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Towards a Guidance

on criteria and methodology for the evaluation of coherence, adequacy and representativity of networks of marine protected areas in European marine regions and sub-regions

Deliverable D4

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Summary
The core of this report is a two-stage method for the assessment of the ecological coherence of Europe's Marine Protected Areas (MPAs). The method presented is based on the existing background knowledge on MPA assessment. The report explains the types of MPAs currently designated in the EU, the goals and ambitions that underlie them, and their legal frameworks. This report aims at offering a perspective to find common ground between these different initiatives.
The proposed assessment was tested in the Baltic Sea; the results are presented. Finally a roadmap for further development is presented.

References
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Contents

Summary

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

The aims of the study are formulated thus: *According to Article 16, the Commission shall assess whether these programmes (of measures – ed.) constitute an appropriate framework to meet the requirements of the MSFD. This assessment will thus also need to include an analysis of the contribution of the Member State's MPAs towards a coherent and representative network of MPAs, adequately covering the diversity of the constituent ecosystems, as required under Art. 13(4). (...)* ***The present contract should develop the harmonised methodology for the evaluation by the European Commission of the coherence, adequacy and representativity of the EU networks of MPAs (...).***

In a first step of the present study the criteria for assessment of the MPAs and MPA networks in Europe and in other marine areas throughout the world were reviewed. A wide range of criteria have been used for the implementation of MPAs and many of those criteria are highly conceptual with only little practical value. The identified criteria were inventoried and catalogued in an electronic annex to this report. The criteria and subcriteria that we propose for the assessment method for ecological coherence are essentially a combination of identical or comparable criteria of the Convention on Biological Diversity and the Regional Sea Conventions: 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 Regional Sea Conventions. Coherence comprises four main criteria: representativity, adequacy, connectivity and replication. Under these four main criteria, nine groups of subcriteria are proposed.

The second step of this study was to review the existing methods for the assessments of ecological coherence. Assessment results are reported from the North Sea, the Baltic Sea and the Mediterranean. These reports discuss whether the network of MPAs was ecologically coherent, and if not, what caused the failure. Despite the wide use of the concept, there is surprisingly little, almost no guidance or theoretical discussion, how the ecological coherence should be technically assessed. 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.

Our suggestion for the assessment method is based on the review findings and builds on them. We propose a two-step approach: a basic assessment method and a more detailed assessment method. In the basic method, only simple GIS files of the region, its bathymetry, the MPAs location and geometry, and a database of species and habitats found within the MPAs are required. The more detailed method includes three more advanced components: (1) spatial distribution of anthropogenic pressures, (2) mapped habitats and species range (and other features of interest) and (3) a database of the legal basis of the protection, i.e. what type of protection has been used for the site and which conservation features are legally protected within it.

Whether ecological coherence is reached or not can be assessed by a simple aggregation tool, where the four main criteria (i.e. representativity, replication, connectivity and adequacy) are equally important and a failure in any of them results in a failure in reaching ecological coherence of the network. This follows the one-out-all-out (OOAO) principle, which is an assessment method that takes the precautionary principle into account. On the sub-criteria level, we suggest that the OOAO cannot be justified as its use will almost certainly lead to unjust downgrading. Instead, we suggest that the subcriteria (within a 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).

Our suggested assessment method emphasizes the role of uncertainty in the assessment. The uncertainty is assessed on the level of sub-criteria, where uncertainty can be found in the data, target or method. We suggest criteria which guide to score the uncertainty and this can be used to weigh the averaging, if necessary. By including the uncertainty estimates, one can also track the reasons for assessment failures and improve the MPA network. 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. Contributing a likelihood of reaching ecologically coherent MPA networks is a way to include the uncertainties in the assessment.

The proposed assessment method was tested in the central part of the Baltic Sea. The ecological coherence was assessed using both a basic assessment and a more detailed assessment method. The four main assessment criteria and the sub-criteria were used. Weighted averages of the four criteria were considered and the uncertainties were taken into account. The basic methodology with more ambitious targets resulted in poorer results. The more detailed assessment had different data and a different methodology in the sub-criteria and therefore the results of the assessment are also different. The use of mapped data decreased uncertainty in the methods but the data were not very reliable and hence the data uncertainty increased. Based on the adequacy criterion, the assessment concluded that it is unlikely that the network is ecologically coherent. Overall the results with the more ambitious targets showed it is very unlikely that the network is ecologically coherent.

We note that the findings of this report are still preliminary and more focus should be given to solve the methodological challenges in bringing ecological reality into MPA assessments. The development of an assessment method for MPAs is therefore work in progress. Some important knowledge gaps still exist. This report sketches the current state of the art and identifies a number of 'next steps', that will help Europe's member states make further progress.

1 About this report

1.1 Background

In the service request the aims of the study were formulated as follows: *Develop an EU guidance document for assessing coherence, adequacy and representativity across the four marine regions and associated sub-regions (...).* An outcome of this study is that we propose 'ecological coherence' as an over-arching criterion, comprising four main criteria: representativity, adequacy, connectivity and replication. This study is therefore aimed at assessments and assessment criteria for the ecological coherence of networks of existing Marine Protected Areas (MPAs) in Europe. It is not aimed at the planning of new MPAs. Although there are obvious links with assessments of the wider marine environment, these are not at the core of this study.

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.

The implementation of MPAs is driven by several international, EU and regional initiatives and legislations. A complete overview is provided in chapter 3 of Annex 3. The most important ones are:

- based on EU legislation:
  - Marine Strategy Framework Directive (MSFD)
  - Natura2000 (= Birds and Habitat Directives combined)
  - Common Fisheries Policy (CFP)
- based on international or regional conventions
  - OSPAR, HELCOM, Barcelona Convention, Black Sea Convention, Bern Convention
  - Convention on Biological Diversity (CBD)

Most of these initiatives have been designated 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 MPAs networks as a tool to protect biodiversity and ecosystem function is an important goal of different EU marine and maritime policies. The Water Framework Directive (WFD, 2006/60/EC) and the MSFD (2008/56/EC) both aim to set targets of good ecological or environmental status and a holistic approach in ecosystem management. Furthermore, establishing representative networks of MPAs at eco-regional and sub-regional scales[1] 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, in particular its biodiversity, and the sustainable use of marine and coastal resources, and to further define the boundaries of the sustainability of human activities that have an impact on the marine environment, in particular in the framework of the MSFD. The information on MPAs must be included within the programmes of management measures, which are to be implemented by Member States under the MSFD Art. 13(4) to achieve or maintain the good environmental status of their marine waters.

[1] *In this report we use the geographical terms proposed by Prins et al. (2014), included as Annex 2.*

1.2 Guidance for reading

In chapter 2 of this report the proposed assessment method of networks of MPA's is presented. This chapter also includes, in section 2.2, the criteria and indicators that were selected to be used in the method. For readers seeking more detailed information, the underpinning of both the method and the choice of the criteria is discussed in Annexes 3 and 5.

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 3; more information is provided in Annex 5.

The final chapter of the report identifies issues that are relevant for further activities in the field of assessment of MPAs. These issues are categorized in paragraph 4.1 and 4.2 and prioritized in paragraph 4.3.

2 Proposed methodology

2.1 Assessments of ecological coherence in MPA networks

Assessments of ecological coherence have evolved rapidly 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 or understandable 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 methodology. It builds on earlier efforts from within Europe (especially in OSPAR and HELCOM) and abroad. The research that preceded the development of our suggested methodology is summarized in chapters 2 and 3 of Annex 3 (for the criteria) and chapter 1 of Annex 5 (for the methodology).

2.2 Selection of criteria

The analysis of the assessment criteria of RSC's in Annex 3 shows that the assessment criteria for MPA networks are similar across the European marine regions. A further analysis of the Natura 2000 assessment criteria shows that the use of the RSC criteria will support the assessment of Natura 2000 network, while there are limitations in the protection of all features.

The European RSC assessment reports focus on four main criteria: representativity (of marine zones, ecoregions, habitats and species and including aspects of geographic distribution), replication (of sites and habitats), connectivity (proximity used as a proxy) and adequacy (including viability, e.g. MPA size, level of protection). The main criteria consist of sub-criteria and there are some differences on the sub-criterion level between the RSC's (as also seen in Annex 3), but a basic set of common sub-criteria can still be distinguished.

Ecological coherence is the key concept for the MPA network design. It consists of four primary principles: representativity of functions and features of marine biodiversity, adequacy of MPAs and the MPA network, connectivity between the protected features, and replication. In order to assess coherence of the MPA network, an assessment of all four criteria is required. All four criteria must meet a minimum standard if the network is to be called coherent.

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. The Network comprises each Habitat type at local, national and regional level; assuring the integrity of inshore-offshore features with a transboundary dimension.

Connectivity between MPAs should offer sufficient opportunities for the dispersal and migration of species between MPAs. The network should take into account 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.

Adequacy means practical evidence that the individual components of the network are of sufficient size and have a sufficient level of protection to ensure ecological viability and resilience of habitats and species. The target for an adequate MPA network is that sites reach a minimum recommended size and the network includes the management categories related with endangered 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. All features should be replicated to enhance resilience, representativity and connectivity and replicates should be spatially separate (HELCOM 2010, OSPAR 2013).

It is crucial that the scale of habitat classification matches the scale of the spatial planning efforts in order to capture the variation in biological assemblages found at that local level. Natural variability is a multidimensional concept and encompasses many scales of variation in biological organization (from genes to ecosystems), involving the linkages of habitats, species, communities, and ecological processes at multiple spatial scales.

An analysis of these criteria can be made on the basis of:
- GIS data of the boundaries of the marine 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 of the protection level.

The number of sub-criteria, 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. The natural variability encompasses many scales of variation in biological organization (from genes to ecosystems), involving the linkages of habitats, species, communities, and ecological processes at multiple spatial scales, therefore it is crucial that the scale of habitat classification matches the scale of the spatial planning efforts in order to capture the variation in biological assemblages found at that the local level.

2.3 Outline of the proposed methodology

Assessments of the ecological coherence of MPA networks have been traditionally 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. Moving from large to small-scale assessments the limiting factor will be data quality, especially concerning the ecological data, which becomes more fragmented and detailed in the smaller scales.

The proposed assessment method follows a step-wise approach and integration process, depicted in figure 1.

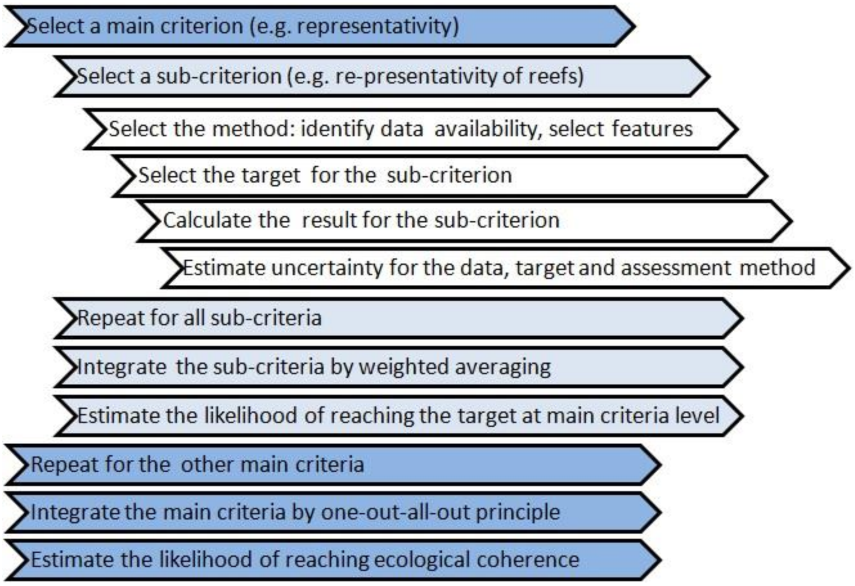

Figure 1 Step-wise approach and integration process.

Step 1. Selection of a main criterion
The main and subcriteria that are used in the method were introduced in section 2.2. The method follows the cycles of steps 1a to 1d for each of these four main criteria. Figure 1 uses Representativity as example.

Step 1a. Selection of a sub-criterion
The subcriteria were also introduced in section 2.2. It is important to understand that in many cases these subcriteria should be regarded as groups of subcriteria, when data of more than one species or habitats that make up a group are available. The method follows the cycles of steps 1a1 to 1a4 for each sub-criterion.

Step 1a1. Selection of the method (basic or detailed)
The assessment method that we propose is divided into a basic assessment method and a more detailed assessment method. A detailed analysis separating attributes at population, community and ecosystem levels in the marine environment can be crucial, because there are conservation implications at each level of the hierarchy (Zacharias and Roff, 2000). A crucial discerning element between the two is data availability and quality.
For a basic assessment method in a region simple GIS files of the area are proposed, its bathymetry and the MPAs, and a database of species and habitats present or absent within the MPAs. In the more detailed method, the assessment includes three more advanced components:
1. Spatial distribution of anthropogenic pressures,
2. Mapped habitats and species range (and other features of interest) and
3. A database of the legal basis of the protection, i.e. what type of protection has been used for the site and which conservation features are legally protected within it.

Step 1a2. Selection of a target

An inventory of target values used in earlier assessments is made in Annex 3. Within the scope of this project it has not been possible to define an agreed list of target values for the proposed criteria.

Step 1a3. Calculate the result for the sub-criterion

See below for some explanations of the suggested calculations for each of the four main criteria.

Step 1a4. Estimate uncertainties

As the sub-criteria 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 be used to weigh the sub-criteria in the averaging.

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

Step 1c. Integrate the results by weighted averaging

The sub-criteria are averaged 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). On the sub-criteria level, the OOAO cannot be justified as its use will almost certainly lead to unjust rejections.

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 sub-criteria 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 sub-criteria level. For instance, if two sub-criteria have high uncertainty and one sub-criterion has moderate uncertainty, it is quite clear that the likelihood should be downgraded. See also section 2.4.

Step 2. Repeat for all main criteria

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

The methodology 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 (OOAO) principle, which is an assessment method taking into account the precautionary principle.
Figure 2 depicts the integration process.

Step 4. Estimate the likelihood of reaching ecological coherence

Explained in section 2.4.

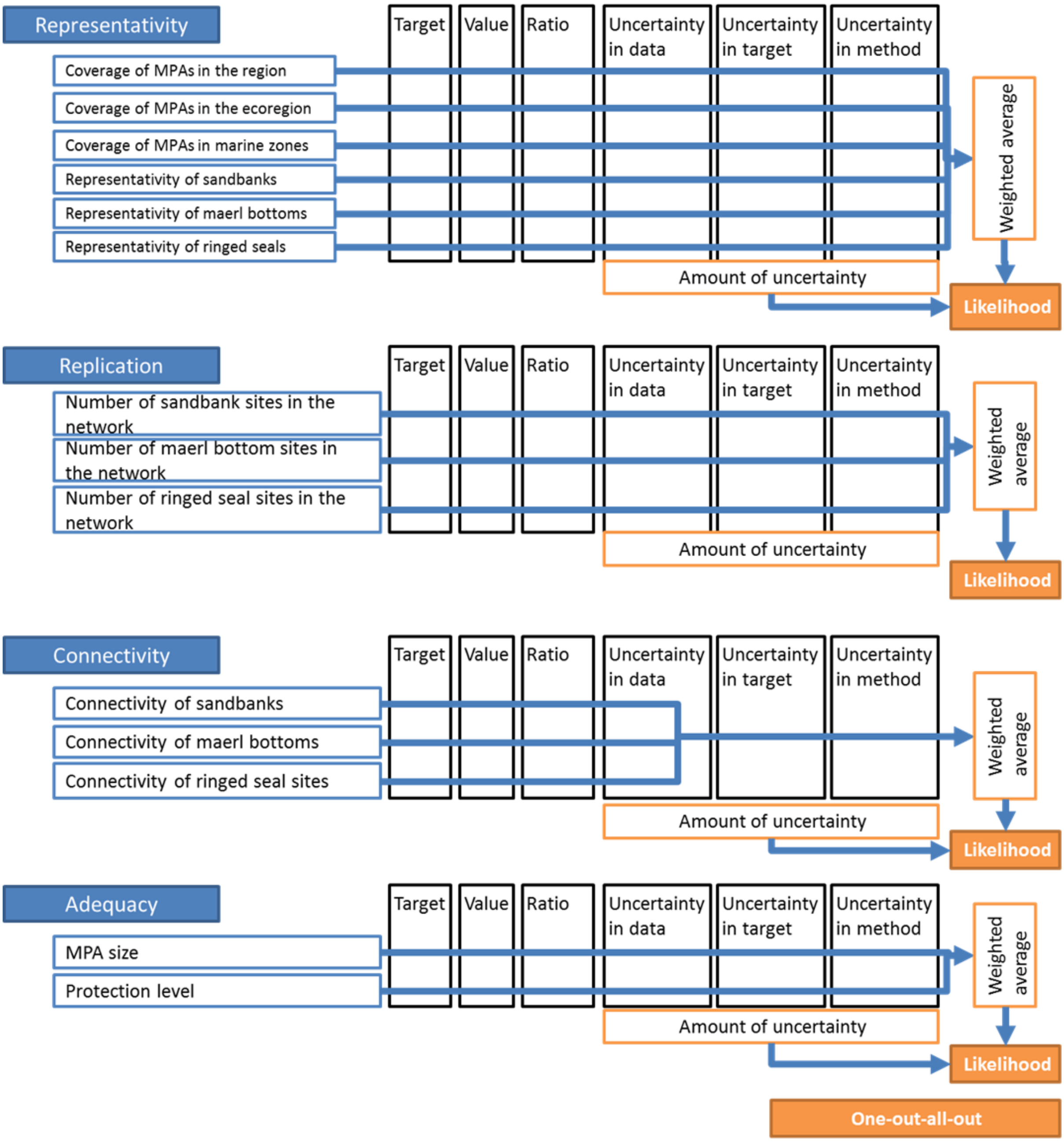

Figure 2. Integration method of assessment criteria and sub-criteria.

Calculations for each of the main criteria

The basic assessment of representativity consists of five analyses. Four GIS analyses compare the area of MPAs with the area of the marine region, sub-basins/ecoregions, depth zones/marine zones and waters under national jurisdiction. The outcome is given as a proportion (%).The representativity of conservation features is an analysis of the presence of selected features in the network. The selected features should include species and habitats of the Habitats and Birds Directive as well as the Regional Sea Conventions' 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, species and habitat distribution maps are used as a baseline and the representativities of selected features are analyzed as proportion of the entire area of the feature. The distribution of a feature within an MPA does not mean that the feature is protected by the site but that depends on the legal instruments used for the protection. The database for each MPA should include the selected features and if the feature is protected by a legal instrument or not.
Since there can be different protection zones within MPAs, protected by different instruments, the database should preferably be spatial in order to differentiate in which areas specific features are protected or not. As the number of selected features may be high and vary, it is suggested that these sub-criteria are averaged and a single 'representativity assessment' is produced. Optionally, the averaging can be weighted by the uncertainty, which can be high in case of habitat and species distribution.

The basic assessment of replication counts the number of MPAs including the selected features. As compared with the representativity analysis, the outcome of this criterion is a number of MPAs for each feature. In a more detailed assessment, one should consider the legal basis of the protection and count only those replicates where the feature enjoys of actual legal protection.

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 no connections, 1-4 connections, 5-10 connections and ≥10 connections.

In the more detailed analysis, the connectivity is assessed on the basis of protected features, which are mapped within the MPAs. Protected features are either patches of habitat occurrence or functionally important areas (e.g. feeding, spawning etc.) of larger species. The more detailed assessment includes only features that are protected by proper legal instruments.

The basic adequacy assessment is divided between two criteria: MPA size and protection level. Sufficient size has usually been set between 10-60 km^2 while sizes of 20-30 km^2 are a good compromise between less mobile species and more mobile species. The basic assessment of the protection level is made by analyzing areas for the protection categories in the region and calculating their proportion (% out of the total MPA area). In many cases, MPAs do not represent only one protection category, but there are zones of various protection levels. In such a case, if spatial data exists, one could make a similar spatial analysis of the area (and proportion) of the protection categories. The proposed categories of protection levels, based on the IUCN-categories and tailored for use here, are described in section 2.5.

In the more detailed assessment, impacts of anthropogenic pressures in the vicinity of the MPAs are analyzed against the MPA size. 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). The third step is to make a spatial analysis of the MPA area (%) impacted by the pressures in the network.

There is no suggestion for a more detailed assessment method for the assessment of protection level. Integration of the adequacy sub-criteria can be done similarly as for the representativity sub-criteria.

This assessment method emphasizes the role of uncertainty in the assessment. In section 2.4 this is addressed in more detail.

Table 1. Overview of the criteria, sub-criteria and indicators used in the assessment method.

Over-arching key concept: Ecological Coherence	Main criteria	Sub-criteria	Indicator basic method	Indicator detailed method	Unit
	Representativity	coverage of MPAs in the marine region	proportion total area MPAs / total area		%
		coverage of MPAs in the sub-basins / eco-regions	average value of area MPAs divided by the area of the ecoregion, for n ecoregions		%
		representativity of depth zones / marine zones	average value of area MPAs divided by the area of the marine zone, for n zones		%
		coverage of MPAs in waters under national jurisdiction	proportion total area MPAs / area waters under national jurisdiction		%
		representativity of conservation features	average value of proportion of MPA area including the feature, divided by total area, for n features	selected features within MAP's as proportion of the entire area of the feature. Discern protected/non-protected areas.	%
	Adequacy	MPA size	average size of MPAs	average size of MPAs free from pressures	km^2
		level of protection	categories based on IUCN, adapted		-
	Connectivity	connectivity of MPAs	proportions of MPAs per class of connections (0, 1-4, etc) within e.g. 20 or 50 km	idem, but based on locations of legally protected features	%
	Replication	replication of sites per feature	number of MPAs including n selected features	include legal protection, select only protected areas	-

2.4 Dealing with uncertainties in assessment results

In the assessment of ecological coherence of a MPA network, uncertainties are high. Thus an uncertainty factor is included in the assessment to bring in flexibility to the stringent OOAO method. Uncertainties have been used in European assessments widely and an example of a guided uncertainty assessment is in the Baltic assessment of hazardous substances (HELCOM 2010). The OSPAR guidelines and principles for an assessment of ecological coherence used a likelihood-based assessment where qualitative likelihoods are considered when results are missing or are not fully trusted. In Annex 3 the assessment criteria and associated likelihoods are organised into a matrix as a visual tool to help the integration of assessment criteria.

The four assessment main criteria are integrated by the one-out-all-out principle and the sub-criteria are averaged to have a single assessment results for the main criteria. As the sub-criteria 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 be used to weigh the sub-criteria in the averaging. The likelihoods are used to estimate whether the target is reached and can be applied only to the level of the main criteria. In this case, the likelihoods would be judged on the basis of the uncertainty on the sub-criteria level.

The ecological coherence should be assessed by a flexible one-out-all-out principle, where likelihoods of meeting targets of all the assessed criteria are inspected in a matrix and the failures to meet the targets (together with the uncertainty estimates) are visualized. The process of the analysis can be shown in the decision tree of **Figure 3**, indicating the necessary steps in the assessment and how can be improved.

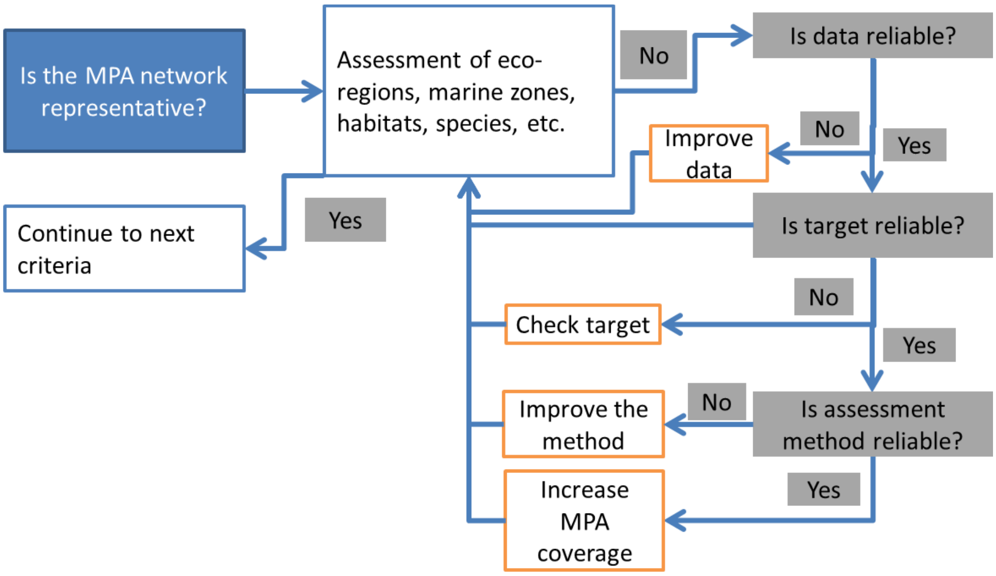

Figure 3 A decision tree to suggest which elements of the assessment need improvement.

2.5 Proposal for management levels of MPAs

MPAs should be managed to ensure the protection of the features for which are selected. In order to reach different conservation goals, MPAs or parts of them could require a variety of management measures from strictly protected areas to areas of sustainable use, depending on the objective of conservation for each site. Ideally the objectives of each individual management plan should contribute to achieving the general objectives of adequacy, representativity, replication and connectivity within the regional and/or European Network.

This report suggests new definitions for the management levels based on the IUCN MPA categories. MPAs should be managed to ensure the protection of the features for which they were selected. In order to reach different conservation goals, MPAs or parts of them require a variety of management measures from strictly protected areas to areas of sustainable use.

This range of management measures can be separated to categories, such as the IUCN management levels (Day et al., 2012). One of the tasks of this project was to suggest management levels for the European MPAs. In this section, we propose seven management categories based on the IUCN classification. The description of the management levels described below is mainly based on the IUCN management levels (Day et al., 2012), because the IUCN system is widely accepted and used on a global scale. Nevertheless, some modifications have been added to the proposed classification in order to suit to the specific requirement for European MPA Network. The proposed classification is below:

1. No entry zones (based on IUCN Ia):

Areas strictly set aside to protect biodiversity and also geological / geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas serve as indispensable reference areas for visual (no lethal) scientific research and monitoring. Ecosystem functions are maintained. The Good Environmental Status (according to MSFD) maintenance is guaranteed, unless external pollution hinders this. It is recommended that areas assigned to this management level also have a buffering area around it (e.g. other management zones) in order to minimize the adverse influence of the surrounding area. Examples of this category include breeding sites of seabird colonies or seal sanctuaries.

2. No take zones (based on IUCN Ib):

Areas without permanent or significant human activity retaining their natural character and ecosystem processes, which are protected and managed so as to preserve and restore pristine conditions. Using the available resources in ways compatible with the conservation objectives (e.g. subsistence fisheries); to protect the relevant cultural and spiritual values and nonmaterial benefits. The natural ecosystem functioning predominate 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 the Good Ecological and Environmental status. Visual (non-destructive) scientific research and monitoring could 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.

3. Protection of large-scale ecological processes based on (IUCN II):

Large scale natural biodiversity along with its underlying ecological processes and habitats are protected. Management measures should be dedicated towards the perpetuation, in as natural a state as possible, of representative examples of physiographic zones within European regions and subregions. It should seek the ecosystem functioning through its integrity and resilience maintenance. It should contribute to regional ecological processes, the conservation of wide-ranging species and migration routes. It should promote the biodiversity and genetic diversity maintenance. These areas provide education, scientific (take) research and recreation, not causing significant biological or ecological degradation. Examples of this category can include important breeding or feeding sites of seabirds and marine mammals, important fish spawning or nursery grounds and migration routes of migratory fish (e.g. estuaries).

4. Singular natural enclaves (based on IUCN III):

Management should be dedicated to protect specific outstanding natural features and their associated biodiversity and habitats. These include specific features such as sea mounts, rock outcrops, submarine caverns, submarine canyons, or other geomorphological features that could host high natural and biological value (i.e. coral gardens). The MPA can cover the entire feature or a part of it. These areas can show a high visitor value and the management needs to be adapted according to the feature.

5. Particular management zones (based on IUCN IV):

Areas with specific management plans dedicated to the protection of priority species or habitats (e.g. according to Habitats or Birds Directives). Protection measures may vary depending on the conservation goal. These areas are included, for example, within the Natura 2000 or Ramsar Network.

6. Traditional activities management zones (based on IUCN V):

Management plans are designed with the aim of protecting and sustaining the area and its associated nature for conservation and other values (i.e. cultural, etc.). It should be focused 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 (commercial or subsistence fishing practices, at small-scale). These areas might contribute to broad-scale conservation by maintaining marine activities that are considered compatible with the conservation objectives.

7. Sustainable management zones (based on IUCN VI):

This category includes MPAs which aim at protecting natural ecosystems while still using natural resources sustainably, so that conservation and sustainable use can be mutually beneficial. 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 are ecosystem-based with long-term objectives. It should promote compatible uses and avoiding undesirable effects that would not allow to the achievement of the good environmental status in 2020 according to MSFD. This type of management plan includes Marine Spatial Planning approaches.

At present, management plans are applied to individual MPAs and the MPA network is composed by individual MPAs that are under different management levels. Ideally the objectives of each individual management plan should contribute to achieving the general objectives of adequacy, representativity, connectivity and coherence within the regional and/or European Network. To achieve this goal, this report proposes that the 'adequacy' criterion would include the target of having a sufficient proportion of the network assigned to each of the management levels.

3 Test results of the proposed method

3.1 Test area

Using the assessment method presented in chapter 2, a basic assessment and two more detailed assessments have been performed. This chapter presents in brief the findings of the test. The detailed description is found in Annex 5, chapters 6 and 7.

The case study area is located in the central Baltic Sea, covering 92 MPAs from four countries (Estonia, Finland, Latvia and Sweden), whereas the total coverage of MPAs is almost 9 % of the case study area.

The study area (Figure 4) was selected on the basis of the following criteria: includes several Member States and several MPAs, availability of MPA data, and availability of data necessary for more detailed assessments.

Figure 4 Map of the 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 or ecoregions,
- (3) Representativity of marine zones or depth zones,
- (4) Representativity of selected habitats (% of MPA area including the habitat),
- (5) Representativity of selected species (% of MPA area including the species),

Replication:
- (6) Replication of sites with selected habitats,
- (7) Replication of sites with selected species,

Adequacy:
- (8) MPA size,
- (9) Level of protection,

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

The more detailed assessment methods included data on the main anthropogenic pressures and broad-scale maps on benthic habitats.

3.2 Test procedure

The assessment criteria were analysed for the case study area by the basic methodology and the more detailed methods. The basic assessment of representativity and replication consisted of analyses of seven species and eight habitats. 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) 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.

As a second step, an impact range was given for each pressure to reflect a ‘significant effect’ of the pressure. 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.

3.3 Conclusions

The ecological coherence was assessed using a basic method and a more detailed method. While the former can be done by simple data sets (polygons of MPAs, marine region, ecoregions and bathymetry and lists of features per MPA), the latter requires more sophisticated GIS data on spatial distribution of conservation features (habitats, species, underwater landscapes, geological formations, etc) and anthropogenic pressures (at least the predominant ones or those affecting specifically the conservation features), as well as a database of legal instruments which have been used to protect the site and a list of features which are legally protected.

The ecological coherence of the MPA network in the case study area was assessed by using the four main assessment criteria and the sub-criteria and by following the methodology suggested. The basic methodology included 30 sub-criteria for representativity, 15 for replication, three for connectivity and two for adequacy. Weighted averages of the four criteria were considered and taking account of the uncertainties, the assessment result is that it is unlikely that the network is ecologically coherent.

The basic methodology with more ambitious targets resulted in poorer results. With the uncertainties and the assessment result being the same: the network is unlikely to be ecologically coherent.

The more detailed assessment had different data and methodology in the sub-criteria and therefore the results of the assessment are also different. The use of mapped data decreased uncertainty in methods but the data were not very reliable and hence the data uncertainty increased. Based on the adequacy criterion, the assessment concluded that it is unlikely that the network is ecologically coherent. Overall the results with the more ambitious targets showed it is very unlikely that the network is ecologically coherent.

We were not able to test the third more detailed assessment method, i.e. the legal basis of protection, as the data for that was not in the international databases. We suspect that in many countries even national databases are not arranged to properly contain information of the features which are legally protected by the site. We think that this addition to the MPA assessments is necessary in the long run.

4 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 existing networks of European MPAs. We have made some important steps in 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 first objective of this chapter.

The second objective of this chapter is to list and characterize some relevant external viewpoints, which sometimes have diverging expectations from it. In the future this may result in a broadened scope of the assessment method. In the course of the project, and in particular after the May 2014 workshop (see Annex 4), it became clear that the practical needs and expectations of the MS's representatives partly go beyond the original aim of the project. We have taken those comments to heart, but addressing them was, within the project, possible to a limited extent only. In this chapter we address these comments and link them to the results of our efforts, as recommendations for follow-up activities.

4.1 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:

- There is a need for an overview of recent and ongoing research related to MPAs.
- The available knowledge of the marine environment is often insufficient to define target values for the assessment criteria on scientific grounds.
- There is a need for the establishment of mechanisms to monitor the implementation and efficiency of the adopted measures.
- The implementation of the Natura 2000 network, which supports the implementation of the Habitats and the Birds Directives, is at the core of the process of establishing networks of MPAs. However in the EU Habitats only a small part of the listed species and habitats are marine, and there are many gaps concerning the deep sea ecosystems.
- The ways in which MPAs support reaching the GES have not yet been made explicit and have not yet been translated into operational criteria.
- Uncertainty has been incorporated in the method that is presented in this report. The purpose of including it is to provide the user with a better 'feel' for the results. Recommendations on how to act on these uncertainties are still lacking.
- The detailed assessment proposed in this report requires more sophisticated GIS data on the spatial distribution of conservation features and anthropogenic pressures (at least the predominant ones or those affecting specifically the conservation features) as well as a database of legal instruments which are used to protect the site and a list of features which are legally protected. Also in the last dataset spatial data is the preferred format, as the legal basis can vary in different parts of an MPA.

- Knowledge gaps exist in the ecological, economic and social aspects of MPAs, and in questions on how to apply this information in planning and management.
- Targeted research and field surveys to address the gaps of knowledge on biodiversity changes caused by human impact and climate change impact on the spatial distribution of organisms is needed to move beyond 'preserve and protect'.
- Mapping pressures and threats and incorporating this knowledge to risk assessment into the management of MPAs is needed for effective implementation of the protection levels.
- Development of databases for MPA management is needed (and also for designation and planning, although that is not the scope of this study). There are data and knowledge gaps on spatial distribution of the conservation features (habitats, species, underwater landscapes, geological formations, etc) and the anthropogenic pressures, as well as on the legal instruments which have been used to protect the site and a list of features which are legally protected. The EMODNet sea basin Checkpoints can be candidate platforms for testing and assessing MPAs networks at regional and sub-regional scale.

A proposal for the priorities in these knowledge gaps is included in paragraph 4.3.

4.2 Considerations and comments relevant for the identification of follow-up activities

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.

Target setting

There are two different types of targets: policy and ecological targets. Even though a common set of criteria and sub-criteria was proposed for all the Regional Seas, the targets may vary, depending on the political, socio-economic and environmental conditions in the marine regions.

For the ecological targets the full range of representative features per region should be identified.

Member States must identify the conservation features in their marine areas (habitats, species, communities and ecological processes) in compliance with the Regional Seas Conventions lists.

It is clear that some of the targets are stronger than others. For example, there is strong political support for the target of 10 % MPA coverage in the marine regions and almost equally strong support for the representativity targets for habitats and species and levels of protection. In contrast, targets for connectivity or replication have not been stated on political fora and there is only some scientific support for those. Somewhere between these extremes are the targets for MPA size and level of protection; both have fairly strong scientific support whereas there are no political statements on them.

Regarding the state of the targets, this report considers many of them preliminary and with certain amount of associated uncertainty. This has been stated in the case study and in particular for the distinction between ‘basic’ and ‘more ambitious’ targets.

Definition of the assessment goals

When performing an assessment it is important to know precisely what the objectives of the assessment are. Two discussions arose after the May 2014 workshop, related to these objectives. The first addressed the interpretation of article 13(4) which lies at the basis of this study; the second was related to the practical use that some MS expect from this study.

Underlying this study is the obligation that the EC has, based on art. 16 of the MSFD. The service request then states: *'This assessment will thus also need to include an analysis of the contribution of the Member State's MPAs towards a coherent and representative network of MPAs, adequately covering the diversity of the constituent ecosystems, as required under Art. 13(4) (...) The present contract should develop the harmonised methodology for the evaluation by the European Commission of the coherence, adequacy and representativity of the EU networks of MPAs bearing in mind the work that has been carried out by European Topic Centres (ETCs) for assessing the sufficiency of the N2000 marine designations under the Habitat Directive."*

Art 13(4) reads: *'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.'*

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 MS. 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 and thus focuses on the ecological coherence of the existing MPA-networks. This is how the aim of the study is described in the Service Request. That said, 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 second discussion on the objectives of the assessment arose from the practical needs of some MS, to identify and use the potential synergies between their efforts for Natura 2000 and MSFD, and/or to provide guidance and support in the fulfillment of the reporting obligations. Leading questions for that approach are:

- Are we protecting sufficient and adequate areas through MPAs and other spatial protection measures to enable us to reach GES with respect to what has already been nominated by Member States for Natura 2000 or other purposes?
- How are existing spatial protection measures by RSC's contributing to reaching GES in individual MS?
- Do we protect adequate habitats and species within these areas to reach GES with respect to what has already been protected under the Habitats and Birds Directives?
- Do we have proper management within and outside of these areas to reach GES?

The proposed assessment method was not developed for such use. Estimating the contribution of spatial measures in general and MPAs in particular to GES still requires some efforts, as indicated in Annex 5. The suggested assessment method can be tailored to answer these questions, but that requires additional studies.

Management

This report has not included aspects of management efficiency as an assessment criterion. This issue was raised during the May 2014 workshop and feedback was provided for the preparation of this report. It became clear during the meeting that management efficiency should be assessed separately from the assessment of ecological coherence. However, we understand that management is an important issue and that it should be assessed in connection with the coherence. 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 stressed the importance of tracking the management effectiveness of individual MPAs within the network (Laffoley 2008).

The OSPAR and HELCOM definitions for the MPA network include the concept of 'well-managed' areas (HELCOM-OSPAR Joint Ministerial Meeting, 2003, Bremen), which implies that management is an important feature of an MPA network. The HELCOM Recommendation 35/1 and OSPAR Recommendation 2010/2 mention, however, the management and ecological coherence separately and put their assessments 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 into the assessment methodology.

Management is 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 ‘level of protection’ 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. Also the OSPAR assessment (2013) included protection level as an ‘essential aspect of ecological coherence’.

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 weigh 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 considered to be the Ecosystem-Based Marine Spatial Management (EB-MSM).

Further remarks on related EU policies

The MSFD contributes to the establishment of a coherent and representative network of MPAs under a holistic, ecosystem-based approach rather than focus on a few habitats and species. The MSFD includes the marine species covered by the Habitats and Birds Directives, since it addresses marine species either as part of the habitat types (e.g. angiosperms, plankton and benthic fauna of seabed and water column), or as marine species of birds, mammals, reptiles and fish. Annex III of the Directive indicates also the species which are the subject of Community legislation or other agreements. Natura 2000 can be the basis to reform, build and re-design real networks of MPAs. In the EU Habitats Directive most sites are small and coastal, therefore Natura 2000 should be extended in the off-shore environment. Coastal MPAs may be nested in greater pelagic MPAs, and this is expected to improve the efficiency of MPAs networks and their conservation targets.

The MSFD GES criteria 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. The spatial measures should target the main pressures on the conservation features at a larger scale than in individual MPAs, and should consider the network component at a regional scale contributing to ecologically coherent networks of MPAs.

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.

Trade-offs between ecological and socio-economic parameters; anthropogenic pressures.

In the advanced assessment method presented in chapter 2, the anthropogenic pressures and their spatial distribution are proposed as additional components of the assessment. Including these components will provide a spatial overview and 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.

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 AIS data and impacts of fishing on the basis of 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.

Maps of habitats and species distribution are, on the other hand, much more difficult to obtain. International projects, such as EUSeaMap or BALANCE have produced broad-scale habitat maps (of abiotoc features) for almost three marine regions and national mapping projects include biotic elements such as habitat-forming species. At the moment, maps of conservation features are on a rough scale and there are proven errors within the data, but it is a good start for more realistic MPA assessments.

Legal aspects

In this report we were not able to test the third more detailed assessment method, i.e. the legal basis of protection, as the data for that was not in the international databases. We suspect that in many countries even national databases are not arranged to properly contain information of the features which are legally protected by the site. We think that this addition to the MPA assessments is necessary in the long run.

4.3 Recommendations for follow-up activities

Short term (1-2 years)

- For the further improvement of the assessment methodology:
  - Extend the pilot application of the proposed assessment methods to all European marine regions, report, and exchange experiences.
  - Start monitoring efforts to describe the base levels, where not available.
  - Develop operational indicators to describe the environmental features which connect our proposed criteria for the assessment of MPA's with the MSFD-GES criteria, building on Table 3-2 of Annex 3.
- For the improvement of the acceptance and application of the assessment methodology:
  - Find agreement on the exact interpretation of Art.13(4).
  - 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 methodology:
  - In general: promote monitoring and research activities that help reducing the uncertainties in the assessment methods.
  - Develop databases on the spatial distribution of conservation features.
  - Develop monitoring, assessment and databases of anthropogenic pressures.
- For the improvement of the acceptance and application of the assessment methodology:
  - Extend the assessments to include other spatial measures than MPA's.
  - Extend the assessments such that they can be linked to the MSP processes.
  - 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 MPA's. The suggested assessment criteria are in many cases similar to criteria that have been suggested and used when setting new sites and designing a network.

Long term

- Collect data on legal arrangements and include these in databases.
- Assess the effectiveness of management practices in place and see if and how management practices could be included in the assessment method.
- Develop legal instruments for managing MPAs in cross-boundary areas and high seas.
- Consider options for common target setting.

5 Discussion and conclusions

This project has focused on the principle 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 (also called viability). Connectivity between habitats and species is considered a critical issue for an effective conservation. By a set of assessment criteria and an integration method we have suggested how ecological coherence can be assessed in the European MPA network(s).

The assessment method suggested in this report is a framework which can be applied at various scales (national network, cross-boundary network, sea basin, Europe). The method builds upon existing guidelines, methods and practices and, hence, it is not novel. However, this is the first attempt to compare 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.

During the workshop with the MEG in May 2014, in which the assessment criteria were discussed, it became clear that at least some Member States hope to see project outputs that will help them with their reporting obligations to the EC. This has not been the purpose of the project, although the outputs can be considered as one of the building blocks that are needed for such an application. A proposal for a roadmap towards a more comprehensive assessment methodology is discussed in Chapter 4.

An important conclusion is that at present, a number of important scientific knowledge gaps still exist. As a consequence, at present it is not yet possible to offer a full, comprehensive assessment method for MPAs. Rather, this report sketches the current state of the art and identifies a number of 'next steps', which will help Europe's Member States to make further progress.

In order to establish a common methodology for assessment of coherence other issues have to be considered. For instance, MS are bound by EU legislation, while the process of appointing MPAs and how to prioritize among different uses of an area is determined by national data availability and criteria. The identification of commonalities in MS approaches and information used in establishing MPAs is essential and should provide the necessary information for developing the next steps towards a more coherent harmonized network of MPAs at the EU level, supporting the GES objective established in the MSFD.

The Natura 2000 could be a good basis to reform, build upon and re-design real networks of MPAs, whereas the spatial measures should target the network component at a regional scale contributing to ecologically coherent networks of MPAs. The management measures should follow a holistic approach of protection of ecosystem function, structure and integrity, in addition to individual resources and physical characteristics, through the scaling up of single sites to a zoned network with multi-use coordinated units.

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A List of acronyms

BHD	Birds and Habitats Directives
CBD	Convention on Biological Diversity
CDDA	Common Database on Designated Areas b
GES	Good Environmental Status
EB-MSM	Ecosystem Based Marine Spatial Management
EMODNET	European Marine Observation Data NETwork
HELCOM	HELsinki COMmission, the Baltic Marine Environment Protection Commission
IMO	International Maritime Organization
IUCN	International Union for the Conservation of Nature
MARPOL	MARine POLlution, the International Convention for the Prevention of Pollution From Ships
MPA	Marine Protected Area
MS	Member State or Member States
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
OOAO	One Out All Out
OSPAR	OSlo convention, PARis convention: Convention for the Protection of the Marine Environment of the North-East Atlantic
PSSA	Particularly Sensitive Sea Areas
RSC	Regional Sea Convention
SAC	Special Areas of Conservation
SPA	Special Protection Areas
SPAMI	Specially Protected Areas of Mediterranean Importance
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive
WHS	World Heritage Site

B Geographical terms used in this report

Geographic term	
(Marine) region	Defined in MSFD Art. 4(1): Baltic Sea, North-east Atlantic Ocean, Mediterranean Sea and Black Sea
(Marine) subregion	Defined in MSFD Art 4(2) for the NE Atlantic Ocean and Mediterranean Sea
(sub)region	Marine region or subregion
subdivision	Spatial delimitation of a part of a member states' marine waters in a smaller spatial unit (MSFD Art. 4(2)
Regional sea	Sea areas falling under the Regional Sea Conventions HELCOM, OSPAR, UNEP/MAP or BSC
Sub-basin	HELCOM's division of the Baltic Sea into smaller spatial units
Region I-V	OSPAR's division of the NE Atlantic into five areas; OSPAR regions do not fully match the marine subregions in the Nort-east Atlantic
Geographical Sub-area	Area defined by FAO for assessment of commercial fish stocks in the Mediterranean Sea and Black Sea
Biogeographical region	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)
Biogeographic zone	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
Ecoregion	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

Source: Prins et al. (2014).

C Criteria for the assessment of MPAs

C.1 Background

The ultimate objective of the Marine Protected Areas is to set aside marine areas where certain conservation objectives can be attained or maintained. Even though the conservation objective is not necessarily ‘good environmental status’, MPAs are a valuable tool in reaching or maintaining GES and, hence, the assessment criteria should have linkages with the MSFD and its criteria for GES.

It is recognised that marine biodiversity plays a fundamental role in supporting a wide range of ecosystem goods and services. But with the increase of human pressures on the marine environment, concern has increased about the necessity of management plans for nature conservation that could guarantee the provision of such goods and services required for human well-being. Today, Marine Protected Areas (MPAs) are recognized by most countries and regions in the world as an important instrument to conserve marine ecosystems. In Europe, the implementation of MPAs is driven by several international, EU and regional obligations and initiatives. The European legislation and Directives should conserve areas of special interest and maintain biodiversity, while considering the socio-economic context of these areas. Among others, the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC) aims to achieve Good Environmental Status (GES) of the European seas by 2020.

To achieve GES at EU level, a coherent, representative, EU-wide network should be set up with adequate MPAs to provide sustainable protection to relevant habitats and species. All EU Member States (MS) are expected to report on Marine Protected Areas (MPAs) according to Article 13, paragraphs 4 and 6. Information on MPAs should be included within the programmes of measures which are to be established by MS under Art. 13(4). According to Article 16, the Commission shall assess whether these programmes constitute an appropriate framework to meet the requirements of the MSFD. The Commission assessment will thus also need to include an analysis of the contribution of the MS's MPAs towards a coherent and representative network of MPAs, adequately covering the diversity of the constituent ecosystems. The methodological approach on how this will be assessed will be developed only after the article 21 report about the ‘progress in the establishment of marine protected areas’ based on this MS reporting in 2014. MS should provide public reporting on MPAs and information on the establishment of MPAs should be included in the programmes of measures under Article 13.

On the other hand, the Habitats and Bird Directives and Natura2000 legislation provide MS with a legal framework for setting up MPAs. These EU-wide networks were established to maintain and develop natural areas within the EU. Many MS have already nominated Natura2000 sites and are in the process of establishing these sites in concert with the Commission. The European Environment Agency maintains the EU Natura 2000 database, and the Common Database on Designated Areas (CDDA), to which MS report. The Natura 2000 database is updated annually according to the Nature directives; the reporting frequency of CDDA database is annual (latest deadline: March 2014) (WG_MPA, 2013).

In relation to the establishment of MPAs, there is fairly well-developed common understanding from recent and on-going projects and also among marine scientists how to define and assess coherence, adequacy and representativity of MPAs. In Europe, region-wide MPA assessments have previously been carried out for the Baltic Sea in the BALANCE project (Liman et al., 2008; Piekäinen & Korpinen, 2008), in HELCOM (HELCOM, 2010) and in OSPAR for the North Sea (Johnson et al., 2013; OSPAR, 2006), in the Mediterranean by the Network of Marine Protected Area Managers (MedPAN) and the Regional Activity Centre for Specially Protected Aeras (RAC/SPA) of the Barcelona Convention (Gabrié et al., 2012),. The European Topic Centres (ETCs) of the EEA, including the European Topic Centre on Inland, Coastal and Marine waters (ETC-ICM) and the European Topic Centre on Biological Diversity (ETC-BD), are already conducting a spatial analysis of MPAs and the European Marine Board published a position paper on the science needs for MPA coherence (Olsen et al., 2013). Furthermore, the EEA produced a report last year with an overview of protected areas in Europe (EEA, 2012) and will publish an inventory report of European marine protected areas (MPAs) in 2014. Concerning the Mediterranean region, another Status Report of MPAs will be published in 2016, beginning in December 2014 data collection for this analysis.

In addition to the documents from the regional organisations, 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 Marine Protected Areas 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 technical group worked to develop a recognized, coordinated, effective and representative network of marine protected areas in the Atlantic arc (http://www.maia-network.org/homepage). In relation to these objectives, the projects MESH and MeshAtlantic also focused their efforts in producing benthic habitat maps of European seas, and specific case studies in Natura2000 areas, to support their management. Likewise, for the Mediterranean region a Database of Marine Protected Areas in the Mediterranean (MAPAMED: www.mapamed.org) was developed, in 2011, and is jointly administered by MedPAN and RAC/SPA. The development of this GIS database that gathers information on MPAs and more generally on sites of conservation interest in the Mediterranean arose from the need to have a resource center collecting and structuring information on Mediterranean MPAs.

In addition, there are several national and international projects and scientific works describing definitions and MPA assessment methods in other parts of the world (e.g. (Smith et al., 2009).

The present Annex has the subsequent specific objectives:

- Provision of operational definitions of primary criteria: coherence, adequacy and representativity, as identified by the MSFD art. 13.4 for assessing European networks of marine protected areas;
- Provision of operational definitions of additional criteria such as replication, connectivity and management effectiveness;
- Contribution to the development and testing of a methodology for assessing whether European networks of marine protected areas are coherent, adequate and representative, as per the operational definitions mentioned above;
- Contribution to the development of an EU guidance document for assessing coherence, adequacy and representativity across the four marine regions and associated sub-regions, and organise a debate with the relevant Member States Marine Expert group.

  In order to achieve these objectives, the subsequent tasks were defined:

  - Analysis of scientific considerations and documentation, for defining regional criteria to the extent possible;

- Comparison of criteria used by Member States, Regional Sea Conventions and third parties;
- Provide operational definitions of relevant criteria for assessing coherence, adequacy and representativity of European networks of marine protected areas at MSFD marine regional and sub-regional levels;
- Describe a classification system for classifying management levels of European marine protected areas, and test its functionality, linking to existing IUCN categories.

The report will be used to develop an EU Guidance document for assessing coherence, adequacy and representativity as listed in Art 13(4) of the MSFD across four marine regions and associated sub-regions.

C.2 Material and methods

In order to collate the information from the different legislation, frameworks and Regional Seas Conventions (RSC's) in a synthetic and comparable way, a catalogue was designed that collates all data. 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 appendix with 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 Marine Protected Areas 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, Regional Sea Conventions, scientific papers.
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 one of the MSFD criteria (i.e. Representativity, Adequacy and Coherence).
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).

As the aim of the project is to develop operational definitions and test a methodology for assessing the networks of European MPA networks, our focus in this report is 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.3 Results

C.3.1 Scientific considerations and documentation for defining regional criteria

Inventory of the reviewed documentation

- Legislation

  - 4 European Directives/policies: Marine Strategy Framework Directive, Water Framework Directive, Habitats Directive, Birds Directive, Common Fisheries Policy;
  - 4 Non-European national legislations: Canada Wildlife Act & Migratory Birds Convention Act, Canadian Ocean Act, Australian Environment Protection and Biodiversity Conservation Act 1999, Lebanon Law no. 690 dated 26/8/2005;
  - 5 European National legislations: Norway Saltwater Fishery Law; Spain Royal Decree 7/11/2011 Criteria selection for MPA integration in Spanish national MPA Network; Romania Order nº 1964 of the Environmental and Durable Development Minister, December 2007; UK Wildlife and Countryside Act 1981 and Marine and Coastal Access Act

- International conventions and agreements:
  - 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;
  - 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/natura2000/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.3.2 Comparison of criteria used by Member States, Regional Sea Conventions and third parties

Table 3.1 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 three that could cover all the terms, which were, adequacy, representativity and coherence. Nevertheless, it could be as coherence being an overarching term for all of them. Annex 1 of the report includes all criteria (and definitions) listed in the catalogue.

According to the classification of criteria, 212 are related to the Representativity concept, 29 to Adequacy, and 17 of them to Coherence concept. Table 3.1 shows criteria classification according to framework type, Summarizing criteria listed in the catalogue. The complete catalogue is provided as an annex document to the report.

Table 3.1 Synthesis of criteria catalogued in Annex classification according to framework type.

Framework Type/Name	CRITERIA CATEGORY			Total
	Representativity	Adequacy	Coherence	
Regional Convention	**39**	**4**	**4**	**47**
Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean"	6			6
Black Sea Strategic Action Plan	10	1	1	12
Helsinki Convention	6	2	2	10
OSPAR Convention	12	1		13
Bern Convention	5		1	6
Other international Conventions and Agreements	**41**	**2**	**1**	**44**
Convention on Biological Diversity	10	1	1	12
MARPOL Convention	16	1		17
World Heritage Convention	10			10
EU Directive	**17**			**17**
Birds Directive	4			4
Habitats Directive	13			13
National legislation	**64**	**13**	**5**	**82**
Law of 14 April 2006 (France)	8	1	1	10
Marine and Coastal Access Act (UK)	7	1		8
Order nº 1964 of the Environmental and Durable Development Minister (2007, Romania)	5	2	1	8
Royal Decree 7/11/2011. Criteria selection for MPA integration in Spanish national MPA Network	10	1	1	12
Wildlife and Countryside Act 1981 (UK)	6	3	1	10
Saltwater Fishery Law (Norway)	2	2		4
Australian Environment Protection and Biodiversity Conservation Act 1999	10	2		12
Canada Wildlife Act	5			5
Canada. Migratory Birds Convention Act	4			4
Canada´s Ocean Act	7	1	1	9
Guidelines	**7**		**2**	**9**
Lebanon MPA Criteria	2		1	3
FAO. International Guidelines for the Management of Deep-sea Fisheries in the High Seas.	5			5
Guidelines_NGO	**24**	**6**	**2**	**32**
Alliance for Zero Extinction	3			3
BirdLIFE	5			5
KBAs	2			2

Framework Type/Name	CRITERIA CATEGORY			Total
	Representativity	Adequacy	Coherence	
IUCN_Davey, 1998.		4	1	5
IUCN_Kelleher, 1999.	8	1		9
WCPA/IUCN, 2007.	6	1	1	8
Projects	**5**	**3**	**2**	**10**
Balance project	2	1	1	4
MISIS project	2	1	1	4
UK MCZ	1	1		2
Scientific articles	**10**	**2**	**1**	**13**
Krause, et. al.,	1			1
Roberts, et. al., 2003.	9	2	1	12
Total	**212**	**29**	**17**	**259**

According to Table 3.1, almost all frameworks include criteria related to the Representativity concept. Conversely, criteria related to Adequacy are cited only in 20 frameworks (i.e. OSPAR, Helsinki Convention, Baltic Sea Strategic Plan, Convention on Biological Diversity, MARPOL Convention, UK MCZ project, Australian Environment Protection and Biodiversity Conservation Act 1999, Canada Ocean Act, IUCN, BALANCE project, and Roberts, et al 2003). The criteria related to the Coherence concept only appear in 15 framework types (i.e. Baltic Sea Strategic Plan, Helsinki Convention, Bern Convention, Convention on Biological Diversity, Lebanon MPA criteria, IUCN (Davey, 1998), UK Defra guidelines (Defra 2010), Balance project, and Roberts et al 2003).
Only 10 frameworks include all three criteria: Baltic Sea Strategic Plan, Helsinki Convention, Convention on Biological Diversity, Law of 14 April 2006 (France), Order nº 1964 of the Environmental and Durable Development Minister (2007, Romania), Royal Decree 7/11/2011. Criteria selection for MPA integration in Spanish national MPA Network, Wildlife and Countryside Act 1981 (UK), IUCN (Davey, 1998), BALANCE and MISIS projects, and Roberts et al. (2003).

Regional Sea Conventions
For OSPAR, 13 criteria have been inventoried in relation to the establishment of single MPAs and the network of MPAs (i.e. Threatened or declining species and habitats/biotopes, Important species and habitats/biotopes, Ecological Significance, High Natural Biological Diversity, Representativity, Sensitivity, Naturalness, Size, Potential for restoration, Degree of acceptance, Potential for success of management measures, Potential damage to the area by human activities, and Scientific value), according to the classification of criteria, all those criteria are related to the Representativity concept, except size criteria related to adequacy concept.

HELCOM identifies 11 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). Network's criteria are related to 3 concepts; MPAs criteria only with Adequacy and Representativity.

Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean" has inventoried 6 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.

Black Sea Strategic Action Plan applies criteria development by Convention of Biological Diversity. This Convention defines 7 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). Also defined are 5 criteria for MPA Networks, 3 of them related to Representativity (Ecologically and biologically significant areas (EBSA areas); Replicated ecological features; Representativity), 1 related to Adequacy (Adequate and Viable sites), and the last one related to Coherence (Connectivity).

Bern Convention includes 6 criteria, of which 5 are 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) and 1 to Coherence (Otherwise contributes substantially to the achievement of the objectives of the convention).

Legislation
Birds Directive lists 4 criteria, all of them related to Representativity (Danger of extinction, Habitat vulnerability, Rarity, Particular attention,).
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.3.3 Definitions of the network assessment criteria by the CBD

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 (EA) taking in account the human component as part of the ecosystem.

The CBD Decision IX/20 (Annex II) 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.

While these criteria are for the *development* of MPA networks, they indicate significant criteria for the assessment purposes and, most importantly, provide definitions for these criteria.

The first component ‘Ecologically and biologically significant areas’ requires that areas where MPAs will locate 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.

C.3.4 Definitions and use of the network assessment criteria by the Regional Sea Conventions

Assessments of the ecological coherence of MPA networks have been traditionally made on the level of regional seas, which usually represent distinctive eco-regions or geographically defined marine areas. Assessments have been based on a few criteria, which resemble the ones created for the establishment of the sites and the network, but do not necessarily fit one to one with them.

In this section, a comparison of the MPA assessment criteria by the Regional Sea Conventions was based on three main sources of information: the MedPan report from 2012, the HELCOM coherence assessment from 2010 and the OSPAR coherence assessment from 2013. There are no specific definitions related to MPAs in the Black Sea, and the Guidelines for the Establishment of MPAs in the Black Sea refer to CBD criteria. The full references are given in Table 3.2.

Table 3.2 Definitions and use of MPA assessment criteria by the Regional Sea Conventions in the European marine regions (green cells). Note that the RSC's may have defined a criterion but not used that in practice or used a criterion without proper definition (shaded cells). The details of the criteria are explained further in the text.

	Barcelona Convention [1]	Bucharest Convention [2]	HELCOM [3]	OSPAR [4]
Ecologically and biologically significant areas				
Replication: number of MPAs				
Surface area of the MPA network				
Age of MPAs				
Distribution/Representativity: marine zones/sub-basins				
Representativity: depth zones				
Representativity: eco-regions				
Representativity: habitats				
Representativity: species				
Representativity: ecological and evolving processes				
Representativity: remarkable features				
Connectivity: populations				
Adequacy: MPA size				
Adequacy: threats				
Adequacy: level of protection (IUCN categories or similar)				
Viability				

1) Source: Gabrié C., Lagabrielle E., Bissery C., Crochelet E., Meola B., Webster C., Claudet J., Chassanite A., Marinesque S., Robert P., Goutx M., Quod C. 2012. The Status of Marine Protected Areas in the Mediterranean Sea. MedPAN & RAC/SPA. Ed: MedPAN Collection. 256 pp.

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 marine protected areas, 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).

3) Source: HELCOM 2010. Towards an ecologically coherent network of well-managed Marine Protected Areas – Implementation report on the status and ecological coherence of the HELCOM BSPA network. Balt. Sea Environ. Proc. No. 124B.

4) OSPAR (2013) An assessment of the ecological coherence of the OSPAR Network of Marine Protected Areas in 2012. OSPAR Commission, Biodiversity Series 619/2013.

Table 3.2 indicates which criteria are adopted by the four RSC's and its purpose is to show which criteria can be chosen for European assessments and which are not used by all the RSC's. In some cases, the criteria were only theoretical and not used in the assessments or there are differences in details. The text below aims to explain the use of criteria in more detail.

Ecologically and biologically significant areas: not defined nor used by any RSC, but this has been raised as an issue at least by OSPAR (OSPAR 2013) and Barcelona Convention (Gabrié et al. 2013). The criterion can, however, be primarily used when finding areas in the need of protection and establishing MPAs. Its usefulness in MPA network assessment is limited and, in practice, it is covered by the representativity criterion (see below).

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 6nm) 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 definition of the CBD, but there are certain differences or additions to that definition. In the Mediterranean, the ecological and evolving processes are considered as part of representativity. In the North Sea, the definition is that 'to be representative an MPA network needs to protect the range of marine biodiversity found in our seas. This also includes protecting those features of conservation importance that are known to be rare, threatened or declining'.
In the Mediterranean and the Baltic Sea, the representativity was assessed by comparing the area protected features with the total area of that feature in the marine region.
A preliminary target level in the North Sea was 5% (species and habitats), in the Mediterranean 10% (habitats), and in the Baltic Sea a preliminary target of 20% (habitats) was used.

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. In the North Sea, 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). In the Baltic, eco-regions have not been identified.

Depth zones (or coastal/offshore/high sea zones): in the Mediterranean representativity of benthic habitats distribution according to depth zoning (infralittoral up to 30-40m; circalittoral 35-200m; bathyal 200-3000m; abyssal zone and beyond) and representativity of sites in coastal/offshore/high sea zones. In the North Sea, 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 was analyzed and also the depth zones were analyzed: 0-10m (coastal zone); 10-75m (shelf seas); 75-200m (deeper shelf seas); 200-2 000m (slope/upper bathyal) and >2000m (lower bathyal/abyssal). In the Baltic Sea, the MPA coverage (%) was analyzed in the coastal versus offshore areas.

Countries: in the Mediterranean, Baltic Sea and North Sea 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 North Sea, 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 RSC's 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. 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 RSC's count the number of sites within the marine region and sub-regions. In addition, in the Baltic Sea and North Sea, number protected features (i.e. habitat patches) are assessed within the assessment area. The North Sea 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.

Connectivity: In the Mediterranean, Baltic Sea and North Sea, connectivity is acknowledged to involve species migrations and larval drift, but assessments are run by proximity analyses with ecologically meaningful intersite distances (e.g. 20, 50, 100 or 150 km).

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

The CBD Programme of Work for the protection of marine biodiversity recognises, 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.

MPA size: In the Mediterranean, MPA size was assessed but no definition or target was given. In the Baltic Sea 30 km^2 is a recommended target and in the North Sea a 5 km^2 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 North Sea, OSPAR recognizes the level of protection as an 'essential part of ecological coherence' but has not included it in the 2013 assessment. HELCOM has not considered the level of protection (except as the implementation of management plans).
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.

C.3.5 Assessment criteria in relation to the European legislation

The MSFD and the criteria for GES
There exists no guidance how GES relates to the ecological coherence of MPA networks. The two concepts have some similarities (wide spatial scope, overarching approach) but also conceptual differences as the former assesses environmental state of a marine region and the latter states whether there is a representative and adequate MPA network.

The MSFD Art. 13(4) states that

> *'Programmes of measures […] 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.'*

The directive uses the term 'coherent and representative networks' in the sense which is comparable with the RSC assessment criteria. The term 'adequately covering the biodiversity…' has a slightly different meaning than the RSC 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'.

The MSFD criteria for GES were given in the Commission Decision (477/2010/EU). The criteria define in more detail how good environmental status can be assessed. It is clear that the MSFD GES criteria 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 exists or not, but by adjusting the targets of those one can indirectly move towards GES (or maintain it).

Bearing this difference in mind, it is also clear that there are some linkages between

1. representativity and replication and the criteria under descriptors 1 and 6,
2. adequacy and the criteria under all the descriptors (since by the protection level one can manage activities within the MPAs), and
3. connectivity and the criteria under descriptor 1.

Thus, to ensure that the GES assessment and the MPA assessment support each other, one should include same biological and environmental features to the assessment. **Table 3.3** gives examples of such mutual features.

Table 3.3 Biological and environmental features which connect GES assessments and MPA assessments.

MPA assessment criteria	GES criteria	Remarks
Representativity of species	1.1, 1.2	The MPA assessments have emphasized threatened species but GES criteria include also the key species and predominant species. Habitats Directive and Birds Directive 'Annex species' should be included in both assessments.
Representativity of habitats	1.4, 1.5, 6.1	The MPA assessments have emphasized threatened habitats but GES criteria include also the predominant habitats. Habitats Directive 'Annex habitats' should be included in both assessments.
Replication of features	1.1, 1.4	See above.
Adequacy: Protection level	all criteria	Protection level defines what is allowed, restricted or forbidden in the area, therefore it affects species, habitats, hydrography, seabed and all the human pressures and impacts. GES assessments should lead to a check of the protection level → if a feature is not in GES, the protection level can be adjusted to provide better protection against pressures.
Adequacy: MPA size	-	No direct connection; MPA size relates to the protection against external threats.
Connectivity of features	1.3, 1.6, 1.7, 4.1, 4.2, 4.3, 6.2	Interconnected populations and habitats have higher viability, and the food web functioning is better. Connectivity analysis could include species (incl. habitat forming species) which have a key role in the food web.

The Habitats Directive and the Natura 2000 network

The Natura 2000 supports 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 very incomplete and most designations are in inshore waters. The Habitats Directive requires the establishment of Special Areas of Conservation (SACs) to be designated for particular species and habitats, listed in Annexes I and II respectively of the Habitats Directive, and the Birds Directive requires the establishment of Special Protection Areas (SPAs) for birds.

According to the HD (Annex III), the sites are selected by 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.

The HD also requires an assessment of the network of MPAs (Annex III). **Table 3.4** relates the Natura 2000 assessment criteria with the RSC assessment criteria. The comparison shows that there are differences in the approach, but in general, the Natura 2000 networks could be assessed by the same set of criteria as the MPAs. The only truly different criterion is 'relative value of the site at national level', which could be assessed separately for each Natura 2000 site. It is also noteworthy that connectivity is not required in assessments of the Natura 2000 network.

Table 3.4 The Natura 2000 assessment criteria (Habitats Directive, Annex III) and their links with the RSC assessment criteria (described in the previous chapter).

Natura 2000 assessment criteria	Similarity with the RSC criteria
Relative value of the site at national level	-
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	Representativity of species (as regards migrating species). Representativity of habitats (if migration routes are considered as wintering, resting and feeding habitats).
Total area of the site	MPA size
Number of natural habitat types in Annex I and species in Annex II present on the site	Replication of features.
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	Representativity of remarkable features. Representativity of species.

The real difference between the Natura 2000 criteria and the RSC 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 discussed in the previous section.

There is, however, a practical challenge in MPA assessments, if a site does not protect the full range of features within its boundaries. A Natura 2000 site established for the protection of 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. This challenge was suggested to be met in the more detailed analysis method (see Chapter 4).

C.3.6 Experience on assessment criteria in science and outside Europe

There are very few assessment criteria presented by NGOs or scientific research. Therefore this section includes some discussion also of the network design criteria which can guide the discussions what assessment criteria can be used for the MPA networks. Moreover, the design criteria also give 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 km^2 and the preferred MPA size range was defined from 47 to 93 km^2. MPAs should be placed within 50-100 km of each other (Saarman et al. 2013; Sciberras 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 marine protected areas with a total area of 344 400 km^2.

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 & Shares (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 experience
The European Marine Board made a position paper on MPA networks (Olsen et al. 2013). The paper presents a good overview of the science behind MPA network design and management and also some aspects of assessment. As an annex to the report, assessment criteria and associated targets from different frameworks are presented. There were only few quantitative targets presented:

- Representativity: 30-50 (-100) % of features covered,
- MPA size: 2-6 km in diameter,
- Connectivity: 20 km apart, but depending on dispersal,
- Replication: a minimum of three occurrences of features,
- Level of protection: high level of protection to at least one feature occurrence,

IUCN proposes the following eight design criteria for MPA networks:

- Representativeness: MPA networks should represent the range of marine and coastal biological diversity (from genes to ecosystems) and the associated physical environment within the given area.
- Replication: All habitats in each region should be replicated within the network and distributed spatially throughout the network.
- Viability: MPA networks should incorporate self-sustaining, geographically dispersed component sites of sufficient extent to ensure population persistence through natural cycles of variation. These sites should be independent (as far as possible) of activities in surrounding areas.
- Precautionary design: Network designers should base their decisions on the best information currently available, rather than delaying the process to await more and better information. Where information is limited, designers should adopt a precautionary approach.
- Permanence: Network design must provide long term protection to effectively conserve diversity and replenish resources.
- Maximum connectivity: MPA network design should seek to maximize and enhance the linkages among individual MPAs, groups of MPAs within a given ecoregion, or networks in the same and/or different regions.
- Resilience: MPA networks must be designed to maintain ecosystems' natural states and to absorb shocks, particularly in the face of large-scale and long-term changes (such as climate change).
- Size and shape: Individual MPA units within the network must be of sufficient size to minimize adverse impacts from activities outside the protected area (avoiding what is called the "edge effect").

The scale of benefits derived from individual MPAs will depend on their location, design, size, and relationship to other forms of management.

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.4 Towards common MPA assessment criteria in the European marine waters

C.4.1 Similarities in the RSC and other assessment criteria

The analysis of the RSC assessment criteria shows that the assessment criteria for MPA networks are similar across the four European marine regions, where information is available from. An analysis of the Natura 2000 assessment criteria also showed that the use of the RSC criteria will support the assessment of Natura 2000 network, while there may be limitations in the protection of all features. It is equally clear that there are subtle differences in theoretical principles laid out in earlier RSC guideline documents and the published assessment reports: the guidelines have higher ambition level for assessments while the assessments seem to rely on more practical approaches. However, the strength of the assessment reports has been the practical approach where scientifically challenging assessment criteria have been simplified in order to make the first steps and more difficult criteria have been left for future analyses.

The European RSC assessment reports as well as experience from other parts of the world focus on four main criteria: <u>representativity</u> (of marine zones, ecoregions, habitats and species and including aspects of geographic distribution), <u>replication</u> (of sites and habitats), <u>connectivity</u> (proximity used as a proxy) and <u>adequacy</u> (including viability, e.g. MPA size, level of protection).

The main criteria consist of sub-criteria, such as presented for representativity criterion (see above). This grouping of sub-criteria into the four main criteria was expressed clearly in the OSPAR 2013 assessment of ecological coherence, where the 13 ecologically coherent design principles set out originally by OSPAR (2006) were grouped into four assessment criteria: Adequacy/viability, representativity, replication and connectivity. It was also inherent in the HELCOM assessment, where the chapters were organized according to the main criteria.

C.4.2 Operational definitions of assessment criteria

Based on the feedback in EU Marine Expert Group (MEG) meeting (6 May 2014) (see Annex 4), a need emerged to align the definitions more with the work of RSC's. Two major modifications were made to the criteria and their definitions:

- the management aspect is removed from the adequacy criterion, as this will be analyzed separately and the assessment of ecological coherence assumes that all sites have management plans in force;

- the replication criterion is included among the main criteria, as an essential part of ecological coherence.

The adequacy criterion reads now:

> *Adequacy means practical evidence that the individual components of the network are of sufficient size and have a sufficient level of protection to ensure ecological viability and resilience of habitats and species. The target for an adequate MPA network is that sites reach a minimum recommended size and the network includes the management categories related with endangered features.*

The new replication criterion reads now:

> **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. All features should be replicated to enhance resilience, representativity and connectivity and replicates should be spatially separate.* (HELCOM 2010, OSPAR 2013).

Other assessment criteria from the RSC's

According to the RSC assessments there are also some sub-criteria, which were not shared by all the marine regions. These are:

- Age of MPAs: *The MPA age indicates quality (or maturity) of the protected site, which can be linked with the adequacy criterion*.
- Anthropogenic pressures: *Presence of human activities, pressures and impacts outside, on the border or within the MPAs affects the quality of MPAs.*
- Connectivity of features (analyzed as proximity): *The expansion of the connectivity criterion to include features (species, habitats, landscapes) requires mapping of the features (at least within the MPAs, but preferably also outside them) and lifts the connectivity analysis closer to ecological meaningfulness (even though it is still proximity that is analyzed).*
- Representativity of underwater habitats and marine species: *The criterion is the proportion of habitats and species ranges by the MPAs, compared to the entire distribution.*
- Representativity of ecological and evolving processes: *Ecological processes are an essential part of ecological coherence, but their operational definition and mapping are challenging and not done in marine environment. This sub-criterion is not proposed to be included in the assessment methods at this stage.*

We propose that the set of assessment criteria consists of four main criteria and nine sub-criteria underneath (note that the number of sub-criteria, however, depends on the number of species and habitats included in the assessment).

An analysis of these criteria can be made on the basis of:

- GIS data of the boundaries of the marine 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 of the protection level (IUCN category or similar).

Table 3.5 Main assessment criteria (bold text) and sub-criteria.

Representativity	**Replication**
Coverage in marine region	Number of sites per feature
Coverage in Member State waters	**Connectivity**
Representativity of sub-regions	Connectivity of MPAs
Representativity of depth zones	**Adequacy**
Representativity of habitats	MPA size
Representativity of species	Level of protection

D Description of a classification system for management levels of European marine protected areas, and its functionality

D.1.1 Review of the existing classification of MPAs

Member States 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 Natura2000 sites), OSPAR, HELCOM and WPDA[2] datasets Europe holds 3444 Marine Protected Areas, classified on the basis of national and international normative requirements. The international protection figures (including Natura2000 figures) were not assigned to any IUCN management category (Table 3.6). For the explanation of the different IUCN categories see A.5.2.

Table 3.6 National and International marine protected areas. National category includes all protected figures established in Europe (including Russia, Argelia, Marocco, Lebano AMPs)).Source: CDDA v11&Nature2000 (EEA), WPDA, OSPAR,and HELCOM.

	AREA (km^2)	NUMBER*
International	**1254413**	**1858**
OSPAR areas (OSPAR Convention)	712774	333
Special Area of Conservation (Habitats Directive)	149204	255
Special Protection Area (Birds Directive)	127318	421
Ramsar Site, Wetland of International Importance (Ramsar Convention)	85303	357
UNESCO-MAB Biosphere Reserve	83501	30
Baltic Sea Protected Area (HELCOM)	47733	159
World Heritage Site (Unesco)	41793	12
Specially Protected Area of Mediterranean Importance (Barcelona Convention)	3305	23
National	**846893**	**1586**

* The total number of MPAs should be considered with caution. Member States have not reported in the same way, and in some cases, the MPAs reported by MS 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, Barcelona Convention (SPAMIs) presents the lowest protection both in terms of number and area (Figure 3.1).

[2] *IUCN and UNEP-WCMC (year), The World Database on Protected Areas (WDPA) [On-line].Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net [Accessed (24/03/2014)].*

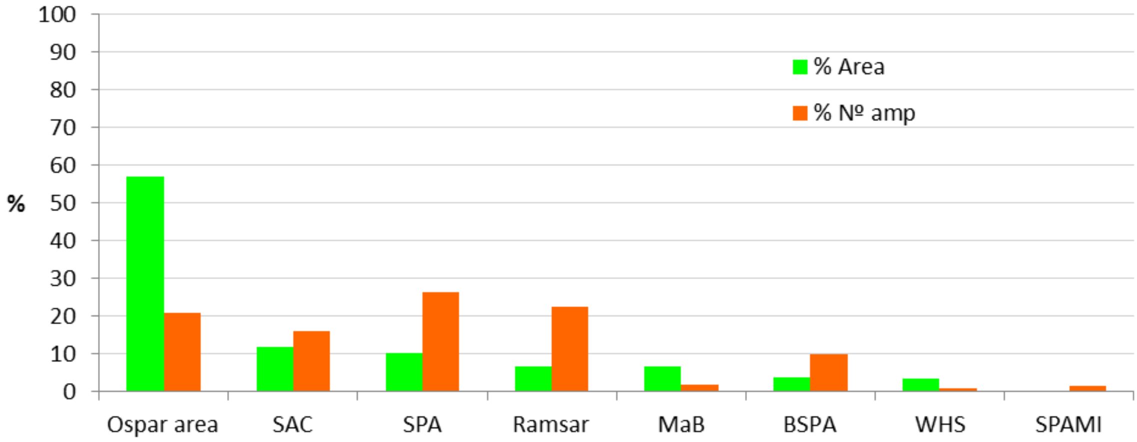


Figure 3.1 All International MPAs. Key to the abbreviations: OSPAR area: OSPAR convention; SAC: Special Area of Conservation (Habitats Directive); SPA: Special Protection Area (Birds Directive); Ramsar area: Wetland of International Importance (Ramsar Convention); MaB: Unesco Man&Biosphere Reserve; BSPA: 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 3.7, IUCN management categories assigned to each protected figure from international and national databases are shown.

Table 3.7 National and International protection figures classified according to IUCN management categories (NA not applicable; NR: not reported) (including Russian European area).

Framework	IUCN Management Categories									
	Ia	Ib	II	III	IV	V	VI	NA	NR	Total*
International								1862		1862
Baltic Sea Protected Area (HELCOM)								159		159
OSPAR areas (OSPAR Convention)								333		333
Specially Protected Area of Marine Mediteranean Importance (Barcelona Convention)								23		23
Ramsar Site, Wetland of International Importance (Ramsar Convention)								359		3359
Site of Community Importance (Habitats Directive)								523		523
Special Protection Area (Birds Directive)								421		421
UNESCO-MAB Biosphere Reserve								32		32
World Heritage Site								12		12
National	246	33	60	60	579	346	68		194	1586

* The total number of MPAs should be considered with caution. The manner in which Member States have reported shows large differences and in some cases, the MPAs reported by MS are not only designed at the MS level, but also under other Regional and International Conventions.

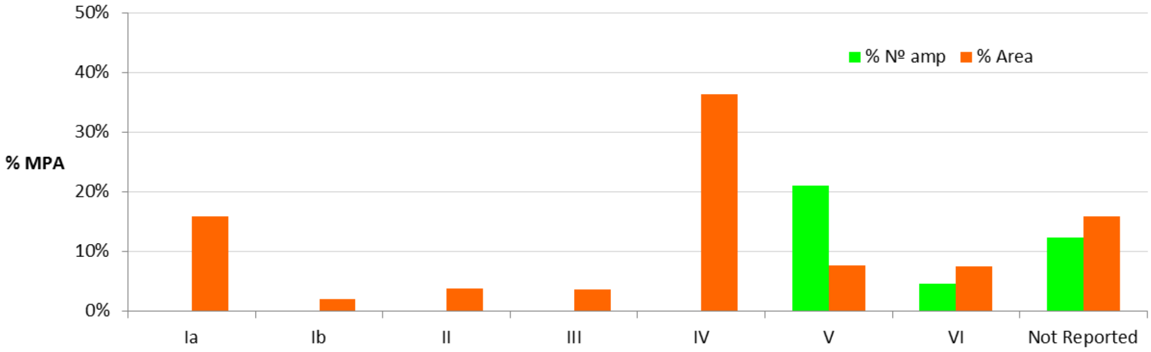


Figure 3.2 All National MPAs in European areas classified according to IUCN management categories (NA not applicable; NR: not reported) (including Russian European area). Source: CDDA v.11, 3/2014.

National Superficies of Marine Protected Areas (%) by country and classified according to IUCN management categories is shown in Figure 3.2.

D.1.2 Proposal for management levels of MPAs

MPAs should be managed to ensure the protection of the features for which they were selected. In order to reach different conservation goals, MPAs or parts of them could require a variety of management measures from strictly protected areas to areas of sustainable use, depending on the objective of conservation for each site. Thus, a network of MPAs seeking overall integrity might be composed by specific MPA sites under different management levels. This range of management measures can be separated into categories, such as the IUCN management levels (Day *et al.*, 2012). One of the tasks of this project was to suggest management levels for the European MPAs. In this section, we propose seven management categories based on the IUCN classification. The description of the management levels described below is mainly based on these IUCN management levels (Day *et al.*, 2012), because the IUCN system is widely accepted and used on a global scale. Nevertheless, some modifications have been added to the proposed classification in order to suit the specific requirement for a European MPA Network. The proposed classification is given below:

1. No entry zones (based on IUCN Ia):

Areas strictly set aside to protect biodiversity and also geological / geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas serve as indispensable reference areas for visual (no lethal) scientific research and monitoring. Ecosystem functions are maintained. The Good Environmental Status (according to MSFD) maintenance is guaranteed, unless external pollution hinders this. It is recommended that areas assigned to this management level also have a buffering area around it (e.g. other management zones) in order to minimize the adverse influence of the surrounding area. Examples of this category include breeding sites of seabird colonies or seal sanctuaries.

2. No take zones (based on IUCN Ib):

Areas without permanent or significant human activity retaining their natural character and ecosystem processes, which are protected and managed so as to preserve and restore pristine conditions. Using the available resources in ways compatible with the conservation objectives (e.g. subsistence fisheries); to protect the relevant cultural and spiritual values and nonmaterial benefits. The natural ecosystem functioning predominate 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 the Good Ecological and Environmental status. Visual (non-destructive) scientific research and monitoring could 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.

3. Protection of large-scale ecological processes based on (IUCN II):

Large scale natural biodiversity along with its underlying ecological processes and habitats are protected. Management measures should be dedicated towards the perpetuation, in as natural a state as possible, of representative examples of physiographic zones within European regions and subregions. It should seek the ecosystem functioning through its integrity and resilience maintenance. It should contribute to regional ecological processes, the conservation of wide-ranging species and migration routes. It should promote the biodiversity and genetic diversity maintenance. These areas provide education, scientific (take) research and recreation, not causing significant biological or ecological degradation. Examples of this category can include important breeding or feeding sites of seabirds and marine mammals, important fish spawning or nursery grounds and migration routes of migratory fish (e.g. estuaries).

4. Singular natural enclaves (based on IUCN III):

Management should be dedicated to protect specific outstanding natural features and their associated biodiversity and habitats. These include specific features such as sea mounts, rock outcrops, submarine caverns, submarine canyons, or other geomorphological features that could host high natural and biological value (i.e. coral gardens). The MPA can cover the entire feature or a part of it. These areas can show a high visitor value and the management needs to be adapted according to the feature.

5. Particular management zones (based on IUCN IV):

Areas with specific management plans dedicated to the protection of priority species or habitats (e.g. according to Habitats or Birds Directives). Protection measures may vary depending on the conservation goal. These areas are included, for example, within the Natura 2000 or Ramsar Network.

6. Traditional activities management zones (based on IUCN V):

Management plans are designed with the aim of protecting and sustaining the area and its associated nature for conservation and other values (i.e. cultural, etc.). It should be focused 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 (commercial or subsistence fishing practices, at small-scale). These areas might contribute to broad-scale conservation by maintaining marine activities that are considered compatible with the conservation objectives.

7. Sustainable management zones (based on IUCN VI):

This category includes MPAs which aim at protecting natural ecosystems while still using natural resources sustainably, so that conservation and sustainable use can be mutually beneficial. 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 are ecosystem-based with long-term objectives. It should promote compatible uses and avoiding undesirable effects that would not allow to the achievement of the good environmental status in 2020 according to MSFD. This type of management plan includes Marine Spatial Planning approaches.

At present, management plans are applied to individual MPAs and the MPA network is composed by individual MPAs that are under different management levels. Ideally the objectives of each individual management plan should contribute to achieving the general objectives of adequacy, representativity, connectivity and coherence within the regional and/or European Network. To achieve this goal, this report proposes that the 'adequacy' criterion would include the target of having a sufficient proportion of the network assigned to each of the management levels.

E Workshop of the Marine Expert Group

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 Regional Sea Conventions, Member States, 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 RSC's. 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 RSC's
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 MS is that they have to make 10% of marine environment into an MPA based on MSFD Article 13.4 (Note: Member States must identify marine protected areas 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 N2000 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)/N2000 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 (2007). 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 RSC's. 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 target value. 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 RSC's, 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 RSC's and N2000 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 RSC's and how the timing of the RSC work relates to the process that the MS 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 RSC's. 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 N2000 was raised; is Article 13.4 sufficiently covered by N2000 and if not, do we need to complete N2000 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 MS, 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 RSC's.
- What is the relationship between N2000 and MSFD Art 13.4? Do we need additional policy instruments? MS 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 RSC's.

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 RSC's are a good starting point for the assessment of coherence, but timelines may diverge between MS and their MSFD timeline and the RSC process. The Commission expects that the RSC can perform this role so that MS are coordinating the work in a regional context.
- There are differences between the work in the RSC's 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.

Member states and RSC's

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

Follow-up after the workshop

The following main points have been synthesized:

1. Build on RSC’s 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 RSC’s, OSPAR and HELCOM in particular. *(This issue is addressed extensively in Annex 3, section 3.5).* The RSC’s 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 RSC’s for their network assessments are covering the aspects that the MSFD requires to take into account for GES, was analyzed in Annex 3, section 3.7).*

2. Specify link between MPAs and GES

Under Article 13.4, one of the options for MS 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 Annex 3 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 N2000 legislation in place that has a relationship with currently existing MPAs. *(N2000 and its interrelations with the MSFD is discussed Annex 3, section 3.7).*

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.
- 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 Annex 3, chapter 5).*

F Details of the assessment method

F.1 Assessments of ecological coherence in MPA networks

Assessments of ecological coherence have evolved rapidly during the 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 criteria by criteria and assessment conclusions have not relied on any transparent or understandable 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'. In this chapter, practices and guidelines for such assessments are introduced and in Chapter 4 methods that could serve as a basis for a common European assessment methodology are suggested.

F.1.1 How the ecological coherence has been assessed by the Regional Sea Conventions

In the European marine regions, assessments of ecological coherence have been made in the Baltic Sea (HELCOM 2010), Mediterranean (Gabrié et al. 2012) and North Sea (OSPAR 2013). No assessment of MPA networks has been made in the Black Sea region.

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 marine protected areas in the convention areas. As a next step, OSPAR developed a guideline document with 13 principles for establishment of an ecologically coherent MPA network (OSPAR 2006), which was followed by a background document for assessing ecological coherence (OSPAR 2007), summarising 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 2008).

The rationale of the OSPAR approach is that it is still premature to aim at a full assessment test with clear targets and detailed methodology, as there are still many scientific challenges on the way. The assessments have therefore started from <u>*likelihoods*</u> 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 2008). 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 2008), 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 Marine Protected Areas in 2012 was published in 2013 (OSPAR 2013). In this assessment the methodology 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 were:

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 were:

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.

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 region laterally and there are separate matrices for each assessment criterion. While the initiative presents a simple way to visualize the assessment criteria, it does not suggest how the criteria are integrated.

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 2010). 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 methodologies of ecological coherence.

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) 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. criteria by criteria.

F.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 defines 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.

F.2 A suggestion for the stepwise methodology for assessing ecological coherence

This chapter answers to the subtask 3.1 of the project contract: *‘Develop and describe a step-wise approach for assessing coherence, adequacy and representativity of existing European networks of marine protected areas moving from initial basic assessments towards consecutively more and more detailed assessment options. The methodology should allow for basic European wide assessments, while at the same time allowing for more detailed assessments in more information-rich marine regions or sub-regions.’*

F.2.1 Basic and more detailed assessment methodology

The set of assessment criteria suggested in Chapter 2.5 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 suggested to lie on data quality: the basic assessment can be done with simple cartographic GIS data and presence/absence data of conservation features. The more detailed assessment will require additional data on predominant pressures, mapped conservation features and a database on legal instruments used for the protection.

F.2.1.1 Impacts of anthropogenic pressures on MPA adequacy

The first more detailed assessment method focuses on the effect of anthropogenic activities and pressures on the conservation features (and conservation objectives). 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. It is obvious that some pressures impact across the MPA boundary, while some are practices even within the boundaries, and an analysis is required whether these jeopardize the conservation objectives.

As the MPA size and shape can affect how deeply impacts of external pressures can affect MPAs (see **Figure 5.1**), we suggest a GIS analysis where different pressures are given impact ranges and the analysis estimates success of reaching the conservation objectives with the current MPA sizes and shapes and current external pressures. 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. Impacts are gradual and they attenuate with distance and therefore one needs to set an impact range for 'significant impacts' on the conservation features. While this is dependent to some extent on expert judgment, scientific literature includes examples of impact ranges. The aim of the assessment is to evaluate whether the MPA size and shape are large enough to protect the conservation features. The assessment can be defined as follows:

> ***Impact of external pressures on conservation features****: MPA size and shape aim to ensure reaching of the conservation objectives and minimize the effects of external anthropogenic pressures. This analysis evaluates MPA size and shape in relation to predominant anthropogenic pressures and impacts around the MPAs, which affect across the MPA boundary. The target is that the pressures do not jeopardize the target MPA size, i.e. the MPA size unaffected by the impacts of the external pressures meets the target of 30 km^2 (if that is the target for the basic assessment criterion of MPA size).*

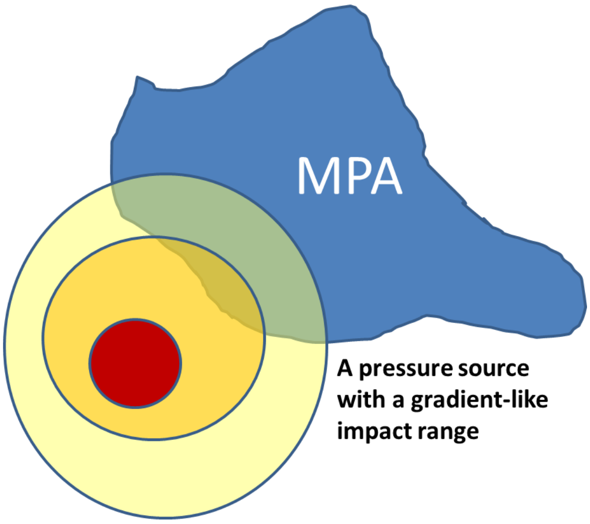


Figure 5.1 Schematic presentation of the impact of a pressure on an MPA. The analysis will estimate the impacted area within the MPA.

F.2.1.2 Mapped distribution of conservation features

The second more detailed assessment method includes analyses of conservation features (mainly underwater habitats and marine species, but also other features) (**Figure 5.2**). This requires that maps of the selected features cover preferably the entire assessment area, but a limited analysis of connectivity and representativity can also be .made by mapping the features within the MPAs only. According to our method suggestion, feature mapping outside MPAs is not required for the connectivity and also an improved analysis of representativity can be made if features are mapped within MPAs (i.e., one can assess how big area of a feature is protected). However, mapping also features for the entire sea area, the assessment method of representativity increases ecological relevance in the assessment.

In the assessment of representativity, the proportion (%) of each of the selected features within the network is calculated. 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). In the assessment of connectivity, it is not sites but feature occurrences which are analyzed; proximity (a distance) relevant for each feature is chosen and the amount of connections is calculated by a spatial analysis.

The target may depend on the feature, but usually the representativity targets range between 10-60 –(100)% (see Annex 3 for a review). For connectivity, there are no clear targets, as the ambition level can be adjusted by two variables: distance (km) and number of connections.

The definitions of the two more detailed methods are:

Representativity of conservation features: *Proportion (%) of selected conservation features (underwater habitats, broad-scale habitats, landscapes and marine species) or their combinations as compared to their entire distribution area in the assessment area. The target is X% for each feature.*

Connectivity of habitats and species *is analyzed as proximity of the selected habitats or species or their combinations in the entire assessment area. A fixed distance is chosen for each feature, representing ecological relevance, and the amount of connections in the network is calculated (e.g. 10 % of feature patches have no connections, 40 % have 1-9 connections, 40 % have 10-19 connections and 10 % have ≥20 connections). The target is set, for instance, as ‘75% of feature occurrences have ≥10 connections’.*

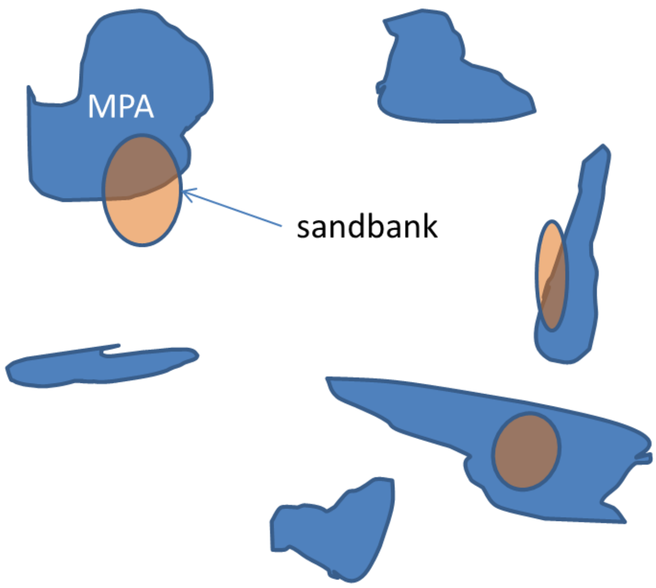


Figure 5.2 Schematic presentation of the analysis of representativity and connectivity in the more detailed assessment where the habitat distribution is mapped enabling an analysis of the actual protection coverage and connectivity between the mapped habitat patches.

F.2.1.3 Legal instruments: which features are actually protected?

The third more detailed assessment method focuses on distinguishing legal bases of the MPAs. Each Member State has likely slightly different legal instruments which are used to implement MPAs and particularly the Natura 2000 sites. Depending on the instrument (e.g. Nature Conservation Act or Water Act), there are different outcomes as regards the level of protection and features that can be protected. For example, a Natura 2000 site protected by a stricter instrument is likely to give protection also 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 area.

In this more detailed assessment, the assessment criteria are re-analyzed by the information of the protection level per feature. A prerequisite for this analysis is a national spatial database of the legal instruments used within the site. We note that this criterion is beyond testing in near future as there is no international database holding such information. We nevertheless consider that this assessment method is necessary for a more realistic MPA assessment.

F.3 How the ecological coherence could be assessed in the European marine regions

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 chapter for examples). All of the existing methods rely more or less on expert judgment and criteria-by-criteria approaches. To suggest a European-wide method, this report aims to build on the existing approaches but also to make them transparent and understandable.

In environmental assessments, such as the assessment of ecological status of coastal waters under Water Framework Directive (WFD), EU Member States 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' (OOAO), where a failure to meet the target in one criterion leads to an overall failure to reach good ecological status. An alternative to the OOAO 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 to argue for the use the OOAO also in the assessment of ecological coherence. In practice, the regional assessments have already applied this principle (e.g. HELCOM 2010, OSPAR 2013).

The OOAO has been criticized for its risk of false positive 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 OOAO is a correct approach to the assessment of ecological coherence. The task is rather to improve the OOAO method and ensure that the targets and the assessment criteria are realistic.

The OOAO method has the greatest risk of false positive errors when the number of assessment criteria is high. This report suggests four main assessment criteria (i.e. representativity, replication, connectivity and adequacy), but these further divide into sub-criteria (e.g. representativity of reefs) which increases the actual number of assessment criteria too high for OOAO (the number of criteria depends on the number of habitats and species included in the assessment). 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 OOAO is used only at the higher end of assessment hierarchy and weighted averaging on the indicator level.
Applied to the assessment criteria, the OOAO would apply only among the main criteria while all the sub-criteria would be averaged. Whether to use weighing among the sub-criteria should be decided case by case, but that could depend on uncertainty of the sub-criteria.

In an assessment of ecological coherence of a MPA network, uncertainties are high. We propose that an uncertainty factor is included in the assessment to bring in flexibility to the stringent OOAO 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 in the Baltic assessment of hazardous substances (HELCOM 2010 b). According to the HELCOM example, the uncertainty factor can be affected, *inter alia*, by the following issues:

- the data to get the result is incomplete, biased or not fully trusted,
- the target is tentative and, depending how ambitious it is, the likelihood of reaching the 'true target' increases,
- the method to assess the criterion is not ideal, is too simple or lacks in ecological reality.

In **Table 5.1** 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 4.3).

Table 5.1 Suggested criteria to estimate the level of uncertainty in the assessment of ecological coherence. If the uncertainty categories are used to weigh sub-criteria 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.

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

The OSPAR guidelines and principles for an assessment of ecological coherence (see Section 3.1) presented 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 the likelihood depends on two variables:

- the distance to the target (a shorter distance - or ultimately meeting the target - increases the likelihood of reaching the target),
- the amount of uncertainty in reaching the target (the lower the uncertainty, the more likely the criteria result and the target can estimate reality; the higher the uncertainty, the more the likelihood will be affected and the outcome depends on the type of the uncertainty).

As an example, *a connectivity analysis can show that 75% of the sites are connected to more than two other sites. If the target is set as 75% for this criterion, the criterion seems to be fulfilled very likely. There can, however, be high uncertainty in this criterion 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 'likely'.*

In the integration phase - when all of the criteria are assessed together rather than as separate criteria – the likelihoods are taken into account in the use of the OOAO. 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'.

Organizing the assessment criteria and associated likelihoods into a matrix is a visual tool to help the integration of assessment criteria. In the next chapter a visualization of the method is shown and Chapter 6 shows test results in the case study area.

F.4 Step-wise methodology for the assessment

The subtask 3.1 of this contract was to develop assessment methods moving from initial basic assessments towards consecutively more and more detailed assessment options. Our approach to this task was to suggest a basic set of assessment criteria and three more detailed assessment criteria which all can be used within the same assessment method. In the more detailed methodology, the assessment should include the mapping of conservation features. As presented in Chapter 2.4, the basic set consists of four main criteria and nine sub-criteria underneath and the more detailed assessments will be done by three additional criteria.

The methodology suggested in this report is not limited to geographical scales. It can be applied to small-scale assessments or scales of a marine region or European marine waters. Moving from large to small-scale assessments the limiting factor will be data quality. This is particularly true with regard to ecosystem data, which becomes more fragmented and detailed in the smaller scales.

In this chapter, we introduce the methodologies in more detail.

F.4.1 Assessment of representativity

The basic assessment of representativity consists of five analyses. Four GIS analyses compare the area of MPAs with the area of the marine region, sub-basins/ecoregions, depth zones/marine zones and waters under national jurisdiction. The outcome is given as a proportion (%). Note that terrestrial areas are excluded from the spatial analysis.

The representativity of conservation features is not a spatial analysis, but an analysis of the presence of selected features in the network. As a prerequisite for the analysis, the databases need to include information of the presence (and preferably absence) of the feature. That is the case for the Natura 2000 sites as well as the RSC MPAs. The selected features should include species and habitats of the Habitats and Birds Directive as well as the Regional Sea Conventions' lists of the threated 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, species and habitat distribution maps are used as a baseline and the representativities of selected features (see previous paragraph) are analyzed as proportion of the entire area of the feature.

Note that the distribution of a feature within an MPA does not necessarily mean that the feature is protected by the site, especially within the Natura 2000 network, but that depends on the legal instruments used for the protection. In the more detailed assessment, one can take into account the various legal instruments which have been used to implement the protection. The prerequisite for the assessment is a database where the legal instrument is mentioned for each MPA and the database should include the selected features and 'a tick in 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. There can also be different protection zones within MPAs, protected by different instruments, and therefore the database should preferably be spatial 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. 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.

As the number of selected features may be high (and vary among Member States), it is suggested that these sub-criteria are averaged and a single 'representativity assessment' is produced. Optionally, the averaging can be weighted by the uncertainty (see **Table 5** for details), which can be high in case of habitat and species distribution.

Targets for the representativity criterion were discussed in Annex 3 and more detailed reviews are available by Piekäinen & Korpinen (2007), OSPAR (2007, 2008) and Liman et al. (2008). These are applied in the case study presented in Chapters 5 and 6.

F.4.2 Assessment of replication

The basic assessment of replication counts the number of MPAs including the selected features (see above). As compared with the representativity analysis, the outcome of this criterion is a number of MPAs for each feature.

In a more detailed assessment, one should consider the legal basis of the protection and count only those replicates where the feature enjoys of actual legal protection (see the discussion under representativity).

The same integration challenge applies to the replication assessment as in the representativity assessment (see above).

There are very few targets suggested in scientific literature or regional assessments. Many guidelines or assessments recommend 2-5 replicates per feature (Smith et al. 2009, HELCOM 2010 and OSPAR 2013). These are applied in the case study presented in Chapters 5 and 6.

F.4.3 Assessment 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). This approach does not take account of species behavior, oceanography or migration barriers. The GIS analysis is done by a neighborhood analysis with defined distances (e.g. 20 km and 50 km). As an outcome, there will be proportions (%) of clusters, where sites have, for example, no connections, 1-4 connections, 5-10 connections and ≥10 connections. Scientific literature suggests different inter-MPA distances (see reviews and practices in Piekäinen & Korpinen 2008, HELCOM 2010, OSPAR 2013).

In the more detailed analysis, the connectivity is assessed on the basis of protected features, which are mapped within the MPAs. Protected features are either patches of habitat occurrence or functionally important areas (e.g. feeding, spawning etc.) of larger species. The analysis follows the method described above, but one ought to set a minimum size of a feature (e.g. a habitat patch).

The more detailed assessment also includes only features that are protected by proper legal instruments (see the discussion under representativity).

In the integration phase, it is recommended that the connectivity assessments by different distances are averaged before taken into the OOAO integration. The averaging can be weighted by uncertainty estimates as discussed for the representativity assessment (above).

The target for the connectivity analysis should depend on the assessment area and the feature. One should set a target as the proportion of sites having a certain number of connections to similar features. For instance, 75 % of the protected features have more than 5 connections. 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).

F.4.4 Assessment of adequacy

The basic adequacy assessment is divided between two criteria: MPA size and protection level. In the former, 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). There are good scientific reviews of the effects of MPA size on species populations (see discussion in Piekäinen & Korpinen 2007). Sufficient size has usually been set between 10-60 km^2 while sizes of 20-30 km^2 are a good compromise between less mobile species and more mobile species.

In the more detailed assessment, impacts of anthropogenic pressures in the vicinity of the MPAs are analyzed against the MPA size. As the first step, one identifies the major pressures on the conservation features (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). The third step is to make a 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 either (1) to increase MPA size or (2) to manage the external pressures by other means. 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 basic assessment of the protection level is made by analyzing areas for the protection categories (e.g. IUCN categories) in the region and calculating their proportion (% out of the total MPA area). In many cases, MPAs do not represent only one protection category, but there are zones of various protection levels. In such a case, if spatial data exists, one could make a similar spatial analysis of the area (and proportion) of the protection categories. There are no examples of targets for this assessment criterion, but guidelines suggest a sufficient amount of sites under the stricter IUCN categories (e.g. Smith et al. 2009) 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 this report, the target proportions for categories I and II are modified from Smith et al. (2009), and they are presented in Chapters 5 and 6.

There is no suggestion for a more detailed assessment method for the assessment of protection level. The analysis of the legal instruments is obviously related to protection level, but the actual assessment focuses on the other assessment criteria.

Integration of the adequacy sub-criteria can be done similarly as for the representativity sub-criteria.

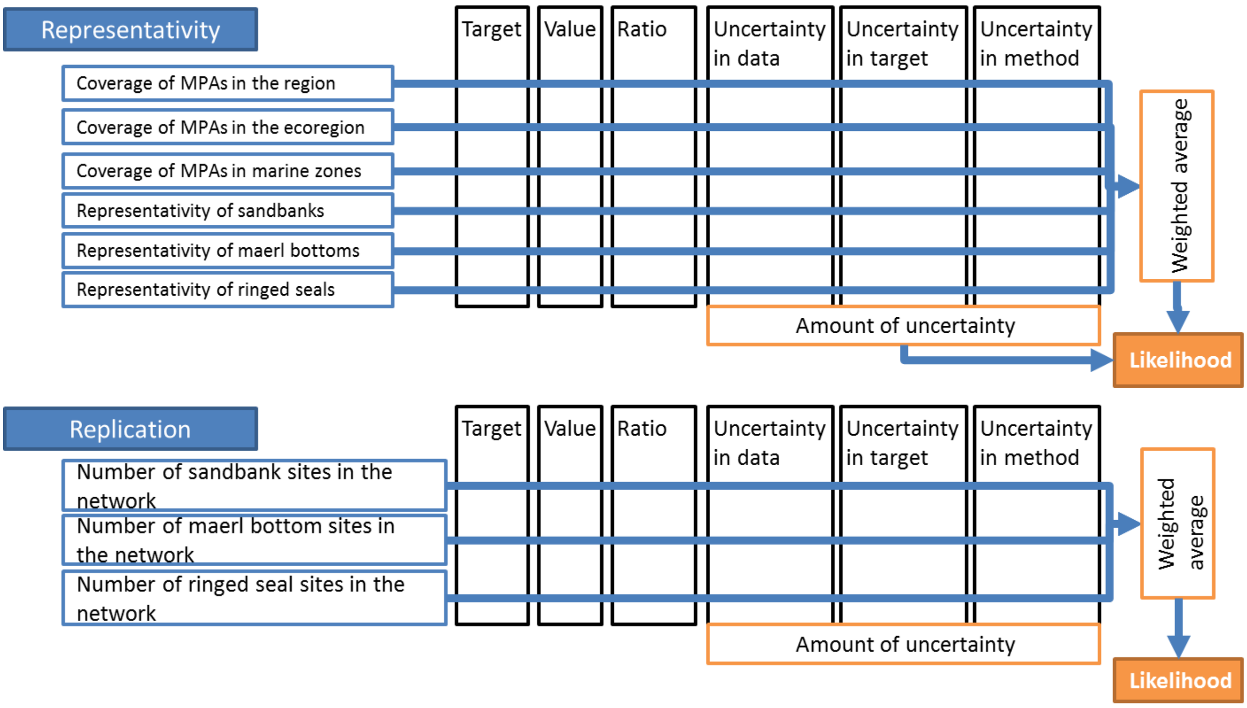
G Visualization of the integration

G.1 Integration of the criteria

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 sub-criteria underneath the main criteria are first averaged to have a single assessment results for the main criteria.

The suggestion for the integration method also included uncertainty estimates. As the sub-criteria 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 be used to weigh the sub-criteria in the averaging.

We also suggested using likelihoods to estimate whether the target is reached. While these likelihoods could be used already at the sub-criteria level, 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 sub-criteria level. For instance, if two sub-criteria have high uncertainty and one sub-criterion has moderate uncertainty, it is quite clear that the likelihood should be downgraded. **Figure 5.3** presents the integration process.



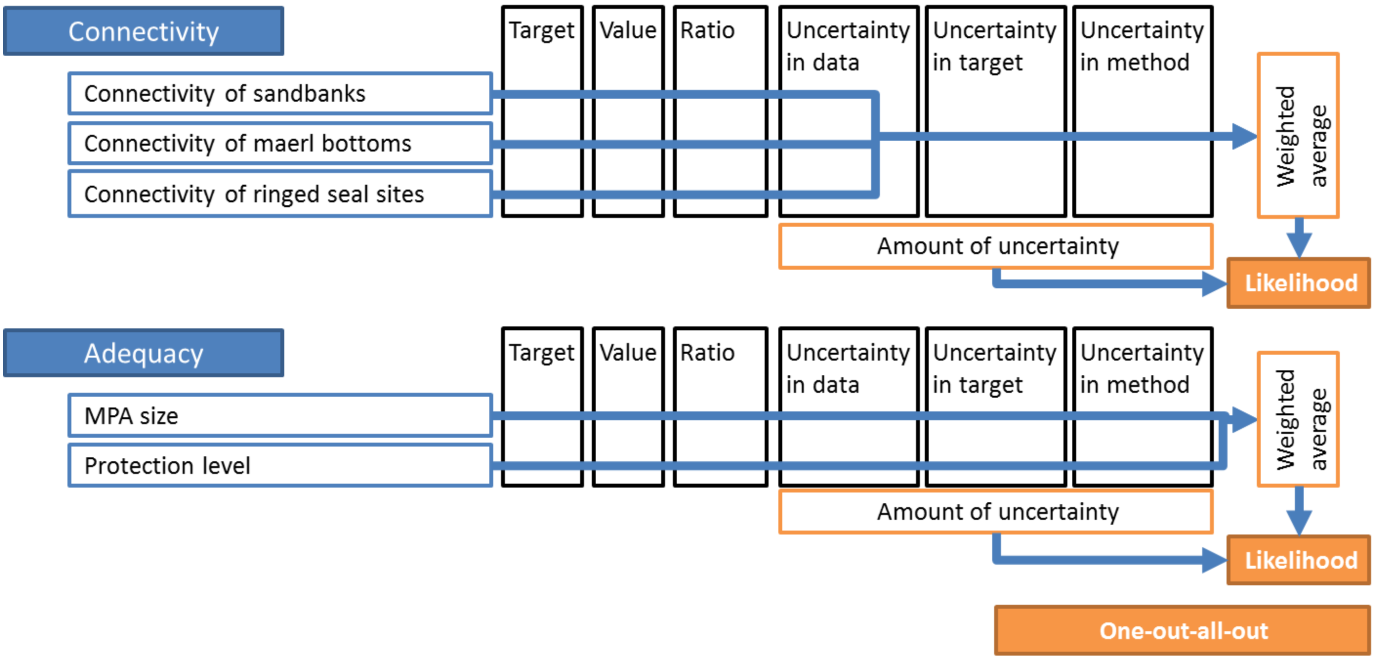


Figure 5.3 Integration method of assessment criteria and sub-criteria.

G.1.1 Decision tree for improving the assessment of ecological coherence

The ecological coherence is, hence, suggested to be assessed by a flexible one-out-all-out principle, where likelihoods of meeting targets of all the assessed criteria are inspected in a matrix and the failures to meet the targets (together with the uncertainty estimates) are visualized. An example of this is in **Chapter 6.4**.

The process of the analysis can also be visualized by a decision tree (**Figure 5.4**). The decision tree shows which steps are needed in the assessment and how the assessment can be improved. The two general actions as regards the assessment are:

(1) improvement of data (and assessment methodology) and
(2) improve the sites.

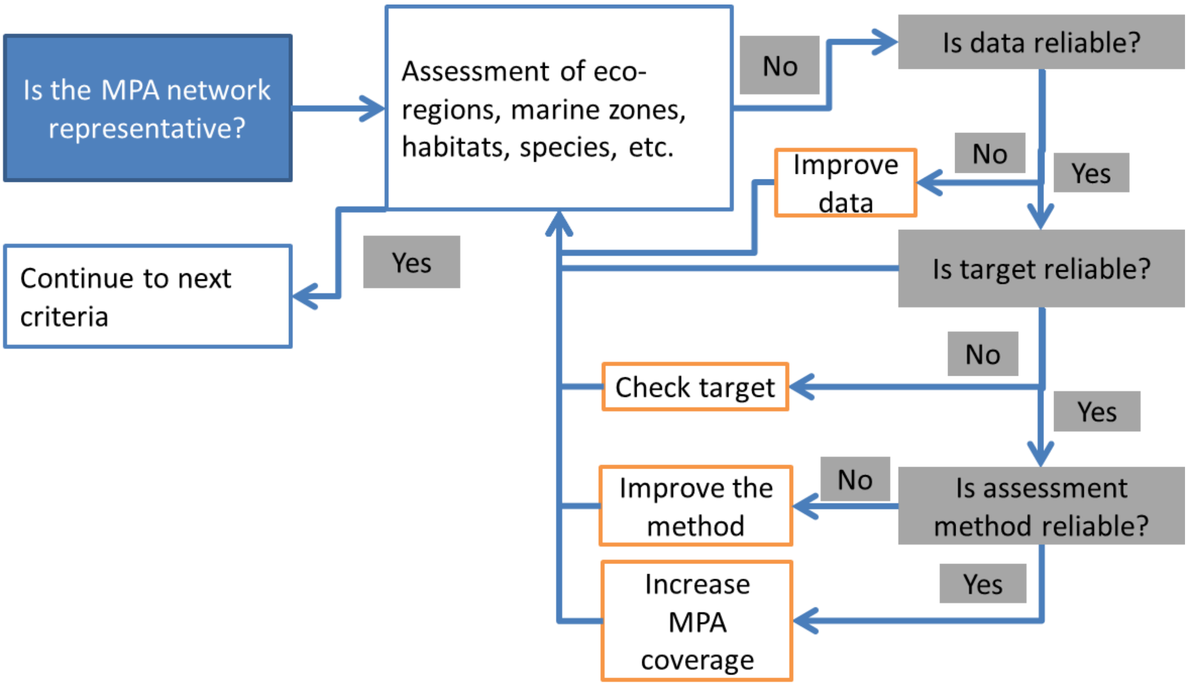


Figure 5.4 A decision tree to suggest which elements of the assessment need improvement.

G.2 Case study methodology

This chapter answers to the subtask 3.2 'Test the criteria developed under subtask 2.3 applying the methodology developed under subtask 3.1 under different levels of information (poor vs. rich). Ideally the test area should cover a sub-region or at least more than the waters of a single Member State.'

G.2.1 Case study area

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.

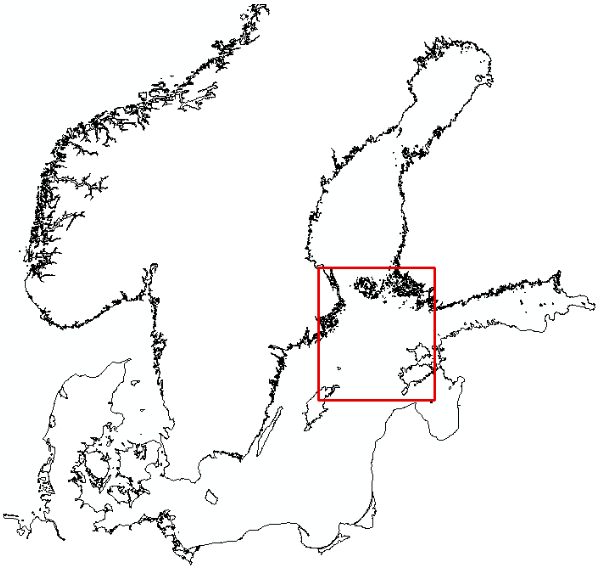


Figure 5.5 Map of the study area.

The study area includes 92 MPAs from the four countries and the total coverage of MPAs is almost 9 % of the marine area. **Table 5.2** gives summary information of the study area.

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

Table 5.2 Summary information of the case study area.

Marine area (km^2)	68 938 km^2
Marine area per country (%)	Finland 46 %, Estonia 31 %, Sweden 27 %, Latvia 3 %
Depth range (m)	mean: 69 m, max. 442 m
Number of MPAs	92
Total area of MPAs (km^2)	5 993 km^2

G.2.2 Assessment criteria

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:
- (11) Coverage of MPAs in the entire assessment area ,
- (12) Representativity of sub-basins or ecoregions,
- (13) Representativity of marine zones or depth zones,
- (14) Representativity of selected habitats (listed in Table 5.3) (% of MPA area including the habitat),
- (15) Representativity of selected species (listed in Table 5.3) (% of MPA area including the species),

Replication:
- (16) Replication of sites with selected habitats (listed in Table 5.3),
- (17) Replication of sites with selected species (listed in Table 5.3),

Adequacy:
- (18) MPA size,
- (19) Level of protection,

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

The more detailed assessment methods included additionally data of the predominant anthropogenic pressures and mapped benthic broad-scale habitats. The more detailed assessment used the same assessment criteria but the sub-criteria (e.g. selection of habitats) were different.

Table 5.3 Selected species and habitats in the case study area. 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*	
HABITATS	
Habitats Directive habitats (Annex I)	Broad-scale underwater habitats *(in the more detailed assessment)*
Sandbanks which are slightly covered by sea water all the time	Non-photic hard-bottom
Reefs	Photic hard-bottom
Estuaries	Non-photic mud and clay
Coastal lagoons	Photic mud and clay
Boreal Baltic narrow inlets	Non-photic sand
Boreal Baltic islets and small islands	Photic sand
Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	
Large shallow inlets and bays	

G.2.3 Data sources

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, 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).

The level of protection (IUCN category) 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.

G.2.4 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 RSC's.
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 5.4 Assessment criteria and targets. See the Annex 3 for the scientific basis of the targets.

Criteria	*Basic target*	*More ambitious target*
Representativity		
sub-regions	10 % (CBD)	10 % (CBD)
depth zones	10 %(CBD)	10 % (CBD)
habitats [1]	20 % (see Annex 3)	40 % (see Annex 3)
species [1]	20 % (see Annex 3)	40 % (see Annex 3)
Replication		
Number of sites / feature	2 (OSPAR 2013)	4 (HELCOM 2010)
Connectivity		
Between sites	50 % of sites have ≥10 connections at 50 km distance (the proportion and the number of connections are not based on science; the distance is an average for mobile species)	50 % of sites have ≥10 connections at 20 km distance (the proportion and the number of connections are not based on science; the distance is an average for mobile species)
Between features [2]	50 % of feature occurrences have ≥20 connections at 50 km distance.	50 % of feature occurrences have ≥20 connections at 20 km distance.
Adequacy		
MPA size	75 % sites are >20 km^2 (lower end of scientific recommendations)	75 % sites >30 km^2 (HELCOM 2010)

1) There should be different target for different habitats and species, but this test used a fixed target.
2) The targets for the features should reflect scientific understanding of the ecology of the species or habitat: how mobile a species is? how dependent it is of a network of habitats? etc.

G.2.5 Methods used in the case study

The assessment criteria were analysed for the case study area by the basic methodology and the more detailed methods (see Chapter 4). The case study did not test the more detailed method, where the legal basis for protection was considered, because such information has not yet been put into international databases.

The basic assessment of representativity and replication consisted of analyses of seven species and eight habitats (**Table 5.3**), 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 5.3**) 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 2010). 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 a 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 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.

G.3 Results of the case study

This chapter answers to the subtask 3.3 'Illustrate the difference between applying the less ambitious values for the criteria compared to the more ambitious values for the criteria (as identified in subtask 1.2) through two scenarios.'

G.3.1 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 km^2 marine area). Thus, the CBD 10 % target was not met in the study area.

Representativity of the sub-regions is presented in **Figure 5.6**. None of the sub-regions was entirely within the case study area, *therefore this analysis is arbitrary*. However, taking account of only the marine area within the study area, three sub-regions met the target of 10 % coverage.

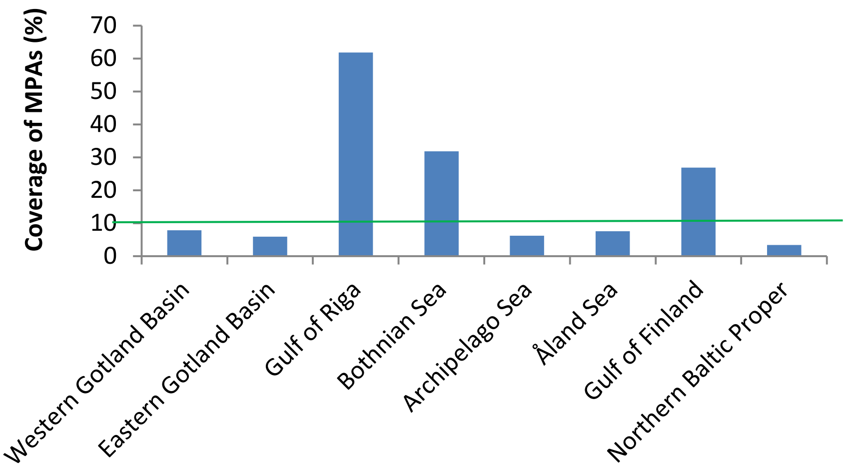


Figure 5.6 Representativity of sub-regions. Proportion (%) of the HELCOM sub-basins under protection. The horizontal line indicates 10% representativity.

The analysis of representativity of depth zones was made for six depth zones (**Figure 5.7**). 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.

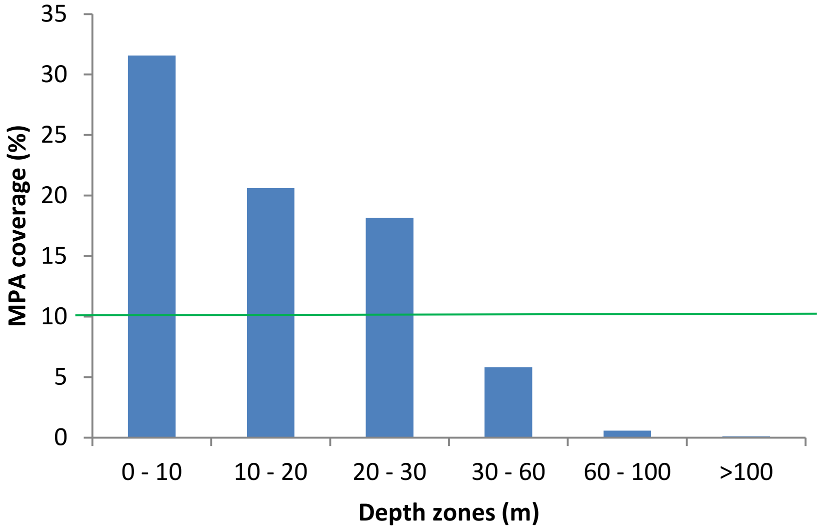


Figure 5.7 Representativity of depth zones. Proportion (%) of depth zones under protection. The target is an equal representation in each depth zone.

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 5.4**). **Table 5.5** presents the results of the sub-criteria.

Table 5.5 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 Member States for this report.

Species	*Z. marina*	*C. baltica*	*F. vesiculosus*	*S. caspia*	*A. marila*	*C. hiaticula*	*P. h. botnica*	
% marine area	0,9	0,7	2,3	3,6	3,6	5,8	4,0	
Habitats	Sandbanks	Reefs	Estuaries	Costal lagoons	Boreal baltic narrow inlets	Boreal baltic islets and small islands	Baltic esker islands	Large shallow inlets and islands
% marine area	5,5	6,5	1,8	6,5	0,6	6,5	0,8	5,0

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.

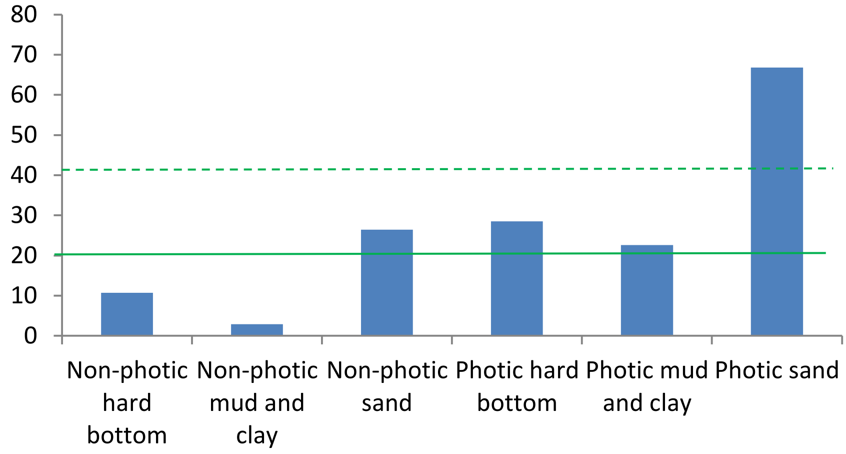


Figure 5.8 Representativity of benthic habitats. Proportion (%) of benthic habitats under protection. The horizontal lines indicate the 20% target (full line) and the 40% target (dashed line). Note that the analysis does not take into account specific conservation goals of MPAs, e.g. some benthic habitats may not be protected by the Natura 2000 network.

Replication

The number of MPAs, which include selected conservation features, were analysed in the study area. The basic 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 5.6 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 basic target and five met the more ambitious target.

Table 5.6 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 Member States for this report.

Species	*Z. marina*	*C. baltica*	*F.vesiculosus*	*S. caspia*	*A. marila*	*C. hiaticula*	*P. h. botnica*	
Number of sites	2	3	5	7	6	6	2	
Habitats	Sandbanks	Reefs	Estuaries	Costal lagoons	Boreal baltic narrow inlets	Boreal baltic islets and small islands	Baltic esker islands	inlets and islands
Number of sites	8	10	1	10	2	10	1	6

G.3.2 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 9**, 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 5.9**, left panel).

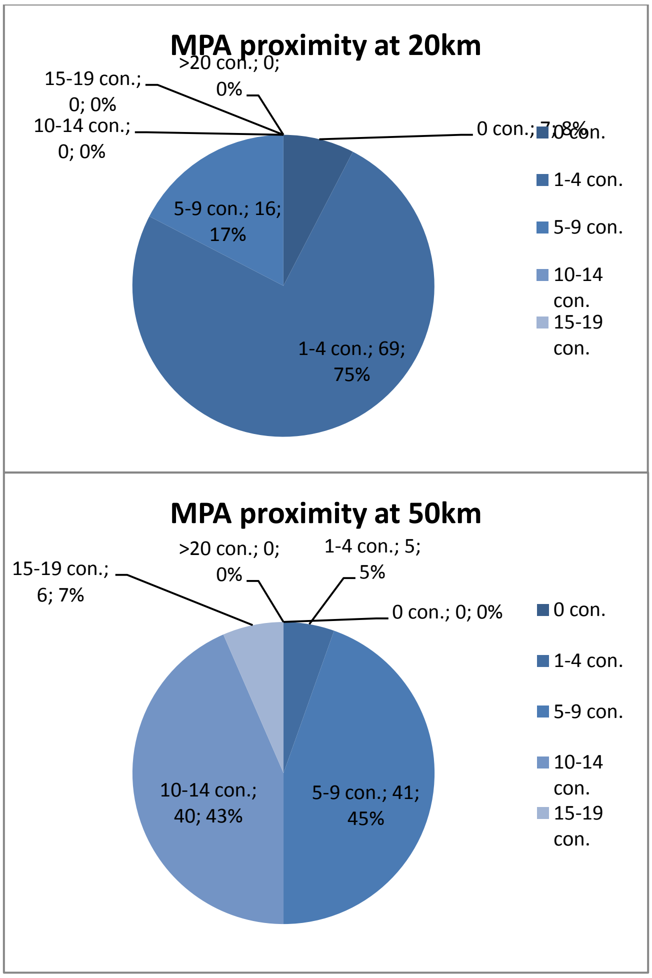
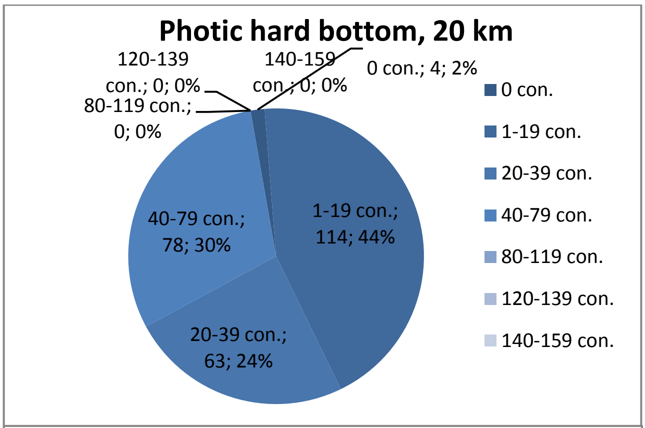
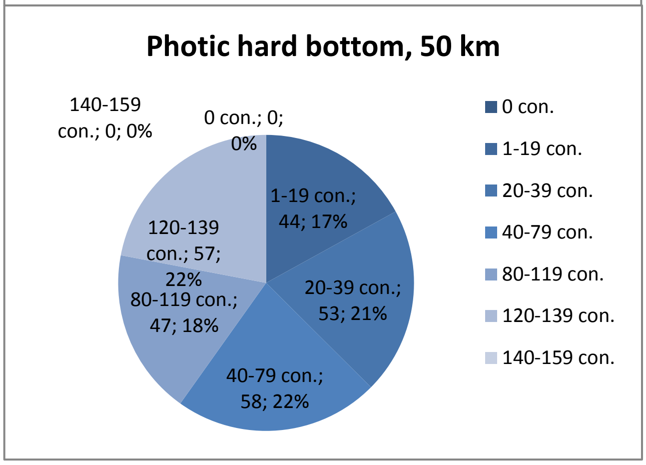


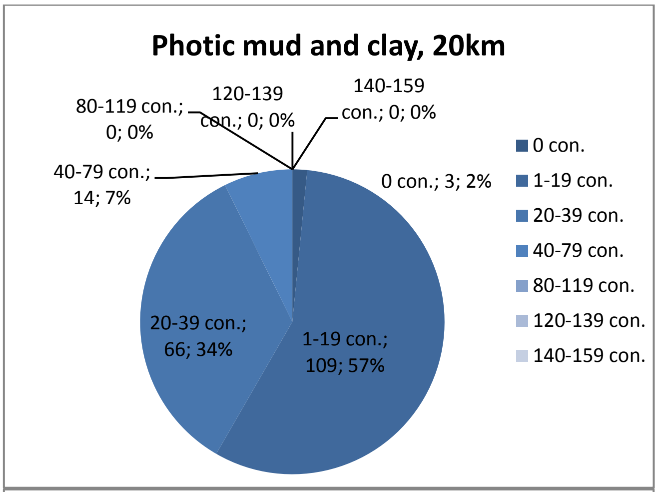
Figure 5.9 Connectivity of the MPAs. Proportion (%) of MPAs which are connected by 20km (left panels) and 50km (right panels) distances.

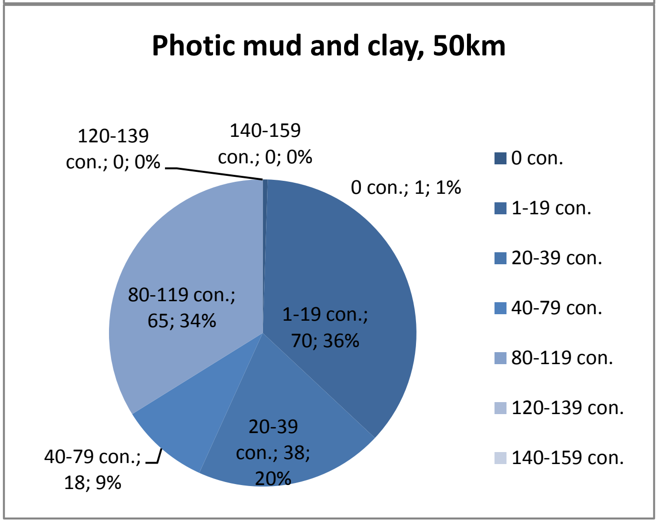
In the more detailed assessment, the protected benthic habitats were treated as single units and therefore there were manifold connections in the network. As adjacent, very small habitat occurrences slow down the analysis, they were combined to a single unit by 200 m radius. As targets for the analysis 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.

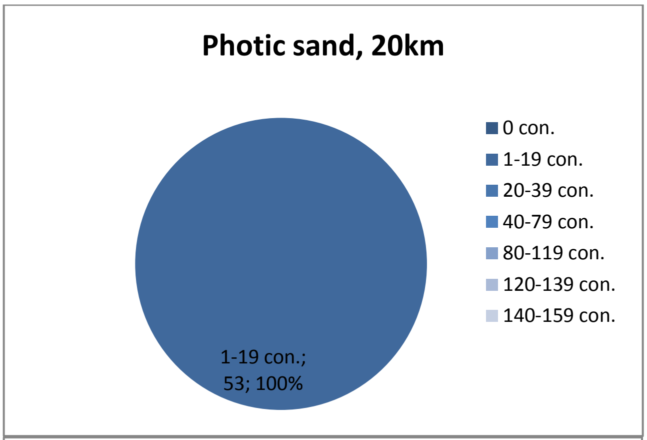
The results are shown in **Figure 5.10** for six broad-scale benthic habitats at 20 km and 50 km distances. There were naturally more connections with the 50 km distance than the 20 km distance. For example, all photic hard-bottom habitats had less than 80 connections within the 20 km distance, while within the 50 km distance 22 % of the habitat patches had even 139 connections. The scores are shown in more detail in **Annex 1**.

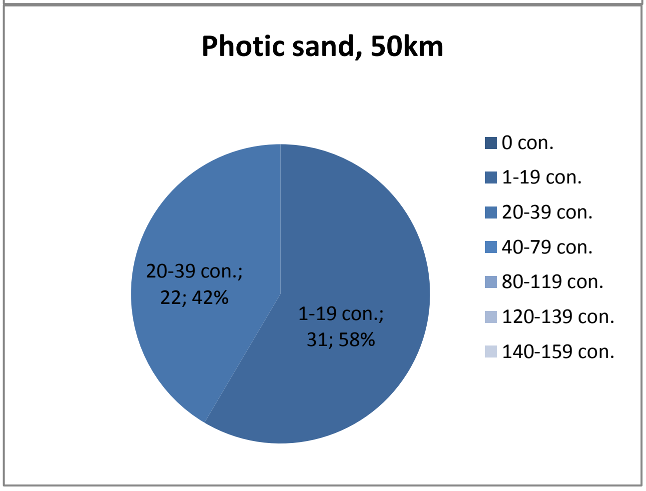

Photic hard bottom, 20 km
120-139 con.; 0; 0%
140-159 con.; 0; 0%
0 con.; 4; 2%
80-119 con.; 0; 0%
40-79 con.; 78; 30%
1-19 con.; 114; 44%
20-39 con.; 63; 24%
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.
120-139 con.
140-159 con.

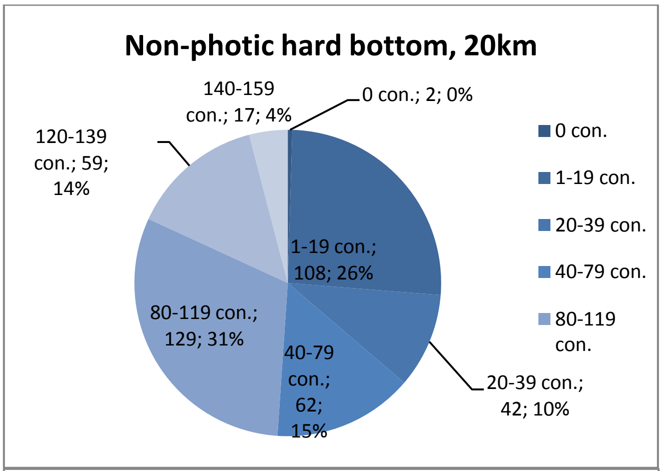

Photic hard bottom, 50 km
140-159 con.; 0; 0%
0 con.; 0; 0%
1-19 con.; 44; 17%
120-139 con.; 57; 22%
80-119 con.; 47; 18%
20-39 con.; 53; 21%
40-79 con.; 58; 22%
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.
120-139 con.
140-159 con.

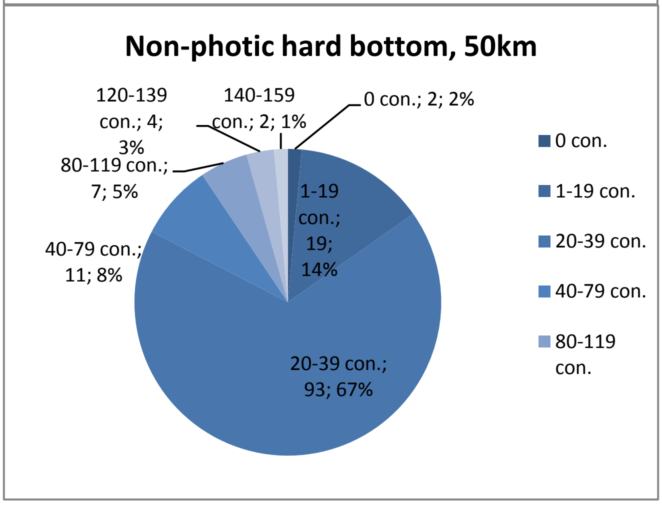

Photic mud and clay, 20km
80-119 con.; 0; 0%
120-139 con.; 0; 0%
140-159 con.; 0; 0%
0 con.; 3; 2%
40-79 con.; 14; 7%
20-39 con.; 66; 34%
1-19 con.; 109; 57%
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.
120-139 con.
140-159 con.

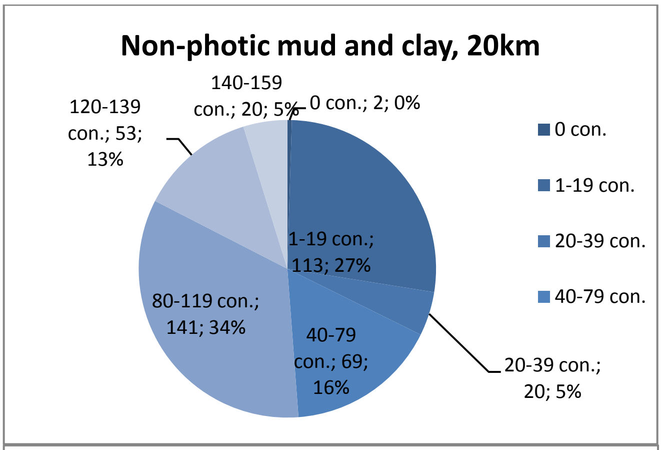

Photic mud and clay, 50km
120-139 con.; 0; 0%
140-159 con.; 0; 0%
0 con.; 1; 1%
80-119 con.; 65; 34%
1-19 con.; 70; 36%
20-39 con.; 38; 20%
40-79 con.; 18; 9%
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.
120-139 con.
140-159 con.

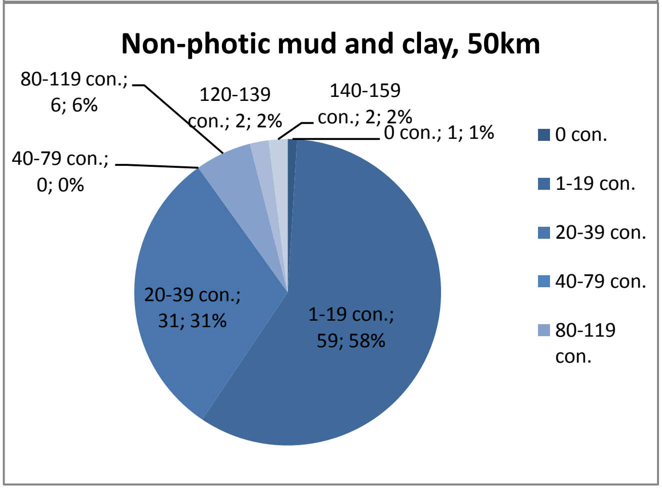

Photic sand, 20km
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.
120-139 con.
140-159 con.
1-19 con.; 53; 100%


Photic sand, 50km
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.
120-139 con.
140-159 con.
20-39 con.; 22; 42%
1-19 con.; 31; 58%


Non-photic hard bottom, 20km
0 con.; 2; 0%
1-19 con.; 108; 26%
20-39 con.; 42; 10%
40-79 con.; 62; 15%
80-119 con.; 129; 31%
120-139 con.; 59; 14%
140-159 con.; 17; 4%
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.


Non-photic hard bottom, 50km
0 con.; 2; 2%
1-19 con.; 19; 14%
20-39 con.; 93; 67%
40-79 con.; 11; 8%
80-119 con.; 7; 5%
120-139 con.; 4; 3%
140-159 con.; 2; 1%
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.


Non-photic mud and clay, 20km
140-159 con.; 20; 5%
0 con.; 2; 0%
120-139 con.; 53; 13%
1-19 con.; 113; 27%
80-119 con.; 141; 34%
40-79 con.; 69; 16%
20-39 con.; 20; 5%
0 con.
1-19 con.
20-39 con.
40-79 con.


Non-photic mud and clay, 50km
80-119 con.; 6; 6%
120-139 con.; 2; 2%
140-159 con.; 2; 2%
0 con.; 1; 1%
40-79 con.; 0; 0%
20-39 con.; 31; 31%
1-19 con.; 59; 58%
0 con.
1-19 con.
20-39 con.
40-79 con.
80-119 con.

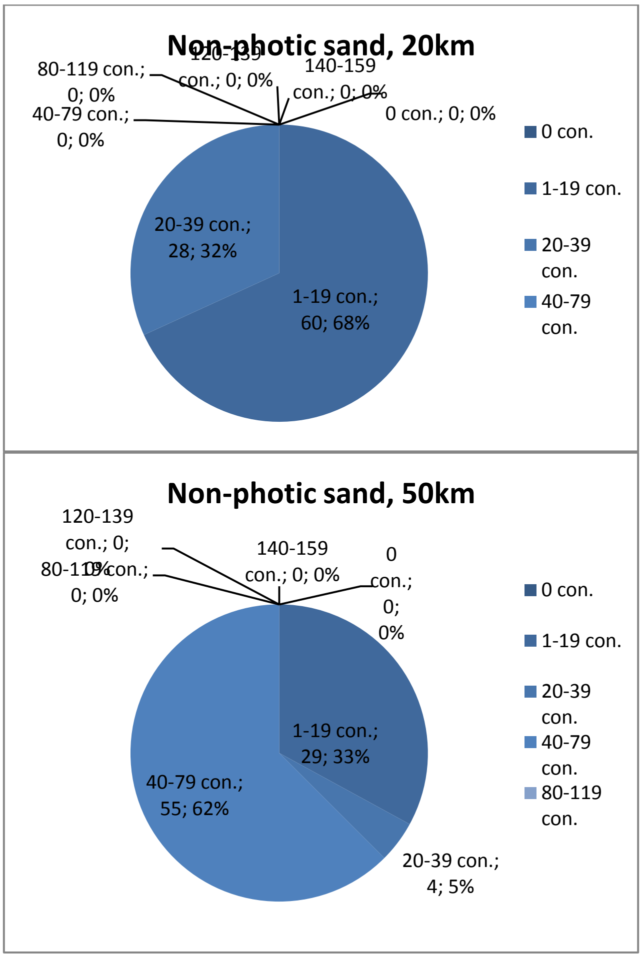


Figure 5.10 Connectivity of the protected benthic broad-scale habitats. Proportion (%) of protected benthic habitat patches which are connected by 20km (left panels) and 50km (right panels) distances.

G.3.3 Adequacy

In the basic assessment, adequacy of the MPA network is 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 10 -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 & Korpinen 2007), and the more ambitious target is '75 % sites are 30 km^2', which is the HELCOM size target for the HELCOM MPAs.

Figure 5.11 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.

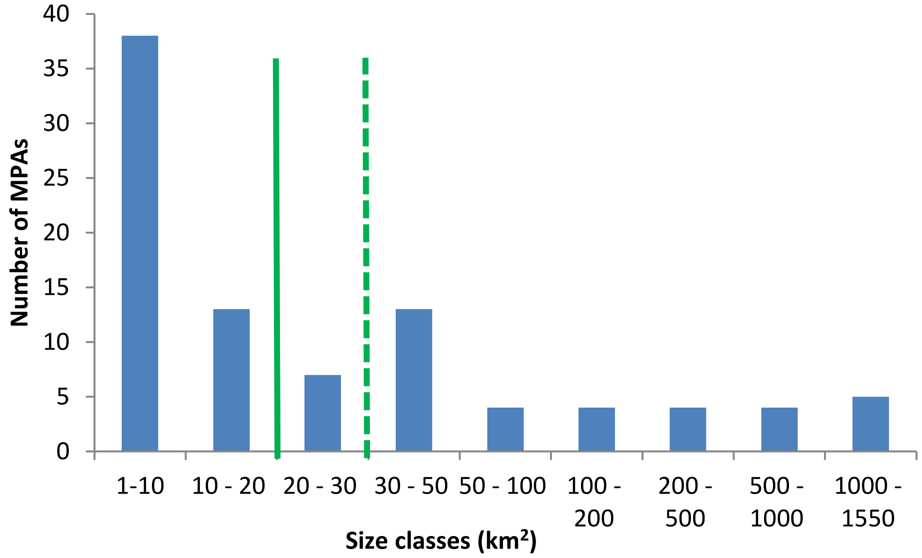


Figure 5.11 Proportion of MPA size classes in the assessment area. The vertical lines indicate the targeted MPA sizes (dashes line indicates the more ambitious target).

The more detailed assessment was suggested to include also MPA size in relation to predominant anthropogenic pressures. After removing the 'affected area' from the MPAs, only 34 % of the MPAs met the basic target of 20 km^2, i.e. the pressures decreased the effective area of conservation (**Figure 5.12**). With the more ambitious target of 30 km^2, only 21% of the MPA sizes met the target.

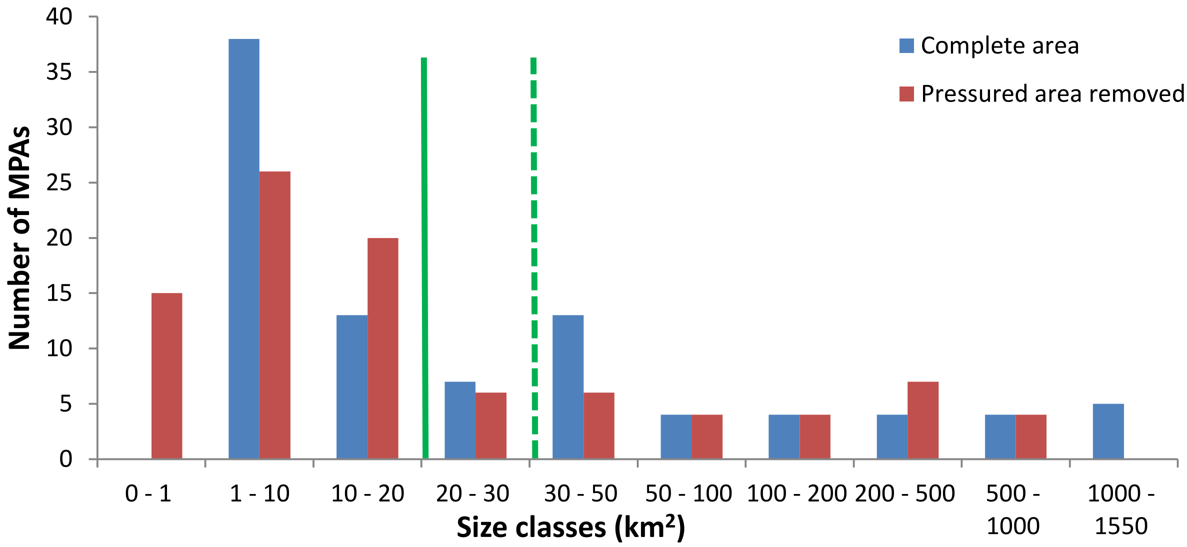


Figure 5.12 MPA size distribution after taking into account the impact ranges of anthropogenic pressures.

Level of protection

The level of protection is a sub-criterion 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 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 %.

Marine protected area under the categories I-II sums to ca. 1150 km^2, which equals ~24 % of the total MPA area (**Figure 5.13**). Categories Ia and Ib sum to 675 km^2, which equals 14 % of the total MPA area. With the given targets, the network obviously fails to meet the target.

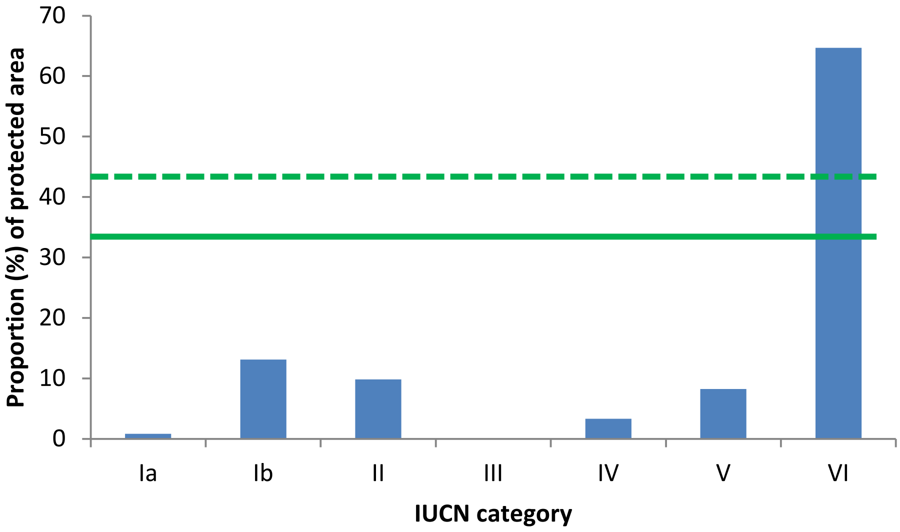


Figure 5.13 Protection level according to IUCN categories (proportion of MPAs in each category). The basic target (full line) and the more ambitious target (dashed line) are indicated by the green line. Note that 25 % of the sites were not analysed due to missing data. The missing MPA area was omitted form the analysis.

G.3.4 Assessment of ecological coherence

The ecological coherence of the MPA network in the case study area was assessed by using the four main assessment criteria and the sub-criteria and by following the methodology suggested in Chapter 4.

The basic methodology included 30 sub-criteria for representativity, 15 for replication, three for connectivity and two for adequacy. 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 5.7** illustrates a summary how the test results were integrated into an assessment of ecological coherence and Table 5.9 shows the full documentation of the test.

The basic methodology 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 remained the same: unlikely to be ecologically coherent.

	Criteria result	Target	Ratio	Uncertainty in data[1]	Uncertainty in target [1]	Uncertainty in method [1]	Weighted average
REPRESENTATIVITY							
Weighted average of the sub-criteria	(see Annex 1)	(see Annex 1)	(see Annex 1)	0.7	1	0.75	0.8
[2] ASSESSMENT RESULT: UNLIKELY							
REPLICATION							
Weighted average of the sub-criteria	(see Annex 1)	(see Annex 1)	(see Annex 1)	0.75	1	0.75	2.2
[2] ASSESSMENT RESULT: VERY LIKELY							
CONNECTIVITY							
Weighted average of the sub-criteria	(see Annex 1)	(see Annex 1)	(see Annex 1)	1	0.7	0.5	0.8
[2] ASSESSMENT RESULT: UNLIKELY							
ADEQUACY							

Weighted average of the sub-criteria	(see Annex 1)	(see Annex 1)	(see Annex 1)	1	1	1	0.7
[2] ASSESSMENT RESULT: UNLIKELY							
ECOLOGICAL COHERENCE IS UNLIKELY REACHED.							

Table 5.7 Summary of the integration table for the assessment of ecological coherence in the study area. The full integration table is given in table 5.9. See Chapter 5 for the data sources and methods and Chapter 6 for the case study assessment. A ratio of the sub-criterion result and the target is first attained for all the sub-criteria. Secondly, uncertainty in the data, target and method is added and the uncertainty is used as weighing of the sub-criterion. In the third step, a weighted average is calculated for each sub-criteria and then for the criteria level. The likelihood of reaching the target is given for each criterion, based on the uncertainty and the weighted average. Finally, the assessment of ecological coherence is done by the one-out-all-out principle, where the weakest criterion determines the final assessment result. The final assessment takes account of the likelihood and even results that do not meet targets can lead to ecological coherence if there is some uncertainty and likelihood estimates suggest acceptance of the coherence 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.

The more detailed assessment had different data and methodology in the sub-criteria and therefore the results of the assessment are also different. The weighted averages were 0.9, 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 data is not very reliable 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 5.8 presents a summary of the results and the full results are presented in table 5.10.

The results with the more ambitious targets showed that the weighted averages were 0.7, 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.

	Criteria result	Target	Ratio	Uncertainty in data[1]	Uncertainty in target [1]	Uncertainty in method [1]	Weighted average
REPRESENTATIVITY							
Weighted average of the sub-criteria	(see Annex 2)	(see Annex 2)	(see Annex 2)	0.79	1	1	0.9
[2] ASSESSMENT RESULT: UNLIKELY							
REPLICATION							
Weighted average of the sub-criteria	(see Annex 2)	(see Annex 2)	(see Annex 2)	0.75	1	0.75	2.2
[2] ASSESSMENT RESULT: VERY LIKELY							
CONNECTIVITY							
Weighted average of the sub-criteria	(see Annex 2)	(see Annex 2)	(see Annex 2)	0.5	0.75	0.5	0.7
[2] ASSESSMENT RESULT: UNLIKELY							
ADEQUACY							
Weighted average of the sub-criteria	(see Annex 2)	(see Annex 2)	(see Annex 2)	1	1	1	0.6
[2] ASSESSMENT RESULT: UNLIKELY							
ECOLOGICAL COHERENCE IS UNLIKELY REACHED.							

Table 5.8 More detailed assessment of ecological coherence in the study area. See Table 5.7 for explanations. The full integration table is given in table 5.10.

(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.

G.4 Discussion

This chapter answers to the subtask 3.4 '*Describe the findings of the tests performed under subtask 3.2 and 3.3 by identifying strengths and weaknesses of each to further inform future processes on assessing European networks of marine protected areas*.'

This report has focused on principle 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 (also called viability). Connectivity between habitats and species is considered a critical issue for an effective conservation. By a set of assessment criteria and an integration method we have suggested how ecological coherence can be assessed in the European MPA network(s).

The assessment method suggested in this report is a framework which can be applied at various scales (national network, cross-boundary network, sea basin, Europe). The method builds upon existing guidelines, methods and practices and, hence, it is not novel. However, this is the first attempt to compare 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.

Applicability of the assessment criteria for MPA assessments
We have reviewed several guidelines, assessments and scientific reports to find common assessment criteria for the assessment of ecological coherence. We came up with four main criteria and a set of sub-criteria which are shared by the Regional Sea Conventions and many assessment frameworks outside Europe. The suggested assessment criteria take into account all necessary aspects of MPA networks from single site adequacy (size, protection level), capturing ecologically significant features in several sites, to a network that is connected at various scales.

The suggested assessment criteria are in many cases similar to establishment criteria, which have been suggested and used when setting new sites and designing a network. More importantly, they have similarities with the assessment criteria of the EU Natura 2000 criteria, CBD criteria and criteria of the Regional Sea Conventions.

The Marine Strategy Framework Directive does not define the term network and does not include the term connectivity. However, we have included the concept of the connectivity as an assessment criterion as the common definition of a network implies that the sites are 'connected'.

Considerations on the target setting
This Annex did not review scientific background of targets for representativity, replication, connectivity or adequacy. The report touches the subject in many places and often refers either to Annex 3 or to external reports and reviews where the issue has been given more space. It is nonetheless clear that some of the targets are stronger than others. For example, there is strong political support for the target of 10 % MPA coverage in the marine regions and almost equally strong support for the representativity targets for habitats and species[3] and level of protection[4]. In contrast, targets for connectivity or replication have not been stated on political for and there is only some scientific support for those. Somewhere between

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

[4] 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.

these extremes are the targets for MPA size and level of protection; both have fairly strong scientific support whereas there are no political statements on them.

Regarding the state of the targets, this report considers many of them preliminary and with certain amount of associated uncertainty. This has been stated in the case study and in particular for the distinction between ‘basic’ and ‘more ambitious’ targets.

Ecological coherence – the sum of assessment results

The previous RSC assessment, other MPA assessments and scientific research have always treated the assessment criteria of ecological coherence separate and – to our knowledge – no integration method has been suggested. In practise, however, the assessments have used the one-out-all-out method, while it has not been separately stated and no formal guidance has been created for the procedure.

For this report we have suggested a method which is a compromise of the current assessment practices of RSC's, while also suggesting a more formal and guided approach for the assessment of ecological coherence. The approach builds on aggregation methods which have been used for assessments under the EU Water Framework Directive, HELCOM assessments and also suggested for the MSFD (Borja et al. 2013). With the method one can rely on quantitative assessments, compare assessment results across marine regions and most importantly deal with the different amounts of species and habitats in marine areas (even within the assessment area).

Building on suggestions and reports been produced in OSPAR, we have suggested a simple tool to visualize the assessment process in a matrix and to include uncertainties to the assessment of the ecological coherence. As a result, we do not suggest that ecological coherence should be assessed strictly by a number, but it can be a likelihood which is affected also by the amount of uncertainty.

Improving data to improve the assessment results

The ecological coherence was suggested to be assessed as a basic assessment and a more detailed assessment. While the former can be done by simple data sets (polygons of MPAs, marine region, ecoregions and bathymetry and lists of features per MPA), the latter requires more sophisticated GIS data on spatial distribution of conservation features (habitats, species, underwater landscapes, geological formations, etc) and anthropogenic pressures (at least the predominant ones or those affecting specifically the conservation features) as well as a database of legal instruments which have been used to protect the site and a list of features which are legally protected. Also in the last dataset spatial data is the preferred format, as the legal basis can vary in different parts of an MPA.

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 AIS data and impacts of fishing on the basis of 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.
Maps of habitats and species distribution are, on the other hand, much more difficult to obtain. International projects, such as EUSeaMap or BALANCE have produced broad-scale habitat maps (of abiotoc features) for almost three marine regions and national mapping projects include biotic elements such as habitat-forming species. At the moment, maps of conservation features are on a rough scale and there are proven errors within the data, but it is a good start for more realistic MPA assessments.

In this report, we were not able to test the third more detailed assessment method, i.e. the legal basis of protection, as the data for that was not in the international databases. We suspect that in many countries even national databases are not arranged to properly contain information of the features which are legally protected by the site. We think that this addition to the MPA assessments is necessary in the long run.

Role of management as a part of an MPA network assessment
This report did not include the aspects of management efficiency among the assessment criteria. This issue was raised during the Marine Expert Group meeting (May 2014) and feedback was given for the preparation of this report. It became clear during the meeting that management efficiency should be assessed separately from the assessment of ecological coherence. However, management is an important issue and it should be assessed in connection with the coherence. 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 stressed the importance of tracking the management effectiveness of individual MPAs within the network (Laffoley 2008).

The OSPAR and HELCOM definitions for the MPA network includes the concept of 'well-managed' (HELCOM-OSPAR Joint Ministerial Meeting, 2003, Bremen), which implies that management is an important feature of an MPA network. The HELCOM Recommendation 35/1 and OSPAR Recommendation 2010/2 mention, however, the management and ecological coherence separately and their assessments in different schedule, 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 to the assessment methodology.

Management is close to the concept of protection level. 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 'level of protection' 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. Also the OSPAR assessment (2013) included protection level as an 'essential aspect of ecological coherence'.

Table 5.9 Full test results of the basic assessment.

	Criteria result	Target	Ratio	Uncertainty in data[1]	Uncertainty in target [1]	Uncertainty in method [1]	Weighted average
REPRESENTATIVITY							
Coverage of the MPAs in the area	8.70 %	10 %	0.87	1	1	1	0.9
Representativity of Gulf of Finland	27 %	10 %	2.7	1	1	1	2.7
Representativity of Gulf of Riga	62 %	10 %	6.2	1	1	1	6.2
Representativity of Bothnian Sea	32 %	10 %	3.2	1	1	1	3.2
Representativity of Archipelago Sea	6 %	10 %	0.6	1	1	1	0.6
Representativity of Åland Sea	8 %	10 %	0.8	1	1	1	0.8
Representativity of Northern Baltic Proper	3 %	10 %	0.3	1	1	1	0.3
Representativity of Eastern Gotland Basin	6 %	10 %	0.6	1	1	1	0.6
Representativity of Western Gotland Basin	8 %	10 %	0.8	1	1	1	0.8
Representativity of 0-10m depth zone	32 %	10 %	3.2	0.75	1	1	2.9
Representativity of 10-20m depth zone	21 %	10 %	2.1	0.75	1	1	1.9
Representativity of 20-30m depth zone	18 %	10 %	1.8	0.75	1	1	1.7
Representativity of 30-60m depth zone	6 %	10 %	0.6	0.75	1	1	0.5
Representativity of 60-100m depth zone	0.6	10 %	0.06	0.75	1	1	0.1
Representativity of >100m depth zone	0.1	10 %	0.01	0.75	1	1	0.01
Representativity of Z, marina	0.9	20 %	0.04	0.5	1	0.5	0.03
Representativity of C, baltica	0.7	20 %	0.03	0.5	1	0.5	0.02
Representativity of F, vesiculosus	2.3	20 %	0.11	0.5	1	0.5	0.1
Representativity of S, caspia	3.6	20 %	0.18	0.5	1	0.5	0.1
Representativity of A, marila	3.6	20 %	0.18	0.5	1	0.5	0.1
Representativity of C, hiaticula	5.8	20 %	0.29	0.5	1	0.5	0.2
Representativity of P,b,hispida	4	20 %	0.2	0.5	1	0.5	0.1
Representativity of sandbanks	5.5	20 %	0.27	0.5	1	0.5	0.2
Representativity of reefs	6.5	20 %	0.32	0.5	1	0.5	0.2
Representativity of estuaries	1.8	20 %	0.09	0.5	1	0.5	0.1
Representativity of coastal lagoons	6.5	20 %	0.32	0.5	1	0.5	0.2
Representativity of boreal baltic narrow inlets	0.6	20 %	0.03	0.5	1	0.5	0.02
Representativity of boreal Baltic islets and small islands	6.5	20 %	0.32	0.5	1	0.5	0.2
Representativity of Baltic esker islands	0.8	20 %	0.04	0.5	1	0.5	0.03
Representativity of large shallow inlets and islands	5	20 %	0.25	0.5	1	0.5	0.2
Average uncertainty and average criterion				0.70	1,00	0.75	0.8
REPLICATION							
Replication of Z, marina	2	2	1	0.75	1	0.75	0.8
Representativity 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
CONNECTIVITY							
Proximity by 50 km	50 %	50 %	1	1	0.75	0.5	0.75
Average uncertainty and average criterion				1	0,75	0.5	0.75
ADEQUACY							
MPA sizes of 20 km^2	45 %	75 %	0.6	1	1	1	0.6

Protection level	24 %	30 %	0.8	1	1	1	0.8
Average uncertainty and average criterion				1	1	1	0.7

Table 5.9Integration table for the assessment of ecological coherence in the study area. See Chapter 5 for the data sources and methods and Chapter 6 for the case study assessment. A ratio of the sub-criterion result and the target is first attained for all the sub-criteria. Secondly, uncertainty in the data, target and method is added and the uncertainty is used as weighing of the sub-criterion. In the third step, a weighted average is calculated for each sub-criteria and then for the criteria level. The likelihood of reaching the target is given for each criterion, based on the uncertainty and the weighted average. Finally, the assessment of ecological coherence is done by the one-out-all-out principle, where the weakest criterion determines the final assessment result. The final assessment takes account of the likelihood and even results that do not meet targets can lead to ecological coherence if there is some uncertainty and likelihood estimates suggest acceptance of the coherence 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 5.10. Full test results of the more detailed assessment

Table 5.10 Integration table for the more detailed assessment of ecological coherence in the study area. See Table A1 for more details.

	Criteria result	Target	Ratio	Uncertainty in data[1]	Uncertainty in target [1]	Uncertainty in method [1]	Weighted average
REPRESENTATIVITY							
Coverage of the MPAs in the area	8.70 %	10 %	0.87	1	1	1	0.9
Representativity of Gulf of Finland	27 %	10 %	1.27	1	1	1	1.3
Representativity of Gulf of Riga	62 %	10 %	1.62	1	1	1	1.6
Representativity of Bothnian Sea	32 %	10 %	1.32	1	1	1	1.3
Representativity of Archipelago Sea	6 %	10 %	0.6	1	1	1	0.6
Representativity of Åland Sea	8 %	10 %	0.8	1	1	1	0.8
Representativity of Northern Baltic Proper	3 %	10 %	0.3	1	1	1	0.3
Representativity of Eastern Gotland Basin	6 %	10 %	0.6	1	1	1	0.6
Representativity of Western Gotland Basin	8 %	10 %	0.8	1	1	1	0.8
Representativity of 0-10m depth zone	32 %	10 %	1.32	0.75	1	1	1.2
Representativity of 10-20m depth zone	21 %	10 %	1.21	0.75	1	1	1.1
Representativity of 20-30m depth zone	18 %	10 %	1.18	0.75	1	1	1.1
Representativity of 30-60m depth zone	6 %	10 %	0.6	0.75	1	1	0.6
Representativity of 60-100m depth zone	0.6	10 %	0.06	0.75	1	1	0.1

Representativity of >100m depth zone	0.1	10 %	0.01	0.75	1	1	0.01
Representativity of photic hard-bottom	29	20 %	1.45	0.5	1	1	0.96
Representativity of photic mud and clay	23	20 %	1.15	0.5	1	1	1.0
Representativity of photic sand	67	20 %	3.35	0.5	1	1	2.8
Representativity of non-photic hard bottom	11	20 %	0.55	0.5	1	1	0.5
Representativity of non-photic mud and clay	3	20 %	0.15	0.5	1	1	0.1
Representativity of non-photic sand	26	20 %	1.3	0.5	1	1	1.1
Average uncertainty and average criterion				**0.79**	**1.00**	**1.00**	**0.9**
REPLICATION							
Replication of Z, marina	2	2	1	0.75	1	0.75	0.8
Representativity 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**
CONNECTIVITY							
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-photic hard bottom (50 km)	84	50	1.68	0.5	0.75	0.5	0.98
Connectivity of non-photic mud and clay (50 km)	41	50	0.82	0.5	0.75	0.5	0.5
Connectivity of non-photic 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**
ADEQUACY							
MPA sizes of 20 km^2	34 %	75 %	0.45	0.75	1	1	0.42
Protection level	24 %	30 %	0.7	1	1	1	0.7
Average uncertainty and average criterion				**0.9**	**1**	**1**	**0.56**