Comparison of MSFD biodiversity indicators of the Netherlands and the United Kingdom

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Preface

The purpose of this thesis is to fulfil the thesis requirement (7,5 EC) for the Master in Environmental Biology at the University of Utrecht.
I wrote my thesis under supervision of Herman Hummel (NIOZ) and Appy Sluijs (University Utrecht). I made a comparison of the Marine Strategy Framework Directive biodiversity indicators proposed by the Netherlands and the United Kingdom. This to reveal the differences and gaps in the marine strategies of both nations and to determine what influence the decision making process had on the proposed indicators.

Inhoud

Abstract

Various anthropogenic pressures have negative effects on marine ecosystems (OSPAR 2010). To protect European marine ecosystems, the European Commission developed the Marine Strategy Framework Directive (MSFD) under which Member States should cooperate as much as possible. In the MSFD, 11 descriptors are set out. Here fore, each Member State was obliged to develop indicators to measure the state and progress of all 11 descriptors (European Commission 2008). However, the Member States struggle with developing indicators. Because all Member States individually developed their indicators, this led to the proposal of various indicators for identical descriptors. The requested cooperation therefore becomes difficult and also comparing data between countries becomes impossible. Furthermore, many Member States did not propose all requested indicators. Already at first glance, the proposed indicators for descriptor 1 biodiversity, shows large differences, especially between the Netherlands and the United Kingdom.
The aim of this study is to assess the differences in the MSFD biodiversity indicators of the United Kingdom and the Netherlands. Subsequently, it is my aim to analyse what policy reasons and/or differences in the decision making process caused discrepancies between the nations.
By assessing the differences in biodiversity indicators and by revealing the outline of the decision making process is determined what caused the differences in indicators of the Netherlands and the United Kingdom.
I analysed the indicators for the biodiversity descriptor of the marine strategies of both nations. Hereby the relevance of the proposed indicators is determined as well. Interviews with experts from the Netherlands and the United Kingdom are also conducted to clarify the decision making process.

The results reveal large gaps in the indicator lists and many indicators are found irrelevant, mainly mammals based indicators. The Netherlands seems to have a policy based decision making process which results in preference for already in use indicators with no further indicator development. Their proposed indicators also are very unspecific. The United Kingdom is more science based. In their strategy, many indicators are mentioned, however they are often found irrelevant.
I expect that this research may be an eye opener for both scientists and policy makers who work on this topic. On policy level, I recommend policy makers to adopt the United Kingdom decision making process. This process then should be supplemented with a critical team of experts who will look into the indicator relevance and also into the applicability of the indicators.
Furthermore, science and policy need to work together in order to prevent excess research and to make sure relevant indicators are chosen. I strongly recommend to, together with diverse experts with backgrounds in different topics, discuss the proposed indicators and do determine which are relevant and which are not.

1.Introduction

Issue
The North Sea is located between Great Britain, Scandinavia, Germany, the Netherlands, Belgium, and France. It accommodates a great diversity of organisms such as fish, marine mammals, benthos, zooplankton, phytoplankton, benthic organisms and birds.
Pressures such as climate change, eutrophication, hazardous substances, radioactive substances, offshore oil and gas industry, the use of living marine resources and other human uses and impacts have negative effects on the North Sea ecosystem (OSPAR 2010).
To protect the North Sea as well as other marine ecosystems, the European Commission developed the Marine Strategy Framework Directive (MSFD). With the MSFD the European Commission aims to achieve a Good Environmental Status (GES) in European waters by 2020.
A Good Environmental Status is defined as “The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive.”

Figure 1 the North Sea and surrounding countries. Graphicmaps.com

In the MSFD, 11 descriptors are set out against which the Good Environmental Status will be measured. Each Member State developed a marine strategy wherein the Good Environmental Status for all 11 descriptors is described. For each descriptor also targets and indicators are described (European Commission 2008).
The described indicators will be used to measure the progress towards the Good Environmental Status. Therefore they are a very important part of the directive. However, since the Member States all individually developed their indicators, this led to the description of different indicators for the same descriptor.

One of these descriptors is biodiversity. This descriptor shows large differences among the Member States, such as different described indicators for the same topic and lack of indicators. Differences in indicator lists are very obvious between the Netherlands and the United Kingdom.
Already at first glance at the biodiversity indicators lists of the two states, the UK stands out with its large list of biodiversity indicators (although not all are operational yet). The Netherlands on the other hand describes a more limited list of indicators and mentions the need for more research.

The aim of my present study is to assess the differences in the MSFD biodiversity indicators of the UK and the Netherlands. Subsequently, it is my aim to analyse what policy reasons and/or differences in the decision making process caused discrepancies between the nations.
By assessing the differences in biodiversity indicators and by revealing the outline of the decision making process, I aim to determine what caused the differences in indicators of NL and the UK. If the use of different indicators is caused by this decision making process, the decision making processes of the nations should be tuned.

1.1 Research questions

Defining biodiversity is complex. This complexity is also reflected in "The Report of the OSPAR workshop on MSFD biodiversity descriptors" (OSPAR 2012). During this workshop many questions were raised but remained unaddressed. Overall, a need for more research was mentioned (OSPAR 2012). The complexity of defining biodiversity indicators may be caused by the manifold (thousands) of species that might indicate diversity, and the lack of consistency in expressing diversity in a quantitative measure. To overcome the difficulty of defining indicators, policy makers often seem to choose the most eye-catching and obvious (easy measurable) indicators. Consequently, pet (cute) animals, such as seals, are chosen as biodiversity indicators, mainly because of their charm (Interview IenM). However, seals have a large range of species to prey upon (Das *et al*. 2003), therefore these animals are not for sure to reflect biodiversity. Similarly, it is the question whether the other described indicators too are relevant or not.
Which leads towards the first research question: Are all proposed biodiversity indicators relevant?

Large differences in the indicator lists may hinder the future cooperation for further development of the indicators and monitoring. By tuning the indicators of the member states in a manner that increase cooperation possibilities, this could result in a better indicator and monitoring development and could lead to major cost reductions since indicator development and monitoring are costly processes. Tuning indicators is not an easy task. Major policy processes occur at the background and at policy level will be determined what will be done. Policy processes differ per member state.
In order to enhance cooperation, these policy decision making processes need to be clear. Therefore the decision making process of the Netherlands and the UK need to be described.
Research question 2: How are the Biodiversity indicators, to be used in the MSFD, selected by the UK and the Netherlands in their decision making process?

Approach
First the indicators of the Netherlands and the UK will be described (chapter 2). Together with NIOZ and scientific literature, the relevance of these indicators will be defined (chapter 3). The defined relevance of the indicators, together with the indicator status will give an overview of what indicators are currently available and relevant and where indicators are missing.
To describe the decision making process of the countries, experts in the Netherlands and the UK will be interviewed and policy documents will be consulted (chapter 4).

1.2 Methods

Relevance of biodiversity indicators
The marine strategies of the Netherlands and the United Kingdom (table 1), are used to address the question whether all described biodiversity indicators are relevant or not. Firstly, the described indicators are set out in a table to give a clear overview of how the criteria in the MSFD are addressed by these indicators (table 4).

Table 1 Marine Strategy documents used in the Netherlands and the UK

Country	Marine Strategy documents
The Netherlands	Marine strategy for the Netherlands part of the North Sea 2012-2020, part 1 (Ministry of Infrastructure and the Environment, 2012).
The United Kingdom	UK Initial Assessment and Proposals for Good Environmental Status 2012 (HM government, 2012).

Hereafter, together with experts from NIOZ (Herman Hummel en Sander van Wijnhoven) and supplemented by scientific literature, is determined if these indicators are relevant as biodiversity indicator. This determination of relevance is based upon four selected criteria: Measurability, food web, recovery and sensitivity. These four criteria are chosen by Sander van Wijnhoven to be relevant to assess the marine biodiversity indicators, and strengthened by relevant scientific articles. These criteria are explained in more detail in chapter 3.
After selecting our criteria, the indicators of NL and the UK are scored on a scale of 0-1 for each of the 4 criteria. Table 2 gives an example of the scoring method of one of the criteria. This is also done for the other 3 criteria.

Table 2 Scoring method on "measurability" of the indicators

Criterion 1. Measurability	score
The indicator does not meet the criterion	0
The indicator meets the criterion a little bit	0,5
The indicator does not meet the criterion	1

For example, the indicator for the mammal group of the UK (table 3) “Distributional range of harbour seal” scored 1 point on measurability (M). The harbour seal is easy to measure and therefore meets this criterion and gains 1 point. This indicator however says nothing about the other criteria, food web (F), recovery (R) and sensibility (S) and therefore scored 0.
When summing the outcome of these criteria, the total score can be found under “relevance” and is 1. An example is given in table 3.

Table 3 Example of criteria 1.1 Species distribution with the indicator that the UK described. The indicator is scored on Measurability, Food web, Recovery and Sensibility. The relevance box is the sum of the former scores.

Criteria	Group	Indicator UK	M	F	R	S	Relevance
1.1 Species distribution	**Mamals**	Distributional range of Harbour seal.	1	0	0	0	1

The maximum achievable score is 4 (4 times 1 point) and the lowest score is 0 (4 times 0 point). When the sum of the scores are between 0-1,5, the box is coloured red. Summed scores of 2-2,5 are coloured orange and scores > 2,5 are coloured green. This to reflect the relevance of the indicators: Not relevant (red), medium relevant (orange) and relevant (green).

Influences during the decision making process

To address how the indicators are chosen in the different countries, the decision making process is studied. In order to reveal how the indicators are chosen and what was important in the considerations, experts of the Netherlands and the UK are interviewed. The processes are described and the differences highlighted where after recommendations are given.

The main questions that were asked during the interview are:

1. How are the indicators, which are proposed in the NL and the UK marine strategy, chosen?
2. Who made the final decision about what indicators are described in the Marine Strategy?
3. What were the main problems for proposing the indicators for biodiversity?
4. To what degree are indicators, which were already available from on other policies, implemented in the MSFD indicator list?
5. How did policy and science cooperate?

2. Biodiversity indicators

Biodiversity
Biodiversity has different meanings. Biodiversity can be restricted to a) species richness (Redford and Sanderson .1992), b) extended to diverse levels of the ecology (such as species and ecosystems) (Heink and Kowarik 2010), and c) entail the composition and structures of the different elements of biodiversity and its related processes (Nos 1990).

In the MSFD, the biodiversity descriptor (descriptor 1) is defined as: “Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions” (European Commission 2008). Thus biodiversity here is restricted to diverse levels of the ecology (b) and does not entail (directly) processes (c).

Indicators
Indicators for the Biodiversity descriptor will be used to assess the environmental condition and to which extent the GES is achieved (with respect to the GES criterion of the European Commission). Indicators will also be used to assess the environmental impact, to reflect the undesirable state and to reveal to what extent the impact is reduced in relation to GES (and targets). The pressures from human activities and the reduction of the pressure related to targets are also used to assess this environmental condition.
In order to help the Member States with the implementation of the Marine Strategy Framework Directive, the Commission Decision paper is made. This can be seen as a guidance paper and contains a list of detailed criteria and indicators (European Commission 2010).

The biodiversity descriptor is organized in different levels as can be seen in the Commission Decision paper. These levels are:

1. Species / individual species - Such as those which are listed under community directives or key species for assessing a wider functional group.
2. Functional groups – Birds, mammals, reptiles, fish and cephalopods. This represents the main functional groups of the highly mobile (and widely-dispersed) taxa.
3. Habitat types – The predominant and special types which cover the seabed and water column habitats. It includes their associated biological communities.
4. Ecosystems – Assessment of several habitats and functional groups as part of larger ecosystems.

All these levels are incorporated in the criteria of the Commission Decision which are listed in table 4. The Member States described specific indicators for these criteria and indicators.

First, the indicators of the Netherlands are described for 1.1 species distribution, 1.2 population size, 1.3 population condition, 1.4 habitat distribution, 1.5 habitat extent, 1.6 habitat condition and 1.7 ecosystem structure. Hereafter the relevance of these indicators is analysed a scoring system. The same is done for the UK (table 5).

Table 4 Topics for Descriptor 1. Biodiversity in the Commission Decision. (European Commission 2010)

Criteria	Indicator description
1.1 Species distribution	Distributional range (1.1.1)
	Distributional pattern within the latter, where appropriate (1.1.2)
	Area covered by the species (for sessile/benthic species) (1.1.3)
1.2 Population size	Population abundance and/or biomass, ass appropriate (1.2.1)
1.3 Population condition	Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival-mortality rates)(1.3.1)
	Population genetic structure, where appropriate (1.3.2)
1.4 Habitat distribution	Distribution range (1.4.1)
	Distribution pattern (1.4.2)
1.5 Habitat extent	Habitat area (1.5.1)
	Habitat volume where relevant (1.5.2)
1.6 Habitat condition	Habitat condition of the typical species and communities (1.6.1)
	Habitat: Relative abundance and/or biomass, as appropriate (1.6.2)
	Habitat: Physical, hydrological and chemical conditions (1.6.3)
1.7 Ecosystem structure	Ecosystem: Composition and relative proportions of ecosystem components (habitats and species) (1.7.1)

2.1 Short description of the biodiversity indicators of the Netherlands

All biodiversity indicators in the Marine Strategy of the Netherlands and the UK are set out in a table (ANNEX I). For each criterion, a short description of the indicators in the marine strategy of the Netherlands is given below.

1.1 Species distribution
The Netherlands addresses this criterion by describing the need for development of indicators for the group's benthos, fish, and birds and mammals.
Two operational indicators are described for mammals such as: "The EcoQO indicator: Population trends of the normal and grey seal (no reduction of >10 per cent over a period of 5 years average). And the EcoQO indicator: Pup production grey seal (no reduction of >10 per cent of the pup production of the pup production over a 5 year average.

1.2 Population sizes
To address this criterion, the Netherlands again describes indicators for the group's benthos, fish, birds and mammals. The Netherlands describe no operative indicators for this criterion. All indicators which are mentioned still need to be developed.

1.3 Population condition
The Netherlands address this criterion by mentioning that indicators for marine mammals, fish, benthos and birds need to be developed.

1.4 Habitat distribution
Only for a small part of this criterion (1.4.1), the Netherlands described the need for development for an indicator for the spreading and size of present habitats (EUNIS level 3) and habitats under the Habitat directive.

1.5 Habitat extent
For this criterion, the Netherlands only mentions an indicator for part 1.5.1 of this descriptor, "The spreading and size of present habitats (EUNIS level 3) and habitats under the Habitat directive". However, this indicator still needs to be developed.

1.6 Habitat condition
For criterion 1.6.1 the Netherlands describes indicators for distribution, presence and condition of sensitive benthos species and bio gene structures that are representative for sea floor disturbance. However, these indicators still need to be developed.
For criterion 1.6.2, the indices for composition of bottom communities (KRW indicator BEQI-2), is mentioned. This is an operative indicator that needs further development.
For criterion 1.6.2, the sea bottom area that is not disturbed and an indicator for the quality of the diverse habitats on EUNIS level 3 is mentioned. However they both need to be developed.

1.7 ecosystem structure

The Netherlands described two existing and operative indicators for ecosystem structure. The first indicator is the percentage of large fish in catches of bottom species. The second indicator is the OSPAR EcoQO large fish indicator. Also indicators for seabirds, sea mammals, sharks and rays as top predators, and the food relation of key species are described as indicator. However the latest two still need to be developed.

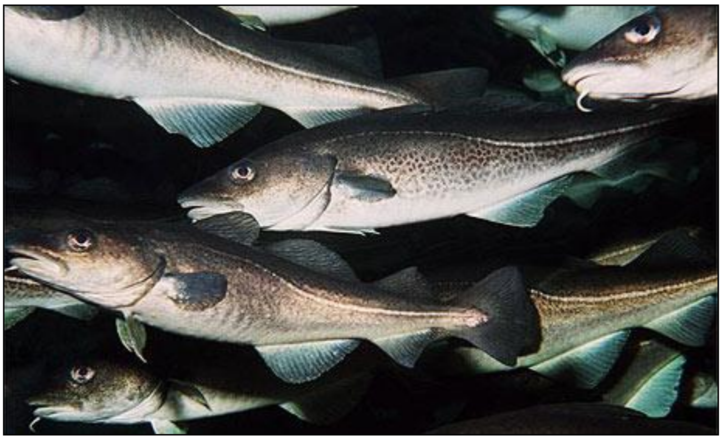

Figure 2 Cod in the North Sea (www.guardian.co.uk)

2.2 Short description of the biodiversity indicators of the United Kingdom

1.1 Species distribution

The UK describes indicators for mammals and birds for part 1.1.1 of this criterion. They describe the indicator: “Distributional range of the harbour seal and the distributional range of the grey seal breeding”. These indicators both are operational.

They also describe the distributional range of fish (Continental Shelf Seas) and the distributional range of Fish (Shelf-edge Seas). But these two both still need to be developed.

Figure 3 Harbour seal seagrant.uaf.edu

Part 1.1.2 is more extensive addressed by the UK. Seven indicators for mammals are described of which 5 still need to be developed. Operational indicators are: “Distributional pattern within range of harbour seal and the distributional pattern within range of grey seal breeding”.

For fish, two indicators are mentioned: “Distributional pattern within range of Fish (Shelf- edge Seas) and the distributional pattern within range of Fish (Continental Shelf Seas)”. They both still need to be developed.

For birds they mention 6 indicators which still need to be developed, such as: “Distributional pattern of winter gull roosts”.

1.2 Population size

The UK defines indicators for this criterion for the groups mammals, fish and birds.

For the mammal group, 8 indicators are defined of which two are operative. The operative indicators are: “Harbour seal abundance and grey seal abundance.”

For fish the indicators: “Population abundance of fish and the fish population biomass” are mentioned. These still need to be developed.

The bird group is addressed by 4 indicators which all need to be developed, such as “Species-specific trends in relative non-breeding abundance of marine birds at sea (inshore and offshore)”

1.3 Population condition

For criterion 1.3.1, the UK defines indicators for marine mammals, fish and birds.

Of the 7 described marine mammals indicators, only 1, “Grey seal pup production”, is operative.

The other indicators need to be developed.

For the fish group the UK describes the indicator “Proportion of mature fish in population”, which also needs to be developed.

Finally, for birds 4 indicators are described which all are not operative yet. "1. Non-native mammal presence on island seabird colonies, 2. Mortality of seabirds from fishing (by catch) and aquaculture, 3. Breeding failure of seabird species sensitive to food availability and 4. Annual breeding success of kittiwakes".

1.4 Habitat distribution

For criterion 1.4.1, the UK describes indicators for the pelagic habitats, the rock and reef habitats, and the sediment habitats.

For the pelagic habitats they describe the change of plankton functional types (life forms) as indicator.

For the rock and reef habitats, as well as the sediment habitats, the distributional range of the habitats as indicators is described. All of these indicators still need to be developed.

For criterion 1.4.2 the UK also describes indicators for the pelagic habitats, the rock and reef habitats and the sediment habitats.

For the pelagic habitats, the change of plankton functional types (life forms) is again described.

For the rock and reef habitats, as well as the sediment habitats, the distributional pattern is described as indicator. Again, all these indicators still need to be developed.

1.5 Habitat extent

For this criterion, 5 indicators are described for the rock and reef habitats but they all need to be developed. Two indicators are described for the sediment habitat: "Area of sediment habitat of predominant habitat types and area of sediment habitat of all (listed) habitat types". However these also need to be developed.

1.6 Habitat condition

For criterion 1.6.1, the UK describes indicators for the pelagic habitats, the rock and reef habitats and the sediment habitats.

For pelagic habitats the indicator: "Change of plankton functional types (life forms)" is described. This indicator however is not operative yet.

For rock and reef habitats, 14 indicators are described but only one is operational: "Intertidal species composition & abundance".

For sediment habitats, 9 indicators are described of which 3 are operational: 1. WFD sea grass tool (Ecological Quality Ratio based on the species composition, density and extent of cover of sea grass communities), 2. Infaunal Quality Index (Ecological Quality Ratio based on the sensitivity, richness and diversity (evenness) of benthic communities) and 3. Opportunistic macro algae.

For criterion 1.6.2 the UK again describes indicators for pelagic habitats and rock and reef habitats.

For pelagic habitats they described zooplankton biomass and phytoplankton biomass as indicators. These indicators both still need to be developed.

For rock and reef habitats, 5 indicators are described such as: "Impact/Vulnerability of habitat to Penetration and/or disturbance of the substrate below the surface of the seabed". These indicators all need to be developed.

For criterion 1.6.3, only an indicator for sediment habitat is described: "Sediment profile imaging". This indicator needs to be developed.

1.7 Ecosystem structure

For this criterion, the UK describes indicators for fish and habitats.

Fish relative abundance (Proportion of Large Fish Indicator (LFI): proportion of demersal fish exceeding a specified length threshold) and fish relative abundance (HILLS N1) are described as indicator. Only the former is operative.

As indicator for pelagic habitats, the change in all pelagic indicators (used in the other descriptors) is described. This indicator is not operative yet.

3. Indicator relevance

Measuring the total biodiversity of a region is impossible. Therefore there is a demand for indicators to represent this biodiversity. To be able to use these indicators, indicators should meet certain criteria. There are several criteria that the ideal indicator should meet according to experts: (1) sufficiently sensitive to provide an early warning of change; (2) distributed over a broad geographical area, or otherwise widely applicable; (3) capable of providing a continuous assessment over a wide range of stress; (4) relatively independent of sample size; (5) easy and cost- effective to measure, collect, assay, and/or calculate; (6) able to differentiate between natural cycles or trends and those induced by anthropogenic stress; and (7) relevant to ecologically significant phenomena (Munn 1988). However, no single indicator could address all these criteria, therefore multiple indicators are often required (Heink and Kowarik, 2010).
Since not all of these criteria are relevant to assess the biodiversity indicators of this research, only relevant criteria are chosen, together with Dr. Sander van Wijnhoven (NIOZ).
The following four criteria are chosen:

1. Sensitivity to disturbance
The first chosen criterion is sensitivity for disturbance (Munn 1988). Indicator species that have a sensitive response to environmental changes are often proposed as early warring mechanisms for the negative impacts on biodiversity. (Nos 1990). Therefore, they indicate changes of the environment they live in.
2. Measurability
The second criterion is measurability. It is important that indicators are easy and cost- effective to measure, collect, assay, and/or calculate (Munn 1988).

Besides these criteria, we added two other criteria which are relevant for the use of these indicators.

3. Recovery
The indicators described in the marine strategies should reflect recovery or deterioration of the ecosystem. Therefore, the relation between the indicator and the ecosystem should be clear (Heink and Kowarik, 2010).
4. Food web
The final criterion is food web. A food web describes who eats who in a certain ecosystem. It gives insight in e.g. the biodiversity of the ecosystem too (Dune *et al*.2002). Therefore, indicators have to reflect (part of) the food web to be a relevant indicator for biodiversity, which is the fourth criterion of this research.

These four criteria are the chosen relevant criteria to assess the marine biodiversity indicators.
Against these criteria the indicators of NL and the UK will be tested.
The indicators will be scored on a scale of 0 to 1. If the indicator does not meet the criterion, it scored 0. If the indicator meets the criterion more or less, it is scored 0,5, and if the indicator completely meets the criterion, it is scored 1.
After summing the scores the maximum score is 4 (4 times 1 point) and the lowest score is 0.

3.1 Indicator relevance of the Netherlands

Many indicators in the Netherlands still need to be developed (marked with a N) (table 5, row "NL relevance"). Indicators that are operative are indicated with an "O".
Criteria 1.1, 1.2 and 1.3 are more or less addressed by NL by describing some operational indicators and often need development.
The following criteria, 1.4, 1.5, 1.6 and 1.7 however are minimally addressed. Only a few indicators with little variation are mentioned. Overall there are "crosses" which means that the Netherlands did not mentioned an indicator or development is needed for this criterion.

The indicators for mammals (criteria 1.1, 1.2 and 1.3) are not very relevant and therefore received a low score (red). It seems that "pet animals" (animals which are found adorable by the community) are chosen as indicator but these indicators do not per se indicate biodiversity. When their food source is abundant, which could be one fish species, yet seals are subsequently also abundant, it does not mean that there is a high degree of biodiversity.
On top of that, there is lack of information about the present levels of seal stocks in the North Sea. This will hinder the development of an indicator (Rogers and Greenaway. 2005).

Figure 4 "Pet animal", seal pup. . (digitaljournal.com)

Furthermore, the indicators for birds for these criteria are doubtful to represent biodiversity. Seabirds are easy notable animals and sudden changes in their population, health or breeding success may indicate pollution or a food supply problem (Furness and Camphuysen 1997).
This food supply problem however is not per se related to biodiversity but is related to its prey. Therefore birds are thought to be not very sensitive for environmental biodiversity change and recovery of the biodiversity.

The indicators described for fish and benthos received higher scores (green) and mediate scores (orange). Benthic indicators are thought to indeed reflect biodiversity. It fulfils most criteria since it is easy to measure, could represent the food web, is sensitive for changes and indicates recovery of the ecosystem and thus biodiversity. Also, benthic organisms are a food source for higher trophic levels. The relative abundance of these organisms is indicative for environmentally driven changes and man-made disturbances. Because most of the adult benthic species are sessile, sedentary or move over limited ranges, these organisms are good indicators of the environmental quality (Rogers and Greenaway. 2005). Local studies show the benefits of using benthos as indicators of activity-specific impacts (Reese *et al.* 2003).

Fish are easy to measure as well. There are already several catch methods to catch these fish (Rijnsdorp *et al.* 1996) and large datasets are available since decades (Engelhard *et al.* 2011). Measuring a diversity of fish could reflect the food web since different fish species have different positions in the food web (figure 5. Level 2, 3 and 4) and therefore could give insight in the food web.

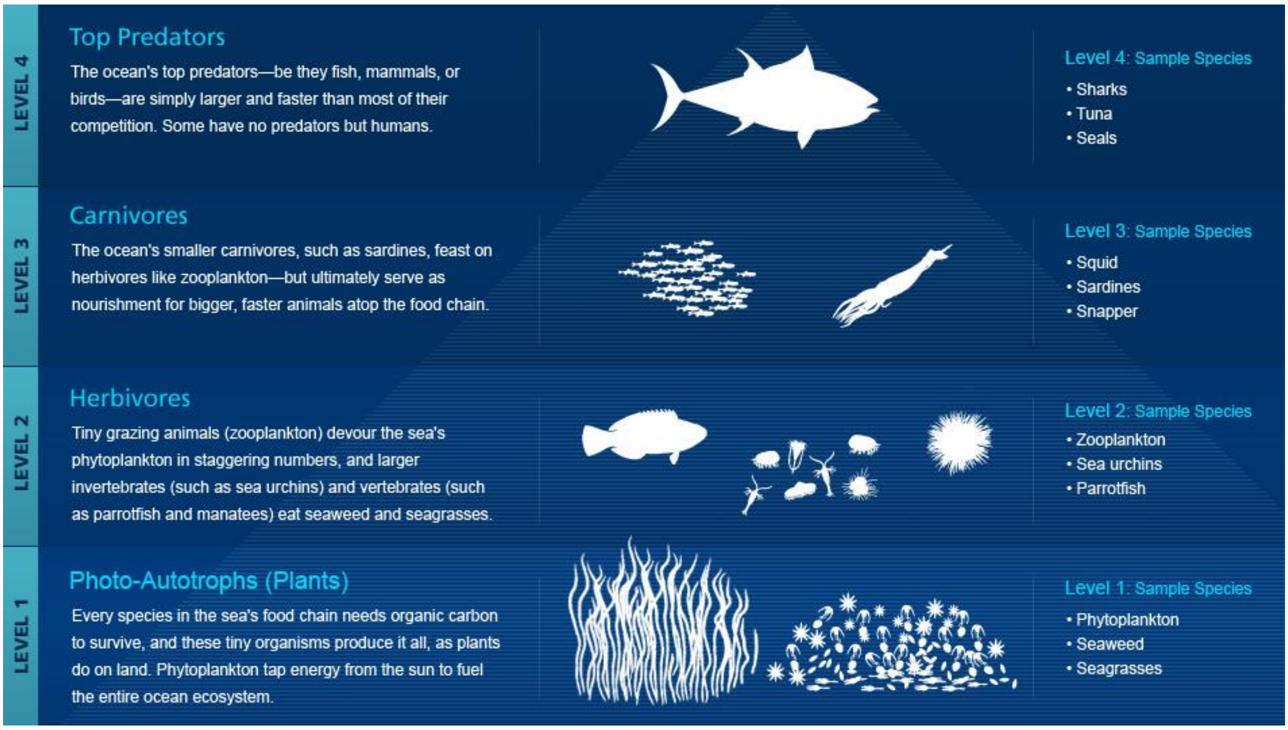

Figure 5 Different food web levels in the marine environment. (Ocean.nationalgeographic.com)

Several fish species in the North Sea are over exploited by fisheries (OSPAR 2010). Therefore it is difficult to define if changes in fish biodiversity are due to environmental changes or fishing practices. Thus since fish do not only reflect changes in biodiversity of the ecosystem it is difficult to use fish as biodiversity indicator.

Overall

Almost all relevant indicators (green/orange) still need to be developed. Only the indicator for 1.6.1 (habitats) and 1.7 (ecosystem) have an operative indicator.

When the indicators which are in development (almost all) indeed will become operative, some indicators (green/orange) could be used to represent biodiversity. Especially fish, benthos and habitats are good indicators for biodiversity. The other indicators (red) are not relevant as indicator for biodiversity.

Table 5 Criteria and indicators of the Netherlands and the UK divided in descriptive groups. O indicates that the indicator is operative. N indicates the need of further development. "NL relevance" and ""UK relevance" are the received scores upon the indicator. The lowest possible score is 0 while the highest possible score is 4. Low scores, 0-1.5, are coloured red and indicate low relevance of the indicator. Medium scores, 2-2,5, are coloured orange and indicate an intermediate relevance. High scores, 3-4 are marked green and indicate high relevance of the indicator.

Criteria	Indicator	Group	NL Status	NL Relevance	UK Status	UK Relevance
1.1 Species distribution	Distributional range (1.1.1)	**Mammals**	O	1	O&N	1
		Fish	N	3	N	3
		Benthos	N	3,5	x	x
		Birds	N	1,5	x	x
	Distributional pattern within the latter, where appropriate (1.1.2)	**Mammals**	O	1	O&N	2
		Fish	N	3	N	3
		Benthos	N	3,5	x	x
		Birds	N	1,5	N	1,5
	Area covered by the species (for sessile/benthic species) (1.1.3)	**Benthos**	N	3,5	x	x
1.2 Population size	Population abundance and/or biomass, ass appropriate (1.2.1)	**Mammals**	N	1	O&N	1,5
		Fish	N	3	N	3
		Benthos	N	3,5	x	x
		Birds	N	1,5	N	1,5
1.3 Population condition	Population demographic characteristics (e.g. body size or age class structure, seks ratio, fecundity rates, survival-mortality rates)(1.3.1)	**Marine mammals**	N	0,5	O&N	1
		Fish	N	2	N	2
		Benthos	N	2	x	x
		Birds	N	1	N	2
	Population genetic structure, where appropriate (1.3.2)	x	x	x	x	x
1.4 Habitat distribution	Distributional range (1.4.1)	**Pelagic habitats**	x	x	N	3
		Rock and biogenic reef habitats.	x	x	N	1,5
		Sediment habitats	x	x	N	1,5
		Habitats	N	2	x	x
	Distributional pattern (1.4.2)	**Pelagic habitats**	x	x	N	3
		Rock and biogenic reef habitats.	x	x	N	1.5
		Sediment habitats	x	x	N	1.5
1.5 Habitat extent	Habitat area (1.5.1)	**Rock and biogenic reef habitats.**	x	x	N	1
		Sediment habitat	x	x	N	1.5
		Habitats	N	2	x	x
	Habitat volume where relevant (1.5.2)	x	x	x	x	x
1.6 Habitat condition	Habitat condition of the typical species and communities (1.6.1)	**Pelagic habitats**	x	x	N	3
		Rock and biogenic reef habitats	x	x	O&N	3,5
		Sediment habitat	x	x	O&N	3,5
		Benthos	N	3,5	x	x
	Habitat: Relative abundance and/or biomass, as appropriate (1.6.2)	**Pelagic habitats**	x	x	N	2
		Rock and biogenic reef habitats	x	x	N	1.5
		Habitats	O	3,5	x	x
	Habitat: Physical, hydrological and chemical conditions (1.6.3)	**Sediment habitat**	N	3	N	3
1.7 Ecosystem structure	Ecosystem: Composition and relative proportions of ecosystem components (habitats and species) (1.7.1)	**Fish**	x	x	O&N	2,5
		Pelagic habitats	x	x	N	2
		Food web	O&N	2,5	x	x

3.2 Indicator relevance of the UK

Also in the UK (table 5, UK relevance) many indicators still need development (N). The UK however did mention for all indicators when they expect them to be operative (2014-2018).
For specific groups of criteria 1.1-1.3 no indicator is provided. Yet, for the mammals in some of these criteria operative indicators were described.
The other criteria 1.4-1.7, which are more habitat related, are specifically divided in pelagic, rock and reef, and sediment habitat. A more complete list of indicators is described for these criteria, however, many are under development.

The relevance of mammals, like the harbour seal, as indicators under criteria 1.1- 1.4 is low. Although mammals are easy to measure its link to the food web and what it says about biodiversity is not clear because the range of species that is preyed upon by marine mammals is wide (Das *et al.* 2003). Even more than 30 fish species occur in the diet of some marine mammals (Hall *et al.* 1998). Thus when several fish species are in decline, others can still be consumed and there is no necessary trend visible in the marine mammals. Because of this wide food range it is likely that they are not very sensitive for changes in biodiversity and also do not per se reflects increasing biodiversity (recovery).

Indicators that are defined for the fish group received a higher relevance score. The fish indicators for distributional range (1.1.1), distributional pattern (1.1.2), population abundance (1.1.3) and ecosystem structure (1.7), are relatively easy to measure since there are several catch methods such as trawl surveys (Rijnsdorp *et al.* 1996). Furthermore, as described earlier there are already several methods to catch these fish (Rijnsdorp *et al.* 1996) and large datasets are available since decades (Engelhard et al. 2011). Fish could be a good food web indicator but since they are not sensitive only to changes in biodiversity and recovery of the ecosystem (fishing pressure), it is difficult to define if changes in fish populations are due to environmental changes or due to fishing practices.

The bird indicators in 1.1.2 and 1.2.1 are not very specific. The described indicators are the distributional pattern of several bird groups (such as the non-breeding shorebirds) and species specific trends. Overall, birds are easy to measure. Sudden changes in their population, health or breeding success may indicate pollution or a food supply problem (Furness and Camphuysen. 1997). Food supply problem however, are not per se related to changes in species but can also be related to the amounts of a birds prey thus does not have to reflect biodiversity. Therefore, birds are thought to be not very sensitive for environmental biodiversity change or recovery of the biodiversity, and score low for relevance.

Birds in criterion 1.3 received a slightly higher score than the former since this indicator is more based upon survival- reproduction success. These indicators (such as breeding failure) are more difficult to measure since it is more labour-intensive. For example, one method to measure this indicator is to monitor all bird nests and number all eggs (Pyk *et al.* 2013).

For the pelagic habitats in criterion 1.4, 1.6 and 1.7, the described indicators are marked as relevant. Indicators for criterion 1.4 and 1.6, change of plankton functional types, are easy to measure. The North Sea is intensively sampled and probably the most intensively sampled marine system in the world (Warner and Hays. 1994).

Plankton is at the base of the marine food web. Therefore, it is essential in the functioning of the ecosystem (Hays *et al*. 2005). Thus changes in plankton can impact higher trophic levels in the marine food web, therefore they can influence (possibly) the biodiversity of the food web and recovery of the ecosystem.
Plankton is very sensitive to changes of the ecosystem. Most plankton species are short living organisms, therefore they have a fast turnover time which leads to a tight coupling between environmental change and plankton dynamics. Recent evidence even suggests plankton to be more sensitive indicators than environmental parameters themselves (Taylor *et al.* 2002).

Criterion 1.6.2 scored low on relevance for its pelagic habitat indicator. The described indicator is zooplankton biomass and phytoplankton biomass. Both are easy to measure but do not per se reflect biodiversity of the food web. The biomass of plankton is variable, for example large biomass shall be found when there is an algae bloom. These blooms sometimes are harmful for the other marine organisms, thus biomass does not have to reflect food web biodiversity. Also, biomass does not reflect the recovery of the ecosystem.

The indicator for pelagic habitat for criterion 1.7 is described as “Changes in all described pelagic indicators in the marine strategy” and received a medium score on relevance. Many aspects needs to be measured for this indicator, such as plankton, geographical changes, but also other factors that might affect plankton such as temperature, nutrients, etc. Therefore, this indicator is not easy to measure.
Biodiversity (food web) is likely to be reflected by this indicator since measuring different plankton species indicate plankton biodiversity. Furthermore, plankton is at the base of the food web (Siege l and Franz, 2010), thus its presence may reflect the possibility of occurrence of other species as well. Furthermore, plankton is highly sensitive for environmental changes of the ecosystem (Edwards et al. 2010).
Indicators for rock and reef habitats in criteria 1.4 and 1.5 are distributional range, distributional pattern and area of certain habitats.
Indicators for criterion 1.4 and 1.5 such as the distributional range of the habitat and area of sub tidal rock are not very relevant regarding biodiversity. The distributional range is measurable but a large area will need to be monitored. It may provide area for benthos, plants and fish to live, therefore it could make it possible for different organisms to live and may reflect some parts of the food web (or some not). However, it is not sensitive for environmental changes and recovery of the ecosystem since it entails mainly rock, chalk, etc.

Indicators for 1.6.1 and 1.6.2 are scored as medium relevant. These indicators also address species and impacts on the habitat. This is less straightforward than measuring rocks and thus less measurable than the former.
However, due to the large lists of indicators, these indicators together could represent part of the food web (since it entails many species from sponges to abundance of typical species).

Indicators for 1.6.2 are only impact based indicators, such as Impact/Vulnerability of habitat to 'Removal of target species”. Impacts are not sensitive nor can they show recovery of the ecosystem. Therefore these indicators scored lower than those for 1.6.1 which were not solely impact based.

Indicators for sediment habitat at 1.4.1, 1.4.2 and 1.5 are scored as not relevant. The indicators are distributional range, pattern and area of sediment habitat. All these indicators are easy to measure since again these are stagnant area's to measure. They could be a reflection of the food web since certain organisms live on/at these areas and with the occurrence of these areas, these organism can occur as well. The sediment habitat is not sensitive for environmental changes and recovery because it is a habitat.

The indicators for sediment habitat for 1.6.1 and 1.6.3 received higher scores for relevance.
Criterion 1.6.1 contains indicators such as the sea grass quality index (SQI) and impact indicators. Some of these indicators are relative simple to measure, such as the SQI (Neto et al. 2013) and some, for example impacts, are more difficult measure.
The SQI is also sensitive for environmental changes (Neto et al. 2013) and may reflect recovery of the ecosystem too. Because of the variable list of indicators and certain sediment types do house marine species, this may reflect some parts of the food web.

For criterion 1.6.3 (Physical, hydrological and chemical conditions), sediment profile imaging is mentioned. This method is not very difficult but time consuming, since photographs are made of the sediment and later on are processed and analysed (Wildish 2003).
It may reflect the food web since again certain sediment types may be the habitat for diverse organisms. This method could reveal those habitats. The sediment is very sensitive for physical, hydrological and chemical disturbance. Especially physical disturbance by bottom trawling fishing can impact and disturb the North Sea sediments.

To conclude

The indicators which are operative for 1.1, 1.2 and 1.3 are thought to be not relevant.
Only the operative indicators of 1.6 and 1.7 are relevant or medium relevant.

3.3 Comparing NL and the UK

Table 5 shows that there are many gaps in the biodiversity indicator lists of the UK and the Netherlands. Many indicators still need to be developed or are not relevant for biodiversity. However, for the indicators that need to be developed, the UK did set an aimed date. The Netherlands on the other hand, only briefly mentioned development need and a Dutch expert even mentioned that further research is on hold. Another difference is that the NL only broadly defined their indicators while the UK is more specific.

When comparing the indicators of NL and the UK, the UK has got more operative indicators then the NL. Also, criteria 1.4 (habitat distribution), 1.5 (habitat extent), 1.6 (habitat condition) and 1.7 (food web) show empty indicator lists (marked with crosses) for the NL part while the UK did mention indicators for these criteria.

Of all indicators of the Netherlands, only 2 indicators under the criteria habitat (1.6) and food web (1.7) are operative and seen as relevant. The UK also has few indicators which are operative and relevant, for criterion 1.1, mammals, 1.6 rock and reef habitat, 1.6 sediment habitat and 1.7 fish.

In both the UK and NL lists, the indicators marine mammals and birds are scored as irrelevant. For these animals, firstly should be determined how and to what extent they reflect biodiversity before they use them as indicator.

4. Decision making process

As shown before, the indicators in the marine strategies of the Netherlands and the United Kingdom show large differences. Differences in the decision making process of the two countries are thought to be the reason. By looking into these processes, the origin of these differences may be clarified. Relevant experts from the Netherlands and the UK are interviewed to get insight into this process. Where the interviews did not provide all required information, reports are consulted.
Firstly, the decision making process for the Dutch indicators will be described followed by the UK process. Hereafter the main differences between the two countries will be highlighted.

4.1 Decision making process of the Netherlands

Initial assessment
Commissioned by the Ministry of Infrastructure and Environment (IenM) and the Ministry of Economic Affairs, Agriculture and Innovation (ELenI), Deltares and IMARES made draft reports with scientific advice for the implementation of the MSFD by the Netherlands. The result was three reports for the Dutch part of the North Sea: 1. Initial Assessment. 2. The determination of Good Environmental Status and 3. The establishment of environmental Indicators and Targets. These scientific background reports serve as advisory documents for the implementation of the MSFD in the Netherlands. They are based on currently available knowledge derived from reports, scientific literature, unpublished literature and judgement of experts (Boon *et al.*, 2011).

The Initial Assessment report describes the current state of the Dutch part of the North Sea. It informs about the physical characteristics of the Dutch North Sea and describes human activities, the associated environmental pressures, and the current environmental status (Prins et al., 2011).

Within the short timeframe given to make this report it was not possible to make an extensive analysis of data. Therefore the report relies on already available information and expert knowledge. The OSPAR quality status report which was published in 2010 and its background documents (OSPAR, 2010) provided valuable information for the initial assessment. Also information from scientific publications, reports and unpublished material is collected (Boon *et al.,* 2011).

Process
The development of indicators is costly and there was a lack of time. Therefore the Netherlands looked at: What do we need, what we already have, what can be used, and what can be used from OSPAR.
During the development process of the indicators, several expert meetings were organized. The starting point was the criteria and indicators from the Commission Decision. The indicators which were usable are proposed in the report.
The 11 descriptors and associated indicators were then divided into three different groups based on previous development in other policy or research frameworks, level of scientific knowledge and the degree of ecological integration (Boon *et al.,* 2011).

Group 1
Consists of proposed indicators that already exist and are used in other policies or agreements: Water Framework Directive, Bird and Habitat Directives, Common Fisheries Policy, OSPAR.

Group 2
Consists of proposed indicators for which targets have not yet been set. Often the relationships between the indicators and human activities are uncertain. This is the case for e.g. indicators relating to non-indigenous species (descriptor 2), seafloor integrity (descriptor 6) and hydrographical conditions (descriptor 7).

Group 3
Consists of indicators that still require mid- to long-term development to become operational, as a consequence of limited understanding of the cause-effect relationships between human activities and environmental effects in the marine environment. The selection of appropriate indicators and the setting of targets that represent Good Environmental Status are complicated matters. This applies in particular to biological diversity (descriptor 1), food webs (descriptor 4), litter (descriptor 10) and underwater noise (descriptor 11). The main focus will need to be on how to describe the different criteria in measurable, ecological terms that have some relationship with manageable activities (Boon *et al.,* 2011). Figure 6 illustrates this process.

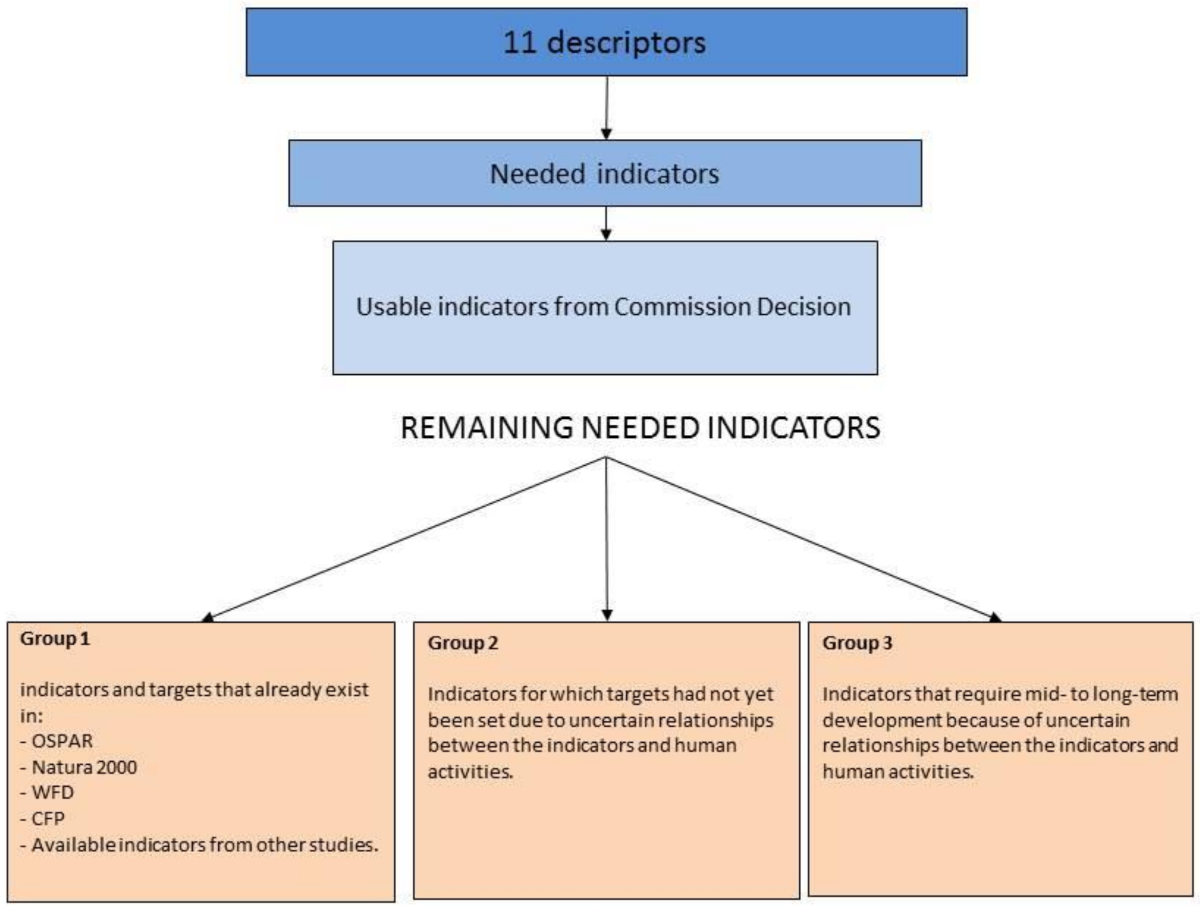

Figure 6 Illustration of the indicator development process of the Netherlands.

For parts where no indicators are available yet, the aim is to find indicators that are sensitive, specific and accurate for the effects of human activities on the environment. Indicators should also be based on scientific understanding, easy to measure and preferably data should already be available. Finally, indicators should be understandable by a non-scientific public too (Boon et al., 2011).
According to the Netherlands it was impossible to identify indicators which fulfil all these criteria. However, it is said that these criteria are used during developing indicators for the Dutch marine strategy (Boon *et al.,* 2011).

The indicators which are described in the Dutch Marine Strategy are a bit vague. This is to create some policy space and also to be able to maneuver/adapt in the process with other member states. The Dutch government feared that if they would commit themselves to strict described indicators they could be punished for not implementing them.
Besides the indicators that the Netherlands report to Brussels, they also measure more, supporting parameters to be able to create a larger context, yet without having at this moment a specific aim for these species.

Overall
The currently proposed indicators are a selection of potential indicators. They are mostly based on already commonly known indicators.
Generally all proposed biodiversity indicators of the Deltares/IMARES reports are accepted by the Ministries and described in the Dutch Marine Strategy.
More research is needed to develop these indicators but no concrete plans are described for this research.
The main problem is the knowledge gap and the insufficient understanding of cause-effect relations in the marine environment.

4.2 Decision making process of the UK

In order to describe the decision making process for biodiversity indicators of the UK, Matt Frost of the Marine Biological Association (MBA) is interviewed. He explained the process in detail. Below, this process is described.

Initial assessment

Before the introduction of the MSFD, DEFRA had already committed to deliver an integrated assessment of the state of UK seas. The result, Charting Progress 2 (UKMMAS, 2010), was a peer-reviewed evidence based report which provided the key findings from the UK marine research and monitoring. The assessment was undertaken at a regional scale with UK seas being divided into 8 regions

The MSFD was transposed into UK law in 2010 and one of the first requirements was an initial assessment of the current state of the marine environment. The Charting Progress 2 report was therefore extreme valuable as it became the basis of this initial assessment.

Differences within the UK (before the MSFD initial assessment)

A public consultation was carried out by the UK government on how the MSFD should be implemented. This consultation addressed issues such as whether a single UK-wide strategy was preferred over separate strategies for sub-regions. The situation is further complicated as the UK is divided into four countries (England, Scotland, Wales and Northern Ireland) each with different areas/amounts of responsibility for their marine environment and associated activities. Separate implementation of policy can lead to anomalies such as happened with the Water Frame Directive (WFD). The WFD for England and Wales goes up to 1 nautical mile while that of Scotland goes up to three nautical miles (Illustrated in figure 7.) Because of the greater extent of the Scottish WFD into the sea, it has a larger overlap with the MSFD than England and Wales.

It is important that the WFD and other current national policies and programs are compatible with the implementation of the MSFD (since using already existing programs/indicators is time and finance beneficial).

Figure 7 Water Framework Directive boundaries England, Wales, Scotland and Ireland (euwfd. 2013).

Process

DEFRA, the UK government department responsible for policy and regulations on environmental, food and rural issues (https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs) "gave" the descriptors to the Marine Monitoring and Assessment Strategy (UKMMAS).UKMMAS was set up to coordinate monitoring to ensure the UK could deliver assessments required by various policy directives including MSFD.

The evidence to support the assessments is gathered by the four evidence groups that sit under UKMMAS, Healthy and Biologically Diverse Seas (HBDSEG), Clean and Safe Seas (CSSEG), Productive Seas (PSEG), and Ocean Processes (OPEG).

The distribution of the technical input amongst these evidence groups is as follow: Descriptors 1, 2, 4 and 6 (and extra support on 3) are being developed by HBDSEG; 5, 8, 9 and 10 by CSSEG and 3, 7, and 11 by PSEG.

OPEG has an overall remit to address the issue of 'prevailing environmental conditions' which is relevant to various descriptors (e.g. Descriptor 1: biological diversity in line with prevailing conditions). This is important because, , if biodiversity changes, then we need to know whether that is down to human impacts or other causes such as climate change.

Figure 8 shows the process from UKMMAS to the evidence groups.

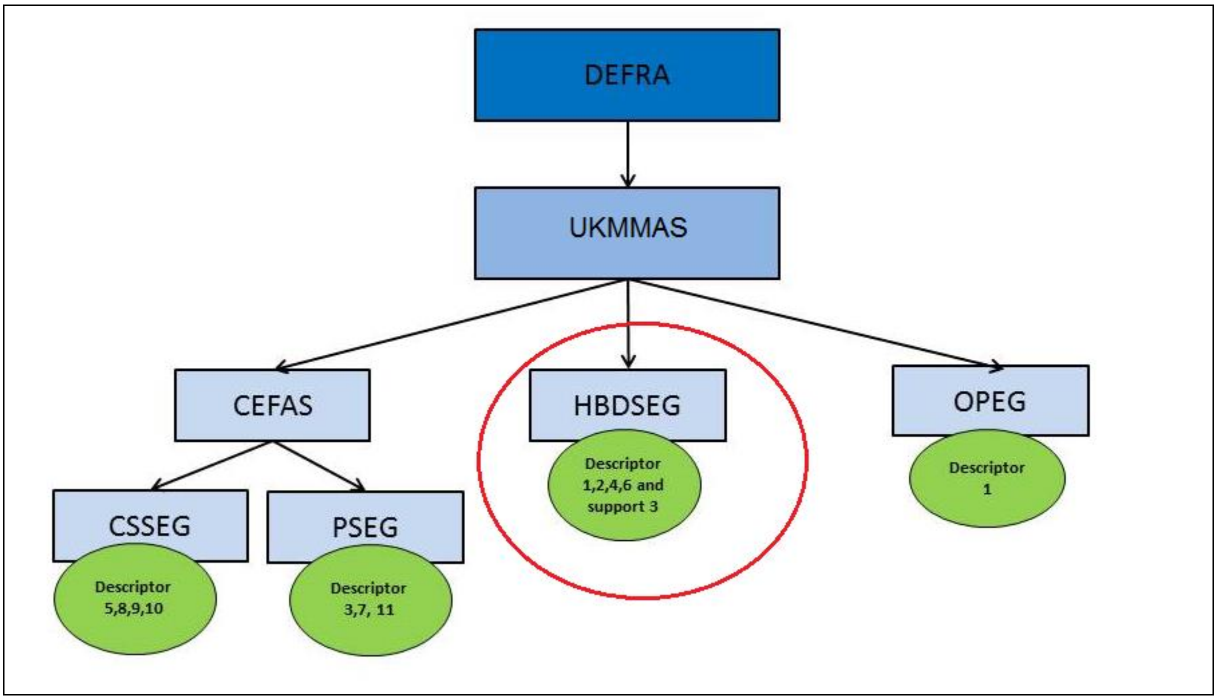

Figure 8 The process of the division of the descriptors into the evidence groups.

Focusing on biodiversity, descriptor 1 is the main focus. Descriptor 2 was set aside in the beginning and being dealt with apart from the other biodiversity work (as it is thought to be more the pressure of non-natives than status).
Descriptor 4 has been set aside as there is not enough science to inform the development of indicators for this. Descriptor 6 shows many overlaps with descriptor 1. Therefore many indicators of D1 and D6 are the same. Thus, descriptor 1 and 6 are the main indicators that the UK focused on.

A number of technical sub- groups have been set up under HBDSEG (figure 9). These groups develop indicator proposals that are delivered to HBDSEG before they are passed onto the MSFD biodiversity indicators R&D funders group for approval.
The technical sub-groups are divided into groups of the major components, marine mammals, fish, birds, benthic habitat and pelagic habitats. The importance of the subgroups is that the indicators are developed with the scientific members of the group via mail contact and/or meetings.
Because there are limited funds for R&D, the main role of HBDSEG and the funders group is to prioritize those indicators to be developed first and to agree the appropriate funding requests (if available).

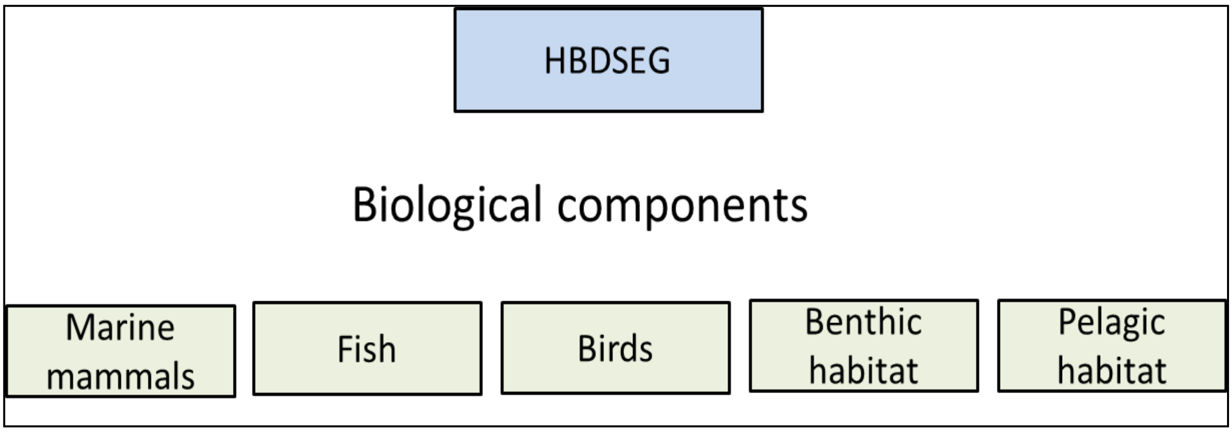

Figure 9 Technical subgroups which deliver to HBDSEG

For each of these subgroups the indicators are split into categories:
1. What indicators do we have already?
2. Indicator is defined by 2012 and operative by 2014 but requires research and development.
3. Indicator will be operative by 2018 but requires much development. These indicators are to be reconsidered after 2014.

Consultation process

Because this MSFD process is a governmental process, a consultation procedure was obliged on defining GES for UK waters (H.M. Government, 2012). HBDSEG produced a report that became the basis for the consultation. The consultation listed the indicators giving 2 options for the associated targets. The government would state its preferred option which was not always that favoured by the experts. As a result of this consultation and further discussion with the expert groups, a number of indicators have currently been proposed

Overall issues

Overall finance is a problem and also certain technical indicators are difficult.

4.3 Differences in the decision making process

Several differences are clear when comparing the decision making processes of NL and the UK. Differences in initial assessment, geography, national policy, and the outline of the process stand out. These differences will be described below.

Differences in initial assessment

The UK (DEFRA) made a very detailed assessment of the state of the sea before the introduction of the MSFD. This assessment was applicable for the initial assessment after some adaptations. Compared to the Netherlands this was a benefit because the Netherlands did not yet have such an assessment.

Within a short timeframe the Netherlands had to make their initial assessment. Therefore they used already available information and expert knowledge from e.g. the OSPAR Quality Status Report, related background documents, as well as information from scientific publications, reports and unpublished material (Boon *et al.,* 2011).

Differences due to geography

The UK and the Netherlands have a different North Sea surface area. The coastline, and already the North Sea area alone, of the UK is much larger and has more varied habitats than the Dutch part of the North Sea. Therefore the UK needed to take all these variations into account during developing the indicators which required more effort compared to the task for the Netherlands.

Due to these differences in geography of the Netherlands and the UK it is impossible to have identical indicators for all criteria.

National policy

The UK and the Netherlands differ in national programmes/measures. Countries have the tendency to prefer the use of currently used indicators since this is cost and time beneficial. This may be one of the reasons of the differences in indicators.

Process outline

Focussing on the process, the Netherlands first defined what indicators in the Commission Decision were applicable. The remaining indicators needed were split in 3 groups: 1. Available indicators. 2. Indicators which lack a target and 3. Indicators which need a lot of development.

The Netherlands mainly used indicators that were already available. Further research is on hold.

The UK on the other hand first divided the descriptors in subgroups and technical subgroups.

Each group focussed on: 1. what do we have already? 2. indicators described in 2012 and ready by 2014, and 3. indicators operative by 2018.

Thus, where the Netherlands set their indicator development on hold, the UK already planned this development.

The Netherlands also do not want to describe their indicators more into detail, in order to prevent the lack of space for changes.

Common problems

A common mentioned problem is lack of finance. Addressing all aspects of the MSFD is very costly. Besides the costs, it also takes a lot of time, which in fact is also a cost. The MSFD process allows only short time-spans, which makes it difficult for the member states finish their tasks within the given time.

5. Conclusions

Indicators

Large differences, such as type of indicator, indicator status and indicator relevance became visible between the indicator lists of the Netherlands and the United Kingdom.
The Netherlands still need to develop many indicators (19 out of 23). However, no future development is mentioned and also no aimed date is set.
The UK also still need to develop many indicators but has set an aimed date for the indicators to be operative. Furthermore, the UK provided more and also more specific indicators. NL on the other hand only describe their indicators briefly and unspecific.
The UK, with its detailed indicators and plans for development of new indicators therefore seems to be more ambitious than NL. This notion is strengthened by the fact that indicators of NL proposed merely “already in use” indicators, derived from other national policies. Hardly any new indicators are proposed.

Criteria 1.1, species distribution and criteria 1.2, population size seems to have received many indicators from the Netherlands. But appearances are deceptive since identical indicators are used multiple times to address different criteria.
The UK proposed indicators for all criteria. However, many of the indicators are scored as not relevant, such as indicators for mammals. Thus NL has a smaller indicator list than the UK but since the indicators of the later often are scored as “not relevant”, developing these indicators is useless to define biodiversity.

Hardly any indicators for criteria 1.4, habitat distribution and 1.5, habitat extent are proposed by NL. This results in a large gap in the indicator list.
The UK on the other hand did described indicators for these criteria. However, these indicators again are scored as irrelevant. Thus on these criteria, many research still is needed.
The only relevant criteria which received operational and relevant indicators from NL are 1.6, habitat and 1.7, food web. For the UK these are criteria 1.1.2, mammals, 6.1, rock and biogenic reef habitats, 6.1, sediment habitats and 1.7, fish.

Overall

Only a very small part of the biodiversity descriptor is addressed by relevant and operative indicators. This is highly concerning since indicators are supposed to measure the progress towards a Good Environmental Status and are also essential in the upcoming monitoring process. With this lack of indicators, the whole process could stagnate. For NL the prospect is worst, since they defined no further development for the indicators and also have unspecific indicator descriptions.

Decision making process
The Dutch policy (in this case), has the tendency to propose “already in use” indicators which are already available from on other policies. This is logic since new indicator development is finance and time consuming. However, where new indicators which are not available in other policies need to be proposed, NL did nothing. They simply mention that development is needed. The UK on the other hand pursues with the development of indicators.

Overall, the Dutch decision making process seems to be more policy based while that of the UK seems more science based. This finding is merely based upon the process outline. This outline revealed that the Netherlands firstly defined which indicators of the Commission Decision were applicable and subsequently, which indicators already were available from out other policies. Further needed research is mentioned but not preceded.
The UK on the other hand firstly divided the descriptors in subgroups and expert groups which focussed on: What we have already and the indicator development. This development is currently taking place. Thus, where the Netherlands set their indicator development on hold, the UK proceeded with the development.
On top of that, the Netherlands described their indicator broadly, not detailed. According to IenM, this is done to prevent a lack of manoeuvre during future cooperation with other member states.
Of course we should also take into account that the Dutch and the UK part of the North Sea have large geographical differences. For example, the UK part of the North Sea is much larger and varied than the Dutch part. The many different habitats in the UK North Sea also require many different indicators which makes the task for the UK extensive.

Overall
It seems that the policy based decision making process of NL results in the preference for already in use indicators and plans for no future indicator development. It gives the impression that NL has done as less as possible and lacks of motivation.
The science based decision making process of the UK resulted in a larger indicator list with planned future research. However, many indicators are marked as irrelevant. It seems that there is the tendency to do excess research.

6. Recommendations

Indicators

The biodiversity descriptor received many irrelevant indicators of both nations. Therefore I strongly recommend to, together with diverse experts with backgrounds in different topics, to discuss the proposed indicators and do determine which are relevant and which are not. Also, knowledge could be collected from different scientists and opinions upon indicators could be discussed and evaluated. At the UK, the indicator development is already in progress but still I recommended assessing the indicators as soon as possible to eliminate irrelevant indicators. The Netherlands hardly described any descriptors, therefore there is much space to define which indicators should be developed. Unfortunately we should keep in mind that under the MSFD, the Member States are obliged to propose indicators for al criteria, even when they might not be relevant.
For example, it is the question what e.g. mammals indicate about biodiversity. However, it has to be addressed according to the directive. To my opinion, we should have a critical look upon the MSFD and cooperate with experts to define the best fitting indicator lists despite the obliged (less relevant) topics. Initiatives such as EMBOS stimulate the biodiversity discussion and bring together experts (science and policy), students and institutes to open the discussion. Such projects should be more stimulated.

Decision making process

The decision making process of NL and the UK differs majorly. The science based approach of the UK resulted into more and more specific proposed indicators. However it also leaded to the proposal of many irrelevant indicators. The policy based approach of the Netherlands on the other hand resulted in fewer and unspecific indicators. However, less irrelevant indicators were mentioned here. Therefore the ultimate decision making process shall be in between these two. I recommend to firstly adopt the UK approach where after a critical team of experts look into the indicator relevance and also into the applicability of the indicators.

I expect the outcome of this research to be an eye opener for both scientists and policy makers which are involved in this topic.
To scientists it reveals that many irrelevant indicators are proposed and that there is a job to do in order to determine which indicators are relevant and which indicators are not.
For policy makers it shows that the current process does not work at all. Major gaps in the indicator lists are shown but also many irrelevant indicators are proposed. A decision making process which is both policy and science based is recommended whereby sharp decisions should be made upon which indicators will be developed.

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ANNEX I

Table of the UK and NL indicators for biodiversity, linked to the criteria and indicators (actually sub-criteria) of the Commission Decision paper (first and second column). Indicators that need to be developed (NTBD) are described in black letters. Indicators which are operative are described in green.

Criteria	Indicator	Group	Indicators UK	Indicators NL
1.1 Species distribution	Distributional range (1.1.1)	**Mamals**	1.1.1 (1) Distributional range of Harbour seal. (2) Distributionalrange of Grey seal breeding.	Distributioin, size and condition and future perspective of populations sea mammals and the quality of the habitat. (1. EcoQO populationtrends of the normal and grey seal (no reduction of >10 percent over a period of 5 years average). 2. EcoQO pup production grey seal (no reduction of >10 percent of the pup production of the pupproduction over a 5 year average. To be developed: EcoQO bycatch brownfish (<1,7% of the population).
		Fish	1.1.1. Distributionalrange of Fish (Continental Shelf Seas) (NTBD) (2) Distributional range of Fish (Shelf-edge Seas) (NTBD).	Indicators for population size, distribution and condition of sharks, ray, fishspecies with longterm negative trend and migrating fish (NTBD)
		Benthos	x	Indicators for distribution, presence and condition of representative for bodemberoering sensitive benthosspecies and biogene structures (NTBD)
		Birds	x	Distribution, size, condition and future perspective of populations vulnerable birdspecies and the quality of the habitat. NTBD)
	Distributional pattern within the latter, where appropriate (1.1.2)	**Mamals**	(1) Distributional pattern within range of harbour porpoises (NTBD) (2) Distributional pattern within range of bottlenose dolphins (NTBD) (3) Distributional pattern within range ofshort- beaked common dolphins (NTBD). (4) Distribution pattern within range of white beaked dolphins (NTBD) (5) Distributional pattern within range of minke whales in summer (NTBD). (6) Distributional pattern within range of harbour seal. (7) Distributional pattern within range of grey seal breeding	Distributioin, size and condition and future perspective of populations sea mammals and the quality of the habitat. (1. EcoQO populationtrends of the normal and grey seal (no reduction of >10 percent over a period of 5 years average). 2. EcoQO production grey seal (no reduction of >10 percent of the pup production of the pupproduction over a 5 year average. To be developed: EcoQO bycatch brownfish (<1,7% of the population).
		Fish	(1) Distributional pattern within range of Fish (Shelf- edge Seas) (NTBD). (2) Distributional pattern within range of Fish (Continental Shelf Seas) (NTBD).	Indicators for population size, distribution and condition of sharks, ray, fishspecies with longterm negative trend and migrating fish (NTBD)
		Benthos	x	Indicators for distribution, presence and condition of representative for bodemberoering sensitive benthosspecies and biogene structures (NTBD)
		Birds	(1) Distributional pattern of winter gullroosts (Further development needed (expected operational by 2014) (2)Distributional pattern of non-breeding shorebirds (NTBD) (3) Distributional pattern of inshore non-breeding waterbirds (NTBD) (4) Distributional pattern of coastal-breeding waterbirds (NTBD) (5) Distributional pattern of breeding seabirds (NTBD). (6) Distributional pattern of seabirds at sea (NTBD).	Distribution, size, condition and future perspective of populations vulnerable birdspecies and the quality of the habitat. (NTBD)
	Area covered by the species (for sessile/benthic species) (1.1.3)	**Benthos**	x	Indicators for distribution, presence and condition of representative for bodemberoering sensitive benthosspecies and biogene structures (NTBD)
1.2 Population size	Population abundance and/or biomass, ass appropriate (1.2.1)	**Mamals**	(1) Abundance oftwo inshore bottlenose dolphin populations (NTBD). (2) Abundance of harbour porpoise (NTBD). (3) Abundance of white- beaked dolphin (NTBD). (4) Abundance ofshort-beaked common dolphin (NTBD). (5) Abundance of minke whale (NTBD). (6) Abundance of bottlenose dolphin (NTBD). (7) Harbour seal abundance. (8) Grey seal abundance.	Distributioin, size and condition and future perspective of populations sea mammals and the quality of the habitat. (NTBD)
		Fish	(1) Population abundance of fish (NTBD) (2) Fish population biomass (NTBD)	Indicators for population size, distribution and condition of sharks, ray, fishspecies with longterm negative trend and migrating fish (NTBD)
		Benthos	x	Indicators for distribution, presence and condition of representative for bodemberoering sensitive benthosspecies and biogene structures (NTBD)
		Birds	(1) Species-specific trendsin relative non-breeding abundance ofmarine birds at sea (inshore and offshore) (NTBD). (2) Species-specific trends in relative breeding abundance of seabirds (NTBD) (3) Species-specific trendsin relative abundance of non- breeding shorebirds (NTBD). (4) Species-specific trendsin relative abundance of breeding waterbirds (NTBD)	Distribution, size, condition and future perspective of populations vulnerable birdspecies and the quality of the habitat. (NTBD)

1.3 Population condition	Population demographic characteristics (e.g. body size or age class structure, seks ratio, fecundity rates, survival-mortality rates)(1.3.1)	**Marine mammals**	(pressure indicator) (1) Grey seal pup production (2) Harbourseal pup production (NTBD) (3) Harbour porpoise bycatch (NTBD) (4) Common dolphin bycatch (NTBD). (5) Harbourseal bycatch (NTBD). (6) Grey seal bycatch (NTBD). (7) PCB and other organohalogenated contamination in porpoises (NTBD)	Distributioin, size and condition and future perspective of populations sea mammals and the quality of the habitat. (NTBD)
		Fish	Proportion ofmature fish in population (NTBD)	Indicators for population size, distribution and condition of sharks, ray, fishspecies with longterm negative trend and migrating fish (NTBD)
		Benthos	x	Indicators for distribution, presence and condition of representative for bodemberoering sensitive benthosspecies and biogene structures (NTBD)
		Birds	)1) Non-nativemammal presence on island seabird colonies.(NTBD) (2) Mortality of seabirds from fishing (bycatch) and aquaculture (NTBD). (3) Breeding failure of seabird species sensitive to food availability (NTBD). (4) Annual breeding success of kittiwakes. (NTBD).	Distribution, size, condition and future perspective of populations vulnerable birdspecies and the quality of the habitat. (NTBD)
	Population genetic structure, where		x	x
1.4 Habitat distribution	Distributional range (1.4.1)	**Pelagic habitats**	Change of plankton functionaltypes(life form) index (NTBD)	x
		Rock and biogenic reef habitats.	Distributionalrange of habitat (NTBD).	x
		Sediment habitats	Distributionalrange of habitat (NTBD)	x
		Habitats	x	Spreading and size of present habitats (EUNIS level 3) and habitats under the Habitatdirective (NTBD)
	Distributional pattern (1.4.2)	**Pelagic habitats**	(1) Change of plankton functionaltypes(life form) index (NTBD)	x
		Rock and biogenic reef habitats.	(1) Distributional pattern of habitat (NTBD)	x
		Sediment habitats	Distributional pattern of habitat (NTBD)	x
1.5 Habitat extent	Habitat area (1.5.1)	**Rock and biogenic reef habitats.**	(1) Area of subtidal biogenic structures (NTBD) (2) Area ofintertidalrock (NTBD) (3) Area ofsubtidalrock (NTBD). (4) Area oflittoral chalk habitat (NTBD). (5) Area ofintertidalsea caves (NTBD).	x
		Sediment habitat	(1)Area of sediment habitat (NTBD) (2) Area ofsediment habitat (NTBD)	x
		Habitats	x	Spreading and size of present habitats (EUNIS level 3) and habitats under the Habitatdirective (NTBD)
	Habitat volume where relevant (1.5.2)		x	x
1.6 Habitat condition	Habitat condition of the typical species and communities (1.6.1)	**Pelagic habitats**	(1) Change of plankton functionaltypes(life form) index (NTBD)	x
		Rock and biogenic reef habitats	(1) Abundance of typical species on biogenic reef (NTBD) (2) Density of biogenic reef forming species (NTBD). (3) Subtidal species composition&abundance (sponge anthozoan community) (NTBD). (4) Sponge diversity (NTBD). (5) Intertidalspecies composition&abundance. (6) Epifaunal indicator species. (7) Boulder turning index (NTBD). (8). Intertidal community indicator(MarClim) (NTBD). (9) Kelp depth and kelp park depth (NTBD). (10) Impact/Vulnerability of habitat to 'Penetration and/or disturbance ofthe substrate below the surface ofthe seabed'(Physical pressure) (NTBD) (11) Impact/Vulnerability of habitatto 'Shallow abrasion/penetration: damage to seabed surface and penetration'(Physical pressure) (NTBD) (12) Impact/Vulnerability of habitat to 'Surface abrasion: damage to seabed surface features' (Physical pressure) (NTBD). (13) Impact/Vulnerability of habitat to 'Removal of targetspecies'(Biological pressure) (NTBD). (14) Impact/Vulnerability of habitat to 'Removal of non- targetspecies'(Biological pressure) (NTBD)	x
		Sediment habitat	(1) WFD seagrasstool (EcologicalQuality Ratio based on the species composition, density and extent of cover of seagrass communities) (2) Infaunal Quality Index (EcologicalQuality Ratio based on the sensitivity,richness and diversity (evenness) of benthic communities) (3) Opportunistic macroalgae. (4) Saltmarsh WFD classification tool (NTBD). (5) Impact/Vulnerability of habitat to 'Penetration and/or disturbance ofthe substrate below the surface of the seabed' (Physical damage) (NTBD). (6) Impact/Vulnerability of habitat to 'Shallow abrasion/penetration: damage to seabed surface and penetration'(Physical damage) (NTBD). (7) Impact/Vulnerability of habitat to 'Surface abrasion: damage to seabed surface features' (Physical damage) (NTBD). (8) Impact/Vulnerability of habitat to 'Removal of target species'(Biological pressure) (NTBD).	x
		Benthos	x	Indicators for distribution, presence and condition of representative for bodemberoering sensitive benthosspecies and biogene structures (NTBD)

	Habitat: Relative abundance and/or biomass, as appropriate	Pelagic habitats	(1) Zooplankton biomass (NTBD). (2) Phytoplankton biomass (NTBD).	x
		Rock and biogenic reef habitats 6.1.2 Extent ofthe seabed significantly affected by human activities for the differentsubstrate types	(1) Impact/Vulnerability of habitat to 'Penetration and/or disturbance of the substrate below the surface of the seabed'(Physical pressure) (NTBD). (2) Impact/Vulnerability of habitatto 'Shallow abrasion/penetration: damage to seabed surface and penetration'(Physical pressure) (NTBD) (3) Impact/Vulnerability of habitat to 'Surface abrasion: damage to seabed surface features' (Physical pressure) (NTBD) (4) Impact/Vulnerability of habitat to 'Removal of target species'(Biological pressure) (NTBD). (5) Impact/Vulnerability of habitatto 'Removal of non- targetspecies'(Biological pressure) (NTBD)	x
		Habitats	x	Indices for composition of bottom communities. KRW indicator BEQI-2.
	Habitat: Physical, hydrological and chemical conditions (1.6.3)	**Sediment habitat**	Sediment profile imaging (NTBD)	Habitats. (1) Seabottom areal that is not disturbed (NTBD) (2) Habitats. Indicator for the quality of the diverse habitats on EUNIS level 3. (NTBD)
1.7 Ecosystem structure	Ecosystem: Composition and relative proportions of ecosystem components (habitats and species) (1.7.1)	**Fish**	(1) Fish relative abundance (Proportion of Large Fish Indicator (LFI): proportion (by weight) of demersalfish exceeding a specified length threshold (current thresholds 40cminNorth Sea, 50cmin Celtic Sea).) (2) Fish relative abundance (HILLS N1 indicator, NTBD)	x
		Pelagic habitats	Change in all pelagic indicatorsfo rD1,D4, D5.2.4,D6 (NTBD)	x
		Foodweb	x	x
			x	(1) Percentaga large fish in catcges of soil species (IBTS): length:frequenty ratio. (1) OSPAR indicator EcoQO largefish indicator. (Weightpercentage of catched fish larger than 40 cm).) (2) Foodweb. Indicators for seabirds, seamammals and sharks and rays as top predators.((2) Use indicators under species (but these need to be develloped)) (3) Foodweb. Food relation key species. NTBD