Proposal for an assessment method of the ecological coherence of networks of marine protected areas in Europe
Proposal for an assessment method of the ecological coherence of networks of marine protected areas in Europe
Keywords
Marine protected areas, assessment methodology, assessment methods, assessment criteria, ecological coherence, representativity, connectivity, replication, adequacy.

Summary
A review of the criteria used in Europe and elsewhere for assessing the ecological coherence of networks of marine protected areas has led to a proposal for the assessment criteria to be used by the Commission: representativity, connectivity of conservation features, replication of these features in several sites and adequacy. The report also presents an assessment method which was developed based on a review of MPA assessments. The proposed method uses both the one-out-all-out approach and averaging of indicators. It also offers the option to include uncertainty in the assessment. The proposed assessment method was tested in the Baltic Sea. A roadmap for further development is presented.

References

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Summary

This report presents the result of a study commissioned by EC/DGENV, Framework contract No ENV.D2/FRA/2012/0019. The study was carried out by a consortium of SYKE (Finland), HCMR (Greece), AZTI-Tecnalia (Spain) and Deltares (the Netherlands), with Deltares as lead partner.

The aim of the study is to develop a harmonised methodology for the evaluation of the coherence of the European networks of Marine Protected Areas (MPAs) by the European Commission.

Work process followed in this study

In the first phase of this study a literature review was made of criteria for assessment of the ecological coherence. The review was complemented with three interviews with experts from several European organisations. The findings of the review were presented and discussed at a workshop with the Marine Expert Group (MEG) and stakeholders in May 2014. The aim of the workshop was to define and confirm the objectives of the assessment method for the assessment of ecological coherence. The comments and recommendations from this workshop were incorporated in the second study phase.

In the second phase we reviewed the existing methods for the assessment of ecological coherence. This review was an important input for the method that we propose for use by the Commission. The method was tested in a case study in part of the Baltic Sea.

In the third phase the results of the method for assessment of networks of MPAs were presented at the MEG again and comments of the member states have been taken into account in this final report. Finally, based on all discussions during the process, a roadmap is included for further development in the field of assessment of the ecological coherence of MPAs for use by the European Commission.

Review of assessment criteria

A review was made of criteria for assessment of the ecological coherence of MPAs and MPA networks in Europe and in other regions. This review was complemented by adding criteria meant for establishment of MPAs and design of MPA networks. The review showed that a wide range of criteria have been used for the designation and assessment of MPAs and that many of those are highly conceptual. There are also good practices in recent assessments, for instance, in the European marine regions and by a few research projects. The criteria were inventoried and catalogued in an electronic annex to this report and we identified assessment criteria and subcriteria that we propose for a method for assessments of ecological coherence. The review showed that the criteria that are in use in the four European marine regions are very similar; or at least they refer to similar concepts.

1 The assessment criteria as named at the outset of the project were coherence, adequacy and representativity. Based on this study this was adapted to four main criteria ‘representativity’, ‘connectivity’, ‘adequacy’ and ‘replication’, under the overarching concept of ‘ecological coherence’. For sake of conciseness we use the term ecological coherence in the rest of this chapter.
Criteria proposed for the assessment by the Commission

The proposed criteria are essentially a combination of identical or comparable criteria from the Convention on Biological Diversity (CBD) and the regional sea conventions (RSCs): primarily OSPAR, HELCOM and the Barcelona Convention and to a lesser degree the Black Sea Convention.

We propose ‘ecological coherence’ as an over-arching criterion. This is a concept that has been mentioned repeatedly in legal documents, theoretically defined in many marine regions and assessed by RSCs. Based on the review, we propose that ecological coherence comprises four main criteria: representativity, adequacy, connectivity and replication. Under these four main criteria, eight subcriteria are proposed.

Review of existing assessment methods

A next step of this study was to review the existing methods for the assessment of ecological coherence. The review showed that despite the wide use of the concept ‘coherence’ there is very little guidance or theoretical discussion available as to how ecological coherence can be technically assessed, let alone how it could become widely accepted. Assessment results are reported from the NE Atlantic, the Baltic Sea and the Mediterranean and to the extent possible also from the Black Sea. These reports discuss whether the network of MPAs is ecologically coherent, and if not, what is the cause for the failure. In this review we noticed that in principle all assessments have used the one-out-all-out principle, where the lowest scoring assessment criterion defines the outcome of the assessment, whereas there was no systematic method described for the way in which the key assessment conclusions can be drawn.

Proposed assessment method for use by the Commission

Our proposal for the assessment method is based on the review findings and builds further upon them. The current practice of using the one-out-all-out principle is included in the core of the method. The four main criteria (i.e. representativity, replication, connectivity and adequacy) are considered to be equally important and a failure in any one of them results in a failure in reaching ecological coherence of the network. We note that in an assessment, the subcriteria should be associated with more detailed information, such as species or habitat identity, and these are called indicators. On the indicator level, we propose not to use the one-out-all-out principle because at this level its use will almost certainly lead to false failures (unjust downgrading). Instead, we suggest that the indicators for each main criterion are averaged, as their number may vary from a few to several (depending on the number of conservation features assessed in the region).

Distinction between a basic and a more detailed method

Data on marine species, habitats and other features of conservation value are accumulating and progress is being made in e.g. mapping marine benthic habitats. However, as these new data are not yet available for all European marine regions, we propose that a basic assessment method is applied in situations where data availability limits ecologically more accurate assessments. In situations where more comprehensive spatial data is available the assessments could use a more detailed method. This can be the case in specific areas or smaller geographical scales. In the basic method, only GIS files of the region, its bathymetry, the MPAs polygons, and a database of species and habitats found within the MPAs are
required. The more detailed method includes two more advanced components: (1) mapped habitats and species range (and other features of interest) and (2) spatial distribution of the main anthropogenic pressures. The biological data ensure that the assessments of representativity, replication and connectivity are based on measurements rather than presence/absence information. The data on anthropogenic pressures give information of the estimated impacts on the conservation features and, hence, can be used to evaluate whether the ecological coherence of the MPA network is threatened.

**Including uncertainty in the assessment results**

Our proposed assessment method takes account of best available science by offering an optional procedure to estimate the uncertainty in the assessment. The uncertainty is assessed on the level of indicators, where it can be found in data, targets or methods. We suggest principles to guide the score of the uncertainty which can then be used to weigh the averaging of indicators. By including uncertainty estimates, it is possible to trace the gaps in the assessment. Finally, the assessment of ecological coherence was suggested to be based on likelihoods, because it is not feasible to give on/off scores for a complex assessment. This is also a way to include the uncertainties in the assessment result.

**Testing the proposed method in the Baltic Sea**

The proposed assessment method was tested in the central part of the Baltic Sea. The ecological coherence was assessed by the four main assessment criteria and eight subcriteria – covering a number of conservation features – using 48 indicators. Each indicator was given a target level based on scientific literature or previous assessment practices. We applied both the basic method and the more detailed method, where mapped broad-scale habitats were used in the assessments of representativity and connectivity. The test assessment used targets that are preliminary and not agreed in the region and therefore the case study should be considered primarily for illustrating the suggested method.

**Outlook for the use of the proposed method**

The proposed method offers an approach that can be implemented in different regions and scales of European seas, with their heterogeneous ecological characteristics and data availability. The method can provide comparable assessment results in different European regions. However, we note that the findings of this report are the first step in a consistent assessment method and more focus should be given to solve the methodological challenges in bringing ecological reality into MPA assessments. While assessments of ecological coherence have been (and can be) made in the European marine regions, the development of an assessment method for MPAs is work in progress. Some important knowledge gaps still exist. Discussions are ongoing on a number of issues, for example on which targets to use and on whether or not to include management or protection categories. This report presents the current practices and identifies a number of 'next steps', that will help the EU Member States (MSs) make further progress.
1 About this report

1.1 Background

To achieve the objectives of the EU Member States (MSs) to reach or maintain good environmental status (GES) in the marine environment, the Marine Strategy Framework Directive (MSFD) in Article 13(4) requires that 'Programmes of measures established pursuant to this Article shall include spatial protection measures, contributing to coherent and representative networks of marine protected areas, adequately covering the diversity of the constituent ecosystems, such as special areas of conservation pursuant to the Habitats Directive, special protection areas pursuant to the Birds Directive, and marine protected areas as agreed by the Community or Member States concerned in the framework of international or regional agreements to which they are parties.' All EU MSs are expected to report on Marine Protected Areas (MPAs) according to Article 13, paragraphs 4 and 6. According to Article 16, the Commission shall assess whether these programmes constitute an appropriate framework to meet the requirements of the MSFD.

The aim of the present study is to develop a harmonised methodology\(^2\) for the evaluation of the coherence, adequacy and representativity\(^3\) of the EU networks of MPAs by the Commission.

A key principle underlying this report is that an MPA network is more than the sum of single sites. It is important not only to establish MPAs to protect key areas but also to ensure their ecological connections and adequacy of single sites as parts of the network. This means that in order to achieve ecologically coherent and representative MPA networks, adequately covering biodiversity, also single sites must contribute to the targets of the whole network and be strategically located.

Designation of MPAs is driven by several international, EU and regional initiatives, obligations and agreements. Therefore the protection levels, spatial coverage and representativity of conservation features vary widely in the existing MPA networks. An overview of the drivers of MPA designation is provided in Annex C, Section C.2. The most important ones are:

- based on EU legislation:
  - Natura 2000 (= Birds and Habitats Directives combined);
  - Marine Strategy Framework Directive (MSFD);
  - Common Fisheries Policy (CFP);
  - Maritime Spatial Planning Framework Directive (MSPFD);

\(^2\) We use the word methodology to refer to an overview of methods, which may include basic principles, paradigms etc; and the word method to refer to a procedure to answer a question. In this report, methodology is used when referring to the results of our reviews; method is used when referring to the proposed way of assessing ecological coherence.

\(^3\) The assessment criteria as named at the outset of the project were coherence, adequacy and representativity. Based on this study this was adapted to the four main criteria 'representativity', 'connectivity', 'adequacy' and 'replication', under the overarching concept of 'ecological coherence', as defined in Section 2.3.
based on international or regional sea conventions:
   o OSPAR, HELCOM, Barcelona Convention, Black Sea Convention, Bern Convention, Ramsar Convention;
   o Convention on Biological Diversity (CBD).

Most of these initiatives have been introduced within the last decades to grant special protection to sites perceived as encompassing the most valuable marine habitats and species. Currently, the definition, design and establishment of MPA networks as a tool to protect biodiversity and ecosystem function is an important goal of different EU coastal, marine and biodiversity policies. The Water Framework Directive (WFD, 2006/60/EC) and the MSFD (2008/56/EC) both set targets for good ecological or environmental status and a holistic approach in ecosystem management. Parallel to the MSFD, the Habitats and Bird Directives and the Natura 2000 legislation provide the MSs with a legal framework for setting up MPAs. The European Environment Agency (EEA) maintains the Natura 2000 database, and the Common Database on Designated Areas (CDDA), to which MSs report. The Natura 2000 database is updated annually according to the Nature directives; the reporting frequency of CDDA database is annual (WG_MPA, 2013).4

The Habitats Directive aims to achieve favorable conservation status of selected species and habitats by the means of, inter alia, the Natura 2000 network of protected areas. Furthermore, establishing representative networks of MPAs at eco-regional and sub-regional scales5 is a fundamental part of any Maritime Spatial Planning and Ecosystem Management approach in their aim to promote the sustainable development and conservation of marine biodiversity environment.

One of the objectives of the Integrated Maritime Policy work programme is to promote the protection of the marine environment and the sustainable use of marine and coastal resources, as well as to further define the boundaries of the sustainability of human activities that have an impact on the marine environment. These objectives represent shared interests and potential synergies with the MPA networks.

In addition, the Common Fisheries Policy (CFP) (EU, 2013) and in particular its Article 8 on the establishment of fish stock recovery areas – which states that in such areas fishing activities may be restricted or prohibited in order to contribute to the conservation of living aquatic resources and marine ecosystems – contribute to the conservation of marine biodiversity in Europe. There is however a subtle difference between MPAs and areas which indirectly or incidentally provide protection. A recent IUCN report about applying the management categories to MPAs (Day et al., 2012) states that an area can qualify as an MPA only if it fulfills the IUCN MPA definition (Dudley 2008). The main criterion is whether or not nature conservation is the primary objective. Applying the definition is not always easy, but Day et al. (2012) specifically mention that ‘fishery management areas with no wider stated conservation aims […] are not necessarily MPAs’. In the framework of CFP Art. 8, a dual objective of ‘conservation of living aquatic resources and marine ecosystems’ has been stated which means that fish stock recovery areas could be qualified as MPAs.

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4 In this report version 11 of the CDDA was used.
5 In this report we use the geographical terms proposed by Prins et al. (2014), included as Annex b.
There are also marine areas where human activities or their possible restriction may benefit marine biodiversity. For example, there is good evidence that offshore wind farms increase species richness as a result of the increased availability of hard substrate, while restrictions of some other activities in e.g. navigation lanes or offshore oil and gas production areas can incidentally protect marine biodiversity. Such areas can be established, e.g. via the EU Maritime Spatial Planning Directive (EU, 2014), which requires MSs to establish and implement maritime spatial planning (MSP). MSP is based, *inter alia*, on an ecosystem-based approach. By the MPA definition, these areas cannot be called MPAs (Day *et al.*, 2012).

1.2 Guidance for reading

Chapter 2 presents the review of criteria by which MPAs have been assessed or designated. For each framework – global, European, regional or national – an inventory of the criteria for the assessment or designation was made. Technical details of the analysis are given in Annex C and the complete dataset of the inventory is provided in a separate database. Chapter 2 proposes management categories of MPAs which are based on the IUCN categories. The chapter presents the proposed set of criteria for use in our assessment method. Finally the synergies and differences with Natura 2000 and GES are discussed.

In Chapter 3 the assessment methodology for the ecological coherence of networks of MPAs is discussed on the basis of a review of assessments, guideline reports and scientific studies. The proposed method for use by the Commission is presented.

The proposed method was tested in the central part of the Baltic Sea. The main results and findings of this test can be found in Chapter 4. This case study can also be considered as an illustrative example of the method.

Chapter 5 is a discussion part of the report, while Chapter 6 summarizes the conclusions. Chapter 7 presents a roadmap for further development. Issues are identified which are relevant for further activities in the field of assessment of the ecological coherence of MPAs.
2 Assessment criteria for the ecological coherence of MPA networks

2.1 Background

In 2004, the Conference of the Parties (COP7) of the Convention on Biological Diversity (CBD) embraced a decision regarding protected areas (Decision VII/28), by which it adopted ‘the programme of work on protected areas annexed to the present decision with the objective of the establishment and maintenance by 2010 for terrestrial and by 2012 for marine areas of comprehensive, effectively managed, and ecologically representative national and regional systems of protected areas that collectively, inter alia through a global network/ contribute to achieving the three objectives of the Convention and the 2010 target to significantly reduce the current rate of biodiversity loss’.

Under the same Convention, a strategic plan covering twenty specific targets were established in 2010. These targets are termed the Aitchi targets. Aichi Target 11 states that 'by 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape'.

With these objectives and targets in mind, international, regional, EU, and MS/local legislation has been implemented to push forward the designation and management of MPAs.

In relation to the establishment of MPAs, there is fairly well-developed common understanding in the global fora (e.g. CBD, IUCN, World Parks Congress) on how to design an ideal MPA network\(^6\). In parallel, experience in how to assess the ecological coherence of MPAs has started to develop. In Europe, region-wide MPA assessments have previously been carried out in the BALANCE project\(^7\) for the Baltic Sea, in OSPAR for the NE Atlantic\(^8\), and by the Network of Marine Protected Area Managers (MedPAN) and the Regional Activity Centre for Specially Protected Areas (RAC/SPA) of the Barcelona Convention\(^9\) for the Mediterranean. The European Topic Centres of the EEA are conducting a spatial analysis of MPAs and the European Marine Board published a position paper on the science needs for MPA coherence\(^10\). Furthermore, the EEA produced a report with an overview of protected areas in Europe (EEA, 2012) and is currently (early 2015) working on an inventory report of European MPAs. Concerning the Mediterranean region, another Status Report of MPAs will be published in 2016, the data collection for this analysis in December 2014.

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\(^6\) IUCN-WCPA, 2008; Lafolley, 2008; UNEP-WCMC, 2008
\(^7\) Liman et al, 2008; Piekäinen & Korpinen, 2007, in HELCOM (HELCOM, 2010a
\(^8\) OSPAR, 2006; Johnson et al., 2013
\(^9\) Gabrié et al., 2012
\(^10\) Olsen et al., 2013

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In addition to the documents from the RSCs, different European scientific projects have been carried out in recent years with the aim of increasing knowledge on different aspects of the implementation and management of MPAs. Among others, the network of MPAs in the Atlantic Arc (MAIA) was a European cooperation project with the aim of creating a network of MPA managers and stakeholders. Spearheading initiative in MPA designation, governance and management on an international scale, this partnership worked on the development of a recognised, coordinated, effective and representative network of MPAs in the Atlantic Arc (http://www.maia-network.org/homepage). The BALANCE, MESH, MeshAtlantic, EUSeaMap and EMODNet Seabed habitats projects also focused their efforts on producing benthic habitat maps of European seas, and included specific case studies in regional sea conventions (RSCs) areas, to management of benthic habitats. Likewise, for the Mediterranean region the EU-FP7 project CoCoNet (Coast to Coast Networks of Marine Protected Areas) has identified groups of interconnected MPAs in the Mediterranean and the Black Seas. Furthermore, in 2011 a database of MPAs in the Mediterranean (MAPAMED: www.mapamed.org) was developed, which is jointly administered by MedPAN and RAC/SPA.

In the following sections, results from a review of national, regional and global assessment criteria are presented and then synthetized. The review was complemented by also including criteria for establishment of MPAs and design of MPA networks and adding results from several national and international projects and scientific studies in different parts of the world.11

The present chapter has the following specific objectives:

• Provide operational definitions of criteria for the assessment of ecological coherence as identified by the MSFD art. 13.4 (quoted in Section 1.1) for assessing European networks of MPAs;
• Provide operational definitions of additional criteria, if necessary.

In order to achieve these objectives, the following tasks were conducted:

• Analysis of the frameworks within which assessment criteria have been defined, to the extent possible; see Annex C, section C.2;
• Categorisation of existing numbers and areas of MPAs by the framework of their designation and by their management category (Annex C Section C-8);
• Review and comparison of criteria used by the CBD, RSCs, MSs, third parties, Natura 2000 and the MSFD in Sections 2.2 and 2.5 with additional information in Annex C, sections C.3 (overview table), C.4 (CBD) and C.5 (RSCs);
• Preparation of operational definitions of relevant criteria for assessing ecological coherence of European networks of MPAs (Section 2.3);
• Description of a classification system for management categories of European MPAs, and discuss its functionality, linking to existing IUCN categories (Section 2.4).

11 e.g. Kelleher et al., 1995.; Roberts et al., 2003; Fernandes et al., 2009; Smith et al., 2009; Natural England & JNCC, 2010, 2012; JNCC, 2013; Saarman et al., 2013.
2.2 Definitions of network assessment criteria by the CBD, the RSCs and other contexts

2.2.1 Convention on Biological Diversity

The Convention on Biological Diversity (CBD) requires that Party states establish, by 2012, comprehensive, effectively managed, and ecologically representative national and regional systems of protected areas. A crucial element to the CBD process is the ecosystem approach taking into account the human component as part of the ecosystem.

The CBD Decision IX/20 (in its Annex B) lists five components for development of networks of MPAs: (1) Ecologically and biologically significant areas, (2) Representativity, (3) Connectivity, (4) Replicated ecological features and (5) Adequate and viable sites (CBD, 2008). While these are criteria for the designation of MPA networks, they indicate significant criteria for the assessment purposes and, most importantly, provide definitions for these criteria. The meaning of the five CBD criteria is explained in Annex C, section C.4.

2.2.2 Regional Sea Conventions

Our comparison of the MPA assessment criteria used by the European RSCs is based on three main sources of information: the MedPan report from 2012 (Gabrié et al., 2012), the HELCOM coherence assessment from 2010 (HELCOM, 2010a) and the OSPAR coherence assessment from 2012 (OSPAR, 2013). There are no specific definitions and references for the Black Sea, except the CBD criteria (CBD, 2008).

Table 2.1 gives an overview of the use of assessment criteria by the RSCs. Its purpose is to show which criteria are similar among the RSCs. In some cases the criteria were only theoretical and not used in the assessments. Annex C, sections C.3 (overview table) and C.5 explain the definitions of these criteria in more detail.
Table 2.1 Definitions and use of MPA assessment criteria by the RSCs in the European marine regions (green cells). Note that the RSCs may have defined or mentioned a criterion but not used that in practice or used a criterion without definition (shaded cells). The details of the criteria are explained further in the text.

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<td>Representativity: species</td>
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<td>Representativity: ecological and evolving processes</td>
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<tr>
<td>Representativity: remarkable features</td>
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<td>Replication: number of MPAs</td>
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<td>Connectivity</td>
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<td>Adequacy: MPA size</td>
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<td>Adequacy: threats</td>
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<tr>
<td>Adequacy: level of protection (IUCN categories or similar)</td>
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<td>Age of MPAs</td>
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<tr>
<td>Viability</td>
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</table>

1) Source: Gabrié et al., 2012.

2) The Black Sea Commission has not defined the criteria, but the BSC Ministerial Declaration in Sofia 2009 states: ‘We, the ministers...have agreed to strengthen regional cooperation in the establishment of network of protected areas, with particular attention to MPAs, and development and introduction of species conservation plans, inter alia, marine mammals, in cooperation with relevant international organizations, in the coastal zone of the Black Sea aiming at species and habitat conservation.’ The table was filled according to the CBD criteria (see text).


4) HELCOM, 2014a. HELCOM recommendation 35/1 System of coastal and marine Baltic sea protected areas. 5) OSPAR, (2013)

Table 2.1 shows that there are very similar assessment criteria in use in the four marine regions (see a description of the similarities and differences in Annex C, Section C.5). The connectivity, MPA size and almost all of the representativity criteria were applied in the three regional assessments and defined for the Black Sea. The replication criterion was used in two regional assessment (i.e. HELCOM and OSPAR), and applied slightly differently in one assessment (i.e. the Black Sea). The protection level was applied in only one assessment but defined for all the marine regions. Table 2.1 also shows that there are some sub-criteria which are not shared by all the marine regions. These are:

- Representativity of ecological and evolving processes: This criterion was not applied in any of the RSC assessment but was mentioned by HELCOM and the Barcelona Convention;
- Representativity of remarkable features: This criterion was applied only by the Barcelona Convention;
- Age of MPAs: This criterion was applied only by the Barcelona Convention;
- Adequacy - threats: This criterion was applied only by HELCOM;
- Viability: This criterion was applied only by OSPAR.
2.2.3 Other assessment criteria from the review

In addition to the specific review of the CBD and the four RSCs, the analysis of MPA assessment criteria also included other international conventions, national legislation, guidelines from countries and international organizations as well as scientific reports. Furthermore, criteria for the establishment of sites and design of MPA networks were also included. The review included 266 criteria, which were catalogued in a database, organised as explained in Annex C, Section C.1. In Annex C, Section C.3 we summarize the results of criteria which are catalogued in the electronic database under Annex C section C.1. The results of this analysis are discussed in Annex C, Sections C.6 and C.7.

2.3 Proposed assessment criteria

The analysis of the assessment criteria used in the CBD, the RSCs, the Habitats Directive and in other assessments, scientific studies and research projects shows that very similar criteria and concepts are used in all the contexts. Moreover the assessments made by the RSCs for MPA networks are relatively similar across the European marine regions and the concept of ecological coherence has been applied in relatively similar ways.

Ecological coherence is an overarching concept in the MPA network design, as stated by the OSPAR-HELCOM Ministerial Declaration in 2003 (OSPAR-HELCOM, 2003). The World Commission on Protected Areas defines an MPA network as ‘a collection of individual MPAs or reserves operating co-operatively and synergistically, at various spatial scales and with a range of protection levels that are designed to meet objectives that a single reserve cannot achieve’ (IUCN-WCPA, 2008). Catchpole (2012) states that ‘...at the scale of the whole network, coherence is achieved when: the full range of variation in valued features is represented; replication of specific features occurs at different sites over a wide geographic area; dispersal, migration and genetic exchange of individuals is possible between relevant sites; all critical areas for rare, highly threatened and endemic species are included; and the network is resilient to disturbance or damage caused by natural and anthropogenic factors’.

Following to the OSPAR-HELCOM work, OSPAR (2014a) defines ecological coherence as ‘An ecologically coherent network of MPAs that
(i) interacts with and supports the wider environment;
(ii) maintains the processes, functions and structures of the intended protected features across their natural range; and
(iii) functions synergistically as a whole and such that the individual protected sites benefit from each other to achieve the two previous objectives.’

This definition is based on OSPAR agreement 2006/3 and on Laffoley et al., 2008. Additionally, the network may also be designed to be resilient to changing conditions (e.g. climate change). In this report we adopt this second definition.

A comparison of the RSC criteria with the Natura 2000 assessment criteria (Section 2.5.2) shows that the use of the RSC criteria can support the assessment of Natura 2000 network (considering a regional scale), while there are obviously differences in the protection of all features.
For the purpose of the development of an assessment methodology at a European scale, we emphasized the criteria being used in Europe and considered the assessment criteria that have been used in (preferably) all marine regions. The criteria that are proposed here ought to be applicable in all European regional seas, produce comparable results, and garner sufficient support. The selection of criteria was supported by global agreements and standards, e.g. under CBD, IUCN, as well as results from research projects, global NGOs and significant national MPA networks (e.g. Great Barrier Reef, Australia). In addition, the number of assessment criteria was kept in minimum, but a hierarchy to subcriteria was considered necessary.

Our review shows that the assessment criteria can be grouped to four main criteria, which are often referred to in MPA network assessments (OSPAR, 2013 and HELCOM, 2010a) and which are also mentioned by the CBD Decision IX/20 (CBD, 2008):

- **Representativity** of functions and features of marine biodiversity (of depth zones, ecoregions, habitats and species, including aspects of geographic distribution);
- **Replication** of sites and features;
- **Connectivity** between sites and protected features, and
- **Adequacy** of individual MPAs as parts of the network (e.g. MPA size, level of protection).

According to the aforementioned, we define the four main criteria as follows:

**Representativity** means that the MPA network includes different biogeographical and depth subdivisions of the sea areas, reflecting the full range of habitats, including all organizational levels of biodiversity (based on the CBD, 2008). The network comprises each habitat type at the appropriate levels; assuring the integrity of inshore-offshore features with a transboundary dimension. An assessment of representativity should include these aspects and be done by comparing the percent coverage of MPAs and conservation features in the assessment area (e.g. HELCOM, 2010a; Gabrié et al., 2012; OSPAR, 2013). The target is defined as percentage of the number of MPAs in which a feature is present. If mapped conservation features are available, representativity can be assessed as the true coverage of the protected features.

**Replication** is the protection of the same feature across multiple sites within the MPA network, taking biogeographic variation into account and ensuring natural variability of all features (based on the CBD, 2008). All features should be replicated to enhance resilience, representativity and connectivity and replicates should be spatially separate. The target is the minimum number of replicates in the assessment area (HELCOM, 2010a; OSPAR, 2013).

**Connectivity** of MPAs should offer sufficient opportunities for the dispersal and migration of species between MPAs. The network should take into account, and quantify whenever possible, different aspects of connectivity, e.g. a wide range of species with different ranges of dispersal and mobility, and not be focused on one element or one species to the detriment of others. The connectivity should also take into account different stages of life history of species (CBD Decision, 2008; HELCOM, 2010a; Gabrié et al., 2012; OSPAR, 2013). Connectivity can be assessed by calculating the proportion (%) of MPAs which are connected to X other MPAs within a selected distance (km) (Piekäinen & Korpinnen 2007, HELCOM, 2010).
For example, one can aim at clusters of 10 connected MPAs with a 50 km distance and set a target that 50% of all the MPAs are in such clusters. In reality, the targets must be set according to regional conditions and likely separately for coastal, offshore and high sea zones (OSPAR, 2013). If mapped conservation features are available, connectivity can be assessed by protected features rather than MPAs.

**Adequacy** refers to the practical evidence that the individual components of the network are of sufficient size, each of which may be categorised under different levels of protection, to ensure ecological viability and resilience of habitats and species within the network (CBD, 2008). While the other criteria assess the network aspects, adequacy assesses the aspects of single sites. The target for an adequate MPA network is that sites reach a minimum recommended size and the network includes management categories related with conservation objectives and endangered features. Recommended MPA sizes vary between 10 and 93 km$^2$ (Annex C, Sections C.1 and C.5.3) and more common estimates range between 20 and 60 km$^2$. The values chosen may depend on regional circumstances and regionally agreed ambition levels. There are no commonly set targets for levels of protection but the fifth World Parks Congress (2003) recommended a 10-30% coverage of each habitat by strictly protected areas and MPA networks in the US. Australia and New Zealand (Annex C, Section C.7) set the no-take areas as the standard for an MPA. The CBD adequacy definition states that MPA networks should include a core system of no-take areas, a larger system of multiple-use MPAs and areas of sustainable use (CBD, 2008). The IUCN states that MPAs can range over a wider range of protection levels as long as the objectives of the site aim at biodiversity conservation (Day *et al.*, 2012).

The four main criteria are high-level definitions, which require more detailed definitions in order to be applicable for MPA network assessments. Therefore the main criteria must be divided into subcriteria. Although there are some differences on the subcriterion level between the RSCs, a basic set of common subcriteria can still be distinguished (Table 2.2). For example, representativity of habitats is a subcriterion under the representativity main criterion. The number of subcriteria, however, depends on the number of species and habitats included in the assessment. Key component of the representativity is a consistent approach to the classification of the marine habitats and ecosystems. As the identity of subcriteria depends on the conservation feature being assessed, we will use the term 'indicator' in the assessments. Indicators describe the subcriteria with more detailed information of the features, the specific target and the assessment method to be used.

We are aware that the MSFD Art. 13(4) includes only the terms ‘coherent’ and ‘representative’, but at the same time we consider that in order to assess coherence of the MPA network, an assessment of all four criteria is required. Because some of the subcriteria can be, in some cases, redundant (for instance the representativity of ecoregions and the representativity of depth zones), the inclusion of the indicators to an assessment of ecological coherence could be considered criterion by criterion. We discuss this in more detail in Section 2.5.1.

All four main criteria must meet a minimum standard (e.g. a target level) if the network is to be called coherent. Although some target levels have been presented in the review (Annex C, sections C.6 and C.7) and some are suggested in the case study (Annex E, section E.3)).
there are very few commonly agreed target levels available for MPA network assessments. This gap is again discussed in Chapter 5.

Table 2.2 Main assessment criteria and sub-criteria which are commonly used in assessments of MPA networks.

<table>
<thead>
<tr>
<th>Main criteria</th>
<th>Sub-criteria</th>
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<tbody>
<tr>
<td>Representativity</td>
<td>Coverage in marine region</td>
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<tr>
<td></td>
<td>Representativity of sub-regions / ecoregions</td>
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<tr>
<td></td>
<td>Representativity of depth zones</td>
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<tr>
<td></td>
<td>Representativity of habitats and species</td>
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<tr>
<td>Replication</td>
<td></td>
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<tr>
<td>Connectivity</td>
<td></td>
</tr>
<tr>
<td>Adequacy</td>
<td>MPA size</td>
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<tr>
<td></td>
<td>Management category</td>
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</table>

2.4 Proposal for management categories of MPAs

MPAs should be designed to ensure the protection of the features for which they are selected. In this report we propose the use of management categories to monitor this. The assignment of a management category to an MPA should be based on the management objectives. Based on these objectives, MPAs or parts of them may require different management measures to achieve varying conservation goals and degrees of protection (i.e. from strictly protected areas to areas of sustainable use). These measures are presumed to be put in place when a category is assigned to (part of) an MPA.

Protected areas in the marine realm present a particular suite of management challenges and need different approaches (i.e. in some cases different management approaches may be considered at various depths; or the scales over which marine connectivity occurs can be very large, etc.). Ideally the objectives of each individual management plan should contribute to achieving the overarching objective of ecological coherence and the underlying objectives of adequacy, representativity, replicability and connectivity within the regional or European network. Such management plans are likely to require regional coordination.

One of the objectives of this project is to propose a classification system to classify management levels for MPAs. In this section, we propose seven management categories, which are mainly based on the widely accepted IUCN classification (IUCN, 1994), and especially take into account the recent IUCN guideline on how these management categories should be applied to MPAs (Laffoley, 2008; Day et al., 2012).

The IUCN management categories are defined after the formal request of the Conference of the Parties of the Convention on Biological Diversity (COP7, 2004) to the IUCN to review and adapt its management categories for protected areas to the new challenges, so that a single international system management could be established and adopted. These categories define different management levels, depending on the aims of the protected areas. The guidelines developed for the assignment of categories are based on the management aims and the level of human use.
In some cases, as in small MPAs where nature conservation is the main objective, one IUCN management category may be relatively easily assigned. However, in most cases MPAs encompass a broad range of protection levels, from fully protected areas to the restriction zones of particular activities. In those cases, MPAs have zones with different protection objectives, and therefore, they require the assignment to different management categories.

Despite discrepancies in the usefulness of IUCN management categories, especially regarding their application to MPAs (e.g. most MPAs may fit under several management categories), the IUCN classification system is the most widely accepted and widely applied system at a global scale. The use of a a common approach and terminology enables the recording of specific information and the comparison of several protected sites with different legal basis of protection, while maintaining differences and specificities of countries and regional seas. Indeed, the IUCN categories are used by the UN’s World database for protected areas, they have been adopted by certain international agreements (e.g. the Antarctic Treaty). At the RSC level, the implementation of the IUCN categories is at different stages, with HELCOM having already classified the Baltic Sea Protected Areas according to the IUCN categories (HELCOM 2013) and recommending their use. The recent HELCOM Recommendation 35/1 recommends the application of the newest IUCN categorisation system when describing the HELCOM MPAs in order to allow for global comparisons of regional networks’ (HELCOM 2014a). The manner in which this can be made operational is currently under discussion (HELCOM, 2014b).

Furthermore, the EC, in its aim to fulfil Art. 21 of the MSFD and report on the progress that has been made on establishment of MPAs, requested MSs to respond to the EEA annual call to update and complete the Common Database on Designated Areas (CDDA) with MPAs information. Such information includes the name of the designated area, date of designation, type of designation and legal status, location and size of the area, and biodiversity features protected, and the management measures, for which it proposes the use of the IUCN categories.

Consequently, MSs have already translated their MPAs protection categories to the IUCN management categories and introduced this information to the CDDA. Outcomes of the analysis of the CDDA inputs on MPAs indicate that the distribution of nationally protected areas under the various IUCN management categories follow different patterns across Europe. As an example, the sites of IUCN category V are mostly located in France, Germany and UK, whereas the IUCN categories Ib and Ia are mainly located in Scandinavia (EEA, 2012). See Figure C.2 in Annex C of the present report for the IUCN category distribution reported by the MSs to the EEA.

Aware of the broad recognition and implementation of IUCN management categories and the work undertaken by EU and non-EU MSs to translate their MPA protection categories into the IUCN management categories, it is considered important to maintain the use of IUCN categories. However, slight modifications to complement the definition of these categories could help to better suit the specific requirements of a European MPA Network.

Considering the IUCN protected areas categories, the IUCN guidelines for MPAs (IUCN, 1994; Dudley, 2008; Laffoley, 2008; Day et al., 2012), and EU legislation requirements (e.g.
MSFD, Habitats and Birds Directive), the proposed classification is as follows (IUCN categories are defined in italics, while complementary information is provided in normal writing):

1. No entry zones (based on IUCN Category Ia):
"Strictly protected areas set aside to protect biodiversity and also possibly geological / geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for non-harmful scientific research and monitoring". It is recommended that areas assigned to this management category also have a buffering area around them (e.g. other management zones) in order to minimize the adverse influence of the surrounding area. Ecosystem functions in MPAs under this category are maintained and the Good Environmental Status (according to MSFD) is guaranteed, unless external direct human pressures originating from the surrounding area hinders this. According to the information reported by the MSs regarding to the MPAs designed in their territories, more than 15%\(^{12}\) of the European MPAs were assigned under this category (see Table C.3 in Annex C).

2. No take zones (based on IUCN Category Ib):
"Usually large unmodified or slightly modified areas retaining their natural character and influence ecosystem processes, without permanent or significant human activity, which are protected and managed so as to preserve and restore their natural conditions". The use of resources in the area is allowed whenever this is compatible with the conservation objectives (e.g. subsistence fisheries). The areas are set up to protect relevant cultural and spiritual values and nonmaterial benefits. The natural ecosystem functioning predominates and the environmental impact produced by the human activities that are held in the area, is negligible or sufficiently low, so as not to interfere with maintaining and/or achieving GES. Non-damaging scientific research and monitoring can be conducted in these areas. No take zones can form 'core areas' of MPAs where, for example, spill-over effects benefit fisheries outside the MPAs. Only 2%\(^{12}\) of the European MPAs were classified in this category (see Table C.3 of Annex C).

3. Protection of large-scale ecological processes (based on IUCN Category II):
Large natural or near natural areas set aside to protect large-scale ecological processes and biodiversity, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities. Any of these activities should not cause significant biological or ecological degradation. Management measures aim to maintain, in a state that is as natural as possible, representative examples of physiographic zones within European regions and sub-regions. It should seek to maintain ecosystem functions through integrity and resilience maintenance. It should also contribute to regional ecological processes, the conservation of wide-ranging and/or ontogenetically disjunctive species and migration routes. It should promote the conservation of biodiversity at large (from

\(^{12}\) Proportion of MPAs under each IUCN category corresponds to the classifications made by MS and reported to the EEA. One site may contribute to more than one IUCN category, depending if different sections of the area have different management goals. Therefore, proportions may be considered with caution.
genes to ecosystems). Almost 4%\(^\text{12}\) of the European MPAs were classified under this management category in the report to the EEA (see Table C.3 in Annex C).

4. **Singular natural sites (based on IUCN Category III):**
   ‘Areas set aside to protect a specific natural monument (for this purpose: ‘feature’) which can be sea mounts, submarine caverns, rock outcrops, submarine canyons, other geomorphological features that could host high natural and biological value, and even a living component, such as a specific coralline feature. They are generally quite small protected areas and often have high visitor value. The MPA can cover the entire feature or a part of it and management measures need to be adapted according to the feature. These areas are often included, for example within the Natura2000. According to the reported information by the European MSs, almost 4%\(^\text{12}\) of the existing MPAs are assigned in this management category (see Table C.3 of Annex C).

5. **Particular management zones (based on IUCN Category IV):**
   ‘Areas that aim to protect particular species or habitats (e.g. according to Habitats or Birds Directives), and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category’. Protection measures may vary depending on the conservation goal. These areas are often included e.g. within the Natura2000 or Ramsar Network. More than 36%\(^\text{12}\) of the European MPAs are classified under this category (see Table C.3 of Annex C).

6. **Traditional activities management zones (based on IUCN Category V):**
   ‘Protected areas are where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values’. It should focus on safeguarding the integrity of the interactions of human activities and the natural environment, for example, maintenance of traditional small-scale fishery. Management plans should consider human uses such as artisanal fisheries (at small-scale). These areas might contribute to broad-scale conservation by maintaining marine activities that are considered compatible with the conservation objectives. Almost 22%\(^\text{12}\) of the MPAs in Europe are in this category (see Table C.3 of Annex C).

7. **Sustainable management zones (based on IUCN Category VI):**
   Areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under low-level non-industrial sustainable natural resource management and where such use of natural resources compatible with nature conservation is seen as one of the main aims of the area. Integrated management plans of human activities at sea are in force. Management plans share the characteristics that they are applicable at a broad-scale and follow an ecosystem-based approach with long-term objectives. It should promote compatible uses and avoiding undesirable effects that would not allow the achievement of the GES by 2020 according to MSFD. At present more than 4%\(^\text{12}\) of the European MPAs were classified in this category (see Table C.3 of Annex C).
At present, management plans are applied to individual MPAs and the MPA network is composed by individual MPAs that are under different protection categories. Ideally the designation of sites and objectives of each individual management plan should contribute to achieving the overarching objective of coherence and therefore, adequacy, representativity, replicability and connectivity, within the regional and/or European network.

Both IUCN management categories and the adapted names used in this report should be used with caution. The names assigned have been selected with the purpose to provide a general overview of the main management measure adopted within the specific category. However, additional management measures may be required. Furthermore, in consistence with the IUCN category, the use of "numbered categories" rather than specific names may be more adequate to promote consistency and avoid misinterpretation of what a category may contain.

2.5 Assessment criteria in relation to the European legislation

2.5.1 The MSFD and the criteria for GES

In the implementation of the MSFD there is a practical need to identify and use the potential synergies between networks of MPAs and working towards GES. There is no guidance on how the ecological coherence of MPA networks relates to good environmental status (GES). The two concepts have some similarities (e.g. wide spatial scope, overarching approach) but also have conceptual differences, as the latter assesses the environmental state of a marine region and the former states whether the MPA network is coherent. The concepts are similar in their aim to protect the biodiversity, but one in all MS waters and the other for selected areas.

The MSFD uses the term ‘coherent and representative networks’ in its Article 13(4) (quoted in Section 1.1) in a sense which is comparable with the RSC assessment criteria. The term ‘adequately covering the diversity of the constituent ecosystems’ is a slightly different term than the RSC and CBD criterion ‘Adequacy’, although it can be argued that the MPA size or level of protection are the means of reaching the MSFD objective of ‘adequately covering the biodiversity’, because ‘representativity’ is not enough to cover biodiversity if the protected areas or too small or the level of protection has not been set to meet the conservation needs of specific features. In this sense, the two terms can be considered to be similar.

The MSFD criteria for GES were given in the Commission Decision (EU, 2010) (Annex G). The criteria define in more detail how GES can be assessed in relation to each of the eleven descriptors of GES set out in Annex I to Directive 2008/56/EC. It is clear that the MSFD GES criteria assigned to the descriptors (Annex G) are not directly comparable with the assessment criteria for MPA networks. The fundamental difference is that the GES criteria are used to assess whether marine waters are in GES or not, whereas the MPA assessment criteria are related to the intensity (or even efficiency) of spatial protection measures within a wider set of measures, which aim to reduce anthropogenic pressures and impacts. Thus, MPA assessment criteria cannot state whether GES is reached or maintained or not, but by
adjusting the targets of those one can indirectly move towards GES (or maintain it). It is the first attempt to discuss this issue, and it is out of the scope of the project, therefore further reflection is needed on this. If MPAs are well managed, GES should be achieved for protected features and this should contribute to achieving GES in the (sub)region.

It is evident that the ultimate aims of the two assessments are similar: to ensure good status of marine biodiversity. It is also clear that they have differences: one assessing GES and one assessing whether the MPA network is in a form to support reaching GES. In order to ensure that the GES assessment and the MPA assessment support each other, one should include the same biological and environmental features to the assessment of GES and the assessment of ecological coherence (e.g. to assess the same species and habitats). This could be done on the level of marine regions, e.g. through RSCs. MPAs are a measure to reach GES, but they can ensure GES only as a contribution to wider measures. Further discussions are needed and a guidance document could be developed on this issue.

2.5.2 The Habitats Directive and the Natura 2000 network

The Natura 2000 networks support the implementation of the Habitats and the Birds Directives. The main goal of Natura 2000 is to contribute to the maintenance or restoration of a favourable conservation status for the target habitats. However, the marine component of Natura 2000 is still being considered as incomplete as most designations are in inshore waters. The Habitats Directive (HD) requires the establishment of Special Areas of Conservation (SACs) to be designated for particular species and habitats, listed in Annexes of the HD, and the Birds Directive (BD) requires the establishment of Special Protection Areas (SPAs) for birds.

Sites designation criteria

The HD process of designating sites to the Natura 2000 network has two stages. In the first stage, MSs are required to assess each site against four criteria for habitats and species to show the site’s importance for the Annex I and II features. Based on this assessment, the MSs can propose a national list of Sites of Community importance (SCI). The criteria for this are given in Annex III of the HD and below.

According to the HD (Annex III), the sites are selected using the following criteria:

Site assessment criteria for a given natural habitat type in Annex I:

a) Degree of representativity of the natural habitat type on the site;

b) Area of the site covered by the natural habitat type in relation to the total area covered by that natural habitat type within national territory;

c) Degree of conservation of the structure and functions of the natural habitat type concerned and restoration possibilities;

d) Global assessment of the value of the site for conservation of the natural habitat type concerned.

Site assessment criteria for a given species in Annex II:

a) Size and density of the population of the species present on the site in relation to the populations present within national territory;

b) Degree of conservation of the features of the habitat which are important for the species concerned and restoration possibilities;
c) Degree of isolation of the population present on the site in relation to the natural range of the species;

d) Global assessment of the value of the site for conservation of the species concerned.

In the second stage of the site designation process, an assessment of the Community importance of sites is made by another set of assessment criteria on the level of EU or biogeographical regions. While all sites including priority species and habitats are directly considered as SCIs, other SCIs can be included into the network on the basis of the stage 2 criteria of the Annex III. After the Commission has adopted the sites to the ‘Community list’, the MSs are required to designate them as Special Areas of Conservation.

The Stage 2 criteria are the following:

a. relative value of the site at national level;

b. geographical situation of the site in relation to migration routes of species in Annex II and whether it belongs to a continuous ecosystem situated on both sides of one or more internal Community frontiers;

c. total area of the site;

d. number of natural habitat types in Annex I and species in Annex II present on the site;

e. global ecological value of the site for the biogeographical regions concerned and/or for the whole of the territory referred to in Article 2, as regards both the characteristic or unique aspect of its features and the way they are combined.

In practice, however, the Community list of sites was developed also by the help of more practical criteria, which are given in the document ‘Criteria for assessing national lists of pSCI at biogeographical level (http://bd.eionet.europa.eu/activities/Natura_2000/pdfs/Hab.97-2.pdf). The more practical criteria are: (1) “Priority” criterion (are there priority habitats/species present), (2) “Uniqueness” criterion (unique occurrence of the priority habitat/species), (3) “High-quality” criterion (high national value for a priority species/habitat), (4) “High-diversity” criterion (a significant number of non-priority habitat/species), (5) “Network coherence” criterion (a site playing a relevant role to ensure the coherence), and (6) “Safeguard clause” criterion (risk of elimination of the site).

Comparison of the Natura 2000 criteria with other assessment criteria

The establishment criteria aim towards a coherent network and therefore they are likely indications of which aspects of the network are important to be assessed. Table 2.3 suggests a relation of the Natura 2000 assessment criteria with the assessment criteria of CBD and RSCs. From the Stage 1 criteria, it is clear that the points (a) and (b) of the habitats list (above) and point (a) of the species list (above) have similarities with the ‘representativity’ criteria of the CBD and RSCs (see Table 2.3). In contrast the other criteria target mainly at locating the sites in strategic areas where the degree of conservation is high (close to natural state and threats are low) (see Anon. 2007) and have little similarity with the CBD and RSC assessment criteria.

Also some of the stage 2 criteria are comparable with the CBD/RSC criteria ‘representativity’, ‘MPA size’ and ‘replication’ (Table 2.3). The practical criteria applied to the stage 2 analysis (see above) also indicated that ‘coherence’ has a significant role in selecting the Natura 2000 sites. Connectivity is included in the case of ensuring MPAs along migration routes. The level of protection is implicitly included in the legislation as necessary conservation needs to be set for the sites in order to protect the listed habitats and species. For instance, the Article 3(1)
has a linkage to the level of protection: ‘This network [...] shall enable the natural habitat types and the species’ habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status’. A similar linkage is in Article 6(1): ‘For special areas of conservation, Member States shall establish the necessary conservation measures [...] which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites.’

In general, the Natura 2000 networks could be assessed by the same set of criteria as the other MPAs. The criteria given in the HD Annex III have the focus in the establishment of the sites and therefore using other criteria for an assessment of the ecological coherence of the entire network does not pose any contradiction to the Annex III criteria.

<table>
<thead>
<tr>
<th>Natura 2000 assessment criteria – Stage 1</th>
<th>Similarity with the RSC and CBD criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of representativity of the natural habitat type on the site.</td>
<td>Representativity of habitats and species.</td>
</tr>
<tr>
<td>Size and density of the population of the species present on the site in relation to the populations present within national territory.</td>
<td></td>
</tr>
<tr>
<td>Area of the site covered by the natural habitat type in relation to the total area covered by that natural habitat type within national territory.</td>
<td>Representativity of habitats.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Natura 2000 assessment criteria – Stage 2</th>
<th>Similarity with the RSC and CBD criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographical situation of the site in relation to migration routes of species in Annex II and whether it belongs to a continuous ecosystem situated on both sides of one or more internal Community frontiers</td>
<td>Connectivity of sites (as regards migrating species).</td>
</tr>
<tr>
<td></td>
<td>Connectivity of habitats (if migration routes are considered as wintering, resting and feeding habitats).</td>
</tr>
<tr>
<td>Total area of the site</td>
<td>MPA size</td>
</tr>
<tr>
<td>Number of natural habitat types in Annex I and species in Annex II present on the site</td>
<td>Replication of features.</td>
</tr>
<tr>
<td>Global ecological value of the site for the biogeographical regions concerned and/or for the whole of the territory referred to in Article 2, as regards both the characteristic or unique aspect of its features and the way they are combined</td>
<td>Representativity of remarkable features.</td>
</tr>
<tr>
<td></td>
<td>Representativity of species.</td>
</tr>
</tbody>
</table>

The real difference between the Natura 2000 criteria and the RSC/CBD criteria is the selection of species and habitats, which are strictly defined in the former and more freely selected in the latter. In order to assess the entire MPA network sufficiently, one should include the HD and BD ‘Annex species and habitats’ to the list of features one uses in the MPA assessment. The assessment should also include predominant (and key) species and habitats as proposed in the previous section, because the concept of ecological coherence covers ‘the full range of ecosystems, including the biotic and habitat diversity of those marine ecosystems’ (CBD, 2008).
There is, however, a practical challenge in MPA assessments if sites have very different protected species within their boundaries. A Natura 2000 site established for the protection of, for instance, sandbanks, grey seals and a list of seabirds does not protect, for instance, fish or hard-bottom communities or any other feature. This means that the assessments for the representativity, replication and connectivity of features cannot include any other species or habitat from that site. In practice, such limitations lead to difficult, site-by-site arrangements in MPA assessments, where databases need to include lists of conservation features which are protected by each site. No database exists, at least internationally, where this information could be found. This challenge will be discussed in Chapter 5.

2.6 Key messages of this chapter

- Existing criteria for the designation and the assessment of MPA networks were reviewed.
- Criteria used and proposed by international conventions, legislation, Non-Governmental Organisations work, research projects and scientific papers have been reviewed at European and global scale.
- The criteria inventory shows generally that, most criteria refer to similar concepts in relation to achieving ecological coherence of MPA networks.
- Based on the analysis of most commonly used and accepted criteria, the criteria proposed for assessment are representativity, replication, connectivity and adequacy, and ecological coherence is considered, as the overarching concept the MPA networks should seek.
- These four criteria have been used to classify all the specific criteria used by international conventions, legislation, NGOs’ work, research projects and scientific papers.
- It is recommended that a minimum standard or target level should be established for each criteria for the assessment of ecological coherence of MPA networks.
- The management category of MPAs should also be considered in the assessment process the IUCN management categories have been put forward for this purpose and adapted to better fit management needs within the EU.
3 Methodology for the assessment of ecological coherence of MPA's

3.1 Experiences with assessments of ecological coherence in MPA networks

Assessments of ecological coherence have evolved during recent years and availability of new knowledge (e.g. underwater habitat maps, integrated environmental assessments, human impact assessments) has enabled progress in the methods. Rather surprisingly, there are very few guideline documents giving a systematic methodology for such an assessment. In many cases MPA assessments have been made criterion by criterion and assessment conclusions have not relied on any transparent method. As the OSPAR background document on MPA assessments states, ‘it is much easier to develop tests that indicate when [ecological coherence] has not been achieved (i.e. some of the parts are missing) than it is to test when it has been achieved’.

This chapter proposes our methodology, which could serve as a basis for a common European assessment method. It builds on earlier efforts from within Europe (especially in OSPAR and HELCOM) and abroad.

3.1.1 Assessments of ecological coherence by the RSCs

In the European marine regions, assessments of ecological coherence have been made in the Baltic Sea (HELCOM, 2010a), Mediterranean (Gabrié et al., 2012) and NE Atlantic (OSPAR, 2013). No assessment of MPA networks has been made in the Black Sea region, but a summary of MPAs is given in UNEP-WCMC (2008).

OSPAR

The OSPAR Commission has been a frontrunner in developing methods for MPA assessments in Europe. The Joint OSPAR-HELCOM Ministerial Meeting in Bremen in 2003 published a joint declaration with a clear objective of establishing an ecologically coherent and well-managed network of MPAs in the convention areas. As the next step, OSPAR developed a guideline document with 13 principles for establishment of an ecologically coherent MPA network (OSPAR, 2006). This was followed by a background document for assessing ecological coherence (OSPAR, 2007) summarizing existing literature on ecological coherence of MPA networks and describing possible criteria and guidelines for assessing whether the OSPAR network of MPAs is ecologically coherent. The background document suggested that the assessment should start with a basic test and be followed by more detailed testing. The basic tests were suggested in ‘Background document on three initial spatial tests used for assessing the ecological coherence of the OSPAR MPA network’ (OSPAR, 2007). Ecological coherence of the OSPAR Network of MPAs has been assessed in 2012, using two broad levels of tests (OSPAR, 2014a). In order to enable assessment against the target of establishing a network of MPAs, OSPAR has developed a ‘Guidance to assess the effectiveness of management of OSPAR MPAs’ (OSPAR, 2014b). The work of
assessing the ecological coherence as well as the development of the method to assess management effectiveness of the OSPAR network of MPAs is ongoing.

The rationale of the OSPAR approach is that it is still premature to aim at a full assessment test with clear targets and detailed methods, as there are still many scientific challenges on the way. The assessments have therefore started from likelihoods that the network could be ecologically coherent. The OSPAR background document noted that ‘the degree to which an MPA network is, or is not, ecologically coherent must be stated as a likelihood, based on a continuum of progressively more detailed tests until a test (or a group of tests) is not met’ (OSPAR, 2007).

According to OSPAR, ecological coherence should be assessed at several scales, from that of a single site protecting a single small feature, to ultimately a global network (OSPAR, 2007). The conclusion of this testing can be expressed as a continuum from ‘very unlikely to be ecologically coherent’ to ‘very likely to be ecologically coherent’. The three initial tests, suggested in the latter background document (OSPAR, 2007), are:

1. Is the OSPAR MPA network spatially well distributed, without more than a few major gaps?
2. Does the OSPAR MPA network cover at least 3% of most (seven of the ten) relevant Dinter biogeographic provinces?
3. Are most (70%) of the OSPAR threatened and/or declining habitats and species (with limited home ranges) represented in the MPA network such that at least 5% [or at least 3 sites] of all areas within each OSPAR region in which they occur is protected?

The limit values for the tests were not set as targets, but represented a minimum level, thus indicating whether the assessment fails even at this minimum level.

An assessment of the ecological coherence of the OSPAR Network of MPAs in 2012 was published in 2013 (OSPAR, 2013). In this assessment the method was updated and two levels of assessment were presented: (1) broad-scale tests across the OSPAR Maritime Area and (2) more detailed tests of ecological coherence at the regional and sub-regional scale.

The level 1 tests are:
- Test 1 – Test to determine whether the network is generally well distributed;
- Test 2 – Test of representation at biogeographic level;
- Test 3 – Testing the representativity of bathymetric zones.

The level 2 tests are:
- Test 4 – Representation of threatened and/or declining species and habitats;
- Test 5 – A matrix to assess features, representativity, replication, resilience and connectivity;
- Test 6 – Spatial analysis of broad-scale habitat representativity and replication;
- Test 7 – Spatial analysis of adequacy;
- Test 8 – Spatial analysis of broad-scale habitat connectivity.

The new OSPAR assessment (OSPAR, 2014a) follows the same steps as the previous assessment.
Within the OSPAR framework, there have also been other initiatives to assess ecological coherence. The OSPAR MPA Network Rapid Self-Assessment Checklist (Annex to OSPAR, 2007) presented a qualitative (partly semi-quantitative) checklist of the assessment criteria and provided scores from 0 to 3 for each criterion. The value of the checklist is in its comprehensiveness (all criteria can be included, even though targets have not been agreed), while the added value remains rather low: it still remains to be solved how the total scores indicate ecological coherence (the total scores are expressed as percentages of meeting the targets).

Another OSPAR initiative was the so-called matrix approach (OSPAR MASH 2008), where conservation features are listed vertically and biogeographic regions horizontally and there are separate matrices for each assessment criterion. OSPAR has not applied this outside the Channel area because of data limitations (OSPAR, 2013). While the initiative presents a simple way to visualize the assessment criteria, it does not suggest how the criteria are integrated.

**HELCOM**

In the Baltic Sea, the HELCOM work on MPAs was initiated in 1994 by HELCOM Recommendation 15/5 on the establishment of a network of coastal and marine Baltic Sea Protected Areas (BSPAs) and followed in 1996 by selection guidelines for and a status overview of BSPAs (HELCOM, 1996). The Joint OSPAR-HELCOM Ministerial Meeting in Bremen in 2003 enhanced the work towards the first assessment of ecological coherence in 2006 (HELCOM, 2006) and a more comprehensive assessment in 2010 (HELCOM, 2010a). The 2010 assessment also presents HELCOM objectives and criteria for the assessment of the status and the coherence of the BSPA network. The HELCOM method does not include any integration phase but basically applies the one-out-all-out principle, where failure in any of the four assessment criteria (representativity, adequacy, replication and connectivity) causes failure to meet ecological coherence. There are no guideline documents in HELCOM for assessment methods of ecological coherence. The recent HELCOM Recommendation 35/1 on HELCOM MPAs does not introduce new criteria or methods to the HELCOM MPA assessments (HELCOM, 2014a).

**Mediterranean**

In the Mediterranean, the Specially Protected Areas and Biological Diversity Protocol in the Mediterranean (SPA/BD Protocol 1982, 1995) and the Strategic Action Plan for the Conservation of Biological Diversity in the Mediterranean (SAP BIO) are the tools under which the countries establish a far-reaching and coherent network of marine and coastal protected areas (Regional Work Programme for marine and coastal protected areas, 2009). Criteria for the MPA selection were presented in Claudet et al., (2011). The collaborative study by the International Union for Conservation of Nature (IUCN), World Wildlife Fund (WWF) and MedPAN, (Status of Marine Protected Areas in the Mediterranean Sea, Gabrié et al., 2012) states that the present system of Mediterranean MPAs is not representative and the objectives set by the Biodiversity Convention for 2012 most likely not attained. Ecological coherence was assessed in the latest report by the same approach as in HELCOM, i.e. criterion by criterion.
3.1.2 Other assessment practices

WWF Canada has presented criteria and tools for the MPA network of Canada’s marine regions (Smith et al., 2009). The report suggests a checklist for evaluating ecological coherence. The checklist goes through five assessment criteria: (1) ecologically or biologically significant areas (EBSA), (2) Representativity, (3) Connectivity, (4) Replicated ecological features and (5) Adequate and viable sites. The target for the first criterion is a balanced coverage of MPAs within the EBSAs. For representativity the report refers to Liman et al. (2008), where target representativity ranges between 20 and 60 %. For connectivity the WWF report suggests the OSPAR minimum limits, which are defined separately for coastal, offshore and high sea areas. Replication of features is recommended to vary between 3 and 5. Adequacy and viability are evaluated, inter alia, by the proportion of sites falling to IUCN categories I-III. The report does not suggest any integrative method for the assessment.

Sundblad et al. (2010) applied two of the assessment criteria – representativity and connectivity – on an assessment of ecological coherence of protected fish nursery habitats. The analysis did not aim to integrate the two assessment criteria but treated them separately.

Sciberras et al. (2013) presented case studies of ecological coherence from different parts of the world. The case studies presented separate assessment criteria (representativity, replication, connectivity, MPA size and protection level), but no assessment was made and no method was presented how the assessment could be done.

3.2 Considerations on aggregation and uncertainty

3.2.1 Integration of criteria

As the assessment of ecological coherence consists of separate assessment criteria, it is obvious that an organized system of integrating the criteria is needed for each assessment area. Surprisingly, there are very few, if any, ready methods for this purpose (see previous section for examples). All of the existing methods rely more or less on criteria-by-criteria approaches and seem to rely, at least partly, on expert judgment. To suggest a basis for a European-wide method, this report aims to build on the existing approaches but also to make them transparent and systematic.

In environmental assessments, such as the assessment of ecological status of coastal waters under Water Framework Directive (WFD), EU MSs already use aggregation methods to reach a status assessment out of several components. Aggregation methods for the MSFD have been reviewed and discussed by Prins et al. (2014).

The WFD assessment uses the so-called ‘one-out-all-out principle’, where a failure to meet the target in one criterion leads to an overall failure to reach good ecological status. An alternative to the one-out-all-out principle is ‘two-out-all-out’, where two criteria are allowed to fail. The rationale behind the principle is the precautionary approach which is a strong argument for the use of the one-out-all-out also in the assessment of ecological coherence. In
practice, the regional assessments have already applied this principle (e.g. HELCOM, 2010a; OSPAR, 2013).

The one-out-all-out principle has been criticized for its risk of false negative errors (i.e. leading to erroneous downgrading) and lack of flexibility; rigid class boundaries do not give room for weighing of criteria or uncertainty (Prins et al., 2014). The two-out-all-out version of the method may help to reduce the downgrading risk, but the decision on the integration method should rather mirror the task at hand; can ecological coherence be met if any of the criteria fails? We argue that all assessment criteria reflect critical aspects of the assessment and the one-out-all-out principle is a correct approach to the assessment of ecological coherence. The task is rather to improve the one-out-all-out method and ensure that the targets and the assessment criteria are realistic.

The one-out-all-out method has the greatest risk of failing when the number of assessment criteria is high. In order to reduce this risk, this report suggests a hierarchical approach, where the one-out-all-out method is applied among only four main assessment criteria (i.e. representativity, replication, connectivity and adequacy), within which the indicators (reflecting sub-criteria, e.g. representativity of reefs) are aggregated. The review by Prins et al. (2014) presented multimetric and hierarchical aggregation tools which have dealt with similar challenges. Among those, the most promising example for the assessment of ecological coherence may be the HELCOM HEAT tool for eutrophication assessments, where the one-out-all-out principle is used only at the higher end of assessment hierarchy and weighted averaging is applied on the indicator level. In this report, we propose to follow the HEAT example and suggest that the indicators are averaged (and weighted, if necessary) within the main criteria. How averaging and weighting can be done is explained in Section 4.2. The proposed approach is further supported by the fact that the number of features which are assessed (e.g. species, habitats, etc) will vary from an assessment area to another, depending on species and habitat lists in the assessment.

3.2.2 Including uncertainty into the assessment

In an assessment of ecological coherence of a MPA network, uncertainties are high, as a result of inadequate data and limited understanding of the marine environment. For this reason some assessment guidelines use the criterion ‘best available science’ which emphasizes that uncertainty ‘should be recognized and taken into account throughout the process’ (OSPAR, 2013). We propose that an uncertainty factor is included in the assessment to bring in flexibility to the stringent one-out-all-out method, but we also think that there should be certain criteria how the uncertainty is estimated.

Uncertainties have been used in European assessments widely and an example of a guided uncertainty assessment is found in the Baltic assessment of hazardous substances (HELCOM, 2010b). According to the HELCOM example, the uncertainty factor can be affected, inter alia, by the following issues:

- the data to get the result (e.g. it is incomplete, biased or not fully trusted);
- the target (e.g. it is artificial, not realistic or not based on scientific principles);
- the method to assess the criterion (e.g. it is not ideal, is too simple or lacks in ecological reality).

In Table 3.1 uncertainties are categorized as ‘low’, ‘moderate’ and ‘high’, where ‘high uncertainty’ indicates that the likelihood of reaching the target will be affected or the criterion may get less weight in the final assessment result. It also should lead to improvements in the assessment (see Section 3.4).

Table 3.1 Suggested criteria to estimate the level of uncertainty in the assessment of ecological coherence. If the uncertainty categories are used to weigh indicators in averaging, it is suggested that the weights 0.5, 0.75 and 1 are used for the categories ‘high uncertainty’, ‘moderate uncertainty’ and ‘low uncertainty’, respectively.

<table>
<thead>
<tr>
<th></th>
<th>LOW</th>
<th>MODERATE</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Data is complete and accurate.</td>
<td>Data is partly incomplete or not fully reliable.</td>
<td>Data is incomplete for several sites.</td>
</tr>
<tr>
<td>Target</td>
<td>Target is nationally or regionally agreed.</td>
<td>Target is tentative.</td>
<td>Target is fully arbitrary.</td>
</tr>
<tr>
<td>Assessment method</td>
<td>Method is ecologically relevant.</td>
<td>Method is not ideal or unnecessarily simplifies reality.</td>
<td>Method is too simple or lacks in ecological reality.</td>
</tr>
</tbody>
</table>

### 3.3 Proposed method

Assessments of the ecological coherence of MPA networks traditionally have been made on the level of regional seas, which usually represent distinctive eco-regions or geographically defined marine areas. The proposed step-wise approach for the assessment is not limited to geographical scales and can be applied to small-scale assessments or scales of a marine region or to the European marine waters. Following the OSPAR guidelines (OSPAR, 2007), the assessment can start on smaller scales and move to larger. However, moving towards larger scales, a limiting factor may be data availability (or comparability) and therefore in this chapter we propose first a basic method which is applicable in all the European marine regions. We also propose a more detailed method, which can be applied in specific areas or smaller scales, according to data availability.

#### 3.3.1 Basic and more detailed assessment methods

The set of assessment criteria suggested in Section 2.3 can be applied in the basic assessment of ecological coherence as well as in a more detailed assessment. The difference between the basic and more detailed methods is in the availability of high quality data.

**A basic assessment** can be made, as a minimum, on the basis of:
- GIS data of the boundaries of the marine (sub)region, sub-basins/eco-regions, territorial zones, exclusive economic zone and MPAs;
- Bathymetric GIS data;
- Presence data of selected habitats, species and other features within MPAs;
- Information on the protection level.
For the basic method, data should be available from all the European marine regions, and it is expected that the assessment of ecological coherence can be made Europe-wide by using the criteria and subcriteria proposed in Section 2.3. Annex D explains how the basic assessment of representativity, replication, connectivity and adequacy can be made in practice.

A more detailed assessment can be made on the basis of:

- spatial data on habitat and species distribution;
- spatial data of the main anthropogenic pressures.

The more detailed method includes aspects which were identified in Chapter 2 as assessment criteria or assessment practice in CBD, RSCs and other sources. The spatial biological data for instance allow more accurate assessments of representativity and connectivity and the spatial data of the pressures were used in the latest HELCOM assessment to check the adequacy of the protection, and to evaluate threats in the Mediterranean assessment.

Depending on data availability, one can add one or more of the above-listed data layers and make a more detailed assessment, where biological relevance may be higher and spatial protection measures may be more accurately assessed. The added value lies mainly in more detailed spatial data (features and pressures). Annex D explains how the more detailed assessment of representativity, replication, connectivity and adequacy can be made in practice.

The core of the method is an evaluation of the four main criteria one by one, following the one-out-all-out principle. This method has been used widely in the MPA assessments, e.g. the latest assessments in the Baltic Sea, the Mediterranean and the NE Atlantic.

The OSPAR guidelines and principles for an assessment of ecological coherence (see Section 3.1.1) present a likelihood-based assessment where qualitative likelihoods (very unlikely, unlikely, likely, very likely) are given for the assessment results. This is a pragmatic approach when quantitative results are missing or not fully trusted. We suggest that these likelihoods are given for each assessment criterion and that the likelihood depends on:

- the distance to the target (i.e. a shorter distance - or ultimately meeting the target - increases the likelihood of reaching the target). In addition, one could:
- take account of the amount of uncertainty in reaching the target. This could mean that in case of high uncertainty there could be lower likelihood to reach the ecological coherence. There are no rules available on how the amount of uncertainty affects the likelihoods, but we suggest a rule in the case study (Chapter 4).

As an example, a connectivity analysis can show that 50% of the sites are connected to more than nine other sites (with a selected distance, e.g. 50 km). If the target is set as 50% for this indicator, the indicator is likely to meet the target value. There can, however, be high uncertainty in this indicator because the target setting is tentative and it is not supported by empirical evidence. Hence, the likelihood of reaching the target can be decreased to ‘unlikely’.
In the integration phase - when all of the indicators and criteria are assessed together – the likelihoods are taken into account in the use of the one-out-all-out principle. By rule, the weakest criterion will determine the assessment result, i.e. a failure to reach the target will lead to a failure to reach ecological coherence. However, as the criteria are assessed by likelihoods, also the ecological coherence should be assessed in such a manner, e.g. ‘it is likely that ecological coherence is reached’. In other words, the lowest likelihood will determine the assessment result.

3.3.2 Assessment of ecological coherence: a step-wise introduction

The ecological coherence of MPA networks is proposed to be assessed by four main assessment criteria, which are further divided into subcriteria. The assessment of the (sub)criteria is made by indicators, which express detailed information in specific units. The indicators are defined by a certain method (basic or more detailed), a target and a feature (e.g. a species or a habitat). Table 3.2 gives an overview of the proposed criteria, subcriteria and indicators. We recommend to perform the complete analysis, also in cases when it becomes clear in an early stage that one main criterion will not meet the target, in order to develop a complete vision on strenghts and weaknesses of the MPA network.

Table 3.2. Overview of the main criteria, subcriteria and indicators used in the assessment method. Note that the indicator definitions partly depend on data availability and are therefore only examples of potential indicators.

<table>
<thead>
<tr>
<th>Main criteria</th>
<th>Subcriteria</th>
<th>Indicator basic method</th>
<th>Indicator more detailed method</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representativeness</td>
<td>Coverage of MPAs in the marine region</td>
<td>proportion total area MPAs / total area</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Coverage of MPAs in eco-regions/sub-regions</td>
<td>MPA area divided by the ecoregion area (for each ecoregion separately)</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Representativeness of depth zones</td>
<td>MPA area divided by the area of the depth zones (for n zones separately)</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Representativeness of conservation features</td>
<td>Proportion of MPA area including a feature (for n features separately)</td>
<td>idem, but based on spatially calculated areas of the features</td>
<td>%</td>
</tr>
<tr>
<td>Adequacy</td>
<td>MPA size</td>
<td>Proportion of MPAs &gt;20 km² (the size may be agreed to be something else)</td>
<td>idem, but size defined as ‘not affected by selected pressures’</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Level of protection</td>
<td>Proportion of sites falling under management category 2 (e.g. no take area) as proposed in Section 2.4</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Connectivity of MPAs</td>
<td>Number of MPAs connected by 50 km distance (the distance can be agreed to be something else)</td>
<td>idem, but based on locations of features (for n features separately)</td>
<td>%</td>
</tr>
<tr>
<td>Replication</td>
<td>Replication of sites</td>
<td>Number of MPAs including a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The proposed assessment method follows a step-wise approach and integration process, depicted in Figure 3.1.

**Step 1. Selection of a main criterion**
Assess each of the four main criteria separately: representativity, replication, connectivity and adequacy. The method follows the cycles of steps 1a to 1d for each of these four main criteria. Figure 3.1 uses Representativity as an example.

**Step 1a. Selection of a sub-criterion**
The subcriteria are introduced in Table 3.2. It is important to understand that in many cases the subcriteria may have several indicators, when more than one feature (species or habitat) is assessed. In the assessment process, the subcriteria are not assessed, only indicators and the main criteria. The method follows the cycles of steps 1a1 to 1a4 for each subcriterion.

**Step 1a1. Selection of the indicator**
The selection of the indicator depends on the method (basic or more detailed) and the feature (which species or habitat is selected). A crucial discerning element in this step is data availability and quality.
For the basic assessment method the required information is GIS layers of the area, its bathymetry and GIS polygons of the MPAs, and a database including...
species and habitats present or absent within the MPAs. In the more detailed method, the assessment includes two more advanced components:

1. Mapped habitats and species range (and other features of interest);
2. Spatial distribution of selected anthropogenic pressures.

Step 1a2. Selection of a target
An inventory of target values used in earlier assessments is made in Chapter 2 and more details are presented in Annex C, Section C.7. It is however noted that only very few targets are commonly agreed and the target selection is a process where scientific recommendations can only provide partial support for a political process. Within the scope of this project it has not been possible to define a list of target values for the proposed criteria, but a tentative list is presented for the case study (Chapter 4).

Step 1a3. Calculate the result for the indicator
See Annex D for the suggested calculations for indicators under each of the four main criteria.

Step 1a4. Estimate uncertainties
As the indicators are the elements that are affected by uncertainties in data, targets and methods, it is clear that the uncertainties are associated to that level. The uncertainties can be used to weigh the indicators in the step 1c (averaging).

Step 1b. Repeat steps 1a1 to 1a4 for all indicators underneath a main criterion.

Step 1c. Integrate the results by weighted averaging
On the indicator level, the one-out-all-out method cannot be justified as its use will almost certainly lead to unjust rejections. Instead, the indicators are averaged (total of n indicator values divided by n) to have single assessment results for the main criteria as their number may vary from a few to several (e.g. depending on the number of conservation features assessed in the region).

If estimates of the uncertainty in the data, targets and methods of the indicators are available, three weigh factors are attributed to these uncertainties. An adequate basis for assigning weights is not always available. Assigning weights often involves expert judgment. Hence, indicators that are thought to be of high quality can be given a higher weight that those with a lower quality and vice versa (Prins et al., 2014). For a more detailed overview of the available methods for the aggregation and integration of data and indicators we refer to Prins et al., (2014). The weight factors proposed in this report are 1 for low uncertainty, 0,75 for moderate uncertainty and 0,5 for high uncertainty. The indicators are multiplied by the average value of these three weigh factors before the average value of the indicators is calculated.

Step 1d. Estimate the likelihood of reaching the target at main criterion level
Likelihoods are used to estimate whether the target is reached. While these likelihoods could be used already at the indicator level, it may be more practical to
apply them on the main criteria level. In that case, the likelihoods would be judged on the basis of the uncertainty on the indicator level. For instance, if two indicators have high uncertainty and one indicator has moderate uncertainty, it is quite clear that the likelihood should be decreased.

**Step 2. Repeat the Step 1 for all remaining main criteria.**

**Step 3. Integrate the main criteria by the one-out-all-out principle**

The method assesses ecological coherence by a simple aggregation tool, where the four main assessment criteria are components of equal importance and a failure in any of them results that ecological coherence of the network has not been reached. This follows the one-out-all-out principle, which is an assessment method taking into account the precautionary principle. Figure 3.2 depicts the integration process.

**Step 4. Estimate the likelihood of reaching ecological coherence**

Explained in Section 3.3.1.

As suggested above, the integration of assessment criteria can be hierarchical. The four main criteria are integrated by the one-out-all-out principle and the indicators underneath the main criteria are first averaged to have a single assessment result for the main criterion.

The suggestion for the integration method also includes uncertainty estimates (step 1a4). As the indicators are the elements that are affected by uncertainties in data, targets and methodological challenges, it is clear that the uncertainties are associated to that level. The uncertainties can, if considered necessary, be used to weigh the indicators in the averaging (step 1c).

We also suggested using likelihoods to estimate whether the target is reached. While these likelihoods could be used already at the indicator, it may be more practical to apply them only on the main criteria level. In that case, the likelihoods would be judged on the basis of the uncertainty on the indicator results. Figure 3.2 presents how the targets, uncertainties, indicator values and likelihoods are dealt with in the proposed integration process.

It should be noted, however, that the use of uncertainties and likelihoods can be considered as optional elements and the assessment of ecological coherence is – as a minimum – made criteria by criteria, which is the practice in all the latest RSC assessments (HELCOM, 2010a, Gabrié *et al.*, 2012; OSPAR, 2013).
Figure 3.2: Integration method of assessment criteria and indicators (reflecting the subcriteria). Each indicator will get a ratio of the value and target and this is averaged for the main criteria. Optionally, one can include an assessment of uncertainty to the indicators, which can affect the average. The assessment result for each main criterion can be given as an averaged indicator ratio or, optionally, as a likelihood. The overall result is according to the one-out-all-out principle. Note that the features in the indicators are examples only.

3.3.3 Calculations for the main criteria
The way in which the four main criteria are calculated, in the basic method and in the more detailed method, is presented in Annex D.
3.4 Decision tree for improving the assessment of ecological coherence

The benefit of a systematic method for the assessment of ecological coherence is to trace the weak points in the MPA network but also to help identify where the assessment of the network could be improved. Such gaps can be shown in the decision tree of Figure 3.3, indicating the necessary steps in the assessment and how they can be improved if the uncertainties are high or the criteria fail to meet the targets. In this process, one of the actions is to improve the MPA network. In case of representativity, replication, connectivity and adequacy criteria that means either an increase in MPA coverage (for specific areas or features), number of MPAs, size of MPAs or protection level of MPAs. Plenty of guidelines and criteria for establishment of MPAs and design of MPA networks are available to improve the ecological coherence (e.g., Roberts et al., 2003; OSPAR, 2006; IUCN/WCPA, 2008; IUCN, 2008; Laffoley, 2008; Smith et al., 2009).

3.5 Key messages of this chapter

- Assessment practices for MPA networks in EU context and the European marine regions were used as a basis for the development of the methodology for the assessment of ecological coherence of networks of MPAs.
- The proposed assessment method has a hierarchical approach and includes a basic and a more detailed level of assessment depending mainly on the data availability. The core of the method is an evaluation of the four main criteria one by one, following the one-out-all-out principle, while each of the main criteria are assessed by indicators, which are averaged.
- The proposed method provides assessment results in terms of a likelihood of the network of MPAs being ecologically coherent.
• Uncertainty can be included in a qualitative manner and can be characterized as ‘low’, ‘moderate’ and ‘high’ depending on the data, target and assessment method.
• The method can be applied at various scales (national network, cross-boundary network, sea basin, Europe), the more detailed method being at the moment limited to areas of better data availability.
• Following the decision tree, gaps in the MPA network can be defined and the assessment can potentially be improved through an increase in the number of MPAs, size of MPAs or protection level of MPAs.
4 Case study to test the proposed method

4.1 Case study description

The selected case study area locates in the central Baltic Sea, covering marine areas of four EU Member State countries: Estonia, Finland, Latvia and Sweden.

The study area includes 92 MPAs from the four countries and the total coverage of MPAs is almost 9 % of the marine area. Table 4.1 gives summary information of the study area.

The study area was selected on the basis of the following criteria:
- includes several MSs;
- includes several MPAs;
- availability of MPA data;
- availability of data necessary for more detailed assessments.

![Figure 4.1 Map of the study area.](image)

Table 4.1 Summary information of the case study area.

<table>
<thead>
<tr>
<th>characteristic</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine area (km²)</td>
<td>68 938 km²</td>
</tr>
<tr>
<td>Marine area per country (%)</td>
<td>Finland 46 %, Estonia 31 %, Sweden 27 %, Latvia 3 %</td>
</tr>
<tr>
<td>Depth range (m)</td>
<td>mean: 69 m, max. 442 m</td>
</tr>
<tr>
<td>Number of MPAs</td>
<td>92</td>
</tr>
<tr>
<td>Total area of MPAs (km²)</td>
<td>5 993 km²</td>
</tr>
</tbody>
</table>

More detailed information of how the case study was carried out (assessment criteria, data sources, target values, and how the basic and more detailed methods were used) can be found in Annex E, Sections E.1 to E.4.

4.2 Assessment of ecological coherence in the case study

The ecological coherence of the MPA network in the case study area was assessed by using the four main assessment criteria and the subcriteria (represented by the indicators) and by following the methodology suggested in Chapter 3.
The basic method included 30 indicators for representativity, 15 for replication, one for connectivity and two for adequacy. The results of the calculations on the indicators for each of the four main criteria are presented in Annex E, Sections E.5 to E.8. Weighted averages of the four criteria were 0.8, 2.2, 0.8 and 0.7. Taking account of the uncertainties, the assessment result is that it is unlikely that the network is ecologically coherent. Table 4.2 illustrates a summary how the test results were integrated into an assessment of ecological coherence and Annex E, Table E.5 shows the full documentation of the test.

The basic method with more ambitious targets resulted in poorer results: weighted averages of the four criteria were 0.8, 1.1, 0 and 0.6 (results not shown). The uncertainties being the same, the assessment result was: very unlikely to be ecologically coherent.

Table 4.2 Summary of the integration table for the assessment of ecological coherence in the study area. The full table is given in Annex E, Table E5. A ratio of the indicator result and the target is first attained for all the indicators. Secondly, uncertainty in the data, target and method is added, and averaged for each indicator. In the third step, a weighted average is calculated for each indicator (mean uncertainty × indicator ratio) and then for the criteria level (simple average of the indicators). The likelihood of reaching the target is given for each criterion, based on the weighted average: scores <0.5, 0.5-1, 1-1.5 and >1.5 can be given respective likelihoods of very unlikely, unlikely, likely and very likely. Note that these scores are given for the purpose of this case study only. Finally, the assessment of ecological coherence is done by the one-out-all-out principle, where the weakest criterion (or likelihood) determines the final assessment result.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Result</th>
<th>Target</th>
<th>Ratio</th>
<th>Uncertainty in data</th>
<th>Uncertainty in target</th>
<th>Uncertainty in method</th>
<th>Weighted average</th>
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<tbody>
<tr>
<td><strong>REPRESENTATIVITY</strong></td>
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<tr>
<td>Weighted average of the criteria (see Annex E)</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>0.75</td>
<td>1</td>
<td>0.75</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td><strong>ASSESSMENT RESULT: UNLIKELY</strong></td>
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<tr>
<td><strong>REPLICATION</strong></td>
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<tr>
<td>Weighted average of the criteria (see Annex E)</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>0.75</td>
<td>1</td>
<td>0.75</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td><strong>ASSESSMENT RESULT: VERY LIKELY</strong></td>
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<td><strong>CONNECTIVITY</strong></td>
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<tr>
<td>Weighted average of the criteria (see Annex E)</td>
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<td>(see Annex E)</td>
<td>1</td>
<td>0.75</td>
<td>0.5</td>
<td>0.8</td>
<td></td>
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<tr>
<td><strong>ASSESSMENT RESULT: UNLIKELY</strong></td>
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<td><strong>ADEQUACY</strong></td>
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<tr>
<td>Weighted average of the criteria (see Annex E)</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.7</td>
<td></td>
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<tr>
<td><strong>ASSESSMENT RESULT: UNLIKELY</strong></td>
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</table>

ECOLOGICAL COHERENCE IS UNLIKELY REACHED.

(1) Values: LOW, MODERATE and HIGH, which are used to weigh the sub-criteria by weights 1, 0.75 and 0.5, respectively. (2) Values: VERY UNLIKELY, UNLIKELY, LIKELY, VERY LIKELY.

The more detailed assessment had spatially more accurate biological data (including different features) and therefore the results of the assessment are different. The weighted averages were 1.5, 2.2, 0.7 and 0.6 for representativity, replication, connectivity and adequacy, respectively. The use of mapped data decreased uncertainty in methods but the confidence
of the data is not very high and hence the uncertainty in data was increased. Based on the adequacy criterion, the assessment concluded that it is unlikely that the network is ecologically coherent. Table 4.3 presents a summary of the results and the full results are presented in Annex E, Table E.6.

The results with the more ambitious targets showed that the weighted averages were 1.3, 1.1, 0.5 and 0.5 for representativity, replication, connectivity and adequacy, respectively. As the connectivity and adequacy criteria had only the scores of 0.5, it is very unlikely that the network is ecologically coherent with the ambitious targets.

Table 4.3 More detailed assessment of ecological coherence in the study area. The full integration table is given in Annex E, Table E.6.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Result</th>
<th>Target</th>
<th>Ratio</th>
<th>Uncertainty in data</th>
<th>Uncertainty in target</th>
<th>Uncertainty in method</th>
<th>Weighted average</th>
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<tbody>
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<td><strong>REPRESENTATIVITY</strong></td>
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<tr>
<td>Weighted average of the criteria</td>
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<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>1.5</td>
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<td>* ASSESSMENT RESULT: UNLIKELY</td>
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<tr>
<td><strong>REPLICATION</strong></td>
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<tr>
<td>Weighted average of the criteria</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>0.75</td>
<td>1</td>
<td>0.75</td>
<td>2.2</td>
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<tr>
<td></td>
<td>* ASSESSMENT RESULT: VERY LIKELY</td>
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<tr>
<td><strong>CONNECTIVITY</strong></td>
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<tr>
<td>Weighted average of the criteria</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>0.5</td>
<td>0.75</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>* ASSESSMENT RESULT: UNLIKELY</td>
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<tr>
<td><strong>ADEQUACY</strong></td>
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<tr>
<td>Weighted average of the criteria</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>(see Annex E)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>* ASSESSMENT RESULT: UNLIKELY</td>
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</tr>
<tr>
<td><strong>ECOLOGICAL COHERENCE</strong></td>
<td>is UNLIKELY REACHED.</td>
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</tbody>
</table>

(1) Values: LOW, MODERATE and HIGH, which are used to weigh the sub-criteria by weights 1, 0.75 and 0.5, respectively. (2) Values: VERY UNLIKELY, UNLIKELY, LIKELY, VERY LIKELY.

4.3 Key messages of this chapter

- The Baltic Sea was used as a case study to illustrate the applicability of the proposed criteria and method using the basic and more detailed method as well as basic and more ambitious target levels. The more ambitious target levels resulted, as expected, in a poorer outcome of the assessment.
- It is shown that the hierarchical use of indicators, sub-criteria and main criteria is a practical approach for the assessment of ecological coherence.
5 Discussion

5.1 Scope of the assessment

When developing an assessment method it is important to know precisely what the objectives of the assessment are, because only the objectives are reflected in the assessment criteria. In the course of this study two still ongoing discussions have emerged, related to these objectives. The first addresses the interpretation of article 13(4) which lies at the basis of this study; the second is related to the practical needs of the MSs in view of their reporting obligations.

The phrasing of Article 13(4) seems to allow for multiple interpretations in view of MPA network assessment. The assessment could focus on spatial protection measures of the Programmes of Measures and assess their (expected) contribution to ecologically coherent, representative and adequate networks of MPAs (whereas this contribution stands for a contribution to the GES by proxy). This seems to be a possible option in view of Article 16, which states that the Commission will ‘consider the coherence of the programmes of measures’ notified by the MSs. On the other hand, the assessment could focus on the MPA networks established in the Programmes of Measures and assess whether they are ecologically coherent, representative and adequate.

This report has taken the second view as a starting point, based on the obligations for the Commission as put down in Article 16 of the MSFD, and thus focuses on the ecological coherence of the existing MPA networks. Based on the inventory presented in this report the authors consider that although MSFD Art.13(4) only mentions the terms ‘coherent’ and ‘representative’, also assessment of the criteria ‘connectivity’, ‘adequacy’ and ‘replication’ is required for the assessment of ecological coherence. We acknowledge that follow-up activities are needed to extend the focus to include other spatial measures and to put our assessment method in the wider context of MSP.

The objective of the report was to develop an EU-wide methodology to test MPA network coherence and representativity. In doing so, the consortium built on ongoing work in RSCs. A second discussion arose from the needs of MSs to tailor these efforts to the potential synergies with and the requirements for Natura 2000 reporting. This step will however require some additional efforts, as indicated in Section 2.5.2.

5.2 Improvement of the MPA network to reach GES

Scientific evidence shows that MPAs have a strong and positive effect on enhancing species populations, restoring habitats and food webs and enhancing functionality of the marine ecosystem (Gell & Roberts, 2003; Marine Parks Authority, 2008; Halpern et al., 2009). Therefore MPAs are also expected to contribute to the EU objective of reaching or maintaining GES in the marine environment (Section 2.5.1). The efficiency of the MPAs to meet this objective cannot be assessed by the methodology proposed in this report. However,
an ecologically coherent MPA network provides the basis for an efficient MPA network: the assessment criteria (and the underlying subcriteria) are selected to address the key elements of marine biodiversity and the targets can be adjusted to set the ambition level. Hence, an ecologically coherent network which is also well managed ought to provide, by definition, sufficient protection of all the conservation features and thus aid in the achievement of GES.

In this report the proposed methods aim to assess the MPA network and not to propose design principles for new sites. Therefore socio-economic or cost-effectiveness criteria, etc., which are usually included among establishment criteria, are not part of the assessment criteria in this report. Such considerations will however be important, if the assessment of ecological coherence shows that there are gaps in meeting the targets of the network. Improvement of any of the gaps – for example designating more sites, larger sites or stricter protection – may require consideration of the establishment criteria.

This report presented a simple decision tree (Section 3.4) which can be used to improve the assessment and identify gaps in the MPA network and, hence, help in placing spatial protection measures within the framework of MSFD programmes of measures. As the MSFD has a strong emphasis on regional coordination in the programmes of measures, it is proposed that the improvement of MPA networks and assessments of ecological coherence will be done within marine regions by concerted actions. This is already taking place in the RSCs at the moment.

5.3 Trade-offs between economic uses and environmental status

Maritime Spatial Planning (MSP) provides a legal framework to manage marine areas, biological resources and services in a sustainable way. When integrating the MPAs in the wider MSP and management framework, the socioeconomic dimensions need to be considered, mapped, and integrated into decision-making. Analyses on socio-economic information should be combined with the biophysical information in order to compare the social and environmental benefits and if needed modify the desired outcomes (e.g. the protection level) and objectives. A valuable planning tool to coordinate the decisions for a sustainable management of the marine resources and to deal with conflicts among various marine space users, is the Ecosystem-Based Marine Spatial Management (EB-MSM).

In the more detailed assessment method the anthropogenic pressures and their spatial distribution are proposed as additional components. The inclusion of these components will provide a spatial overview and can help in counteracting the risk of pressure displacement, in which areas outside of the MPAs might be more affected by fisheries or other socio-economic activities, such as tourism and boating. Further work should be undertaken when selecting sites to understand the socio-economic impacts of possible designations. Based on the present and potential impacts of anthropogenic pressures, we foresee that their inclusion in the assessment methodology will improve the accuracy of assessments of ecological coherence.

5.4 Considerations on target setting
We acknowledge that target setting is to a large degree a political process and as such beyond the scope of this study. Both the political and ecological context can cause targets to vary between the European marine regions. We suggest that target setting be coordinated within the RSCs.

This report made an initial review of the scientific backgrounds of targets for representativity, replication, connectivity or adequacy. The report touches in many places and often refers either to Chapter 2, Annex C Section C.7 and Annex E Section E.3 or to external reports and reviews. It is nonetheless clear that support for some of the targets is stronger than for others. For example, there is strong political support for the Aitchi target of 10% MPA coverage in the marine regions13 and almost equally strong support for the representativity targets for habitats and species14 and level of protection15. Replication targets have been proposed by HELCOM (2010a), OSPAR (2013), the Interreg project PANACHE (Sciberras et al., 2013) and WWF Canada (Smith et al., 2009); between two and five replicate sites for each conservation feature. MPA size has been in focus of several scientific studies and there are good suggestions of recommendable sizes for specific conservation objectives as well as for general purposes (e.g. Piekäinen & Korpinen, 2007; Olsen et al., 2013); HELCOM is the only RSC giving a recommendation of the minimum MPA size (30 km²). In contrast, targets for connectivity have not been officially communicated on political fora and the scientific support is limited only to the distances between the sites or protected features. We acknowledge that using distance between sites only, without taking species behaviour, oceanography or migration barriers into account, is too simplistic in some cases, and will only be useful as a first approximation. Scientific literature suggests different inter-MPA distances (see reviews and practices in Piekäinen & Korpinen 2007, HELCOM 2010, OSPAR 2013).

Even though a common set of criteria and sub-criteria was proposed for all the regional seas, in practice the targets may vary, depending on the political, socio-economic and environmental conditions in the marine regions. Adaptation of targets to local or regional needs could be necessary in order to still have a realistic grasp of the area(s) under assessment.

5.5 Improving data to improve the assessment results

Conservation features, i.e. the species, habitats, geomorphological formations, landscapes, etc., are the core elements of any assessment of ecological coherence. In the basic method, we proposed that the presence of the features within the MPAs is used as a simple proxy for representativity of these features in the network. Data are available, but the agreed lists focus only on threatened species whereas the assessment could also include key species, habitat-forming species and predominant habitats. As the lists of key species and predominant

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13 The 10% target refers also to other spatial protection measures, but in this report we interpret it to mean only MPAs as there is not yet a common understanding how to define the other spatial protection measures.

14 In addition to extensive scientific research, the Habitats Directive assessment targets have been set for species and habitats.

15 The fifth World Parks Congress (2003) called, inter alia, for extensive coverage of marine and coastal areas and that these networks should include strictly protected areas that amount to at least 10 – 30% of each habitat type.
species are also a focus in the assessments of GES under the MSFD, we propose that such regional lists are agreed on within the marine regions.

Spatial maps of habitats and species distribution are much more difficult to obtain. International projects, such as EMODNet Habitats, EUSeaMap, MESH or BALANCE have produced broad-scale habitat maps (of abiotic features) and national mapping projects include biotic elements such as habitat-forming species. At the moment, maps of conservation features are available for three marine regions on a rough scale.

Anthropogenic pressures have not been thoroughly mapped in any marine region, but datasets of different human activities or pressures are available in all of the marine regions. Impacts of shipping can be modelled on the basis of Automated Identification System (AIS) data and impacts of fishing on the basis of Vessel Monitoring System (VMS) data. Sources of nutrients and contaminants can be modelled from GIS files on waste water treatment plants, industry and aquaculture. Also activities requiring permits, such as dredging, dumping of dredged matter and underwater or coastal construction, can be rather easily mapped.

A potential third more detailed assessment method could focus on distinguishing legal bases of the MPAs. Each MS is likely to have slightly different legal instruments to implement MPAs and Natura 2000 sites. Depending on the instrument (e.g. Nature Conservation Act or Water Act), there are different outcomes regarding the features that can be protected. For example, a Natura 2000 site protected by a stricter instrument is likely to also give protection to other features than the ones listed by the Habitats Directive, whereas a weaker instrument does not. Furthermore, a marine national park may have strict nature protection on islands but weaker protection on marine areas.

The prerequisite for such an assessment is a database where the legal instrument that is used as a context for the designation of the MPA is mentioned for each MPA. The database should include the selected features and ‘tick the box’ if the feature is protected or not. The spatial analysis should, thus, be preceded by a filtering process of sites for each feature. It is also biologically meaningful to consider an assessment of a cluster of habitats, which for instance, are used by a key species during its life cycle. Since there can also be different protection zones within MPAs, protected by different instruments, the database should preferably have a spatial component in order to differentiate in which areas specific features are protected or not. As an outcome of this more detailed assessment criterion, one can re-analyze all the other assessment criteria (cf. the decision tree, Section 3.4). For the representativity, replication and connectivity assessments this means that only the features that are really under legal protection within each site are included in the assessment.

We did not include this third method in the report, because the required data are not available in the international databases and we suspect that in many countries even national databases are not arranged to contain information of the features which are legally protected by the site. However, we foresee that this more detailed assessment method would improve the accuracy of assessments of ecological coherence.
5.6 Role of management aspects as a part of an MPA network assessment

Management is an important issue which should be assessed in connection with the ecological coherence of MPA networks. Within this report, management effectiveness or efficiency has not been included as a criterion. In literature though, the importance of tracking the management effectiveness of individual MPAs within the network is stressed (Laffoley 2008). For instance, the IUCN World Conservation Congress (Barcelona, Spain, September 2008) of the Marine Protected Areas Plan of Action for IUCN’s World Commission on Protected Areas and the IUCN Green List (Laffoley, 2014), as well as the OSPAR and HELCOM definitions for the MPA network include the concept of ‘well-managed MPAs’.

HELCOM Recommendation 35/1 and OSPAR Recommendation 2010/2 mention management and ecological coherence separately and their assessments take place in different schedules, implying that an assessment of management success is not necessarily included in an assessment of ecological coherence. In line with this, the latest OSPAR assessment of ecological coherence (OSPAR, 2013) did not include the management aspects in the assessment method.

The IUCN, through the establishment of a Green List of protected areas, aims to promote effective management, as well as sound planning, equitable governance and achievement of conservation goals/successful outcomes. Protected areas wishing to be included on the Green List will have to satisfy a threshold of agreed criteria and minimum standards regarding these aspects, appropriate for the local and national context.

In the course of this study the question of whether or not to include management aspects has been raised several times, and the discussion has not ended yet. Arguing from the viewpoint of selecting the best indicators for the criterion of ‘Adequacy’ we have concluded that management categories should be included. This recommendation could become more acceptable if parties agree that the proposed management categories come close to the concept of protection levels. The important difference is that the protection level is defined a priori, i.e. when establishing the site, based on the conservation objective. For example, a no-take zone is established as a strictly protected site with a specific objective to allow no exploitation. Management of that site is planned a posteriori to ensure this objective. Hence, the suggestion of this report to include ‘management category’ as a sub-criterion for Adequacy is not considered as a ‘management criterion’ but as an important building block to ensure ecological coherence of the network. Supporting this view is the fact that the OSPAR assessment (2013) included protection level as an ‘essential aspect of ecological coherence’.

A further step to be taken in the future could be to integrate additional assessment criteria related to planning, management, governance and others, as suggested by the IUCN, as they may ultimately determine achieving coherence of MPA networks.
There are obviously different interpretations of the IUCN management categories and difficulties of assigning the categories to individual MPAs. We argue for the use of the worldwide most commonly accepted and standardized classification and categories, i.e. the IUCN classification, in order to allow an assessment at broad-scale level. In this report, we proposed improvements to the classification to better apply to MPAs, but those would require MSs and experts to contribute to the definitions provided in this report in order to fit in the best possible way to the European legislation and practice.
6 Conclusions

6.1 Conclusions with respect to the assessment criteria for MPAs
- The existing criteria for the assessment of ecological coherence in MPAs that are in use in the four European marine regions are very similar; or at least they refer to similar concepts.

- The four main assessment criteria as proposed in this report are: representativity, connectivity of conservation features, replication of these features in several sites and adequacy. These criteria are supported by the CBD, the RSCs and by global agreements and standards.

- The proposed assessment criteria are in many cases similar to designation criteria, which have been suggested and used when setting new sites and designing a network. The criteria for designing MPA networks indicate how an ecologically coherent network could look like and therefore they can give important indications for the selection of assessment criteria.

- While we emphasized in our selection the European criteria, we noted that MPA design and assessment criteria are very similar all over the globe and good support for our selection was found, *inter alia*, from California, Canada, Australia and New Zealand. Moreover, the definitions applied in this report and elsewhere follow the CBD definitions of the Decision IX/20 (CBD, 2008; see Section 2.2.1).

- The IUCN management categories can be applied to European networks of MPAs and have the advantage of offering an internationally accepted standard. They are not unanimously accepted, though; see Section 5.6.

- The proposed MPA assessment criteria are not comparable to the MSFD GES criteria, as MPAs can only *support* reaching GES. To ensure that their assessments support each other, the same features should be included in both.

- The use of the proposed criteria can support the assessment of Natura 2000 network (while considering differences in scale). To make this synergy operational, the selected lists of species and habitats should be harmonised.

- The suggested criteria focus on achieving ecological coherence. Further criteria on planning, management, governance, and others may also need to be considered, as they are related to the achievement of ecological coherence.

6.2 Conclusions with respect to the assessment method
- The assessment method suggested in this report is a framework which can be applied at various scales (e.g. to national network, cross-boundary networks, sea basins, and European scale).

- The proposed method builds upon existing guidelines, methods and practices and hence it is not novel.
The proposed method is the first to be based on a comparison of the guidelines, methods and practices of all the European marine regions and to suggest a common approach to the assessment of ecological coherence of MPA networks.

Using the proposed method can bring transparency to the MPA assessments and also identify gaps in the network.

With the proposed method it is possible to develop quantitative assessments, to compare assessment results across marine regions and most importantly, to deal with the different amounts of species and habitats. This is because the averaging on the level of indicators is not too sensitive to the number features included in the assessment.

We have suggested a simple tool to visualize the assessment process in a matrix and to include uncertainties in the assessment of the ecological coherence. As a result, ecological coherence is not necessarily assessed strictly by a number, but it can be a 'likelihood' which is affected also by the amount of uncertainty.

At present, a number of important scientific knowledge gaps still exist. The gaps lie especially in the understanding of setting targets for connectivity and representativity, i.e. how much of a feature should be protected and how closely to one another the protected features should be located. Another gap is the selection of conservation features in the assessment; which species, habitats or other features should be included in the assessment.

As a consequence of the previous conclusion, assessments of ecological coherence are not yet fully mature and should be accompanied with confidence estimates.

This report considers many of the targets as preliminary and some are associated with a wide range of uncertainty.

6.3 Conclusions from the case study

The case study has demonstrated how the basic and more detailed assessment methods can be used, and that the uncertainties in data and method can be used as an operational element in the method.

The use of the less and more ambitious target levels was reflected in the assessment results as expected: the more ambitious targets obviously produced a result farther away from the target level.

The averaging of indicators is especially beneficial in case of different numbers of conservation features in the assessment.

The use of the one-out-all-out principle to get the final result was considered functional.

The purpose of the case study was to test and exemplify the suggested methods. It cannot be considered as an assessment for the study area. For instance, the targets in the case study were based on scientific evidence but not all of them are agreed upon in the region.
7 Proposal for a Roadmap for further development

The main subject of the work presented in this report is the development of an assessment method of the ecological coherence of the networks of European MPAs. We have proposed some steps for its development, but a lot of work still needs to be done. Describing the necessary follow-up activities and putting them in a tentative time-frame is the objective of this chapter.

7.1 Research questions and information needs

In the course of this project we have come across the following knowledge gaps that in some way or other affect the efforts towards the assessment of the European MPAs:

- The available knowledge of the marine environment is often insufficient to define target values for the assessment criteria on scientific grounds. However, in many cases the science is in place but agreements of the use of target values are lacking.
- The implementation of the Natura 2000 network, which supports the implementation of the HD and the BD, is at the core of the process of establishing networks of MPAs. However in the HD only a small number of the listed species and habitats are marine, and there are many knowledge gaps concerning key species, especially in the deep sea ecosystems. In this regard, we have proposed in this report that the lists of key species and predominant habitats, which have been defined for marine regions and used in the assessments under the MSFD, in the future could also be used for the assessment of ecological coherence. Additional research is required before this can be applied in practice.
- It is clear from several scientific analyses that MPAs are an efficient protection measure and, hence, support reaching the GES. However, there are not yet many good examples of such success stories in relation to the MSFD assessments. Thus, there is a need for the establishment of mechanisms to monitor the ecological efficiency of the adopted measures.
- A means for including uncertainty has been incorporated in the method that is presented in this report. The purpose of including uncertainty is to provide the user with a better 'feel' for the results. Recommendations on how to act on these uncertainties are still lacking.
- The assessment of ecological coherence is based on an analysis of conservation features, but lists of such features have not been set in any marine regions, except the Habitats Directive Annex species and habitats.
- The assessments of marine environment are beginning to rely on mapped species and habitat distributions, which will likely steer the development of MPA assessments in the near future. The more detailed method proposed in this report requires GIS data on the spatial distribution of conservation features and anthropogenic pressures, which is not yet available for all features and for all marine regions. As the data accumulates, we propose that the assessments of ecological coherence shift towards these spatially more accurate methods.
There are major differences between MPAs as to which conservation features are legally protected, but no international database has information on this. We consider this as a major challenge, not scientifically but technically, as the current MPA assessments (e.g. HELCOM, 2010a; Gabrié et al., 2012; OSPAR, 2013) assume that the assessed features are protected in all the sites in the network. In practice, the legal basis can vary in neighbouring sites and even in different parts of a single MPA.

7.2 Recommendations for follow-up activities

**Short term (1-2 years)**

- For the further improvement of the assessment method:
  - Extend the pilot application of the proposed assessment methods to all European marine regions, and report, and exchange experiences;
  - Start monitoring efforts to describe the base levels, where these are not available.
- For the improvement of the acceptance and application of the assessment method:
  - Find agreement on the exact interpretation of Art.13(4);
  - Elaborate on the synergies between GES and MPAs along the lines that are proposed in Section 2.5.1;
  - Elaborate on the synergies between assessment of MPAs and Natura 2000, along the lines that are proposed in Section 2.5.2;
  - Find agreement on monitoring of MPAs as an important part of the MSFD implementation monitoring strategy;
  - Harmonise with the 6 year progress reporting cycle starting next year (with the Commission progress reporting on MPAs).

**Mid term (2-5 years)**

- For the further improvement of the assessment method:
  - In general: promote research activities that help reducing the uncertainties in the assessment methods;
  - Develop databases on the spatial distribution of conservation features and pressures impacting them;
- For the improvement of the acceptance and application of the assessment method:
  - Develop views on how to act on the outcomes of the assessment, in case these indicate deficiencies in the MPA networks;
  - Develop guidelines for the use of uncertainties and likelihoods as described by the method, in decision-making;
  - Extend the assessment method for use in planning of new MPAs. The suggested assessment criteria are in many cases similar to establishment criteria for setting new sites and designing a network.
Long term

- Collect data on legal arrangements of MPAs and include these in databases;
- Assess the effectiveness of applied management practices and see if and how management practices could support the assessment of ecological coherence;
- Develop legal instruments for managing MPAs in cross-boundary areas and high seas;
- Consider options for common target setting.
8 References


COP7. 2014. Decisions adopted by the Conference of the parties to the Convention of Biological Diversity at its seventh meeting. Accessible at: http://www.cbd.int/decisions/cop/?m=cop-07


Proposal for an assessment method of the ecological coherence of networks of marine protected areas in Europe


IUCN (1994) Guidelines for Protected Area Management Categories. CNPPA with the assistance of WCMC-IUCN. Gland, Switzerland and Cambridge, UK.


Laffoley, D. & Wells, S. 2014. The IUCN Green List of Protected Areas (GLPA) and Marine Protected Areas. The World Conservation Protected Areas Congress.


OSPAR (2014a) DRAFT 2014 Status Report on the OSPAR Network of Marine Protected Areas. OSPAR Convention for the Protection of the Marine Environment of the North-

OSPAR ICG-MPA 14/3/4E (2014b) Proposal on a methodology to assess management effectiveness of the OSPAR network of MPAs


# A List of acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD</td>
<td>Birds Directive</td>
<td>Birds Directive</td>
</tr>
<tr>
<td>BHD</td>
<td>Birds and Habitats Directives</td>
<td>Birds and Habitats Directives</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>CDDA</td>
<td>Common Database on Designated Areas b</td>
<td>Common Database on Designated Areas b</td>
</tr>
<tr>
<td>CFP</td>
<td>Common Fisheries Policy</td>
<td>Common Fisheries Policy</td>
</tr>
<tr>
<td>GES</td>
<td>Good Environmental Status</td>
<td>Good Environmental Status</td>
</tr>
<tr>
<td>EEA</td>
<td>European Environment Agency</td>
<td>European Environment Agency</td>
</tr>
<tr>
<td>EMODNET</td>
<td>European Marine Observation Data NETwork</td>
<td>European Marine Observation Data NETwork</td>
</tr>
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<td>HD</td>
<td>Habitats Directive</td>
<td>Habitats Directive</td>
</tr>
<tr>
<td>HELCOM</td>
<td>HELsinki COMmission, the Baltic Marine Environment Protection Commission</td>
<td>HELsinki COMmission, the Baltic Marine Environment Protection Commission</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature</td>
<td>International Union for the Conservation of Nature</td>
</tr>
<tr>
<td>MARPOL</td>
<td>MARine POLLution, the International Convention for the Prevention of Pollution From Ships</td>
<td>MARine POLLution, the International Convention for the Prevention of Pollution From Ships</td>
</tr>
<tr>
<td>MPA</td>
<td>Marine Protected Area</td>
<td>Marine Protected Area</td>
</tr>
<tr>
<td>MS</td>
<td>Member State</td>
<td>Member State</td>
</tr>
<tr>
<td>MSP</td>
<td>Maritime Spatial Planning</td>
<td>Maritime Spatial Planning</td>
</tr>
<tr>
<td>OSPAR</td>
<td>OSlo convention, PARis convention: Convention for the Protection of the Marine Environment of the North-East Atlantic</td>
<td>OSlo convention, PARis convention: Convention for the Protection of the Marine Environment of the North-East Atlantic</td>
</tr>
<tr>
<td>PSSA</td>
<td>Particularly Sensitive Sea Areas</td>
<td>Particularly Sensitive Sea Areas</td>
</tr>
<tr>
<td>RSC</td>
<td>Regional Sea Convention</td>
<td>Regional Sea Convention</td>
</tr>
<tr>
<td>SAC</td>
<td>Special Areas of Conservation</td>
<td>Special Areas of Conservation</td>
</tr>
<tr>
<td>SPA</td>
<td>Special Protection Areas</td>
<td>Special Protection Areas</td>
</tr>
<tr>
<td>SPAMI</td>
<td>Specially Protected Areas of Mediterranean Importance</td>
<td>Specially Protected Areas of Mediterranean Importance</td>
</tr>
<tr>
<td>SSSI</td>
<td>Site of Special Scientific Interest</td>
<td>Site of Special Scientific Interest</td>
</tr>
<tr>
<td>WHS</td>
<td>World Heritage Site</td>
<td>World Heritage Site</td>
</tr>
</tbody>
</table>
B Geographical terms used in this report

Source: Prins et al. (2014)

<table>
<thead>
<tr>
<th>Geographic term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Marine) region</td>
<td>Defined in MSFD Art. 4(1): Baltic Sea, North-east Atlantic Ocean, Mediterranean Sea and Black Sea</td>
</tr>
<tr>
<td>(Marine) subregion</td>
<td>Defined in MSFD Art 4(2) for the NE Atlantic Ocean and Mediterranean Sea</td>
</tr>
<tr>
<td>(sub)region</td>
<td>Marine region or subregion</td>
</tr>
<tr>
<td>subdivision</td>
<td>Spatial delimitation of a part of a member states’ marine waters in a smaller spatial unit (MSFD Art. 4(2))</td>
</tr>
<tr>
<td>Regional sea</td>
<td>Sea areas falling under the Regional Sea Conventions HELCOM, OSPAR, UNEP/MAP or BSC</td>
</tr>
<tr>
<td>Sub-basin</td>
<td>HELCOM’s division of the Baltic Sea into smaller spatial units</td>
</tr>
<tr>
<td>Region I-V</td>
<td>OSPAR’s division of the NE Atlantic into five areas; OSPAR regions do not fully match the marine subregions in the Nort-east Atlantic</td>
</tr>
<tr>
<td>Geographical Sub-area</td>
<td>Area defined by FAO for assessment of commercial fish stocks in the Mediterranean Sea and Black Sea</td>
</tr>
<tr>
<td>Biogeographical region</td>
<td>The Habitats Directive divides the EU into 9 ecologically coherent “biogeographical” regions. For the marine environment, the following biogeographical regions are relevant: the Atlantic, Boreal, Continental, Macaronesian, Mediterranean and Black Sea region The Baltic Sea is divided in two biogeographical regions (Boreal, Continental)</td>
</tr>
<tr>
<td>Biogeographic zone</td>
<td>Used in ICED/JRC Task group 1 report (Cochrane et al. 2010) without definition. Spalding et al. (2007) distinguish Northern European seas (contains marine subregions: Baltic Sea, Greater North Sea, Celtic Seas), Lusitanian (contains marine subregions Bay of Biscay and Iberian coast, Macaronesia), Mediterranean Sea and Black Sea</td>
</tr>
<tr>
<td>Ecoregion</td>
<td>Defined by Spalding et . (2007) as the smallest-scale units in marine ecoregions of the world: Areas of relatively homogeneous species composition, clearly distinct from adjacent systems. The species composition is likely to be determined by the predominance of a small number of ecosystems and/or a distinct suite of oceanographic or topographic features. The dominant biogeographic forcing agents defining the eco-regions vary from location to location but may include isolation, upwelling, nutrient inputs, freshwater influx, temperature regimes, ice regimes, exposure, sediments, currents, and bathymetric or coastal complexity. The boundaries of ecoregions do not fully match the boundaries of marine (sub)regions</td>
</tr>
</tbody>
</table>
C Annex to Chapter 2 - Inventory of criteria for the assessment of MPAs

C.1 Material and methods

In order to collate the information from the different legislation, frameworks and Regional Seas Conventions (RSCs) in a synthetic and comparable way, a catalogue was designed that collates, in a structured way, all the information consulted. The bibliographic review was based on available public information, including institutional, Public Administrations, scientific articles, reports from research project, NGOs, etc. The catalogue, collected in an Excel file (presented as electronic annex to this report), contains 6 sections, which are divided by the same number of sheets):

1. Intro. It contains the information about the catalogue’s objective, content and meta-information.
2. Definitions. This sheet contains different definitions regarding MPAs and Network of Protected Areas.
3. Framework. Contains the classes of criteria sources: i.e. 3rd Parties approaches, EU Directives, Guidelines, National Legislation, International Conventions and Agreements, research project, RSCs, scientific papers, etc.
4. Criteria. Contains the list of criteria for each of the frameworks inventoried, as well as the definition used for each criterion and bibliographical references. Here, each of the listed criteria was linked to the CBD criteria which have also been used commonly in assessment of ecological coherence by the RSCs (i.e. Representativity, Adequacy, Replication and Connectivity).
5. Catalogue. This is the proper catalogue of criteria used for each of the Frameworks. Here, the framework name and type, as well as the defined criteria are listed. For each of the criteria defined quantitative and qualitative targets were inventoried (when available).

Click on this icon to open the criteria catalogue.

The review included 266 criteria, which were catalogued in a database. Only 80 of these were meant for assessments of MPAs while the majority were criteria for establishing sites or designing a network. In the review, the criteria were related to the four concepts which are referred to in the CBD (2008) and RSC assessments (HELCOM 2010, Gabrié et al. 2012, OSPAR 2013). Of all the criteria 190 were related to the representativity concept, 11 to replication, 15 to connectivity, 40 to adequacy and 10 to the ecological coherence concept. Besides, of the assessment criteria, 33 were related to representativity, ten were related to
replication, 11 were related to connectivity, 22 were related to adequacy (MPA size and shape, level of protection and viability), and four to ecological coherence. Many of the criteria were not related to the four assessment criteria. Such criteria were, for instance, degree of acceptance, economic importance, monitoring effectiveness, education, potential for restoration, etc.

While some of the criteria were less frequently applied in the reviewed documentation, they all have been part of the major assessments. For instance, the California Marine Life Protection Act Initiative considered not only representativity and replication of habitats but also MPA size and spacing between the sites, i.e. connectivity (Saarman et al., 2013). The targets for MPA size ranged between 23-47 km² (minimum) and 47-93 km² (preferred), the sites should placed within 50-100 km from each other, every key habitat should be represented in a site and replicated in multiple sites.

As the aim of the study was to develop operational definitions and test a method for assessing the coherence of European MPA networks, our focus in this report was based on network criteria and assessment criteria. We acknowledge that the criteria for a network assessment and criteria for selecting MPA sites should not be too divergent, but also notice that for a network assessment many of the site-selection criteria are not applicable. In this report we discuss both, but give priority to the criteria for assessing networks of MPAs.

C.2 Legislation and international and scientific frameworks for defining regional criteria

Inventory of the reviewed documentation
- Legislation

- International conventions and agreements:
  o 5 Regional Conventions: Helsinki Convention, OSPAR Convention, Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean* (SPA/BD Protocol) of the Barcelona Convention, Convention on the Protection of the Black Sea against Pollution (Bucharest Convention), Black Sea Convention, Bern Convention;
  o 7 International Conventions & Agreements: Convention on Biological Diversity (CBD), Bonn Convention & agreements (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS), Agreement on the Conservation of Cetaceans of the Black
Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), International Convention for the Regulation of Whaling, MARPOL Convention, World Heritage Convention;

- 9 Guidelines: Guidelines for the establishment of the Natura 2000 network in the marine environment: Application of the Habitats and Birds Directives by EC(http://ec.europa.eu/environment/nature/RSCs/marine/docs/marine_guidelines.pdf), Guidelines for the Establishment of MPAs in the Black Sea according to Black Sea Commission (BSC), the “Regional Working Programme for the Coastal and Marine Protected Areas in the Mediterranean, including the High Sea” and the “Guidelines to improve the implementation of the Mediterranean Specially Protected Areas network and connectivity between Specially Protected Areas”, IUCN, Guidance on achieving comprehensiveness, adequacy, and representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas (Australia), Globally significant sites for biodiversity conservation identified using universal standards, BirdLIFE, Alliance for Zero Extinction, International Guidelines by FAO;

- Research projects technical reports: BALANCE, MAIA, JNCC Marine Conservation Zone project (MCZ);
- Scientific papers.

C.3 Comparison of criteria used by MSs, RSCs and third parties

Table C.1 shows the number of criteria that have been inventoried corresponding to different legislations, international conventions, guidelines, research projects and scientific investigations. In order to classify the specific criteria used in different frameworks, we decided to classify them into the five (including Ecological coherence) that could cover all the terms, which were, representativity, adequacy, coherence, connectivity and replicability. Nevertheless, it could be as coherence being an overarching term for all of them. The complete catalogue is provided as an annex document to this report.

Table C.1 Synthesis of criteria catalogued in Annex classification according to framework type.

<table>
<thead>
<tr>
<th>Framework Type/Name</th>
<th>Representativity</th>
<th>Adequacy</th>
<th>Ecological Coherence</th>
<th>Connectivity</th>
<th>Replicability</th>
<th>Total general</th>
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<td>Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean*</td>
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<td>Bern Convention</td>
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<td>Other international Conventions and Agreements</td>
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<td>Integration</td>
<td>Specificity</td>
<td>Level</td>
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<td>Habitats Directive</td>
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<td><strong>National legislation</strong></td>
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The first component 'Ecologically and biologically significant areas' requires that areas where MPAs will be located are biologically diverse, productive, sensitive or unique or have threatened species or habitats or have special importance for species life history.

The ‘Representativity’ component means that the network consists of areas representing the different biogeographical subdivisions of the global oceans and regional seas that reasonably reflect the full range of ecosystems, including the biotic and habitat diversity of those marine ecosystems.

The ‘Connectivity’ component in the design of a network allows for linkages whereby protected sites benefit from larval and/or species exchanges, and functional linkages from other network sites. In a connected network individual sites benefit one another.

The ‘Replication of ecological features’ means that more than one site contains examples of a given feature in the given biogeographic area. The term ‘features’ means "species, habitats and ecological processes" that naturally occur in the given biogeographic area. Replication accounts for uncertainty, natural variation and the possibility of catastrophic events. Features that exhibit less natural variation or are precisely defined may require less replication than features that are inherently highly variable or are only very generally defined.

The ‘Adequate and viable sites’ mean that all sites within a network should have size and protection sufficient to ensure the ecological viability and integrity of the feature(s) for which they were selected. Adequacy and viability will depend on size, shape, buffers, persistence of features, threats, surrounding environment (context), physical constraints, scale of features/processes and spillover/compactness. The CBD Programme of Work for the protection of marine biodiversity recognises that there are at least three levels of spatial planning for MPAs within a country: a core system of no-take areas (NTAs) within a large MPA; a larger system of multiple-use MPAs, including fishery management areas; and a national MPA system embedded within a national integrated coastal management programme and overall management framework for the Exclusive Economic Zone (EEZ). Increasingly, NTA networks are being developed as part of the zonation of multiple use MPAs.
C.5 Definitions and use of the network assessment criteria by the RSCs

C.5.1 Numbers of criteria used per RSC

From Table C.1:
For OSPAR, when assessing the ecological coherence of the OSPAR Network of Marine Protected Areas (OSPAR, 2013) the criteria used were: representativity, adequacy, viability, connectivity, replication protection level and best available science.

HELCOM identifies 10 criteria in relation to the establishment of single MPAs: Objects of protection, Size, Naturalness, Pollution, Representativeness), and the network of MPAs (Coherence, Adequacy, Representativity, Connectivity, Replication).

Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean" has inventoried 5 criteria in relation to the choice of areas that could be included in the SPAMI List (Specially Protected Areas of Mediterranean Importance), all of them related to Representativity (Uniqueness, Natural representativeness, Cultural representativeness, Naturalness, Diversity, Presence of habitats that are critical to endangered, threatened or endemic species). However, the "Regional Working Programme for the Coastal and Marine Protected Areas in the Mediterranean, including the High Sea", adopted in 2009 by the Contracting Parties to the Barcelona Convention, has identified a set of 5 criteria (adapted from those established by CBD in 2007) related to Representativity, Adequacy and Connectivity. These criteria are: Ecologically and biologically significant areas, Representativity, Connectivity, Replicated ecological features, Adequate and viable sites.

The Black Sea Strategic Action Plan applies criteria development by Convention of Biological Diversity. This Convention defines 12 criteria for MPA design, all of them related to Representativity (Uniqueness or rarity; Special importance for life-history stages of species; Importance for threatened, endangered or declining species and/or habitats; Vulnerability, fragility, sensitivity, or slow recovery; Biological productivity; Biological diversity; Naturalness).

The Bern Convention includes 6 criteria related to Representativity (Threatened, endemic or any species listed in Appendices I and II of the convention, Richness, Importance and Representativity, Rarity, Area of migratory species).

C.5.2 Definitions and interpretations of criteria in each of the RSCs

Ecologically and biologically significant areas: not used by any RSC, but this has been discussed (but not applied) by OSPAR (OSPAR, 2013) and defined by the by the Barcelona Convention (see section C.5.1). The criterion may be more practical when finding areas in the need of protection and establishing MPAs, as also mentioned in the HELCOM Recommendation 35/1 (HELCOM, 2014a). Its usefulness in MPA network assessment is limited and, in practice, it is covered by the representativity criterion (see below). Furthermore, HELCOM Recommendation 35/1 (b) recommends to review whether new coastal and marine areas justify being selected as HELCOM MPAs, and to designate new
sites as HELCOM MPAs where these are ecologically meaningful, especially in offshore area beyond territorial waters.

**Surface area of the MPA network:** In all the marine regions, the CBD target of 10% of MPA coverage is being used or referred to. The percentage of protection has been also assessed separately for coastal (12 nm zone except for Greece and Turkey with 6 nm) and offshore areas (some Mediterranean countries have established various types of environmental protection beyond their territorial waters).

**Representativity:** All the marine regions use, in general, the CBD definition of representativity, but in the Baltic Sea, Mediterranean and NE Atlantic the ecological and evolving processes are considered as part of representativity and the definition also encompasses rare, threatened or declining features. In the Mediterranean and the Baltic Sea, the representativity was assessed by comparing the area of protected features with the total area of that feature in the marine region.

**Ecoregions/sub-basins:** In the Mediterranean, analyses have included epipelagic ecoregions and sub-basins (tentative target of 10%). In the Baltic Sea, the MPA coverage (%) in the HELCOM sub-basins was used to show whether there are major gaps in the spatial coverage (target of 10%). In the NE Atlantic, the OSPAR assessment made an analysis for ‘major gaps’ in OSPAR Regions and in Dinter biogeographic provinces and a preliminary limit level was 3% (setting a minimum level, usually one tenth of a potential target).

**Depth zones (or coastal/offshore/high sea zones):** In the Mediterranean representativity of benthic habitats distribution was assessed according to depth zoning (infralittoral up to 30-40 m; circalittoral 35-200 m; bathyal 200-3000 m; abyssal zone and beyond) and representativity of sites in coastal/offshore/high sea zones. In the NE Atlantic, the depth zones were assessed in 0-10 m (coastal zone), 10-75 m (shelf seas), 75-200 m (deeper shelf seas), 200-2000 m (slope/upper bathyal) and >2000 m (lower bathyal/abyssal). In the Baltic Sea, the MPA coverage (%) was analyzed in the territorial versus EEZ areas and the 10% target is applied to both zones (HELCOM, 2014a).

**Countries:** in the Mediterranean, Baltic Sea and NE Atlantic this criterion is used to present summary information of the MPA distribution and it is not an assessment criterion for ecological coherence.

**Habitats and species:** In the NE Atlantic, the limit level for the MPA Network representativity is that most (70%) of the OSPAR threatened and/or declining habitats and species (with limited home ranges) are protected and that at least 5% of each habitat type/species distribution for each OSPAR Region in which they occur is protected [or at least 3 replicate sites per region]. In the Mediterranean, RAC/SPA habitats are assessed (tentative target of 10%), but there is lack of benthic mapping to carry out this analysis and depth zones are used as proxies. Representativity of Mediterranean species (mammals, turtles, birds, fish) is analyzed (tentative target of 10%). In the Baltic Sea, a few indicator habitats and species (e.g. eelgrass, grey seals, charophytes) as well as benthic broad-scale habitats are included as assessment criteria and a target of 20% was used in the assessment.
All the RSCs also analyse the presence of habitats and species within the MPAs without comparing to the whole distribution range but comparing with lists of threatened species or Habitats Directive annexes.

**Ecological and evolving processes:** This has not been included in the CBD definition, but is found, e.g. in the definition of the Barcelona Convention and as an objective of the HELCOM MPA network (http://www.helcom.fi/action-areas/marine-protected-areas/Background%20of%20HELCOM%20MPAs/). However, the criterion was not used in the latest assessment.

**Remarkable features:** In the Mediterranean, representativity of the most iconic or rare features (seamounts, sub-marine knolls, deep-sea banks, deep-sea canyons) are assessed (tentative target of 10%).

**Replication:** The three RSCs count the number of sites within the marine region and sub-regions. In addition, in the Baltic Sea, Mediterranean and NE Atlantic, the number of protected features (e.g. habitat patches, species occurrence) are assessed within the assessment area. The NE Atlantic limit level is two sites/features, while in the Baltic Sea four sites/features was considered the minimum target. The OSPAR definition is that “Replication is the protection of the same feature across multiple sites within the MPA network, taking biogeographic variation into account. All features should be replicated and replicates should be spatially separate.” The HELCOM definition seems to be similar to this. In the Mediterranean report (Gabrié et al., 2012), the term replication was not used.

**Connectivity:** In the Mediterranean, Baltic Sea and NE Atlantic, connectivity is acknowledged to involve species migrations and larval drift, but assessments are run by proximity analyses with ecologically meaningful inter-site distances (e.g. 20, 50, 100 or 150 km). In the NE Atlantic, the assessment included the distance between sites in coastal (250 km), offshore (500 km) and high seas areas (1000 km) by using ten times greater distances than commonly found in scientific literature. In the HELCOM assessment, also the connectivity of features (based on GIS) was assessed. HELCOM Recommendation 5/1 (d) indicates that ‘HELCOM MPAs are ecologically coherent and take into account connectivity between sites including for example migration routes, species mobility and areas of special ecological significance such as spawning areas’.

**Adequacy:** The CBD definition, including both MPA size and level of protection is adopted in the Mediterranean and NE Atlantic regions, whereas in the Baltic Sea, the criterion includes MPA size and an analysis of human pressures. The NE Atlantic is the only region where viability is defined separately from adequacy (in the CBD definition it was combined with adequacy).

**MPA size:** In the Mediterranean, the MPA size was assessed but no definition or target was given. In the Baltic Sea 30 km² is a recommended target and in the NE Atlantic a 5 km² limit level was used as a minimum.

**Anthropogenic pressures:** In the Baltic Sea, overlap of predominant anthropogenic pressures (eutrophication status classification and amount of fishing and maritime traffic) with MPAs was used as a criterion for MPA quality.
**Level of protection (IUCN categories or similar):** In the Mediterranean, the level of protection is analyzed as a proportion of MPA types (based on IUCN categories); balanced distribution across types and the region is aimed at. The level of protection was not mentioned as ‘adequacy criteria’ in the Mediterranean, but it was assessed in a same context, indicating that they were meant to reflect the CBD definition of adequacy. In the NE Atlantic, OSPAR recognizes the level of protection as an ‘essential part of ecological coherence’ but has not included it in the 2013 assessment. HELCOM did not consider the level of protection in the previous assessment but the Recommendation 35/1 refers to the level of protection and IUCN categories as a means of categorizing MPAs: ‘noting that the International Union for Conservation of Nature (IUCN), has set new criteria for categorizing MPAs and that acknowledging these categories and following the same standards and terminology when setting up new criteria for HELCOM MPAs makes it possible to link up HELCOM’s MPA network with global networks of MPAs [...] apply the newest IUCN categorisation system when describing the HELCOM MPAs in order to allow for global comparisons of regional networks’ (HELCOM, 2014a).

**Age of MPAs** has been used only in the Mediterranean region. The minimum age for an MPA to reach maturity has been considered as 10 years.

**Legislation**
The Birds Directive lists 4 criteria, all of them related to Representativity (Danger of extinction, Habitat vulnerability, Rarity, Particular attention,).
The Habitats Directive lists 4 site assessment criteria for a natural habitat type (Representativity, Coverage, Conservation and Restoration, Global value), 4 for site assessment criteria for a given species (Population size, Population density, Conservation and Restoration, Degree of isolation, Global value); and other 4 criteria for selecting sites eligible for identification as SCIs and designations as SAC. All criteria above mentioned are related to the Representativity concept.
In the case of the Australian Environment Protection and Biodiversity Conservation Act (1999), 10 criteria related to Representativity and 2 other related to Adequacy are considered. On the other hand, Canada Wildlife Act and Canada’s Migratory Birds Convention Act only define criteria related to Representativity; in turn, Canada’s Ocean Act lists 8 criteria related to Representativity and 1 related to Adequacy.

**C.6 Definitions and use of the network assessment criteria in other contexts**

**Coherence**
This term could be interpreted as the way to achieve ecological harmonization of MPAs on national, regional and EU scale and could be considered as being the key concept in order to shift from single MPAs to regional and EU level MPA networks. An ecologically coherent network of MPAs supports the wider environment; maintains the processes, functions and structures of the protected features across their natural range; functions synergistically as a whole and is designed to be resilient to changing conditions (Piekäinen & Korpinen, 2008). It also considers other related principles that include adequacy, representativity, replication, viability, connectivity, integrity and protection level (JNCC 2013, Olsen et al., 2013). OSPAR
(2006) has defined the following criteria for ecological coherence: features, representativity, biogeographic representation, characterisation of the marine environment, connectivity, resilience, replication, size and management. The focus lies on the contribution of each individual protected area towards the whole set of conservation and sustainable development objectives defined for the global marine environment and their contribution to the achievement of Good Environmental Status. To achieve these objectives, enough managed sites should be established to form a European network of MPAs dedicated to connecting, preserving and restoring coastal and oceanic relevant features, while on the level of single sites, the sites should contain priority species and habitats, be large enough to maintain their conservation features and have focused measures to safeguard/reach the conservation objectives (e.g. JNCC 2013).

A coherent network of MPAs could include sites (or zones within MPAs) which have higher priority than other areas, similar to the Priority Conservation Areas (PCAs) in the USA (see http://www2.cec.org/nampan/pcas). Special focus should be dedicated to those areas due to their ecological significance, high biodiversity and continental uniqueness, incorporating aspects of ecological value, anthropogenic threat, and opportunity for conservation. One or several MPAs may exist within a PCA (see as example NAMPAN: North-American Marine Protected Areas Network project; http://www2.cec.org/nampan/mpas). Taking the above into account, the connectivity criteria should also be considered.

**Connectivity**

The connectivity is often defined as the degree to which local production results in recruitment to other populations in other MPAs (Kinlan *et al.*, 2005; Martin *et al.*, 2006) and surrounding areas. For any local population, connectivity could be characterized by (1) the proportion of recruitment into the local population that is endogenous, (2) the proportional contributions of other populations to recruitment into the local population, in a spatially explicit manner, and (3) the spatial distribution and proportional representation of the contributions of local production to exogenous recruitment on other populations (Warner & Cowen, 2002). The connectivity includes the capacity of different species populations to exchange larvae, recruitment of juveniles and thus, the genetic interchange and diversity (Berglund *et al.*, 2012; Moksnes *et al.*, 2014). It also considers the distribution and presence of different habitat types within each site. Hence, it should be considered for the spatial distribution of MPAs. Supporting the conservation of genetic variation within species by selecting different populations is particularly important for species which are declining in numbers. The connection capacity is also dependent on other ecosystem factors such as flow of oceanographic conditions, non-living organic matter and the dependence of related habitat types for structural integrity.

The connectivity considers that the exchange of individuals is guaranteed across boundaries of MPAs, but also to a wider coastal and marine environment, which would help to maintain biodiversity and ecosystem functioning at different scales (local, national, regional and global, both inshore and offshore). In terms of its implementation, and in the absence of knowledge of specific ecosystem functioning, such as models of egg and larvae dispersal data, connectivity may be approximated by ensuring that the MPA Network is well distributed in space, considering the distribution of habitats and reflecting the different scales of the marine environment (Natural England & JNCC 2010). Consideration of physical parameters such as
geographic or topographic constraints (canyons, headlands and sills), linkages (narrrows and islands), flows (seasonal and long-term currents, eddies and up/downwellings) and migration routes, should also be considered. More specifically, detailed connectivity issues should be considered for those cases where a specific path between identified places is known (critical areas of a life cycle). Thus, connectivity should guarantee sufficient opportunities for dispersal and migration of species within and between sites; not only focusing on one element or species to the detriment of others but taking into account different life history stages. Reviews of species' migration or drifting distances show remarkable variation: local fish species may spend their entire life cycle within an area less than 10 km in diameter, while macroalgal spores may drift 20-30 km and invertebrate larvae even 100 km (Kinlan & Gaines, 2003; Martin et al., 2006). Thus, the between-site connectivity may require 10-100 km site-to-site distances, depending on the conservation features. Distances falling within this range have been used, for instance, in the UK and the Baltic Sea, while it has been emphasized that species-specific distances should be used if they are known or relevant for the assessment purpose (HELCOM, 2010; Natural England & JNCC, 2010). In addition, viability of some populations may require large enough MPAs to retain their reproductive propagules. This is called within-site connectivity and is can be handled by the concept of MPA size (see below). The lack of knowledge with regard to connectivity in the marine environment should not prevent the development of the Network.

Replication
Another aspect to be considered in relation to the coherence of a functional MPA network is the replication. This term refers to the duplication of features in geographically separated units within a given biogeographic area. Replication assures diversity improvement of each feature (at a genetic level, within species or within habitat and landscape types), enhancing the resilience of the ecosystem, increasing representation and the number of connections between sites. It should be considered to spread risks against locally damaging events and long term changes affecting individual areas. It should ensure that natural variation is covered (from genetic level within species up to habitat type level). It should also allow the establishment of scientific reference points and enhancement of interchanges within the Network by increasing the number of connections between sites. Replication ensures that enough sites are connected to each other at sufficiently short distances; it ensures that sites cover different sub-divisions, habitats and other features, and it ensures that there are enough sites of sufficient size and sites of different management levels.

An efficient Network of MPAs is composed of reserves operating cooperatively and synergistically, at various spatial scales and with a range of protection levels, designed to meet objectives that a single one cannot achieve.

Adequacy
Adequacy refers to the availability of practical evidence that individually or mutually designated components of the Network are of sufficient size and shape and properly protected to ensure the ecological viability, integrity and resilience of habitats and species (UNEP-WCMC, 2008). Hence, adequacy refers mainly to the protection efficiency of a site and the entire network. Adequacy is assessed on a site-by-site basis; accounting for appropriate size and shape as well as protection level to ensure the ecological viability and integrity of the populations, species and communities, which have been selected as
conservation features, and to protect against adverse impacts from human activities (e.g. HELCOM, 2010; Sciberras et al., 2013).

The size of a site is important because larger sites tend to be more species rich, have more viable species populations, and contain more types of habitats, more subsidiary habitats and greater structural diversity (JNCC, 2013). The size of a protected area could be related to the diversity of environmental conditions in the wider environment that are represented within the area and the proportion of individuals which flow between it and the adjacent environment. According to this, MPAs aimed at the conservation of specific wide-ranging species may need to be substantially larger than sites for benthic species since they may be tied to more localized oceanographic processes. For benthic communities, such as mussel beds, there is even evidence that large sites may not be necessary (Koivisto, 2011). Edge effects, such as dispersal of organisms to the wider environment (spillover) or incursion of harmful activities across the boundary, are reduced as the size of the protected areas increase (e.g. buffer area; JNCC, 2013). There are only a few studies suggesting minimum sizes for MPAs, but the general outcome seems to support the minimum size of 20-30 km$^2$ (Curley et al., 2002; HELCOM, 2003; Parnell et al., 2005; Shanks et al., 2003). For example, the UK guidance gives a minimum diameter of 5 km and an average diameter of 10-20 km (giving a minimum of 20 km$^2$ and average areas of 80 - 300 km$^2$, respectively) (Natural England & JNCC, 2010).

In terms of conservation efficiency, round, square or rectangle shapes can be prioritized as they reduce edge effects, while in terms of implementation, it is considered that the most desirable shapes are squares or rectangles because they can be delineated by lines of latitude and longitude, and consequently are more easily identified by user groups. This facilitates adequacy in management. However, shape may be a difficult criterion to operationalize in a network assessment and therefore it is suggested that it is not included in the assessment methodology at this stage.

The adequacy criterion is directly linked to conservation efficiency and, thus, provides a significant criterion for an assessment of MPA networks. In order to be efficient, the MPAs need to be based on relevant legislation and they need to have an implemented management plan which covers the conservation features of the site. This is closely linked to the site selection criteria Naturalness and potential value (e.g. JNCC, 2013). The UK approach links the protection level to the quality objectives of relevant EU directives and sensitivity of the conservation features to anthropogenic pressures (Natural England & JNCC, 2010). Moreover, the HELCOM Recommendation 35/1 calls for harmonization of management plans of neighbouring MPAs in transboundary marine areas (HELCOM 2014a).

In this report, definitions for management categories have been suggested, which are based on the IUCN MPA categories. The management categories take into account, for instance, the new Common Fisheries Policy (CFP, regulation EU 1380/2013) and in particular Article 8 on the establishment of fish stock recovery areas, which states that in such areas fishing activities may be restricted or prohibited in order to contribute to the conservation of living aquatic recourses and marine ecosystems. They also use the guidance report by IUCN how the IUCN management categories are to be applied for MPAs (Dudley, 2008; Day et al., 2012). Together with the information on the implementation status of the management plans, the proposed management categories can be considered as an operational criterion for MPA
management. It is suggested that the network should include different management categories from the strictly protected areas to the areas of sustainable development as suggested in several fora, e.g. Fifth World Parks Congress, 2003; the CBD Decision IX/20 (CBD, 2008) and practice in Australia (Fernandes et al., 2009), New Zealand (Thomas & Shares, 2013) and US (Saarman et al., 2013).

Representativity

Representativity refers to the inclusion of the full range of species, habitats, broad-scale habitats and ecological processes present within each region represented within the network; also reflecting the biogeographic variation across borders. The ecological processes could include, for instance, areas key life cycle stages of species, such as spawning, nursery or juvenile areas, and areas important for behaviours, such as foraging, breeding, moulting, loafing, rafting, wintering or resting (Natural England & JNCC, 2010). The natural and induced variability of features should be adequately represented by the MPA network across their distribution range. This criterion refers to the placement of sites within the network in order to assure the protection of the full range of biological diversity (from genes to ecosystems) with the associated oceanographic environment and to ensure protection of features that have internationally significant status (Habitats Directive, JNCC, 2013; Olsen et al., 2013). In correspondence with the different biogeographical and depth subdivisions of sea areas, representativity reflects the full range of ecosystems, comprising their biotic and habitat diversity. The network requires the inclusion of all habitat types at local, national, regional and European scale, both in inshore and offshore areas as well as the features with a transborder dimension.

In the catalogue developed within this project, criteria related to the representativity were priority, importance (local/regional/global), rarity, threat status of species or communities, sensitivity/fragility, ecological significance (key oceanographical processes, habitats and biodiversity elements), typicalness, diversity and naturalness. For example, the Habitats Directive Annex III criteria and the UK site selection criteria included most of these criteria (McLeod et al., 2005). In the site-selection process, priority was given to sites that contain several key biodiversity elements (rare, high-quality and multiple contiguous habitats such as coastal reefs, canyons and seamounts), with a variety of depths and transition zones (inshore/offshore, benthic/pelagic and hard/soft bottom shifts of species) and accounting for integrity and connectivity of ecosystem processes (nutrient flows, disturbance regimes and food-web interactions). Such a set includes several units of different sizes, located in critical habitats, containing components of a particular type or portions of different kinds of important ones, and interconnected by the movement of propagules (PISCO, 2007). Established to improve fish catch, conserve biodiversity or a combination of these two reasons, the MPA is usually placed so that larvae can migrate to more impacted zones (i.e. the spillover effect) and provides a framework that unifies the central aims of conservation and fishery; also meeting other needs such as maintenance of coastal water quality, shoreline protection, education, research and recreational opportunities.

The UK representativity criterion has four sub-criteria which account for the broad-scale habitats, habitats of conservation importance, low/limited mobility species of conservation importance and high mobility species of conservation importance (Natural England & JNCC,
The UK connectivity criteria include the aspect of balanced distribution of MPAs across the assessment area, but in this report that is considered as part of the representativity.

The network needs to include a sufficient part of the coastal and marine environment to be effective and ecologically viable. At the level of marine region, the minimal contribution to the MPA network by each Member State is 10% protection (cf. CBD 2005). MPA networks should be extensive and seek to include strictly protected areas that amount to at least 20 to 30% of each habitat, as IUCN member states agreed in the World Parks Congress in 2003 (IUCN, 2005). The 20% protection has been used in the assessments of coherence in the Baltic Sea (Piekkäinen & Korpinnen, 2008; HELCOM, 2010). In Krause et al. (2006) the target coverage is also discussed and the coverage of <20 % was considered inadequate and >60 % sufficient. We propose at least 20-30 % protection of habitats (e.g. EUNIS level 3) according to the IUCN target (IUCN 2005). This could include the Habitats Directive (92/43/ECC) Annex I habitats or populations of Annex II species (with a proportional surplus according to the rarity of each habitat or species: up to 100% for priority ones such as Posidonia beds, Coastal lagoons, Sea turtles hatching beaches and Monachus enclaves).

C.7 Examples of the use of assessment criteria and associated targets

This section includes some discussion on assessment criteria and also on the network design criteria for the MPA networks. The reason to include design criteria is to get an overview of examples of targets for a coherent network.

Experience from United States of America

In California Marine Life Protection Act Initiative (MLPA Initiative) a total of 124 MPAs was designated covering 16% of total state waters, including no-take zones covering 9.4%. The MLPA extends to 3 nautical miles including the offshore islands and tidal estuaries. The scientific guidelines for the spatial configuration of MPAs included four categories: habitat representation, habitat replication, MPA size and spacing. Each guideline for the design of the network was directly addressing specific MLPA goals, i.e. the guideline on MPA size address the goal of protecting populations of marine species by ensuring that individual organisms within an MPA are protected from fishing mortality over their lifetime (Saarman et al., 2013). According to the guidelines of the California MLPA Science Advisory Team every ‘key’ marine habitat should be represented in the MPA network and should be replicated in multiple MPAs across large environmental and geographic gradients. The alongshore span of MPAs should be of 5-10 km of the coastline and preferably 10-20 km and should extend from the intertidal zone to the deeper waters. The minimum MPA size should range from 23-47 km² and the preferred MPA size range was defined from 47 to 93 km². MPAs should be placed within 50-100 km of each other (Saarman et al., 2013).

Habitat representation was approached assessing the proportion of each available ‘key’ habitat included in an MPA network proposal, replication was evaluated assessing the number of replicates of each key habitat protected in proposed MPAs and the distribution of these replicates across environmental gradients. The MPAs were considered to constitute a ‘replicate’ had at least the minimum size and contained sufficient extent of a habitat to encompass 90% of associated biodiversity.
The size of MPAs was evaluated assessing the number of proposed MPAs that met the minimum and preferred size guidelines, while estuarine sites were excepted from the size guidelines.

The scale for protection initially was identified at the scale of major biogeographic regions, or areas "with distinctive biological characteristics". This scale was further refined to reflect the variation in species composition and community structure associated with a particular habitat or ecosystem across environmental gradients. To define the representative key-habitats, the California MLPA Science Advisory Team used large scale ecological, oceanographic and geological datasets in order to classify habitats according to two biological patterns, one described by community assemblage and the other by depth (Saarman et al., 2013).

MPA spacing assessment was based on the larval dispersal distances of marine organisms across a range of taxa. Since information on larval dispersal is largely unknown, two types of analyses were used: i) estimating dispersal capacities based on genetic similarity measures across space; and ii) analyses on oceanographic currents and the time that the larvae of a species spends drifting on those currents. For species with short dispersal distances, including many marine algae and some marine invertebrates, the scales of dispersal are accommodated within a single MPA. The information on patterns of larval dispersal across taxa in this region, suggested that MPAs that contain similar habitats and marine communities and are placed within 50-100 km distance are connected by larval dispersal (Saarman et al., 2013).

Experience from Australia and New Zealand

Australia and New Zealand Environment and Conservation Council’s (ANZECC’s) principles state that the development of a National Representative System of Marine Protected Areas (NRSMPA) should be based upon comprehensiveness, adequacy and representativeness. The Great Barrier Reef Marine Park (the Marine Park) is one of the world’s largest MPAs with a total area of 344 400 km². The Australian Great Barrier Reef Marine Park followed its Representative Areas Program (GBRMP RAP). The review and design of the network was based on a set of specific conservation goals and principles (Biophysical Operational Principles) to identify new marine reserves. The GBRMP set a minimum threshold of 20% of each bioregion to be protected within no-take zones, but exceed this threshold, ultimately designating 32.7% of the GBRMP as no-take areas.

The Scientific Committee defined comprehensiveness to include examples for each bioregion, habitat, community or natural feature. Representativity was accounted for every bioregion, habitat, community or natural feature which is typical of the feature, and not an outstanding or rare or unique example. Special or unique biological sites or features were dealt separately (Fernades et al., 2009).

According to the Biophysical Operation Principles the no-take areas (NTAs) should be at least 20 km long on the smallest dimension (except for coastal bioregions), and 3–4 NTAs are recommended for most bioregions. Connectivity was assessed by spatial configurations of migration patterns, currents and connectivity among habitats. The minimum size requirements in the Principles were mainly based on the patterns of distribution of habitats.
and patterns of larval dispersal and recruitment within the Great Barrier Reef ecosystem; on the edge effects; and the vastness of the Marine Park.

The objective of New Zealand’s policy and plan for MPAs is to protect marine biodiversity by establishing a network of MPAs that is comprehensive and representative of New Zealand’s marine habitats and ecosystems. Key components of the policy are 1) a consistent approach to classification of the marine habitats and ecosystems, 2) mechanisms to coordinate a range of management tools, 3) an inventory to identify areas where MPAs are required; and (4) a nationally consistent basis for planning and establishing new MPAs. (www.biodiversity.govt.nz/seas/biodiversity/protected/MPA_policy.html).

Thomas & Shears (2013) in the guidelines of ecological design of New Zealand’s Reserves recommend that
1) all habitats should be represented in the network,
2) enough of each specific habitat should be included in the network to be functionally protected. If sufficient biodiversity data permit, habitat-specific targets would be recommended. In the absence of such data rigorous application of other scientifically robust design principles is recommended (e.g. viability, connectivity and representativity).
3) MPAs should be large enough to cover the majority of species adult movement distances. MPAs should have a minimum coastline length of 5-10 km, preferably 10-20 km, and should extend along the depth gradient from intertidal to deeper offshore waters, preferably to the 12 nautical mile limit.
4) Several examples of each habitat should be included within separated MPAs. A precautionary number of replicates would be 3, with two replicates being the minimum.
5) The spacing between MPAs should allow larval dispersal to occur, and MPAs, with similar habitats should be placed within 50-100 km of each other.

Although most of the case studies for designing MPA networks are not identical, the key principles for the network design processes can be identified as: 1) habitat representativity; 2) adequacy of habitat coverage; 3) viability of MPA size; 4) replication of habitats in MPAs; 5) connectivity between MPAs; 6) using best available evidence; and 7) levels of protection (variety of MPA types and amount of habitat in no-take zones) (Thomas & Shares, 2013).

Other examples
Optimal size and spacing of marine reserves in a network is strongly related to the spatial scale of movement of the target species (Palumbi et al., 2004). Species with low mobility and short-distance dispersal are more dependent on MPA size, whereas species with high mobility or long-distance dispersal benefit of interconnected MPAs. Species’ migration or drifting distances show remarkable variations; recommendations range between 10–200 km. In the absence of models of egg and larvae dispersal, the MPA network should be well distributed in space, considering oceanographic data and habitat distribution at different scales of the marine environment (Natural England & JNCC 2010, White et al., 2010). In the EmodNet MedSea CheckPoint project, connectivity will be assessed by the analysis of the migration routes of key species through wildlife satellite telemetry programs (e.g. ARGOS data).
Some studies on connectivity use biophysical models coupling species specific larval dispersal capacities and oceanographic data (Andrello et al., 2013; Christie et al., 2010). However, it is suggested that connectivity needs to be approached maximizing the possibilities for larval and individual exchange within a wide range of species. In CoCoNet project field studies are performed on several pilot areas in the Mediterranean and Black Sea collecting biodiversity and genetic data on priority species of marine flora, invertebrates and fish. The patterns of larval dispersal and adult movement distances coupled with oceanographic conditions will better define the larval dispersal across taxa in these regions. Biophysical models will also be used in the EmodNet MedSea Checkpoint in order to assess the connectivity of the Mediterranean MPAs network.

C.8 Existing MPAs by designation type and management category

MSs of the EU as well as most other countries, as signatory countries of the Convention of Biological Diversity, have agreed that “a national framework of marine and coastal protected areas should include a range of levels of protection, encompassing both areas that allow sustainable uses and those that prohibit extractive uses (i.e., “no-take” areas)”. According to EEA (CDDA v11 and RSCs sites), OSPAR, HELCOM and WPDA\textsuperscript{16} datasets Europe holds 3444 MPAs, classified on the basis of national and international normative requirements. The international protection figures (including RSCs figures) were not assigned to any IUCN management category (Table C.3). However the IUCN categories are used by the UN’s World database for protected areas and they have been adopted by certain international agreements (e.g. the Antarctic Treaty). At the RSC level, HELCOM has classified the Baltic Sea Protected Areas according to the IUCN categories (HELCOM 2013) and is recommending their use\textsuperscript{17}.

<table>
<thead>
<tr>
<th>AREA ($\text{km}^2$)</th>
<th>NUMBER*</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td></td>
</tr>
<tr>
<td>OSPAR areas (OSPAR Convention)</td>
<td>712774</td>
</tr>
<tr>
<td>Special Area of Conservation (Habitats Directive)</td>
<td>149204</td>
</tr>
<tr>
<td>Special Protection Area (Birds Directive)</td>
<td>127318</td>
</tr>
<tr>
<td>Ramsar Site, Wetland of International Importance (Ramsar Convention)</td>
<td>85303</td>
</tr>
<tr>
<td>UNESCO-MAB Biosphere Reserve</td>
<td>83501</td>
</tr>
<tr>
<td>Baltic Sea Protected Area (HELCOM)</td>
<td>47733</td>
</tr>
<tr>
<td>World Heritage Site (Unesco)</td>
<td>41793</td>
</tr>
<tr>
<td>Specially Protected Area of Mediterranean Importance (Barcelona Convention)</td>
<td>3305</td>
</tr>
<tr>
<td>National</td>
<td>846893</td>
</tr>
</tbody>
</table>

\textsuperscript{16} IUCN and UNEP-WCMC, The World Database on Protected Areas (WDPA) [On-line]. Cambridge, UK: UNEP- WCMC. Available at: \url{www.protectedplanet.net} [Accessed (24/03/2014)].

\textsuperscript{17} The HELCOM recommendation to use the IUCN categories means that HELCOM will use these but at the moment not all MPAs have the category in the database. The main reason is that countries are sometimes unsure which category to apply.
* The total number of MPAs should be considered with caution. Not all MSs have reported in the same way, and in some cases, the MPAs reported by MSs are also designed under other Regional and International Conventions.

Birds Directive holds the largest number or MPA (SPAs), but the total area protected by OSPAR Convention is the biggest. Conversely, the Barcelona Convention (SPAMIs) presents the lowest protection both in terms of number and area (Figure C.1).

Figure C.1 All International MPAs. Key to the abbreviations: OSPAR area: OSPAR convention; SAC: Special Area of Conservation (Habitats Directive); SPA: Special Protection Area (Birds Directive); Ramsar area: Wetland of International Importance (Ramsar Convention); MaB: Unesco Man&Biosphere Reserve; BSPA: Baltic Sea Protected Area (HELCOM Convention); WHS: World Heritage Site; SPAMI: Specially Protected Area of Marine Importance (Barcelona Convention). Information extracted from CDDA v11 & Nature2000 datasets (EEA), WPDA, OSPAR, HELCOM datasets

In Table C.3, IUCN management categories assigned to each protected figure from national databases are shown.

Table C.3 National protection figures classified according to IUCN management categories (NR: not reported) (including Russian European area); figures refer to the number of MPAs.

<table>
<thead>
<tr>
<th>Framework</th>
<th>IUCN category</th>
<th>la</th>
<th>lb</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>NR</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td>National (number)**</td>
<td></td>
<td>246</td>
<td>33</td>
<td>60</td>
<td>60</td>
<td>579</td>
<td>346</td>
<td>68</td>
<td>194</td>
<td>1586</td>
</tr>
<tr>
<td>National representation (%)***</td>
<td></td>
<td>15.5</td>
<td>2</td>
<td>3.8</td>
<td>3.8</td>
<td>36.5</td>
<td>21.8</td>
<td>4.3</td>
<td>12.2</td>
<td>100</td>
</tr>
</tbody>
</table>

* The total number of MPAs should be considered with caution. The manner in which MSs have reported shows large differences and in some cases, the MPAs reported by MSs are not only designed at the MS level, but also under other regional and international Conventions (See Table C.2.).

** One site may contribute to one or more categories depending on whether the site has one or more management goals.

*** Percentages have been calculated for the areas reported by Member States to the EEA.

The National areas of MPAs (% of number of MPAs and % of total MPA area) by country and classified according to IUCN management categories are shown in Figure C.2.
Figure C.2  All National MPAs in European areas classified according to IUCN management categories (NA not applicable; NR: not reported) (including Russian European area). Source: CDDA v.11, 3/2014.
D Annex to Chapter 3 - Calculations of the four assessment criteria

D.1 Calculations of representativity

The basic assessment of representativity consists of four sub-criteria (Table 3.2) which are calculated by as many indicators as there are selected features. Three GIS analyses compare the area of MPAs with the area of the marine region, sub-basins/ecoregions and depth zones. The outcome is given as a proportion (%) and usually there are no features included in these analyses. Note that terrestrial areas are excluded from the spatial analysis. The fourth analysis, of representativity of conservation features, is an analysis of the presence of selected features within the network. The selected features should include species and habitats included in the annexes of the Habitats and Birds Directive as well as the RSCs’ lists of the threatened species and habitats and key species and predominant habitats. The outcome is a proportion (%) of the MPA area protecting the feature (MPA area vs. the total marine area).

In the more detailed assessment of representativity, species and habitat distribution maps are used as a baseline and the proportion of the features within MPAs is analyzed in the assessment area (Figure D.1). This follows the method used, e.g. in HELCOM (2010a). Note however that the presence of a feature within an MPA does not guarantee that the feature is protected by the site; that depends on the legal instruments used for the protection. This was however not included to the method at this stage, but this need is discussed in Chapter 5.

Preferably the species and habitat maps cover the entire assessment area, but a limited analysis of representativity – following the more detailed method – can also be made by mapping the features within the MPAs only. It may also be relevant to assess representativity of a combination of features (e.g. all the habitats being important for a whole life cycle of a species).

The target of MPA coverage is commonly following the Aitchi CBD target of 10% but for specific features the representativity targets range between 10-60 –(100)%. Targets for the representativity criterion are reviewed by Piekäinen & Korpinen (2007), OSPAR (2007, 2008) and Liman et al. (2008) and summarized also in Annex C. These are applied in the case study presented in Chapter 4.
Figure D.1 Schematic presentation of the analysis of representativity and connectivity by the more detailed method where the habitat distribution (brown) is mapped enabling an analysis of the actual protection coverage (MPAs indicated by blue colour) and connectivity between the mapped habitat patches.

D.2 Calculations of replication

The basic assessment of replication counts the number of MPAs which include the selected conservation features. As compared with the representativity analysis, the outcome of this criterion is a number of MPAs for each feature. This report does not suggest any more detailed method for the assessment of replication, but Chapter 5 discusses whether one could count only those replicates where the feature enjoys actual legal protection. As this information is not always available, the more detailed assessment can optionally be done for specific areas.

There are very few targets suggested in scientific literature or regional assessments. Many guidelines or assessments recommend two to five replicates per feature (Smith et al., 2009; HELCOM, 2010a; Sciberras et al., 2013; and OSPAR, 2013). These are applied in the case study presented in Chapter 4.

D.3 Calculations of connectivity

The basic assessment of connectivity is a simple spatial analysis of the number of connections an MPA has to other MPAs (from a boundary to a boundary) without taking species behavior, oceanography or migration barriers into account. The GIS analysis is done by a neighborhood analysis with defined distances (e.g. 20 km and 50 km). The outcomes are proportions (%) of clusters, where sites may have, for instance, no connections, 1-4 connections, 5-10 connections, ≥10 connections etc. Scientific literature suggests different inter-MPA distances (see reviews and practices in Piekäinen & Korpinen 2007; HELCOM, 2010; OSPAR, 2013).
In the more detailed assessment of connectivity, the connectivity is assessed on the basis of protected features, which are mapped within the MPAs. Protected features are either patches of habitat/species occurrence or functionally important areas (e.g. feeding, spawning etc.) of larger species (e.g. HELCOM, 2010a). As discussed in the calculation of representativity (Section D.1), one should select a list of features (species and habitats) for the assessment and these are assessed as separate indicators (see the case study for a pragmatic example). The analysis follows the method described above, but one ought to set a minimum size of a feature patch (e.g. a habitat patch; see example in Piekäinen & Korpinnen, 2007).

There are no agreed targets for the connectivity assessment. One could set a target as the proportion of sites having a certain number of connections to similar features. For instance, 50 % of the protected features have more than 20 connections at 50 km distance from each other. The number of connections depends also how that is counted: (1) all protected feature occurrences are treated as separate units (→ ecological relevance) or (2) protected feature units within the same MPA are treated as a unit (→ ensures a geographically wider network).

D.4 Calculations of adequacy

The basic adequacy assessment is divided between two subcriteria: MPA size and protection level. For assessment of MPA size a spatial analysis is made of the area of each MPA and the outcome is given, for example, as a histogram (MPA size categories on horizontal axis, number of sites on vertical axis) (see e.g. HELCOM, 2010a, Gabrié et al., 2012). There are good scientific reviews of the effects of MPA size on species populations (see discussion in Piekäinen & Korpinnen, 2007). Sufficient size has usually been set between 10-60 km² while sizes of 20-30 km² are a good compromise between less mobile species and more mobile species.

The basic assessment of the protection level is made by analyzing the proportion of the sites under different levels of protection (e.g. the protection categories proposed in this report or IUCN categories which are being used in the current MPA databases) in the region (% out of the total MPA area). It is often the case that MPAs encompass zones with different protection categories. In such a case, if spatial data exists, one can make a similar, more detailed spatial analysis. There are no examples of targets for this assessment criterion, but guidelines suggest a sufficient amount of sites under the stricter protection (e.g. Fernandes et al., 2009; Smith et al., 2009; Olsen et al., 2013; Saarman et al., 2013; Sciberras et al., 2013; Thomas & Shears, 2013) and the scientific literature has plenty of examples of the benefits of a combination of stricter protection areas and less strict (i.e. supporting) protection areas.

In the more detailed assessment of adequacy, impacts of anthropogenic pressures in the vicinity of the MPAs are analyzed against the MPA size (see Figure D.2). This follows the assessments by in the Baltic Sea (HELCOM, 2010a) and the Mediterranean (Gabrié et al., 2012). For instance, dredging or sand extraction affect areas over the distance of some kilometers from the activity, fishery on the border of an MPA affects to a certain degree the fish stocks within the MPA (the effect depending on the species) and a pollution point source affects the MPA even farther away. As the first step, major pressures on the conservation features are defined (e.g. MSFD Annex III, Table 2). The second step is to estimate the
impact range (km) of the pressure from the source (as pressures attenuate with distance, the range should be based on an arbitrary estimate of a significant impact e.g. sensu 2010/477/EU). The third step is to rerun the spatial analysis of the MPA area impacted by the pressures in the network. As the amount of non-impacted area depends on the MPA size and the MPA shape, the outcome of the assessment gives indications, for instance, (1) to increase MPA size or (2) to manage the external pressures by other means (e.g. placing buffer zones around MPAs for certain human activities). The target for this assessment criterion can be the same as for the MPA size (e.g. 30 km$^2$). This means that the assessment of MPA size is rerun by the size that is unaffected by the deteriorating pressures.

The HELCOM 2010 assessment included an overlay analysis of human pressures inside and outside the MPAs, and the impacts of the pressures on the conservation features were discussed. In the Mediterranean assessment, the pressures were analyzed mainly within the MPA boundaries. It is obvious that some pressures impact across the MPA boundary, while some are practices even within the boundaries, and an analysis may be required whether these jeopardize the conservation objectives. There is no suggestion for a more detailed assessment method for the assessment of protection level.

Figure D.2 Schematic presentation of the impact of a pressure on an MPA. Red area indicates the source of the pressure, yellow indicates significant impact and the light red area indicates less significant impacts. The analysis will estimate the significantly impacted area within the MPA.
E  Annex to Chapter 4 - Results of the case study

E.1  Assessment criteria in the case study

In this report we have proposed assessment criteria for a basic assessment and two more detailed assessments. The same assessment criteria were also used for the testing in the case study area.

The basic assessment in the case study area included the following assessment criteria:

Representativity:
(1) Coverage of MPAs in the entire assessment area;
(2) Representativity of sub-basins;
(3) Representativity of depth zones;
(4) Representativity of selected habitats (listed in Table E.1) (% of MPA area including the habitat);
(5) Representativity of selected species (listed in Table E.1) (% of MPA area including the species).

Replication:
(6) Replication of sites with selected habitats (listed in Table E.12);
(7) Replication of sites with selected species (listed in Table E.1).

Adequacy:
(8) MPA size;
(9) Level of protection.

Connectivity between sites:
(10) Proximity of MPAs (20 and 50 km apart).

The more detailed assessment method included additionally data of the predominant anthropogenic pressures and mapped benthic broad-scale habitats. The more detailed assessment was made for the same four assessment criteria but the indicators were modified by the additional data.
Table E.1 Selected species and habitats in the case study area. In the basic assessment method, only presence information of the species and habitats was applied, while in the more detailed assessment method the GIS-maps of broad-scale underwater habitats were used as the features. Source: HELCOM BSPA database (http://bspa.helcom.fi) and HELCOM data and map service (http://maps.helcom.fi/website/mapservice/index.html).

**SPECIES**

Plants: Zostera marina, Chara baltica, Fucus vesiculosus

Birds: Sterna caspia, Aythya marila, Charadrius hiaticula

Mammals: Phoca hispida botnica

<table>
<thead>
<tr>
<th>HABITATS</th>
<th>Broad-scale underwater habitats (in the more detailed assessment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandbanks which are slightly covered by sea water all the time</td>
<td>Non-photic hard-bottom</td>
</tr>
<tr>
<td>Reefs</td>
<td>Photic hard-bottom</td>
</tr>
<tr>
<td>Estuaries</td>
<td>Non-photic mud and clay</td>
</tr>
<tr>
<td>Coastal lagoons</td>
<td>Photic mud and clay</td>
</tr>
<tr>
<td>Boreal Baltic narrow inlets</td>
<td>Non-photic sand</td>
</tr>
<tr>
<td>Boreal Baltic islets and small islands</td>
<td>Photic sand</td>
</tr>
<tr>
<td>Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation</td>
<td></td>
</tr>
<tr>
<td>Large shallow inlets and bays</td>
<td></td>
</tr>
</tbody>
</table>

E.2 Data sources used in the case study

The assessment area is in the HELCOM area and therefore the main data source was the HELCOM database. While there is a new database under consideration (HELCOM, 2014b), this case study used the HELCOM BSPA database (http://bspa.helcom.fi). The listed species and habitats were harvested from the HELCOM MPAs (formerly known as Baltic Sea Protected Areas, BSPA).

As the level of protection, we used the IUCN category, which was harvested from the CDDA database (Source: European Environment Agency).

The GIS files of the MPAs, marine region, sub-regions, depth contours and habitat maps were downloaded from the HELCOM Data and Map Service (http://maps.helcom.fi).

The HELCOM Baltic Sea Pressure Index (BSPI) was used to estimate the predominant pressures around the MPAs. The BSPI GIS files and separate pressure files are downloadable from the HELCOM Data and Map Service.

E.3 Setting targets for the assessment criteria

The case study used two kinds of targets:

1. basic targets which reflect an average of scientific recommendations or is commonly used by RSCs;
2. more ambitious targets which are either from the stricter end of the scientific recommendations or arbitrarily set slightly above the basic target.
The 10 % target for the coverage of the marine region and representativity of sub-regions and depth zones was considered so established that we did not suggest a more ambitious target for those sub-criteria.

Table E.2 Assessment criteria and targets. See the Annex C for the scientific basis of the targets.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Basic target</th>
<th>More ambitious target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representativity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sub-regions</td>
<td>10 % (CBD)</td>
<td>10 % (CBD)</td>
</tr>
<tr>
<td>depth zones</td>
<td>10 % (CBD)</td>
<td>10 % (CBD)</td>
</tr>
<tr>
<td>habitats *</td>
<td>20 % (HELCOM, 2010a)</td>
<td>40 %</td>
</tr>
<tr>
<td>species *</td>
<td>20 % (HELCOM, 2010a)</td>
<td>40 %</td>
</tr>
<tr>
<td>Replication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of sites /</td>
<td>2 (OSPAR, 2013)</td>
<td>4 (HELCOM, 2010a)</td>
</tr>
<tr>
<td>feature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connectivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between sites</td>
<td>50 % of sites have ≥10</td>
<td>50 % of sites have ≥10</td>
</tr>
<tr>
<td></td>
<td>connections at 50 km</td>
<td>connections at 20 km</td>
</tr>
<tr>
<td></td>
<td>distance (the proportion and</td>
<td>distance (the proportion</td>
</tr>
<tr>
<td></td>
<td>the number of connections are</td>
<td>and the number of</td>
</tr>
<tr>
<td></td>
<td>not based on science; the</td>
<td>connections are not</td>
</tr>
<tr>
<td></td>
<td>distance is an average for</td>
<td>based on science; the</td>
</tr>
<tr>
<td></td>
<td>mobile species)</td>
<td>distance is an average</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for mobile species)</td>
</tr>
<tr>
<td>Between features *</td>
<td>50 % of feature occurrences</td>
<td>50 % of feature</td>
</tr>
<tr>
<td></td>
<td>have ≥20 connections at 50 km</td>
<td>occurrences have ≥20</td>
</tr>
<tr>
<td></td>
<td>distance.</td>
<td>connections at 20 km</td>
</tr>
<tr>
<td>Adequacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPA size</td>
<td>75 % sites are &gt;20 km² (lower</td>
<td>75 % sites &gt;30 km²</td>
</tr>
<tr>
<td></td>
<td>end of scientific</td>
<td>(HELCOM, 2010a)</td>
</tr>
<tr>
<td></td>
<td>recommendations)</td>
<td></td>
</tr>
<tr>
<td>Protection level *</td>
<td>30% of sites are strictly</td>
<td>40% of sites are strictly</td>
</tr>
<tr>
<td></td>
<td>protected (IUCN categories I-II)</td>
<td>protected (IUCN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>categories I-II)</td>
</tr>
</tbody>
</table>

1) There should be different target for different habitats and species, but this test used a fixed target.
2) The target is based on the practice to assess 50 km distances (e.g. HELCOM, 2010a), but the proportion is set only for this case study.
3) The fifth World Parks Congress (2003) called for 10-30% coverage of each habitat type by strictly protected areas.

E.4 Use of the basic and more detailed methods in the case study

The assessment criteria were analysed for the case study area by the basic method and the more detailed methods.

The basic assessment of representativity and replication consisted of analyses of seven species and eight habitats (Table E.1), which were listed as ‘present’ in the MPAs. Connectivity was analysed as the proximity of MPAs (from boundaries to boundaries) by 20 km and 50 km distances. Adequacy was assessed first by analysing MPA size from the GIS data (only marine area) and secondly by analysing the area of IUCN categories in the marine area.

The more detailed assessments included two levels: an analysis of mapped habitats (six habitats in Table E.1) and an analysis of predominant pressures affecting the MPAs. The reason for a different set of habitats in the more detailed analysis was that there is no mapped information available of the distribution of Habitats Directive habitats in the region. The habitat data was used to rerun the assessments of representativity and connectivity. The
GIS features in the analyses were not the MPAs but the habitat polygons within the MPAs. Moreover, the connectivity analysis used the habitat polygons as independent features in the analysis (and not grouped them under the administrative MPA borders).

The predominant anthropogenic pressures in the Baltic Sea are nutrient inputs, fishing, inputs of hazardous substances and physical damage (mainly siltation) (HELCOM, 2010a). As fishing data (in the required spatial resolution) was not available within the time frame of the project, we did not select fishing into the pressure analysis. Furthermore, commercial fishing is restricted in hardly any MPA in the Baltic Sea and an analysis of its impacts on MPA size has therefore only limited value. We selected three pressures as test cases for the analysis:

1. Waterborne nitrogen inputs (plumes from input sources),
2. Resuspension caused by shipping in waters less than 15 m deep,
3. Physical damage of the seabed (dredging, dumping, constructions).

As the second step, an impact range was given for each pressure. The impact ranges are based on an expert workshop in Finnish Environment Institute, where an assessment of cumulative pressures was prepared for a coastal area in the Gulf of Finland (applicable to the case study area).

- Shipping was considered to cause a 0.5 km siltation pressure in shallow marine areas (<15 m deep) on both sides of the ship route. Though the siltation was considered as the main pressure, resuspension of the sediment will also increase the amount of nutrients and contaminants in the water column.
- Physical damage of the seabed was estimated to cause a significant pressure to less than 10 km from the activity (depending on hydrographics).
- Nitrogen inputs were estimated to have different impact range from rivers (10 km) and waste water treatment plants (1 km). These are rough estimates which depend on the water flow and season.

The impact range reflects a 'significant effect' of the pressure and, hence, attenuated impacts at longer distances were not considered. A GIS analysis was made where the impact ranges were added around the pressure sources and overlapping MPA areas were omitted from the MPA size analysis. The outcome was a GIS file of MPA polygons with reduced size. The MPA sizes were re-analyzed.

E.5 Results of the calculations of representativity

Coverage in the study area, sub-regions and depth zones

These three assessment sub-criteria focus on the MPA coverage in the marine area. There is a CBD target of 10 % coverage, which can be applied to all of these sub-criteria. The target is well-established and we did not consider alternative targets for these sub-criteria.

The analyses of the MPA coverage in the study area and the representativity of the sub-regions are not ideal in this case study, as these sub-criteria are meant for an assessment of an entire marine region. Anyway, the MPAs cover 8.7 % of the study area (5994 km² marine area). Thus, the CBD 10 % target was not met in the study area.
Representativeness of the sub-regions is presented in Figure E.1. None of the sub-regions was entirely within the case study area, therefore this indicator is arbitrary. However, taking account of only the marine area within the study area, three sub-regions met the target of 10% coverage.

![Figure E.1 Representativity of sub-regions. Proportion (%) of the HELCOM sub-basins under protection. The horizontal line indicates 10% representativity.](image1)

The analysis of representativeness of depth zones was made for six depth zones (Figure E.2). As the Baltic Sea is relatively shallow (mean depth 52 m), the depth zones over-emphasize shallow waters. The analysis showed that the MPAs are located in shallow waters and marine waters > 30 m do not meet the 10% target.

![Figure E.2 Representativity of depth zones. Proportion (%) of depth zones under protection. The target is an equal representation in each depth zone.](image2)
Representativity of species and habitats
The basic assessment of representativity of species and habitats was made by analyzing the marine area of MPAs where the species and habitats were listed as ‘present’. Although this does not reflect their true distribution, it is a simple assessment of representativity if mapped species and habitat data is not available. Targets for species and habitats representativity vary between 10 and 60 % in this study area. We chose to use 20 % as the basic target level and 40 % as the alternative (more ambitious) target level (Table E.2). Table E.3 presents the results of the sub-criteria and shows that none of the features met the target.

Table E.3 Representativity of species and habitats in the basic assessment of representativity, where listed species and habitats are assumed to cover the entire MPA. The representativity is assessed as the proportion (%) of the species and habitats in the study area. Note that the information was obtained from the HELCOM BSPA database and has not been checked by MSs for this report.

<table>
<thead>
<tr>
<th>Species</th>
<th>Z. marina</th>
<th>C. baltica</th>
<th>F. vesiculosus</th>
<th>S. caspia</th>
<th>A. marila</th>
<th>C. hiaticula</th>
<th>P. h. botnica</th>
</tr>
</thead>
<tbody>
<tr>
<td>% marine area</td>
<td>0.9</td>
<td>0.7</td>
<td>2.3</td>
<td>3.6</td>
<td>3.6</td>
<td>5.8</td>
<td>4.0</td>
</tr>
</tbody>
</table>

The more detailed assessment of representativity used six broad-scale habitats which were defined by the seabed substrate type (hard bottom, mud and clay and sand) and photic depth (1 % light availability). The analysis showed that four of the habitat types met the 20 % target, while only one met the 40 % target. This was considered as a more realistic assessment of representativity.

Figure E.3 Representativity of benthic habitats. Proportion (%) of benthic habitats under protection. The horizontal lines indicate the 20% target (full line) and the 40% target (dashed line). Note that the analysis does not take into account specific conservation goals of MPAs, e.g. some benthic habitats may not be protected by the Natura 2000 network.
E.6 Results of the calculations of replication

The number of MPAs, which include selected conservation features, were analysed in the study area. The target for the criterion comes from the OSPAR assessment (at least two sites host the feature). A more ambitious target was set as four sites.

Table E.4 presents the results of the test results, where all species exceeded the lower target level and four of them met the more ambitious target. Of the habitats, 6 of 8 MPAs met the lower target and five met the more ambitious target.

Table E.4 Numbers of species and habitats within MPAs in the basic assessment of replication. Note that the information was obtained from the HELCOM BSPA database and has not been checked by MSs for this report.

<table>
<thead>
<tr>
<th>Species</th>
<th>Z. marina</th>
<th>C. baltica</th>
<th>F. vesiculosus</th>
<th>S. caspia</th>
<th>A. marila</th>
<th>C. hiatricula</th>
<th>P. h. botnica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sites</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Habitats</td>
<td>Sandbanks</td>
<td>Reefs</td>
<td>Estuaries</td>
<td>Costal lagoons</td>
<td>Boreal lagoon</td>
<td>Boreal</td>
<td>Boreal lagoon</td>
</tr>
<tr>
<td>Number of sites</td>
<td>8</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

E.7 Results of the calculations of connectivity

Connectivity in the basic analysis was assessed by MPA proximity analyses with 20 km and 50 km distances. The 92 MPAs in the case study area were relatively well connected with the 50 km distance; all the MPAs had at least one connection and 50 % of the MPAs were connected to ten or more other MPAs (Figure E.4, right panel). With the more ambitious target (20 km), all the MPAs were connected to less than ten MPAs; the majority (75 %) were connected to 1-4 MPAs and 8 % were isolated from other MPAs (Figure E.4, left panel).

Figure E.4. Connectivity of the MPAs. Proportion (%) of MPAs which are connected by 20 km (left panel) and 50 km (right panel) distances.
In the more detailed assessment, the protected benthic habitats were treated as single units and therefore there were manifold connections in the network. As adjacent, very small habitat occurrences slow down the analysis, they were combined to a single unit by 200 m radius. As targets for the analysis would require more thorough understanding of the habitat characteristics, this case study will only tentatively use a basic target of ‘50 % of habitat patches have >20 connections at 50 km distance’ and a more ambitious target is the same for the 20 km distance.

The results are shown in Figure E.5 for six broad-scale benthic habitats at 20 km and 50 km distances. There were naturally more connections with the 50 km distance than the 20 km distance. For example, all photic hard-bottom habitats had less than 80 connections within the 20 km distance, while within the 50 km distance 22 % of the habitat patches had even 139 connections. The scores are shown in more detail in Table E.5 and E.6.
Proposal for an assessment method of the ecological coherence of networks of marine protected areas in Europe
E.8 Results of the calculations of adequacy

In the basic assessment, adequacy of the MPA network was analysed by two assessment criteria: MPA size and level of protection.

MPA size
The MPA size was analysed as square kilometres of marine area. Scientific recommendations give that the MPA sizes of 20-30 km$^2$ give adequate protection for species of low mobility (or short dispersal). As it is not realistic that 100 % of the MPAs reach a size target, it is proposed that the basic target is '75 % of sites are 20 km$^2$', which is the lower end of scientific recommendations (Piekäinen & Korpinnen 2007), and the more ambitious target is '75 % sites are 30 km$^2$', which is the HELCOM size target for the HELCOM MPAs.

Figure E.6 presents the case study results, showing that 45 % of the sites met the basic target of 20 km$^2$, while the more ambitious target size (30 km$^2$) was met only in 37 % of the sites.
The more detailed assessment was suggested to include also MPA size in relation to impacted MPA area by predominant anthropogenic pressures. After removing the ‘affected area’ from the MPAs, only 34 % of the MPAs met the basic target of 20 km², i.e. the pressures decreased the effective area of conservation (Figure E.7). With the more ambitious target of 30 km², only 21% of the MPA sizes met the target.

**Level of protection**

The level of protection is a subcriterion to assess whether the network consists of more stringent protection areas, which have been shown to have highly positive effects in the species populations and habitat quality. There are no commonly agreed targets available for this sub-criterion and therefore we have used an arbitrary target of 30 % coverage of IUCN I-II categories (i.e. no-take and no-entry zones and protection of the natural areas). A more ambitious target was set as 40 %.

---

**Figure E.6** Proportion of MPA size classes in the assessment area. The vertical lines indicate the targeted MPA sizes (dashes line indicates the more ambitious target).

**Figure E.7** MPA size distribution after taking into account the impact ranges of anthropogenic pressures.
Marine protected area under the categories I-II sums to ca. 1150 km², which equals ~24 % of the total MPA area (Figure E.8). Categories Ia and Ib sum to 675 km², which equals 14 % of the total MPA area. With the given targets, the network fails to meet the target.

Table E.5 Full test results of the basic assessment.

<table>
<thead>
<tr>
<th>REPRESENTATIVITY</th>
<th>Indicator result</th>
<th>Target</th>
<th>Ratio</th>
<th>Uncertainty in data 1</th>
<th>Uncertainty in target 1</th>
<th>Uncertainty in method 1</th>
<th>Weighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage of the MPAs in the area</td>
<td>8.70 %</td>
<td>10 %</td>
<td>0.87</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>Representativity of Gulf of Finland</td>
<td>27 %</td>
<td>10 %</td>
<td>2.7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.7</td>
</tr>
<tr>
<td>Representativity of Gulf of Riga</td>
<td>62 %</td>
<td>10 %</td>
<td>6.2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6.2</td>
</tr>
<tr>
<td>Representativity of Bothnian Sea</td>
<td>32 %</td>
<td>10 %</td>
<td>3.2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td>Representativity of Archipelago Sea</td>
<td>6 %</td>
<td>10 %</td>
<td>0.6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Representativity of Åland Sea</td>
<td>8 %</td>
<td>10 %</td>
<td>0.8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Representativity of Northern Baltic Proper</td>
<td>3 %</td>
<td>10 %</td>
<td>0.3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Representativity of Eastern Gotland Basin</td>
<td>6 %</td>
<td>10 %</td>
<td>0.6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Representativity of Western Gotland Basin</td>
<td>8 %</td>
<td>10 %</td>
<td>0.8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Representativity of 0-10m depth zone</td>
<td>32 %</td>
<td>10 %</td>
<td>3.2</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Representativity of 10-20m depth zone</td>
<td>21 %</td>
<td>10 %</td>
<td>2.1</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Representativity of 20-30m depth zone</td>
<td>18 %</td>
<td>10 %</td>
<td>1.8</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>1.7</td>
</tr>
<tr>
<td>Representativity of 30-60m depth zone</td>
<td>6 %</td>
<td>10 %</td>
<td>0.6</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Representativity of 60-100m depth zone</td>
<td>0.6</td>
<td>10 %</td>
<td>0.06</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Representativity of &gt;100m depth zone</td>
<td>0.1</td>
<td>10 %</td>
<td>0.01</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>0.01</td>
</tr>
<tr>
<td>Representativity of Zostera marina</td>
<td>0.9</td>
<td>20 %</td>
<td>0.04</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Representativity of Chara baltica</td>
<td>0.7</td>
<td>20 %</td>
<td>0.03</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.02</td>
</tr>
<tr>
<td>Representativity of Fucus vesiculosus</td>
<td>2.3</td>
<td>20 %</td>
<td>0.11</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Representativity of Spera caspia</td>
<td>3.6</td>
<td>20 %</td>
<td>0.18</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Representativity of Aythya marila</td>
<td>3.6</td>
<td>20 %</td>
<td>0.18</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Representativity of Charadrius hiaticula</td>
<td>5.8</td>
<td>20 %</td>
<td>0.29</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Representativity of Pusa bothnica.hispidula</td>
<td>4</td>
<td>20 %</td>
<td>0.2</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Representativity of sandbanks</td>
<td>5.5</td>
<td>20 %</td>
<td>0.27</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Representativity of reefs</td>
<td>6.5</td>
<td>20 %</td>
<td>0.32</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Representativity of estuaries</td>
<td>1.8</td>
<td>20 %</td>
<td>0.09</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Representativity of coastal lagoons</td>
<td>6.5</td>
<td>20 %</td>
<td>0.32</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
</tbody>
</table>
### Integration table for the assessment of ecological coherence in the study area.

See Chapter 4 for the data sources and methods and for the case study assessment. A ratio of the indicator result and the target is first attained for all the indicators. Secondly, uncertainty in the data, target and method is added, and averaged for each indicator. In the third step, a weighted average is calculated for each indicator (mean uncertainty × indicator ratio) and then for the criteria level (simple average of the indicators). The likelihood of reaching the target is given for each criterion, based on the weighted average: scores <0.5, 0.5-<1, 1-1.5 and >1.5 can be given respective likelihoods of very unlikely, unlikely, likely and very likely. Finally, the assessment of ecological coherence is done by the one-out-all-out principle, where the weakest criterion (or likelihood) determines the final assessment result.

(1) Values: LOW, MODERATE and HIGH, which are used to weigh the sub-criteria by weights 1, 0.75 and 0.5, respectively. (2) Values: VERY UNLIKELY, UNLIKELY, LIKELY, VERY LIKELY.
Table E.6 Full test results of the more detailed assessment.

Integration table for the more detailed assessment of ecological coherence in the study area. Explanation see Table E.5

<table>
<thead>
<tr>
<th>Indicator result</th>
<th>Target</th>
<th>Ratio</th>
<th>Uncertainty in data</th>
<th>Uncertainty in target</th>
<th>Uncertainty in method</th>
<th>Weighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REPRESENTATIVITY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coverage of the MPAs in the area</td>
<td>8.70 %</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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<td>6.2</td>
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<td>1</td>
<td>1</td>
</tr>
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<td>Representativity of Bothnian Sea</td>
<td>32 %</td>
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<td>3.2</td>
<td>1</td>
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<td>1</td>
</tr>
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<td>Representativity of Archipelago Sea</td>
<td>6 %</td>
<td>10 %</td>
<td>0.6</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of Åland Sea</td>
<td>8 %</td>
<td>10 %</td>
<td>0.8</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of Northern Baltic Proper</td>
<td>3 %</td>
<td>10 %</td>
<td>0.3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of Eastern Gotland Basin</td>
<td>6 %</td>
<td>10 %</td>
<td>0.6</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of Western Gotland Basin</td>
<td>8 %</td>
<td>10 %</td>
<td>0.8</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of 0-10m depth zone</td>
<td>32 %</td>
<td>10 %</td>
<td>3.2</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of 10-20m depth zone</td>
<td>21 %</td>
<td>10 %</td>
<td>2.1</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of 20-30m depth zone</td>
<td>18 %</td>
<td>10 %</td>
<td>1.8</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of 30-60m depth zone</td>
<td>6 %</td>
<td>10 %</td>
<td>0.6</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of 60-100m depth zone</td>
<td>0.6%</td>
<td>10 %</td>
<td>0.06</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of &gt;100m depth zone</td>
<td>0.1%</td>
<td>10 %</td>
<td>0.01</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of photic hard-bottom</td>
<td>29%</td>
<td>20 %</td>
<td>1.45</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Representativity of photic mud and clay</td>
<td>23%</td>
<td>20 %</td>
<td>1.15</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of photic sand</td>
<td>67%</td>
<td>20 %</td>
<td>3.35</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of non-photic hard bottom</td>
<td>11%</td>
<td>20 %</td>
<td>0.55</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Representativity of non-photic mud and clay</td>
<td>3%</td>
<td>20 %</td>
<td>0.15</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
### Proposal for an assessment method of the ecological coherence of networks of marine protected areas in Europe

#### Indicator result | Target | Ratio | Uncertainty in data | Uncertainty in target | Uncertainty in method | Weighted average
--- | --- | --- | --- | --- | --- | ---
Representativity of non-photonic sand | 26% | 20% | 1.3 | 0.5 | 1 | 1 | 1.1

**Average uncertainty and average criterion** | 0.79 | 1.00 | 1.00 | 1.5

**Likelihood:** LIKELY

#### Replication

| Replication | Replication | Target | Ratio | Uncertainty in data | Uncertainty in target | Uncertainty in method | Weighted average |
--- | --- | --- | --- | --- | --- | --- | ---
Replication of Z. marina | 2 | 2 | 1 | 0.75 | 1 | 0.75 | 0.8
Replication of C. baltica | 3 | 2 | 1.5 | 0.75 | 1 | 0.75 | 1.3
Replication of F. vesiculosus | 5 | 2 | 2.5 | 0.75 | 1 | 0.75 | 2.1
Replication of S. caspia | 7 | 2 | 3.5 | 0.75 | 1 | 0.75 | 2.9
Replication of A. marila | 6 | 2 | 3 | 0.75 | 1 | 0.75 | 2.5
Replication of C. hiaticula | 6 | 2 | 3 | 0.75 | 1 | 0.75 | 2.5
Replication of P.b. hispida | 2 | 2 | 1 | 0.75 | 1 | 0.75 | 0.8
Replication of sandbanks | 8 | 2 | 4 | 0.75 | 1 | 0.75 | 3.3
Replication of reefs | 10 | 2 | 5 | 0.75 | 1 | 0.75 | 4.2
Replication of estuaries | 1 | 2 | 0.5 | 0.75 | 1 | 0.75 | 0.4
Replication of coastal lagoons | 10 | 2 | 5 | 0.75 | 1 | 0.75 | 4.2
Replication of boreal Baltic narrow inlets | 2 | 2 | 1 | 0.75 | 1 | 0.75 | 0.8
Replication of boreal Baltic islets and small islands | 10 | 2 | 5 | 0.75 | 1 | 0.75 | 4.2
Replication of Baltic esker islands | 1 | 2 | 0.5 | 0.75 | 1 | 0.75 | 0.4
Replication of large shallow inlets and islands | 6 | 2 | 3 | 0.75 | 1 | 0.75 | 2.5

**Average uncertainty and average criterion** | 0.75 | 1 | 0.75 | 2.2

**Likelihood:** VERY LIKELY

#### Connectivity

| Connectivity | Target | Ratio | Uncertainty in data | Uncertainty in target | Uncertainty in method | Weighted average |
--- | --- | --- | --- | --- | --- | ---
Connectivity of photic hard-bottom (50 km) | 83 | 50 | 1.66 | 0.5 | 0.75 | 0.5 | 0.97 |
Connectivity of photic mud and clay (50 km) | 63 | 50 | 1.26 | 0.5 | 0.75 | 0.5 | 0.7 |
Connectivity of photic sand (50 km) | 42 | 50 | 0.84 | 0.5 | 0.75 | 0.5 | 0.5 |
Connectivity of non-photonic hard bottom (50 km) | 84 | 50 | 1.68 | 0.5 | 0.75 | 0.5 | 0.98 |
Connectivity of non-photonic mud and clay (50 km) | 41 | 50 | 0.82 | 0.5 | 0.75 | 0.5 | 0.5 |
Connectivity of non-photonic sand (50 km) | 67 | 50 | 1.34 | 0.5 | 0.75 | 0.5 | 0.8 |

**Average uncertainty and average criterion** | 0.5 | 0.75 | 0.5 | 0.7

**Likelihood:** UNLIKELY
<table>
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<tr>
<th>Indicator result</th>
<th>Target</th>
<th>Ratio</th>
<th>Uncertainty in data</th>
<th>Uncertainty in target</th>
<th>Uncertainty in method</th>
<th>Weighted average</th>
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<tr>
<td>ADEQUACY</td>
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<tr>
<td>MPA sizes of 20 km²</td>
<td>34 %</td>
<td>75 %</td>
<td>0.45</td>
<td>0.75</td>
<td>1</td>
<td>0.42</td>
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<tr>
<td>Protection level</td>
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<td>30 %</td>
<td>0.7</td>
<td>1</td>
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<td>0.7</td>
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<tr>
<td>Average uncertainty and average criterion</td>
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<td>0.9</td>
<td>1</td>
<td>1</td>
<td><strong>0.56</strong></td>
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F Workshops with the Marine Expert Group

F.1 Part 1: Addressing comments from the MEG of May 6th, 2014

On May 6th 2014, a workshop was organized for the Marine Expert Group (MEG) in Brussels by the consortium in co-operation with DG ENV. The aim of the workshop was to discuss the definitions of the criteria and the classification method developed in the project.

The workshop was attended by about 40 participants including representatives from RSCs, MSs, networks and stakeholder organisations.

Presentations by non-EU speakers

Mark Carr of the University of California gave a presentation on a network of MPAs in the state of California, USA. In the Californian process the stakeholders were responsible for creating the network which was then evaluated by the scientists. They had several iterations to come to a division of state waters into no-take and take zones up to 5 miles off-shore. It was a single sector user process in which only fisheries were taken into account. The process of assigning the MPA was based on the species that were aimed to be protected, mainly fish. The modelled larval dispersal was used as a guideline in determining the spacing between the MPAs. The biological responses of the implementation of the MPA network are currently being monitored, so at this moment it is hard to say what the effect of the MPAs is.

Mat Vanderklift of CSIRO in Perth, Australia, presented his lessons learned from MPAs in Australia, which were not set up to be a network. The most important question to ask in installing an MPA is what do you really want to achieve with the MPA. Do you want to conserve specific species, or is your aim to safeguard the ecosystem services that an area provides? To determine the effectiveness of the MPA, individual fish were tagged. Results showed that the MPA was working well for some species, but for some of the species they were most eager to protect it was not working very well. This probably has to do with the fact that fish move out of the MPA and then get caught by fishermen (compliance for the MPA is 98%). Furthermore, external factors, like heating events, can have a marked effect on an area, for which it is hard to foresee management measures unless management is done in an adaptive way.

In the discussion that followed several topics were raised. The objectives of a network should be that the whole is greater than the sum of the separate parts. Also objectives for the MPA network should be seen in the light of the larger context of the MSFD and that of the RSCs. Furthermore, it was asked whether there was a list available for the proxies used in the Australian case and if they worked well. They seem to work well for algae and seagrass for example, but not as a proxy for fish.

Presentation by the project and the RSCs

Raul Castro of AZTI, Spain, presented the main outcomes of the draft study on assessment criteria. Within the MSFD there is a need to define quality and quantity targets. The interpretation of some MSs is that they have to make 10% of marine environment into an
MPA based on MSFD Article 13.4 (Note: MSs must identify MPAs other than those designated as Natura 2000 sites (cf. Article 13.4 and 13.5)).

Jochen Krause of the Federal Agency for Nature Conservation, Germany, provided an overview of the process around MPAs in Germany in the context of HELCOM and OSPAR. HELCOM and OSPAR should complete an ecologically coherent and well-managed network of MPAs together with the NATURA 2000 network by 2010. Under article 13.4 it is stated that spatial protection measures can be taken, which do not necessarily have to be MPAs. OSPAR has assessed coherence in its region and found that there were gaps in the high seas and offshore areas and a strong bias towards the coastal zones. HELCOM also has criteria to assess ecological coherence. Neither the HELCOM network nor the common network of BSPA (Baltic Sea Protected Area)/NATURA 2000 is considered coherent. There was a short discussion here on targets and whether there is a need to have a species list of protected species. For OSPAR such a list exists which is based mainly on the features for which the MPAs have been designated in terms of their objective.

Souha el Asmi from the RAC/SPA UNEP/MAP and Chloe Webster of MEDPan together presented assessment criteria and feasibility for establishing coherent, adequate and representative MPA networks from a Mediterranean point of view. Here, about 700 MPAs have been evaluated (about 5% of the Mediterranean). A large part of the MPA area consists of the Pelagos sanctuary for marine mammals. Criteria for the assessment were based on the CBD (2008). To assess connectivity, surface currents and larval dispersal from groupers were used. Modelling needs to be coupled with genetic studies and the final currentology of an area should be looked at. A status report has been made of MPAs in the Mediterranean in 2012. A next status report should be published in 2016 and the Mediterranean has adopted a Roadmap to 2020 for regional level, for national level and local level. In the discussion that followed the adequacy criterion was discussed in relation to management. Also it was discussed that science should eventually lead to the incorporation of the MSFD and that already major progress has been made in the RSCs. This information should be used.

Parallel sessions
In the afternoon two parallel sessions took place: on assessment criteria (group 1) and on assessment methods (group 2).

In group 1 the main point of discussion was the establishment of target values. The main conclusions of the discussions were:

1. The 10% target value is a given by MSFD Art. 13.4, however the interpretation of what this means is not only related to MPAs but can also be achieved through different spatial measures. The point is what has to be 10%? The habitat, the species?
2. We should try to think in human pressures. How are the human pressures interfering with the ecosystem? The system has its own dynamics.
3. There is a need to start talking about ambitions first and later address the quantitative targets, as well involving stakeholders in the process.

In group 2 the session started with an exercise in which the attendees wrote down shortly what they would like to discuss in terms of assessment methods. The topics raised were very
diverse: Data sources and databases, Conservation features (spatial scale, habitats and species), Connectivity, Objectives and criteria (sub-criteria), Management (adaptive and effectiveness) and RSCs, MSFD Art. 13.4 related to how the network is contributing to GES. There was a discussion on the RSC work and how it can be used as a basis. There appears to be a range of terms used in the different RSCs and NATURA 2000 and there should be some agreement on how to interpret these terms. It was also stated that the practicalities of what is feasible and achievable could help focus the work in the RSCs and how the timing of the RSC work relates to the process that the MSs have to carry out under the MSFD. It seems that the linkage between the MPAs and descriptors under the MSFD is unclear. Then the topic of looking at management in the assessment was discussed. The main question here was: what are we looking for in completing the network? An MPA should be adequately managed in order to achieve GES. Furthermore, the assessment should be practical in terms of management objectives, which can be different on different scales.

In discussing connectivity, it was stated that this criterion is not included in Art 13.4 and agreeing on human activities that cut off connectivity for various species is really difficult to assess across RSCs. In order to come to some agreement, the proxy that can be used could be determined.

**Final discussion on criteria and method: scientifically sound, practically feasible**

This discussion started off with a common conclusion from both parallel sessions; that there is a need to establish a link between the MPAs and achieving GES under the MSFD. There was a discussion on targets and that there are two different types: policy and ecological targets and how to deal with those in the context of MPAs. Then, the topic of the relationship between Article 13.4 and NATURA 2000 was raised; is Article 13.4 sufficiently covered by NATURA 2000 and if not, do we need to complete NATURA 2000 to achieve GES or do we need additional policy instruments? Another point that is raised is that Art 13.4 should be read well by MSs, but there is a need to stick with the spirit of the text rather than the literal interpretation.

**Main conclusions of the workshop**

**Relation with MSFD and other EU policies**

- The project should build more on the work that has already been carried out in the RSCs.
- What is the relationship between NATURA 2000 and MSFD Art 13.4? Do we need additional policy instruments? MSs need to comply with Art 13.4, but the interpretation and the spirit of the text should not be forgotten; there is more to it than the 10% target value.
- It was discussed that there is a need to establish a link between MPAs and GES. Ecological objectives should be clear and should provide a basis for the policy objectives.
- There is a need to have a clear overview of the objectives of the MPAs and how these should be classified in a regional/EU wide approach with which objectives.
- There is a need to streamline the different terminologies: is the project contributing to this or rather confusing the discussions? It seems that there is some difference in the interpretation of the terminology among the RSCs.
Process

- There are different types of targets: policy and ecology related, the latter are harder to measure.
- New management perspectives are needed with clear targets and objectives.
- Management objectives should be used as a basis for an assessment of coherence and different management categories are needed rather than IUCN categories.
- Involving the stakeholders in the process is important.
- There are lessons to be learned from overseas MPA implementations.
- The assessments by RSCs are a good starting point for the assessment of coherence, but timelines may diverge between MSs and their MSFD timeline and the RSC process. The Commission expects that the RSC can perform this role so that MSs are coordinating the work in a regional context.
- There are differences between the work in the RSCs and the question is whether management should be part of the assessment as a part of adequacy. Within OSPAR the assessment is first focusing on the ecological feature and then on the management.
- Management objectives should be used as a basis for an assessment of coherence and different management categories are needed rather than IUCN categories. Do these objectives exist and do they relate both to national and regional objectives? IUCN categories are thought to be a theoretical exercise since these are not connected to obligations.

MSs and RSCs

- There are differences between the RSCs in terms of criteria and assessment methods, these should be clarified.

Addressing the needs of the marine ecosystem

As was remarked by one of the speakers during the May 2014 workshop, it is important to think innovatively about managing biodiversity: move beyond just ‘preserve and protect’, as the current EU legislative frameworks do, and address the ecosystems as a whole. Integrate protected areas into a wider seascape in order to improve biodiversity conservation and to reduce the impact of climate change. The spatial measures should protect entire sites, a key concept of ecosystem-based management.

Another key concept (from the CoCoNet project) is to ‘protect and connect’, and therefore identify, and protect the ecological connectivity (especially the large corridor areas) as a strategy for biodiversity conservation. The connectivity has to be considered within a framework of Integrated Marine Spatial Planning and beyond the MPA boundaries.

Linking up with EU reporting cycles

It is recommended to align follow-up studies and tools within the context of the 6 year progress reporting cycle starting next year, with the Commission progress reporting on MPAs.
Stakeholder involvement
Consultation and cooperation with stakeholders, although not at the core of this project, is essential in creating support for the protection measures of the marine environment. It should already be organized during the early stages of a planning process. This is a general insight from earlier processes (e.g. Ridder et al., 2005) and it was reconfirmed during the May workshop.

Follow-up after the workshop
The following main points have been synthesized:
1. Build on RSCs networks assessment experience. The report should build to a much greater extent upon the work already done over the past decade on network assessment by the RSCs, OSPAR and HELCOM in particular. *(This issue is addressed extensively in Annex C, Sections C.3 and C.5). The RSCs have already developed network assessment criteria and methods, although the objective against which the MPA-networks are assessed, as well as the types of MPAs that constitute the assessed networks differ from those of the MSFD. *(As a result of this recommendation, the extent to which the criteria and methods used by the RSCs for their network assessments are covering the aspects that the MSFD requires to take into account for GES, was analyzed in Section 2.5.1)*.

2. Specify link between MPAs and GES
Under Article 13.4, one of the options for MSs to achieve GES in their waters is to assign MPAs as a spatial protection measure. From the workshop it appeared that the interpretation of this Article can vary among institutions, which means that there is still a need for debate on this topic. *(This issue is addressed in Section 2.5.1 where the interrelations between MPAs and achieving GES are discussed). MPAs are not a goal in themselves, but are a means of achieving a certain conservation status, which could aid in achieving GES. Apart from the MSFD, there is of course the NATURA 2000 legislation in place that has a relationship with currently existing MPAs. *(NATURA 2000 and its interrelations with the MSFD is discussed Section 2.5.2)*.

3. More reflection is needed regarding management aspects
Management plans are a means of assessing the objectives for a specific area. Opinions amongst MEG members vary as regards management aspects to be included into, or excluded from networks assessment criteria.
Some participants welcome the inclusion of management into the adequacy criterion, either with or without application of IUCN-levels; others are against inclusion altogether or against inclusion in the adequacy criterion in particular, while some also dispute the use of IUCN-levels; yet other participants argue that management aspects should constitute a separate criterion. It is clear that the views diverge and that this issue cannot be solved within the framework of this report. There seems however to be a common view that:
- Management status should not be operationalized in terms of having a management plan in place and implementing it; it should rather be assessed on the existence of management arrangements or measures that allow the site to meet its respective objectives. Whether or how this is enforced is of course important, but difficult to assess in the scope of this project.
- A range of protection levels should be possible, depending on the conservation features to be protected (Section 2.4).
For the moment, including management status in the assessment criteria seems relevant, the more so as the assessment criteria may apply to spatial protection measures as part of the MSFD Program of Measures (This point is addressed in Section 2.4).

### F.2 Part 2: Addressing comments from the MEG of October 30th, 2014

This document has been created in response to the feedback from the MEG workshop on the 30th of October. This MEG group had provided comments at an earlier stage of the project (May 2014) on the first idea for criteria preliminary methodology. In the workshop in October, the project was at a more mature stage and more elaborate comments were provided on the core of this document.

In this document we have made a selection of the main comments per person who provided feedback on the Task 4 guidance report of this project, as presented in the MEG workshop of October 30th.

The main comments revolve around the following issues:

- The objective of the report and the links with the other relevant (EU) legislation are unclear
- The definition of some of the criteria (mainly adequacy) is not agreed with or the justification not clear
- The structure of the document and references to the Annexes is unclear which makes the document difficult to read
- Points are raised on the quantification of the criteria and targets and how these should be determined
- There seems to be a need for more explanation on how the methodology should be applied, including the application of management criteria

We have tried to address these comments as specifically as possible in various ways:

- Comments have already been addressed in the workshop report 'Workshop document of the MEG workshop, 6th of May, Brussels' of the 7th of July (see section above);
- Comments have been taken into account in the final version of the Task 4 work, now named ‘Proposal for an assessment methodology of ecological coherence of networks of marine protected areas in Europe’
- Comments will not be addressed and give an explanation why.

#### 1. Department of Arts, Heritage and the Gaeltacht (IR), Dr. Eamonn Kelly, received by the consortium 4th of November

1. We would recommend that the title of the report be revised to remove the word “Guidance”.
   - This comment has been addressed in the final version of the Task 4 work and is now called ‘Proposal for an assessment methodology of the ecological coherence of networks of marine protected areas in Europe’.
2. Better address the ambition and operational context of the project in the introduction of the draft report, i.e. the extent to which the MAP network under Art 13(4) is expected to contribute to GES, interaction between ‘spatial protection measures’ and the MPA networks and the interaction between N2000 and the MPA network.

   o This comment has been addressed; there is a section on the MSFD and criteria for GES (section 2.5.1) in which MPAs assessment criteria are discussed in the context of the MSFD. The criteria for the Habitats Directive and Natura2000 network are also discussed in a separate section (2.5.2). We have also included some text on the program of measures in relation to MPAs (see second paragraph under section 5.1).

3. It is unclear why the planning of new MPAs is not taken into consideration in the document.

   o There is a strong connection between the assessment of existing MPAs and the creation of new MPAs, since new (networks of) MPAs could be considered in light of the criteria that are to be met during the assessment. In section 2.5 (2.5.1), we have added a paragraph on the link between the MSFD and criteria for GES and in section 5.3 we discuss criteria in relation to the planning of new MPAs (section 5.2). In this section, we have also provided references to planning tools. Furthermore, in section 2.4 we discuss the reasoning behind the designation of MPAs and how this relates to management. The similarities between assessment and designation criteria is further incorporated in section 6.1. The extension of this methodology towards the operational use in planning of new MPAs is included as a recommendation in the mid-term under section 7.2.

4. We advise a sharp degree of focus between theoretical and practical options in terms of cost-effectiveness across large areas. There is also concern that not enough adequate background information or contextual verification is provided in this document that quotes, draws from and ultimately applies criteria from other works. This comment includes a list of additional comments on the criteria (A-D).

   o This comment has partly been addressed. We agree that costs are a very important factor in the implementation of an MPA network, however, at the moment the methodology we propose is not yet fully operational. We have also taken into account a section, section 5.3, on the trade-offs between economic uses and the environmental status of an area.

   - A. Connectivity is a developing concept and should be cautiously pursued in a quantitative manner

   - The proposed method relies on quantitative methods that have been in use by OSPAR and HELCOM and, hence, can be considered as operational in Europe. We do recognize that connectivity is still under debate in these RSCs as well. Therefore, we have suggested that cautiousness on the
quantification of the criteria, including connectivity, could be included by uncertainty estimations (section 3.2.2) and also suggested more detailed methods, which potentially improve the connectivity concept (section 3.3.1).

- **B. Not clear why Adequacy is required in relation to Art 13(4)**

  - Adequacy – which commonly includes the sub-criteria of MPA size and protection level –is a criterion which is used worldwide in MPA assessments (see section 2.2 and the criteria catalogue, Annex C). Although Art 13 (4) does not specifically state the need to integrate the concept “Adequacy” as such, it indicates that programmes of measures shall include spatial protection measures, which should adequately cover the diversity of the constituent ecosystems. In this sense, we understand that the inclusion of Adequacy, as defined and considered in this study, is appropriate and in concordance with Art 13 (4). Furthermore, through this study we are able to indicate that in addition to the concepts included in Art 13 (4), that is “coherent”, “representative” and “adequately”, other criteria should also be included in the assessment of (networks of) MPAs. The over-arching criteria may be coherence, but four main criteria (representativity, connectivity, replication and adequacy) and several sub-criteria may also want to be considered. We have included this line of thinking into section 2.3 and section 3.3.

- **C. Useful to more fully explore the relevance of rounded figures for the minimum size of MPAs in the context of specific habitats/species**

  - In section 2.3, we discuss the minimum size of MPAs and which are recommended.

- **D. Important to provide some indication of the ecological units that will represent the focus of future efforts**

  - We added text to the report (see section 6.2) that the selection of conservation features in the assessment is still a knowledge gap. Furthermore, under section 5.5 we propose that a list of species and habitats should be developed for marine regions. These could serve as the basis of assessments of ecological coherence.

5. Document would benefit from a simplification of text and process.

  - This comment has been taken into account throughout the document. The main report aims to be a summary of the findings of the work including the main reasoning behind the choices that were made, while more detailed and technical work is included in the Appendices.
6. A very clear communication strategy in understandable, non-technical language will be required to outline (i) strategic and operational goals for the network and its sites, (ii) why it is important to achieve these goals, and (iii) what facilitating mechanisms are available including financial to support delivery and implementation.

   o In our report strategic and operational goals for the network and sites and the reason why they should be reached are given, for instance, in the CBD Decision IX/20 and the European Marine Board Position Paper (Olsen et al. 2013); both have been cited in this report (see section 5.4 as Annex C).

7. Advice towards the Commission (excerpt):

   Ireland provides some general comments on the implementation of Art 13(4) and provides suggestions for the follow-up process building forward on this project.
   o This comment has been communicated to the Commission.

2. Department for Environment, Food & Rural Affairs (UK), John Clorley, received by the consortium on the 14th of November

1. Acknowledge that key changes were made since June 2014 in the document which have made the format more accessible and sets out a clearer method that better reflects work of the RSCs.

2. Legal aspects of Article 13.4:

   1.1 The UK position considers art 13.4 to mean that MS put in place ‘spatial protection measures’ that contribute towards the aim to ‘adequately cover the diversity of constituent ecosystems’. Thus the spatial measures are not in themselves a direct measure of GES but will contribute to its achievement.
   o We agree with this position and it has been well reflected in our report (see for example sections 5.1 and 5.2).

3. Commentary on criteria proposed by Deltares

   3.1 We welcome the removal of quantitative targets towards achieving these criteria in the main body of the document, but would support a change in terminology from ‘criteria’ to ‘principles’ to reflect this.
   o We understand that that the “criteria” has two very different meanings, one directly associated to descriptors of the MSFD (which cannot be changed), and an additional one referring to what the UK representative suggests calling “principles”. Although we have removed the “quantitative targets”, we still believe there is an intrinsic quantitative component to the criteria concept (see chapter 2), which will be necessary in the future if assessment of the progress made towards achieving a coherence network of MPAs is to be made.
a. If a percentage is to be suggested as the unit of measure, we propose the 10% Aitchi target which is reflected in OSPAR. However it should be noted that the Aitchi target itself is not limited to MPAs, so coverage of MPAs could be lower and still achieve that target.

   o This comment has been taken into account. We propose the use of Aitchi target of 10% for some of the representativity subcriteria. We have now incorporated some text that makes clear that our 10% target is based on the Aitchi target (see section 5.4 and also see Annex C and E).

b. Coverage of MPAs in waters under national jurisdiction seems to duplicate regions, sub-regions and depth classes as mentioned in a. above and so we consider that this is deleted as a sub-criteria

   o We agree with this comment and the sub-criterion has been deleted from the text. Even though (networks of) MPAs in terms of management and administration may have a “geographical/political” component, this should not be reflected in the representativity. The coverage of (networks of) MPAs in waters under national jurisdiction only makes sense in the context of achieving protection goals of the different countries, but it does not have a biological/ecological foundation for considering this as a sub-criteria.

   o We do not believe this sub-criteria should be quantified as a percentage of features, as experience through OSPAR and UK has taught us. Instead, simple counts ensuring a feature is represented in a given region it is present would be more appropriate in our view

   o We understand this comment to be referring to the coverage of MPAs. If so, we do not refer to proportion of features protected, but to the number of MPAs in which a feature is present (see section 2.3). But if the comment actually refers to the coverage of protected features, indeed, proportion of protected features may be difficult to take into account, since often we do not have the information of the “Total coverage of the feature”. In this case, we would suggest proportions whenever information is available. In the absence of such information, counts should be considered. (e.g. benthic habitat, species, etc., see Annex D, section D.2). Although we have removed the “quantitative targets”, we still believe there is an intrinsic quantitative component to the criteria concept, which will be necessary in the future if assessment of the progress made towards achieving a coherence network of MPAs is to be made.

c. We still strongly disagree with how adequacy has been treated as part of this exercise: 1) MPA size is a site-specific consideration and it makes little sense ecologically to set generic targets, 2) ‘Levels of protection’ is still referring to usage of IUCN modified management categories which is not acceptable. These IUCN criteria are not reflected in the key EU legislation delivering MPAs and therefore should not be used in this report, 3) unclear as to where ‘size of areas free from pressures’ has been derived from. It should be noted
all sites will be subject to a degree of pressure, both natural and anthropogenic. Is this a proxy for the areas within MPAs considered to be managed? We suggest propose these three elements to be removed from the report.

Our general response to this comment is that we have revisited the definition of the criteria in the text (see section 2.3 and Appendix C).

1. We have included MPA size because it is one of the few globally agreed assessment criteria for MPAs and is included in a similar manner as a criterion under The Barcelona Convention, OSPAR and HELCOM (see section 2.2.2, table 2.1).

2. We have further developed the IUCN criteria in light of MPAs and provided justifications for why we think these are important instruments in the management of MPAs (see section 2.4).

3. In the case study, we have tested the assessment criteria based on a case study area (chapter 4 and Annex E). Here it was stated that in the more detailed assessment methods additional data of predominant anthropogenic pressures can be included. In Table 3.2, the indicator for the more detailed method for adequacy is ‘size defined as not affected by selected pressures’, which is an example of a potential indicator and pressures are further discussed in section 5.3. According to the method (see particularly the decision tree in section 3.4), the ecological coherence of the network can be improved by addressing the weak links in the network. An MPA that is impacted by a human activity across the MPA border is a weak link in such an analysis.

We are encouraged to see our previous suggestion regarding adequacy has been taken forward through the representativity criterion and would therefore argue that the entire adequacy section could be deleted.

See our response to Ireland above (point 4 B, page 2 of this document).

d. It is not clear from Table 1 or the supplementary information in Annex F whether there is or is not a quantitative target for connectivity included in the document. We suggest the examples in brackets in Table 1 referring to connectivity distances are removed. We are pleased to see however that this connectivity criteria relates to legally protected features.

This comment has been taken into account, there are no numbers mentioned in this Table (now called table 3.2) and the section instead focuses more on the underlying principles (see section 3.3.2). Furthermore, it is mentioned here that only very few targets are commonly agreed, which is scientific, but to a large extent a political discussion.

4. Wider use of the work of Deltares by the Commission

a. We welcome the fact that the report will no longer be titled ‘guidance’.
This comment has been addressed in the final version of the Task 4 work, which is now called ‘Proposal for an assessment methodology of the ecological coherence of networks of marine protected areas in Europe’.

We would seek clarity from The Commission on their intended use of the report as a contribution to the Article 21 report, as this was somewhat confused at the MEG meeting.

This comment has been communicated to the Commission.

3. BirdLife Partnership (UK), Bruna Campos & Tom Hooper, received by the consortium on the 14th of November

1. Overall the report has much improved since the May version. However, it is disappointing not to see more detail about how Article 13(4) should be interpreted and how MS could cooperate in developing MPA networks

   a. During the workshop in May, it already became clear from the discussions that MSs struggle with the interpretation of this article and how to implement it. Even though the criteria and methodology we have developed focus on the assessment of networks of MPAs, the methodology could also be applied for the development of new MPAs. Article 13(4) can be interpreted in multiple ways. A paragraph on Article 13(4) can be found under section 2.5.1) in which MPAs assessment criteria are discussed in the context of the MSFD. Furthermore, we have added a section (section 5.2) that further discusses the improvement of the MPA network to reach GES, in which regional coordination through the RSCs is considered as an important vehicle for cooperation.

2. The document does not take into account the sufficiency of the network. The current criteria are not enough for determining the sufficiency of protection of an area. Therefore the methodology should also form such a link, such as the designation process of Marine Natura 2000 sites.

   a. It is unclear from this comment what is meant by ‘sufficiency of the protection of an area’. We interpret the word ‘sufficient’ to be the same as ‘being assessed as ecologically coherent’. We have taken a separate description into account for ecological coherence under section 2.3. If the comment was intended more to mean the protection level of a specific MPA, we have discussed these as part of the proposed management categories under section 2.4. Furthermore, a separate section has been included on the criteria under N2000 and how this relates to the HD and MSFD (see section 2.5.2).
3. A lot of the content of the Annexes served to confuse rather than enlighten, there is a lot of information here that is difficult to digest.

   a. This comment has been taken into account. Since the information from the Annexes has previously been published in former reports and had to be presented there is indeed a lot of information present in the Annexes. We have therefore moved the main messages from the Annexes back to the main body of text. We feel that the information in the Annexes now provides more detailed background information for the main conclusions drawn in the main report text. For example in Chapter 4 on the case study; we have kept the main discussion points from applying the methodology we proposed to the case study in the main body of the text, and the more detailed information on the calculations in Annex E.

4. The discussion on whether management should be part of ecological coherence is interesting, and likewise we have heard arguments on both sides. BirdLife feels that ecological coherence is a significant element for measuring the effectiveness of a network. There are still many unanswered questions about how ecological coherence can be realistically measured and allow us to have greater certainty that it is achieved, or close to being achieved.

   We would prefer to see a much greater emphasis on what can be done now with the data available. We would also like to see some guidance on how and where the European seas should be split for analysis. Consistency in bio-regions from the Mediterranean to the Baltic is clearly not going to be possible. Would analyses take place at different scales and how would they relate to each other?

   a. This comment has partly been taken into account. The question of the spatial scale at which specific features of the European waters should be assessed is a complex one. In a previous study carried out by this consortium, ‘Coherent geographic scales and aggregation rules for environmental status assessment within the Marine Strategy Framework Directive’. Here, the main guidance we have provided to the Commission is that a nested approach would be most suitable. This approach is proposed by HELCOM and means that spatial assessment scales can be used as a way to develop a framework of assessment areas that can be adapted to the specific needs of an indicator or descriptor and the specific characteristics of a regional sea, and can help to develop a coherent approach within a regional sea (Prins et al., 2014, see also Annex B). We have tried to incorporate that thinking into the current report as well (see for example section 2.3 and section 3.3). As described in the report (Chapter 3), the basic analysis of ecological coherence can be made in all the marine regions of Europe. The more detailed method requires, for instance, biological data which is not available for all regions, but we project that the progress with the EMODNET sebed habitats project (http://www.emodnet.eu/seabed-habitats) will help in this situation very soon.
5. We agree with the authors that the report (and analysis) in this context should focus on the ecological coherence of existing MPA networks. The outcomes from ecological coherence tests for many regions and sub regions are that the network is unlikely/very unlikely to be ecologically coherent. Could reporting also include an element of identifying gaps?

   a. This comment has been taken into account in Figure 3.3 (in section 3.4), where the decision tree was presented to identify gaps in the MPA network. Here, the necessary steps in the assessment and how they can be improved if the uncertainties are high or the criteria fail to meet the targets.

Proposed changes to the document:
Summary: Last sentence- the phrase 'state of the art' is wrong in this context, and it should be 'state of play'
   
   b. This has been corrected, see the adapted Summary.

Point 2.2: No mention of the importance of EBSAs in criteria. The inclusion of areas that are important ecologically is an important element of 'ecological coherence'.

   c. The EBSAs have been presented and discussed in section 3.1.2. We noted that CBD lists them and OSPAR and Barcelona Convention note them but that none of the assessment has used this as an assessment criterion. We agree that EBSAs are important to identify and take into account when establishing MPAs, but we stipulate that in assessments of ecological coherence their importance is included through the species and habitat data.

Point 2.3: 1a1 Many of the tests will probably fall at 1a1 when it comes to identifying data availability. It would be useful therefore if the report could detail a bit more explicitly how ecological coherence would be measured at a more basic level initially. For the calculations of main criteria, why use selected features rather than a broad scale proxy?

   d. The text in the step 1a1 reads: “For a basic assessment method in a region the required information is GIS layers of the area.” (see section 3.3). We argue that every marine region has this data from MPAs and can thus be used in a basic assessment. Furthermore, we have made calculations for the assessment of ecological coherence (see Annex D) and in a case study (see Annex E).

Page 8: In calculation of replication and representativity is there a minimum patchsize?

   e. This is a good question and goes deep into the procedure. In the MPA assessment of the BALANCE project (www.balance-eu.org; Piekäinen & Korpinen 2007) a minimum size was set based on the data resolution (too small patches were discarded as their real existence was uncertain).
We provided a calculation of replication and representativity of this to Appendix D.

Point 2.4: It is good to see a practical assessment of how to cope with uncertainty. The reliability, quality and coverage of data across different regions are likely to make many of these analyses challenging. It would be good to see more detail for how modelling or proxies would be used.

a. This comment has been taken into account; the methodology has been designed to use proxies in the more detailed assessment method, for example in the case of underwater habitat maps and models (section 5.5). These therefore already include some uncertainty. Furthermore, we have provided a separate section on uncertainty (section 3.2.2).

Point 2.5: One of the problems of using the IUCN criteria is that the vast majority of MPAs in Europe fit into category IV (and some also in III) and it is therefore difficult to differentiate whether management is either active or effective. The use of the IUCN Green list would ultimately be a more effective way of assessing management. Defining whether a feature is managed remains one of the most challenging aspects of measuring ecological coherence. This point is made in the report, but using IUCN criteria is not the answer.

a. We have adapted and better justified the use of IUCN criteria in our report (see section 2.4.). We present our main arguments for using IUCN, for example that they have to eventually be implemented on a global scale and that MSs have already reported on MPAs using these categories, in this section. The Green List has been investigated as well, however, this list is has the objective to promote effective management, which is not the objective of management categories as part of a network assessment of MPAs (see section 5.6).

Point 4: Management is currently not ‘close to the concept of protection levels’. The majority of European countries manage features reactively based on an assessment of the impact of a plan or project on that feature. As for the relationship of GES and ecological coherence, it would be useful to see some further ideas here. At the moment the report says that they aren’t related, although GES the development of a ECN of MPAs will clearly help in the achievement of GES.

a. See our response to the UK (point 2).

Page 22: Impacts of inshore fishing (less than 12m) not captured in VMS, but use of mapped interviews (e.g. Fishermap in the UK) allow for greater spatial understanding of the inshore fleet.
a. We agree that such approaches can be used to support the assessment, however, these have not been specifically included since they are going very much into detail on the human activities side of MPAs. We have included some discussion on these types of data under section 5.5. Our efforts have been focused more on the determination of the criteria and the methodology for assessment. We discussed the importance of socio-economic activities in the report in section 5.2 and section 5.3) as well as considerations on target setting (section 5.4).

3. Proposal for the development of a common understanding of Art 13(4) MSFD (GER), received by the consortium 1st of December 2014

Summary
In light of the Birds and Habitat Directive, the Convention on Biological Diversity, the HELCOM recommendation 15/5, the OSPAR recommendation 2003/2 and those of the other RS Conventions, we consider it necessary to develop a common understanding between MSs and the Commission on Article 13(4). The MEG is considered a good forum for this.

Considerations:
1. The EU MPA network follows the requirements of Art 13(4) and is established to achieve GES for all EU seas
2. A three tier approach for the development of an EU MPA network seems adequate:
   a. National contribution is constituted by the requirements of the HD (meagre marine elements)
   b. Regional contribution constituted by requirements of the RSCs (existing list of conservation features including threatened and declining marine species and habitats which shall be included in the designing of MPAs
   c. European roof requirements of MPA network are not described sufficiently. Should be developed based on Article 13(4) and at least cover both above mentioned considerations.

Proposal for next steps
A report should be made as a basis for the common understanding, which analysis the three tier approach. The report needs to make reference to Annex I, features of Annex III and revised COM decision 2010 on indicators, criteria and methodological standards. An important criteria that is currently missing are those for the European tier of the approach above.

a. We welcome this proposal for the development of a common understanding of Art 13(4) as well as the considerations and next steps proposed and have taken this up as part of the recommendations for follow-up (see short term recommendations, section 7.2). The report with the criteria and assessment methodology as we have put forward here can be seen as a background to further developing this thinking. To reach this common understanding however, a
politically oriented process will be necessary, which is why these comments have been further communicated to the Commission.

4. Comments on the Deltares document from France (FR), received by the consortium 3rd of December 2014

1. The initial purpose of the Deltares study was to develop an EU guidance document for assessing the contribution of European MPA network to achieving Good Environmental Status (GES) under the MSFD. We note that the current report has now been converted into a guidance document for a proposed methodology for assessing the ecological coherence of MPA networks.

   a. Indeed, we have not presented a guidance document in this report. Hence, we have changed the title of the report from Guidance document to ‘Proposal for an assessment methodology of the ecological coherence of networks of marine protected areas in Europe’. We have focused our efforts on the development of a methodology with GES, Article 13(4) and other existing directives as an important context (see sections 2.1 and 5.1).

2. GES has probably more to do with the effectiveness of the network, as with Favourable Conservation Status in the context of Natura 2000. This essential assumption has been given very little attention in the report (p.57 to p.59). Furthermore, this section often confuses ecological coherence criteria (in short which try to assess the means) with MSFD GES criteria (which try to assess the results).

   a. We agree with the interpretation that MPAs are a means to attain GES and therefore the MPA assessment criteria and GES criteria are not comparable. We have clarified this discussion chapter 2, mainly section 2.5.1).

3. Some of the criteria are still confusing:

   a. Representativity: it is unclear whether the sub-criteria for species and habitats are assessed against biological data or against tabular data present in MPAs forms.

      i. As explained in the Section 3.3, Step 1a1 the basic methodology uses both tabular and GIS data (the former for species and habitats and the latter for size, areas coverage, location and proximity). Furthermore, we have further elaborated on the criteria of representativity in section 2.3.

   b. Adequacy: the definition is confusing since it mixes up MPA sizes and the level of protection.

      i. We have further developed and provided arguments for the criteria that we propose to underlie the assessment methodology in section 2.3). A network of MPAs may encompass different MPAs, which may have different sizes (according to the needs) and be categorized under different management/protection levels. That is, there is no need for a network of MPAs to encompass e.g. only MPAs that have the highest level of protection. HELCOM assessment of ecological coherence (2010) placed MPA size and level of protection fall under
the adequacy criterion, which is one of the reasons we have included it there.

4. Last but not least, the document suffers from a considerable lack of structure and this jeopardizes the understanding of the key messages which were initially in the one hand, how to ensure bridges between the several protection marine tools and in another hand, what are the European roof requirements to talk about a coherent and a representative network of marine protected areas?

   a. This comment has been taken into account, the document has been restructured and a guidance for reading has been created under section 1.2.

5. Comments on the Deltares document from DG ENV, received by the consortium 11th of December 2014

1. Inconsistencies and structural deficiencies

   a. The text (report and annexes) suffers from lack of coherence and clarity. Information should be reorganised in a way that one subject matter is treated in one place.

      i. This comment has been taken into account, the document has been restructured and a guidance for reading has been created under section 1.2. Furthermore, key messages are presented to further clarify the line of thinking and improve the structure of the document.

   b. Terminology should be used in a consistent way and when introducing definitions, it should be clear if you define a criterion, method or measurement tool (i.e. p E-5 representatitivity and connectivity re-defined in an unclear way)

      i. This comment has been taken into account, the criteria have been re-defined (see section 2.3 and Annex C).

   c. Factual inconsistencies between the report and the annexes, across annexes and sometimes within one annex (see extended comments for examples).

      i. This comment has been taken into account, the document has been re-structured and a guidance for reading has been created under section 1.2. Furthermore, a cross-check between the Annexes and the main body of text has been carried out.

2. Methodological deficiencies

   General comments:

   a. The report does not take into account the latest developments (e.g. HELCOM 2014 recommendation 35/1) and uses references (e.g. IUCN classification for criteria on site management) without explanations on the choice.

      i. This comment has been taken into account and the references have been updated (see section 2.2). Furthermore, we have tried to explain our line of thought more explicitly in section 2.3 on the criteria
including the application of the IUCN criteria (see section 2.4) as well as on the methodology (see section 3.3)

b. Bold statements are made (e.g. "ecological coherence is the key concept for the MPA network design")p.3) without further development. Where developments are found elsewhere in the report, a clear link should be made. See point 3.

i. This comment has been taken into account, the document has been re-structured with clearer links between the main text and the Appendices and a guidance for reading has been created under section 1.2 (p. 14). Furthermore, we have further developed the statements made in the report which are better supported with arguments and clear lines of thinking (for example see section 5.4).

c. The methodology in the report and Annex E is rather confusing. Unclear how many 'detailed' methods are used. In Chapter 2 of the report, reference is made to one basic and two detailed methods. Also, the method described in point E2.1.1 concerns the criterion 'adequacy' while the method E2.1.2 has implications for representativity and connectivity. It is unclear if these two methods are merged in the report, or, if not, which one is used.

i. This comment has been taken into account, the document has been re-structured with clearer links between the main text and the Appendices. Furthermore, the methodology has been reviewed and now consists of a basic and more detailed assessment methodology (see section 3.3).

d. The third detailed method introduced in point E2.1.3 seems to overlap with the level of protection which may be part of measuring adequacy (depending on the definition of adequacy – see point 1 of this note).

i. The methodology has been reviewed (see section 3.3) and now consists of a basic and more detailed assessment methodology (see the second and third paragraphs of 3.3.1, p. 34). The previously existing even more detailed methodology was removed since it seemed that very few MSs would have data to be able to conduct such a detailed assessment. We have now discussed the possibility of creating this more detailed level under section 5.5.

e. The report states that there is currently no dataset available on legal instruments protecting MPAs. In this context, it is questionable if this 3rd detailed method should be mentioned – maybe it could be moved to recommendations if the level of protection is taken out of the definition of adequacy.

i. This comment has been taken into account, the previously existing even more detailed methodology was removed from the report. A recommendation on a database on the legal protection has been incorporated in section 7.2, long term recommendations.
f. Would be useful to have a short description of all the methodologies and an explanation of the objectives and added value of these different approaches from the outset. Then have separate sections describing the basic and the more detailed methodologies. It would greatly increase clarity to always have a visible distinction (e.g. sub-headings) between what relates to the basic methodology and what relates to the more detailed ones throughout the entire report (including annexes).

i. We have removed the third more detailed level of the methodology (revolving around the legislation in order to make the different approaches more clear (see section 3.3) and have made calculations in the case study (Chapter 4 and Annex E) on how to deal with these two different methodologies in practice.

3. Assessment criteria

a. Annex C provides an overview of assessment criteria used at various levels. Although the report says to focus on network criteria (p. C-3), it keeps listing criteria for single MPAs together with network criteria on p. C-6-7. In addition, while the report appears to choose the four specific assessment criteria due to their wide acceptance across RSCs, it does not examine their appropriateness for an EU-wide assessment, and it is not explicitly stated why additional criteria are discarded. In this context, the inclusion of Annex E point E.8 in the report could be considered (applicability of the assessment criteria).

i. The structure of the report has been adapted and more information from the Annexes has been included in the main body of text (for example in chapter 2, where text has been moved from Annex C to the main body of text. Furthermore, the fact that adequacy relates to a single MPA and the other criteria more to the network as a whole has been included under section 2.3. Finally, in the criteria catalogue (Annex C), a distinction was made for all criteria between those of a single MPA and that of a network of MPAs.

b. When discussing the selection of assessment criteria, a stronger link should be created with the terminology of art. 13(4) of the MSFD. Here, the issue is acknowledged, but not addressed.

i. A section is included in the report in which Article 13(4) is discussed in light of the MSFD (see section 2.5.1). Furthermore, we have adhered to the terminology of Article 13(4) throughout the report as much as possible.

4. Management levels and their functionality

a. In the offer, the consortium proposed to ‘describe a classification system for classifying management levels of European marine protected areas, and test its functionality. Linkage should be made to existing IUCN categories and application criteria to MPAs”. In its report, the consortium simply applied the IUCN categories
to European MPAs without considering other alternatives which might be more appropriate. The functionality of the classification system was not tested.

i. The use of the IUCN categories in our methodology has been further argued in section 2.4. and has been applied to a case study area (Chapter 4, Annex E). The second part of the comment, on testing the functionality of the classification system, we find hard to incorporate. We feel that the fact that MSs have already reported on MPAs using the IUCN categories implies that they can be used within the context of the EU.

b. In addition, as the consortium also noted in its report, the concept of management is close to the concept of protection levels, yet it is not the same. The terms "protection level", "management level", "management measures" and "legal basis of protection" and the relationship between them should be clearly defined.

i. These terms have been further clarified in the report (see section 5.6)

c. The consortium could consider going beyond its current approach and examine the question how to determine the appropriate level of protection, and how to manage MPAs in an inclusive and transparent way.

i. This comment has been taken into account, we have made a separate section in the discussion chapter in chapter 5 on this issue (see section 5.6. third paragraph, p. 51) on the role of management as a part of an MPA network assessment.

5. General remarks

a. An overall quality check should be carried to reinforce links between the annexes and the report. The trains of thought in the Annexes are not sufficiently reflected in the report, seeming therefore to be not well underpinned. A clear reference should be made to the Annexes in the main report. Also, it is not sufficient to treat fundamental policy issues only in the annexes (for example relation between GES and MPAs, which should be brought to the main body of the text (now in C-12).

i. This comment has been taken into account, the document has been re-structured to better support the line of thinking, with clearer links between the main text and the Appendices and a guidance for reading under section 1.2.

b. Deltares is asked to not quote directly the service request

i. This comment has been taken into account and all quotes of the service request have been removed.

6. Integration of stakeholders’ views in the report

a. The main conclusions from the workshop in May 2014 is summarised in Annex D. Stakeholders pointed out the need for:
i. A more integrated approach towards MPAs and GES

ii. More reflections on management aspects

iii. More emphasis on work already carried out by the RSCs

In certain cases these comments are fully accommodated without further explanation (e.g. RSCs or dropping the management aspect of the adequacy criterion), in other cases the issues seem completely disregarded (point on GES – see general remarks). A more coherent and transparent approach towards the integration of stakeholders’ views is necessary. This is also applicable to the comments received after the MEG held on 30 and 31 October 2014.

i. This comment has been taken into account, in AnnexF the comments/discussion points from the MEG in May and October have been reflected on. The discussion points from the May workshop are collected at a higher level than that of October, where we have addressed each comment separately.
### G Descriptors and criteria for the MSFD


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<th>DESCRIPTOR</th>
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| **Descriptor 1:** Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions. | 1.1 Species distribution  
1.2 Population size  
1.3 Population condition  
1.4 Habitat condition  
1.5 Habitat extent  
1.6 Habitat distribution  
1.7 Ecosystem structure |
| **Descriptor 2:** Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem. | 2.1 Abundance and state characterisation of non-indigenous species, in particular invasive species  
2.2 Environmental impact of invasive non-indigenous species |
| **Descriptor 3:** Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. | 3.1 Level of pressure of the fishing activity  
3.2 Reproductive capacity of the stock  
3.3 Population age and size distribution |
| **Descriptor 4:** All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity. | 4.1 Productivity (production per unit biomass) of key species or trophic groups  
4.2 Proportion of selected species at the top of food webs  
4.3 Abundance/distribution of key trophic groups/species |
| **Descriptor 5:** Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters. | 5.1 Nutrients levels  
5.2 Direct effects of nutrient enrichment  
5.3 Indirect effects of nutrient enrichment |
| **Descriptor 6:** Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. | 6.1 Physical damage, having regard to substrate characteristics  
6.2 Condition of benthic community |
| **Descriptor 7:** Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems. | 7.1 Spatial characterisation of permanent alterations  
7.2 Impact of permanent hydrographical changes |
| **Descriptor 8:** Concentrations of contaminants are at levels not giving rise to pollution effects. | 8.1 Concentration of contaminants  
8.2 Effects of contaminants |
| **Descriptor 9:** Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards. | 9.1 Levels, number and frequency of contaminants |
| **Descriptor 10:** Properties and quantities of marine litter do not cause harm to the coastal and marine environment. | 10.1 Characteristics of litter in the marine and coastal environment  
10.2 Impacts of litter on marine life |
| **Descriptor 11:** Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment. | 11.1 Distribution in time and place of loud, low and mid frequency impulsive sounds  
11.2 Continuous low frequency sound |