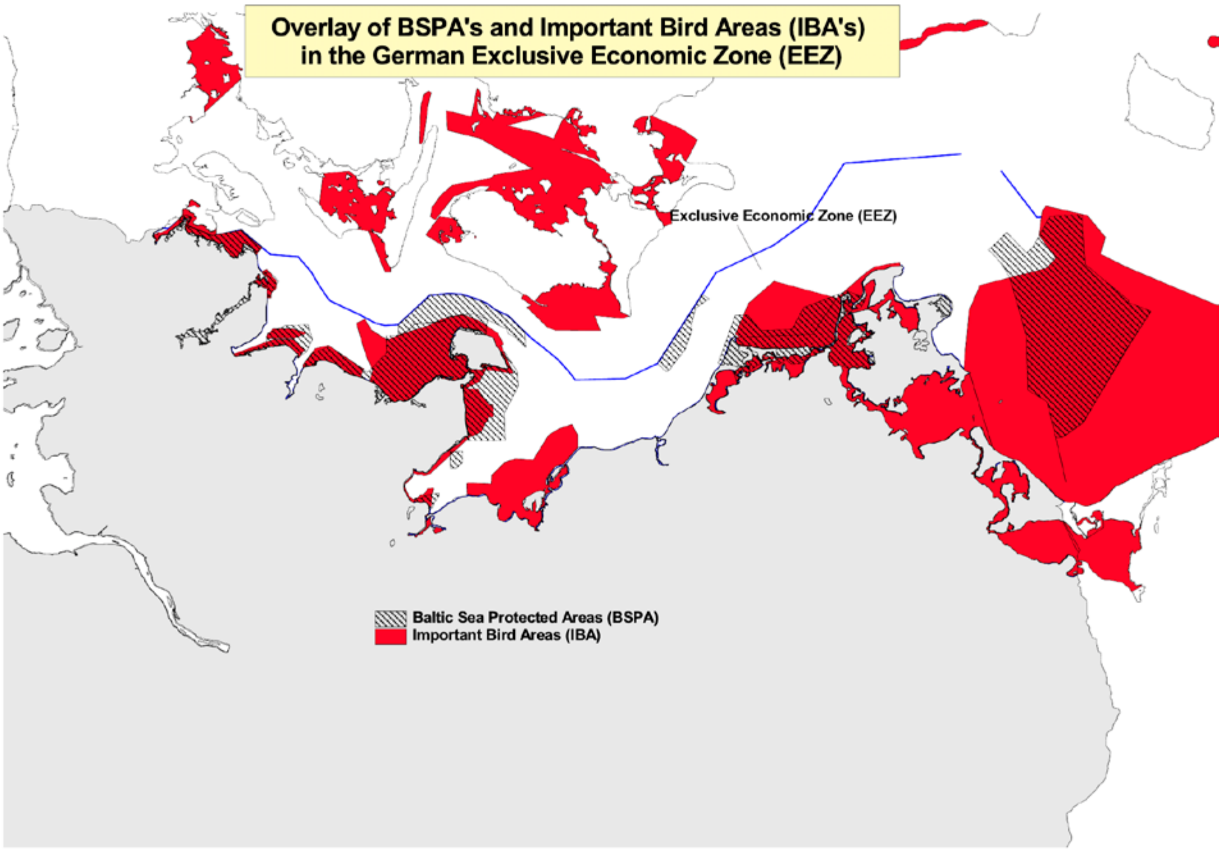


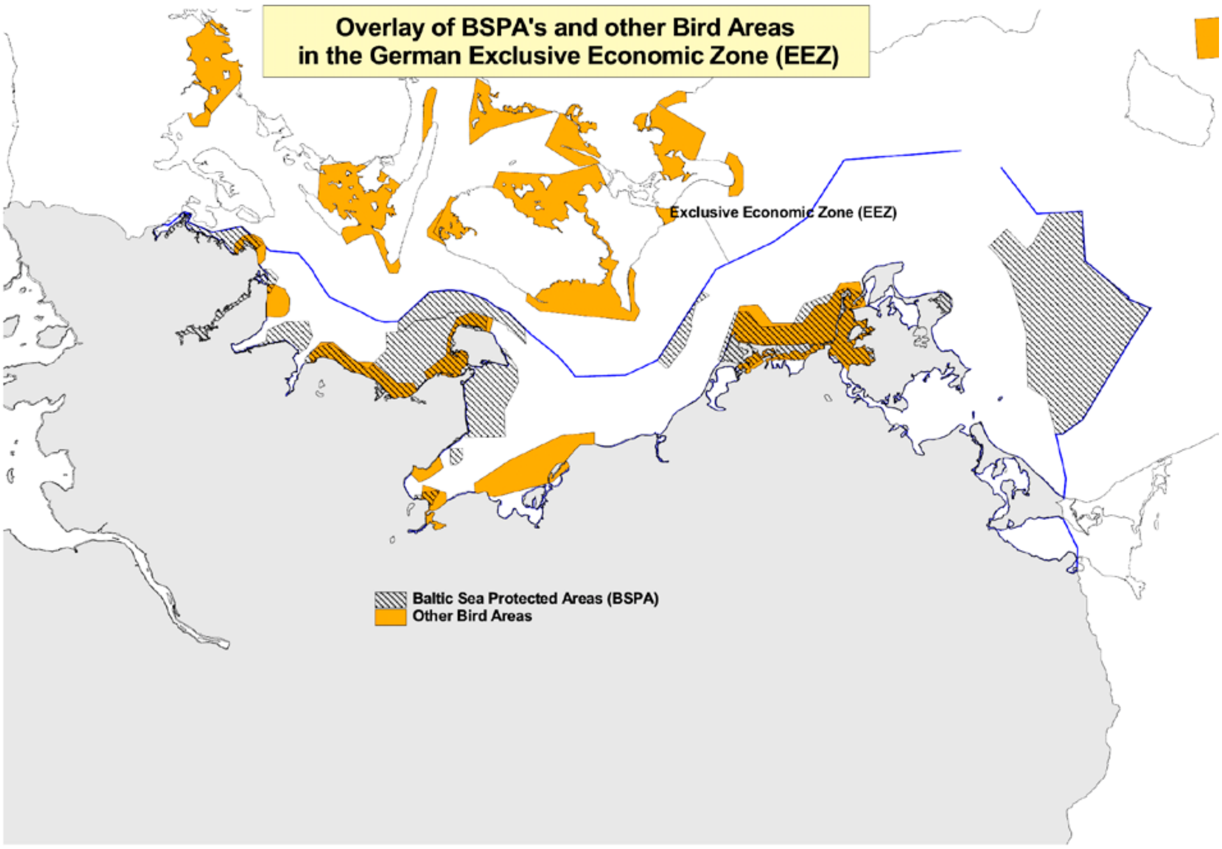


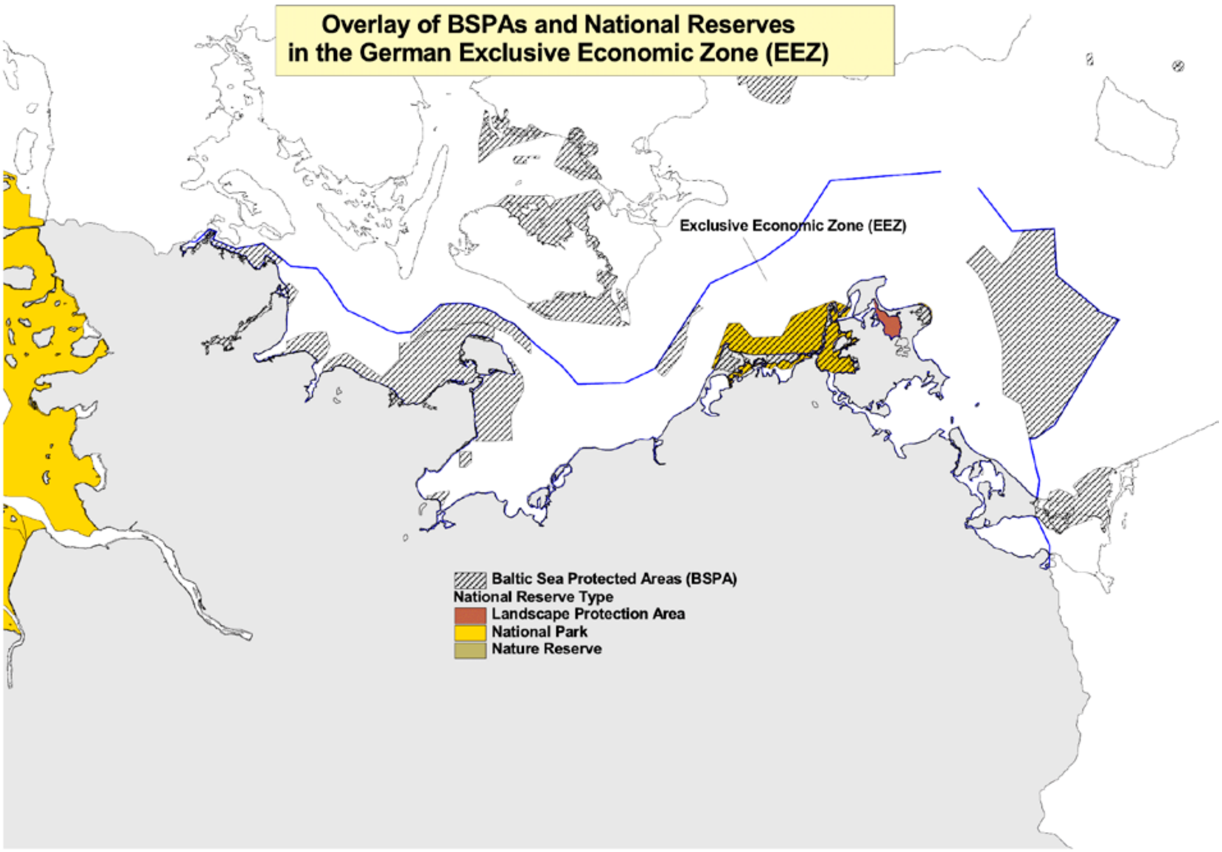

Overlay of BSPA's and Sites as proposed by Hägerhäll & Skov (1998) in the German Exclusive Economic Zone (EEZ)


Overlay of BSPA's and Natura 2000 sites in the German Exclusive Economic Zone (EEZ)


Overlay of BSPAs and RAMSAR sites
in the German Exclusive Economic Zone (EEZ)
Exclusive Economic Zone (EEZ)
▨ Baltic Sea Protected Areas (BSPA)
🟩 Wetlands of International Importance (Ramsar)

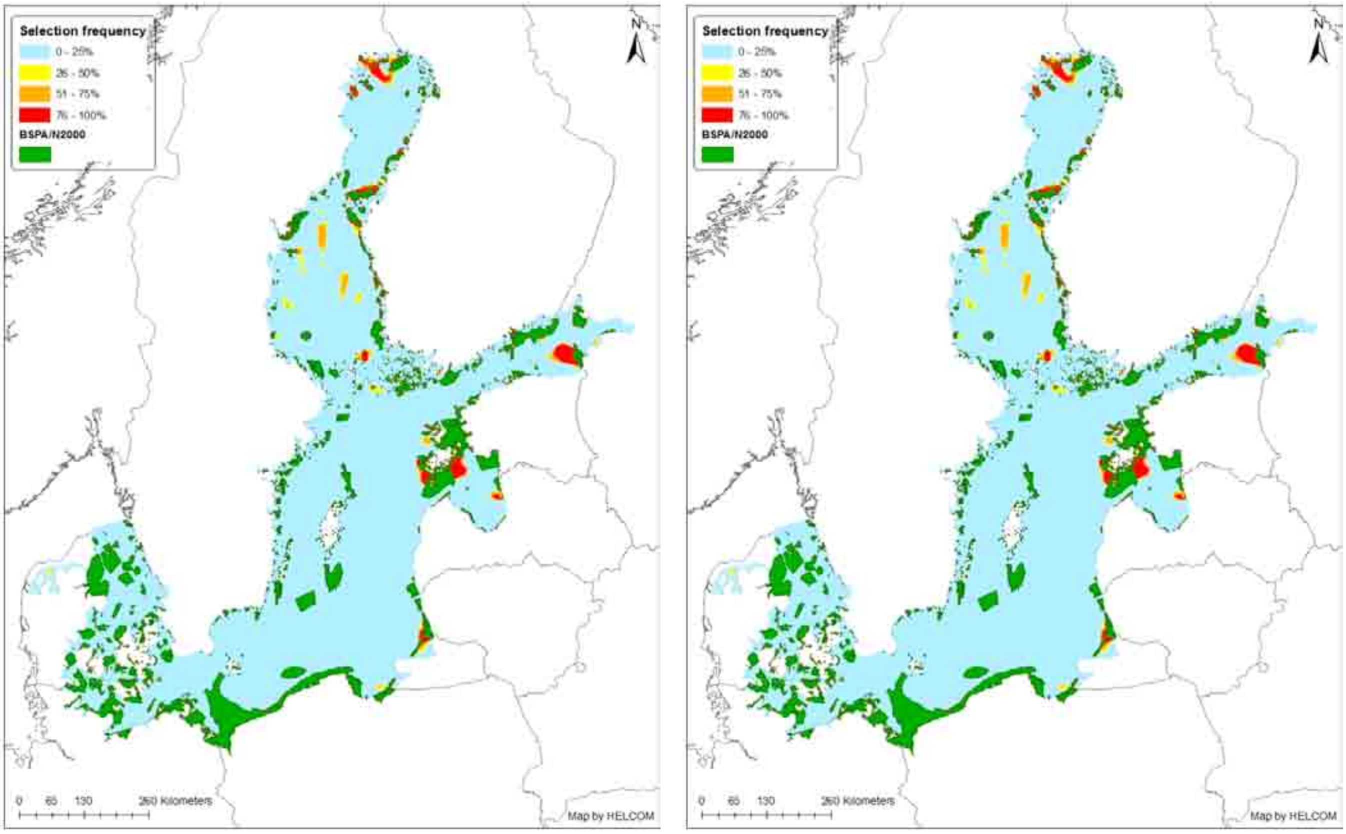

Overlay of BSPA's and Important Bird Areas (IBA's)
in the German Exclusive Economic Zone (EEZ)
Exclusive Economic Zone (EEZ)
▨ Baltic Sea Protected Areas (BSPA)
🟥 Important Bird Areas (IBA)


Overlay of BSPA's and other Bird Areas
in the German Exclusive Economic Zone (EEZ)
Exclusive Economic Zone (EEZ)
▨ Baltic Sea Protected Areas (BSPA)
🟧 Other Bird Areas


Overlay of BSPAs and National Reserves
in the German Exclusive Economic Zone (EEZ)
Exclusive Economic Zone (EEZ)
▨ Baltic Sea Protected Areas (BSPA)
National Reserve Type
🟥 Landscape Protection Area
🟨 National Park
🟫 Nature Reserve

Annex V

Selection frequency maps showing scenarios analysed and their parameters


a)

b)

Figure 1. Selection frequency of different areas with a) lower; and b) higher conservation targets with no minimum sub-regional coverage with existing MPAs included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 1 million; SPF: 2; BLM: 4.
b) Number of iterations: 100 runs, 5 million; SPF: 3; BLM: 4.

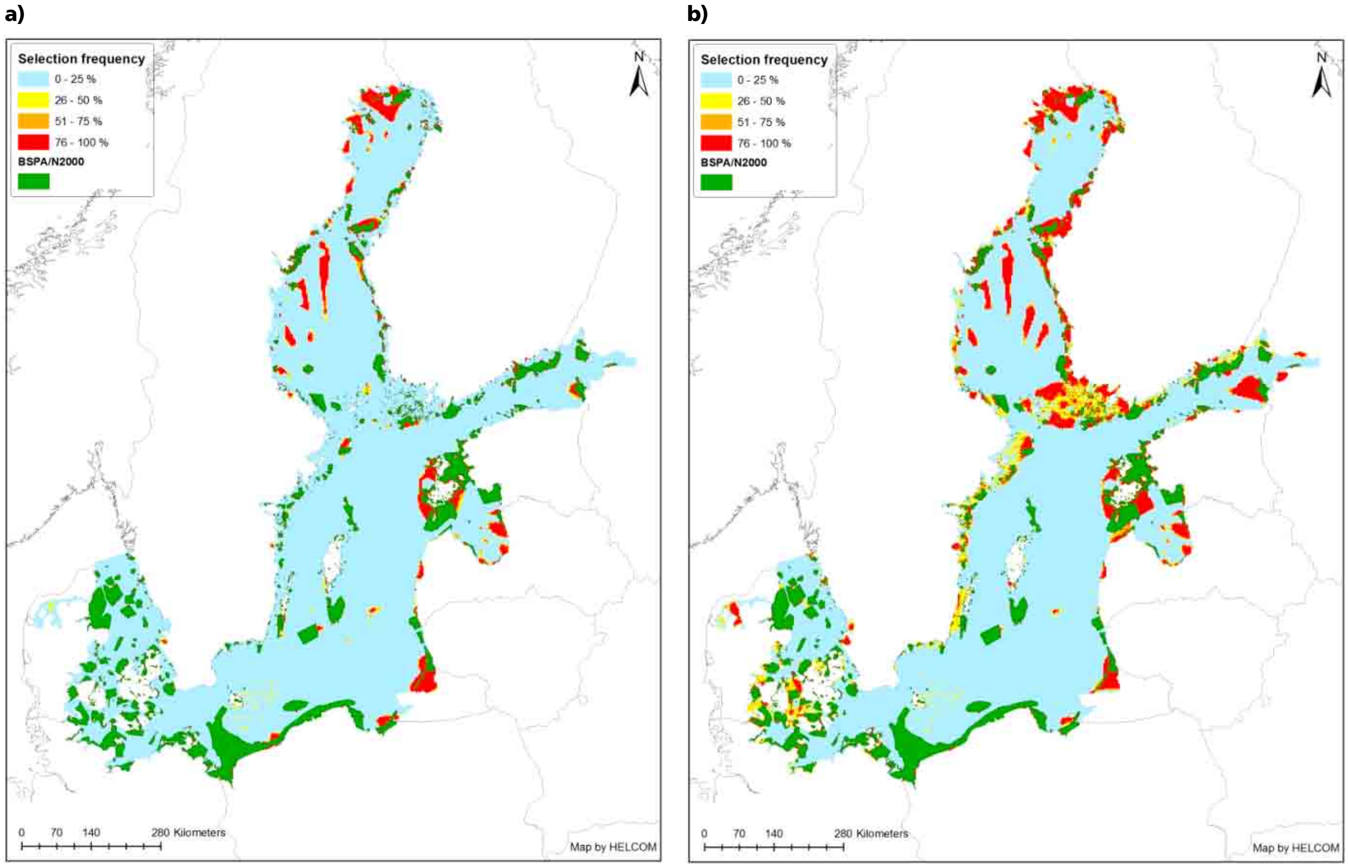


Figure 2. Selection frequency of different areas with a) lower; and b) higher conservation targets with minimum 12% sub-regional coverage with existing MPAs included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 2 million; SPF: 2; BLM: 3.
b) Number of iterations: 100 runs, 5 million; SPF: 3; BLM: 5.

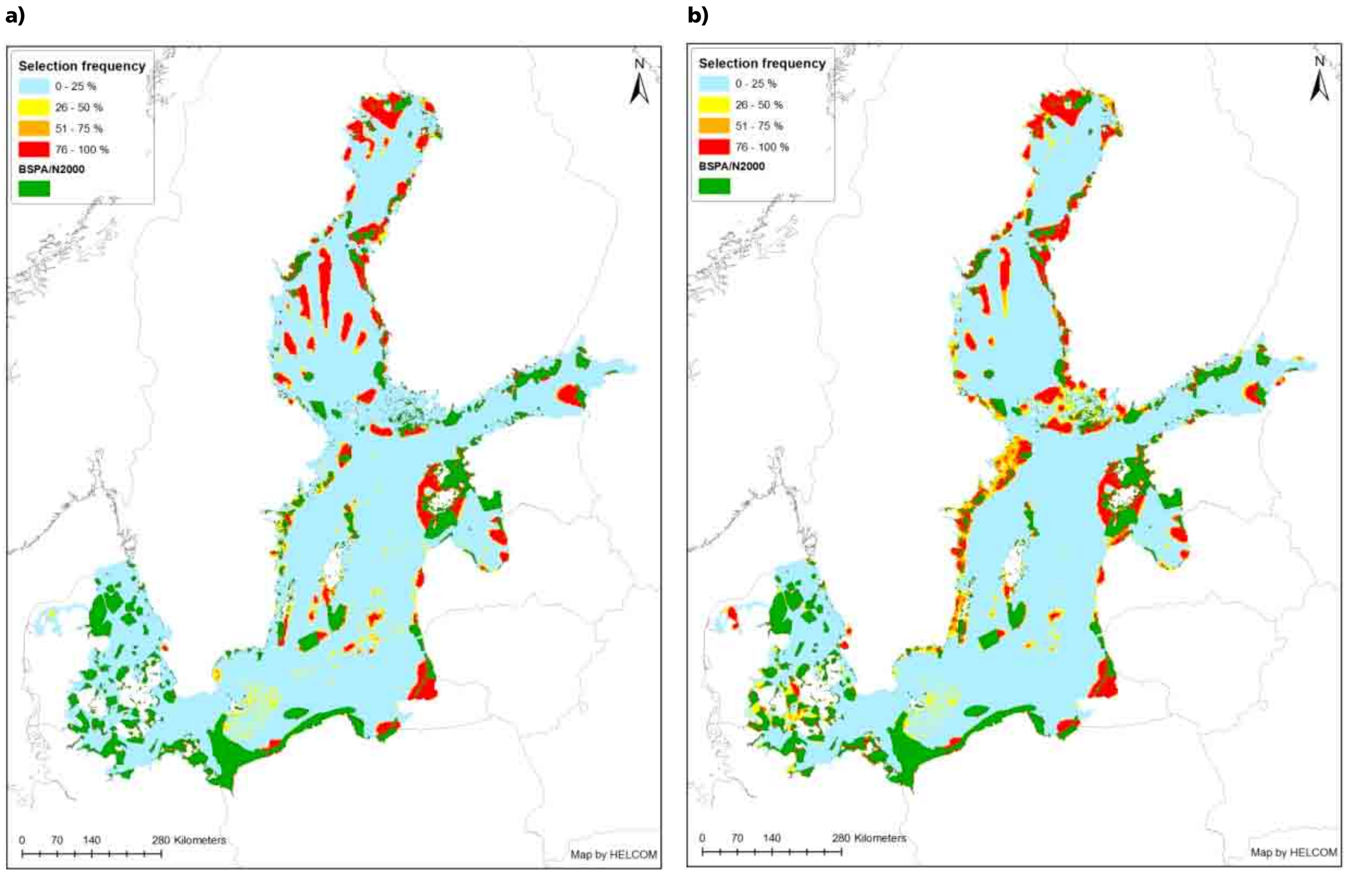


Figure 3. Selection frequency of different areas with a) lower; and b) higher conservation targets with minimum 20% sub-regional coverage with existing MPAs included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 5 million; SPF: 3; BLM: 6.
b) Number of iterations: 100 runs, 4 million; SPF: 8; BLM: 10.

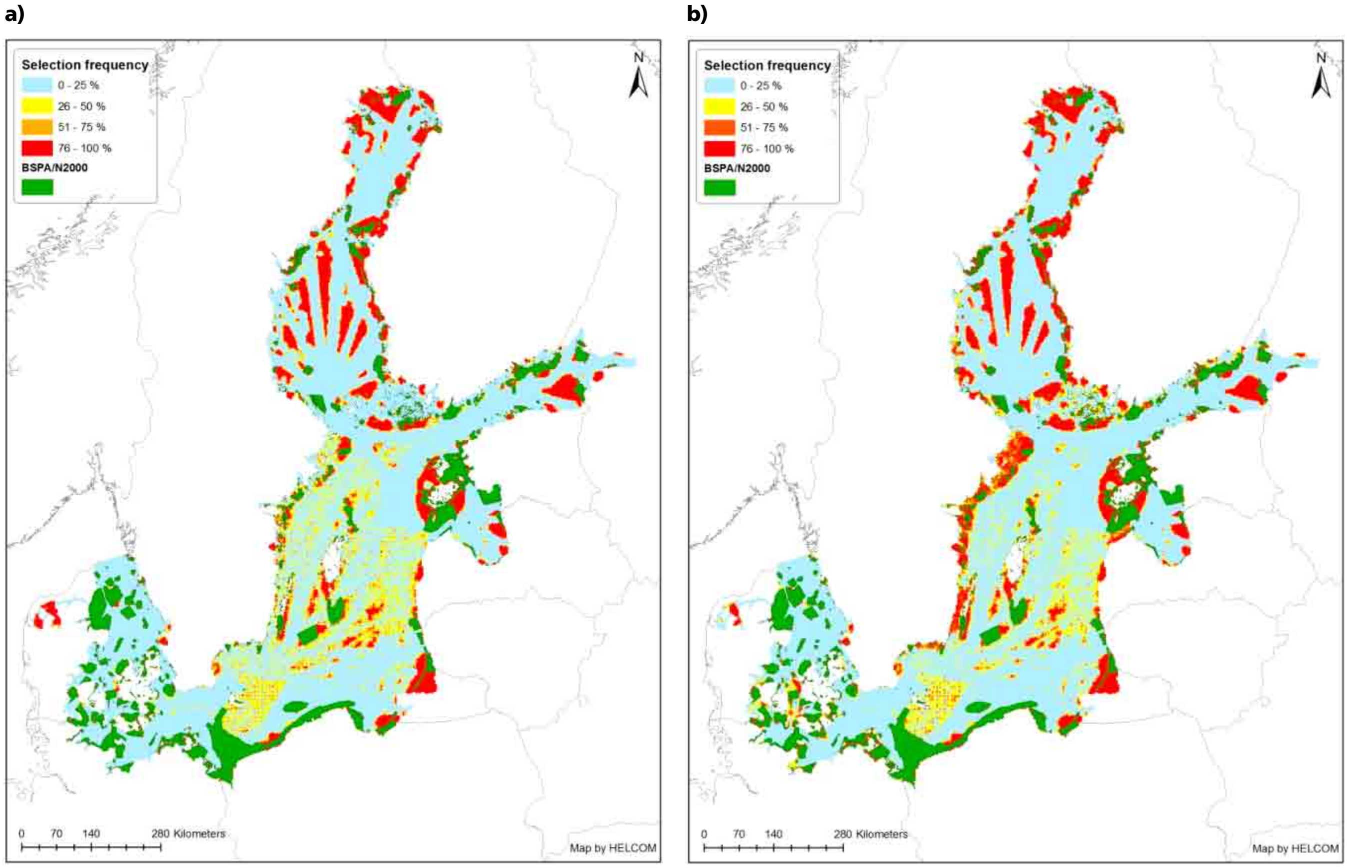


Figure 4. Selection frequency of different areas with a) lower; and b) higher conservation targets with minimum 30% sub-regional coverage with existing MPAs included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 6 million; SPF: 3; BLM: 5.
b) Number of iterations: 100 runs, 4 million; SPF: 5; BLM: 6.

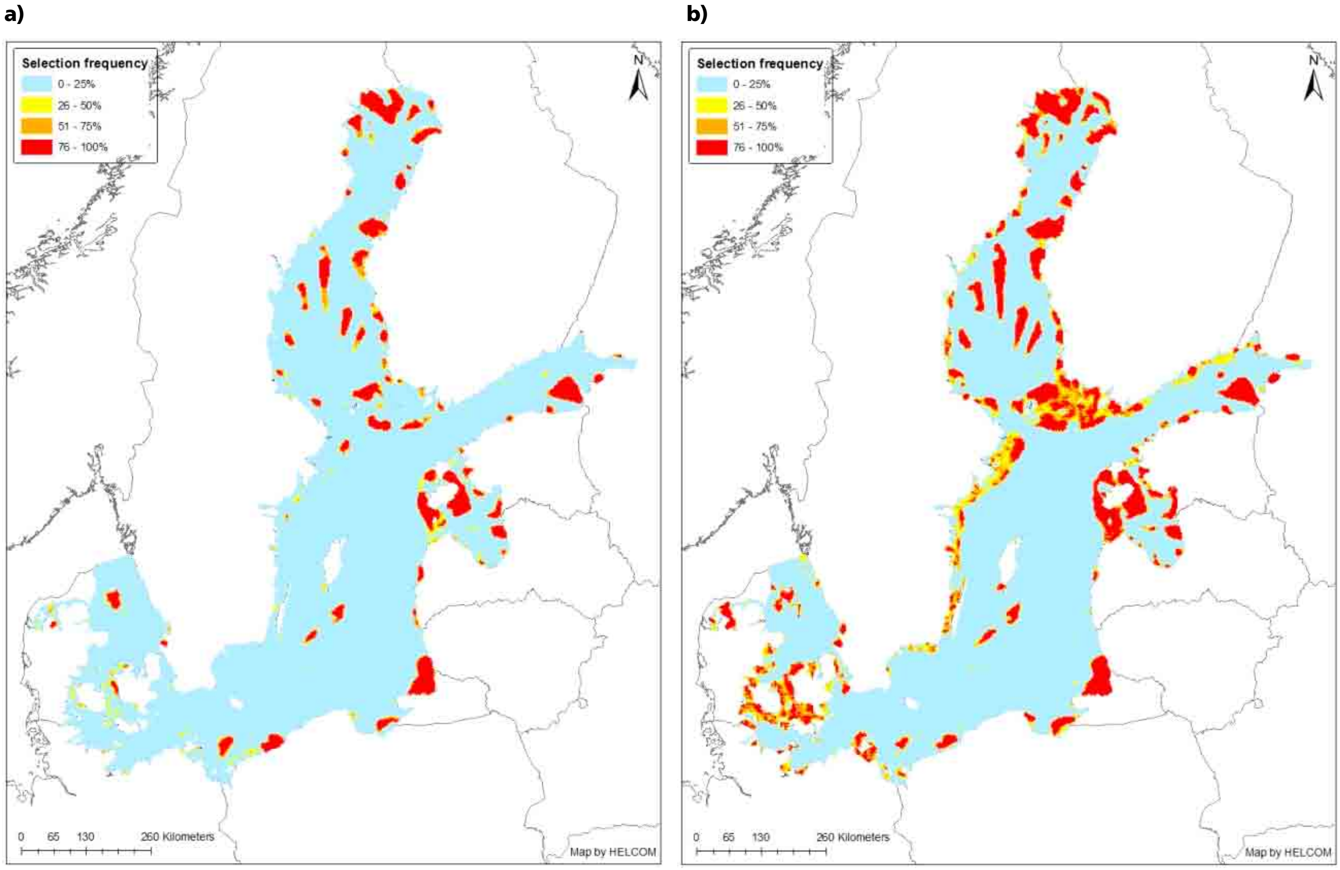
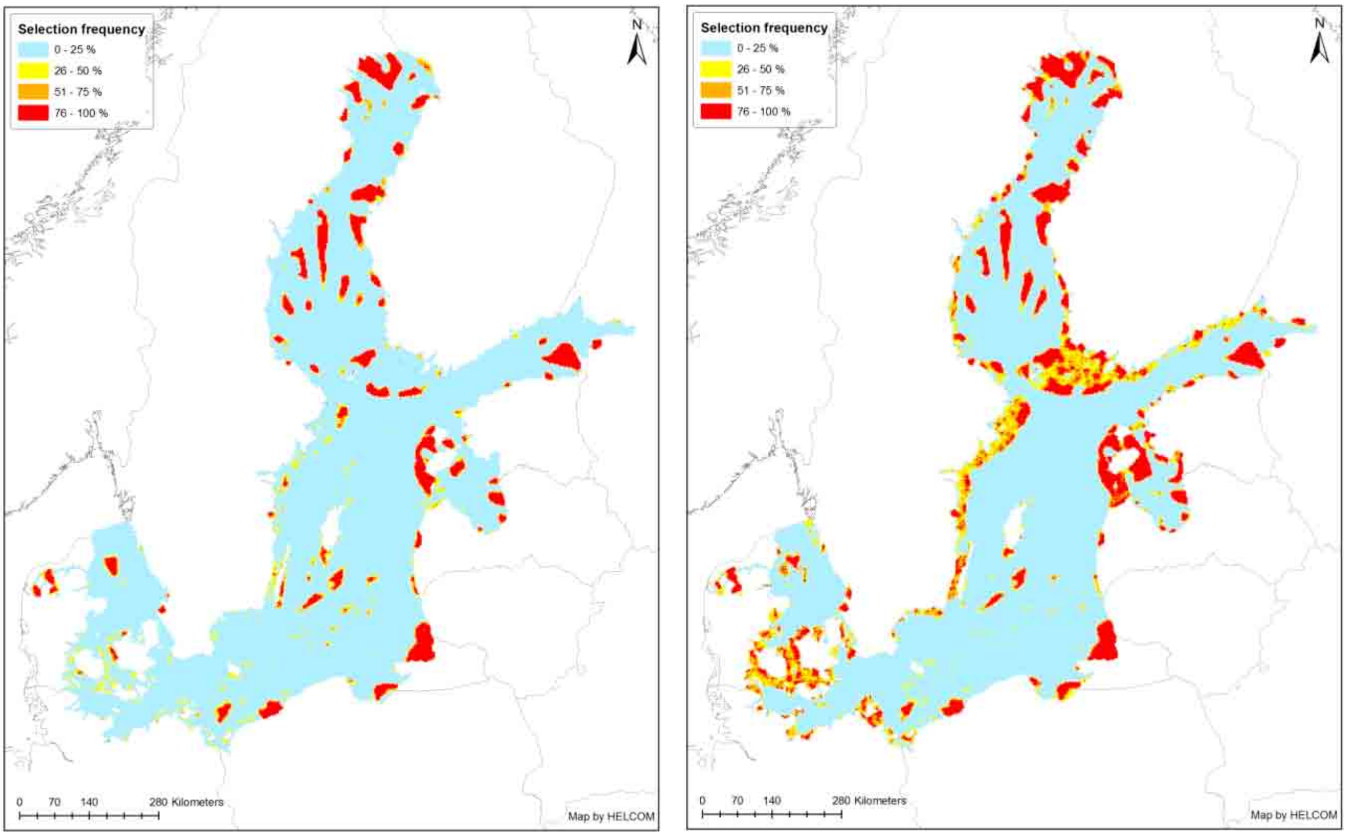


Figure 5. Selection frequency of different areas with a) lower; and b) higher conservation targets with no minimum sub-regional coverage. Existing MPAs were not included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 5 million; SPF: 10; BLM: 12.
b) Number of iterations: 100 runs, 6 million; SPF: 9; BLM: 12.


a)

b)

Figure 6. Selection frequency of different areas with a) lower; and b) higher conservation targets with minimum 12% sub-regional coverage. Existing MPAs were not included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 4 million; SPF: 9; BLM: 8.
b) Number of iterations: 100 runs, 5 million; SPF: 15; BLM: 8.

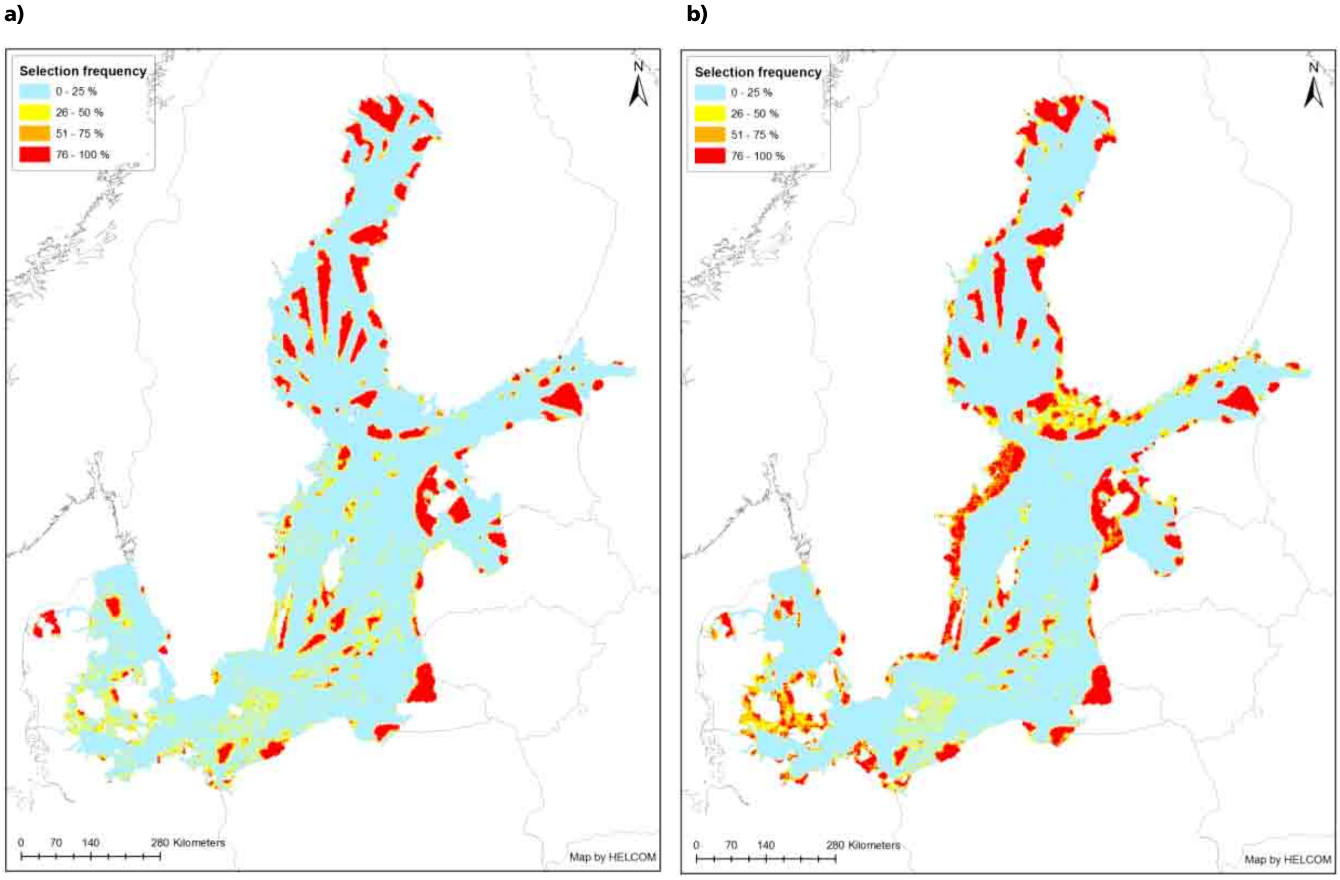


Figure 7. Selection frequency of different areas with a) lower; and b) higher conservation targets with minimum 20% sub-regional coverage. Existing MPAs were not included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 6 million; SPF: 8; BLM: 7.
b) Number of iterations: 100 runs, 6 million; SPF: 8; BLM: 7.

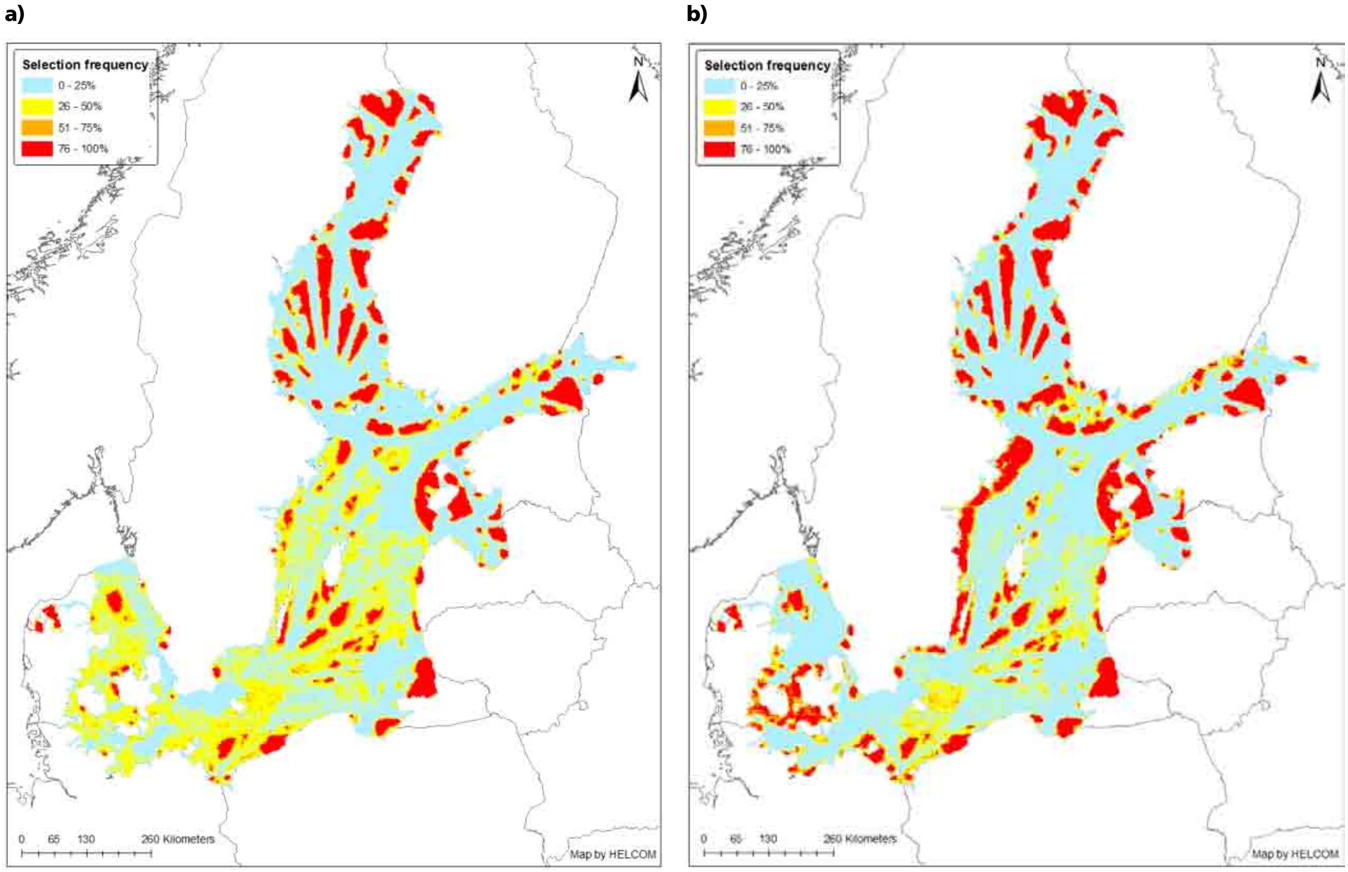


Figure 8. Selection frequency of different areas with a) lower; and b) higher conservation targets with minimum 30% sub-regional coverage. Existing MPAs were not included. For conservation targets see Tables 49 and 50 in the report.

Parameters used:
a) Number of iterations: 100 runs, 6 million; SPF: 5; BLM: 15.
b) Number of iterations: 100 runs, 6 million; SPF: 4; BLM: 15.

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