Determination of Good Environmental Status & establishment of Environmental Targets for the Belgian marine waters

Marine Strategy Framework Directive – Art 9 & 10

Introduction

1. The Marine Strategy Framework Directive 2008/56/EC (MSFD) that was adopted on 17 June 2008 and entered into force on 15 July 2008 is one of the key legal instruments of the European Union (EU) for the protection of the marine environment and its associated ecosystems and biodiversity. It was developed as a legal follow-up to the Thematic Strategy on the Protection and Conservation of the Marine Environment that was presented by the European Commission on 25 October 2005. The objective of this strategy is 'to protect and restore Europe's oceans and seas and ensure that human activities are carried out in a sustainable manner so that current and future generations enjoy and benefit from biologically diverse and dynamic oceans and seas that are safe, clean, healthy and productive.' The MSFD serves as the legal framework to achieve this objective and as the environmental pillar of the EU's broader maritime policy.

2. The main objective of the MSFD is to achieve or maintain 'Good Environmental Status' (GES) in the marine environment by 2020, which in terms of the Directive comprises protecting species and habitats, preventing and reversing human-induced decline of biodiversity and ensuring that 'diverse biological components function in balance.' The MSFD thus embraces issues that are also the subject of a variety of other international and EU nature conservation instruments.

3. "Good environmental status" means the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations, i.e.:

   a) the structure, functions and processes of the constituent marine ecosystems, together with the associated physiographic, geographic, geological and climatic factors, allow those ecosystems to function fully and to maintain their resilience to human-induced environmental change. Marine species and habitats are protected, human-induced decline of biodiversity is prevented and diverse biological components function in balance;

   b) hydro-morphological, physical and chemical properties of the ecosystems, including those properties which result from human activities in the area concerned, support the ecosystems as described above. Anthropogenic inputs of substances and energy, including noise, into the marine environment do not cause pollution effects;. (definition explicit in Directive 2008/56/EC)

4. Implementation of the MSFD should deliver an improved understanding and management of pressures and impacts arising from human activity and ultimately result in a reduction in undesirable impacts on the marine environment. This should lead to improved environmental status and resilience of marine ecosystems to counteract natural and human induced changes whilst ensuring the sustainable use of ecosystem goods and services.

5. To reach GES by 2020, national Marine Strategies are to be developed and implemented (Art. 5) in order, to protect and preserve the marine environment, prevent its deterioration or, where practicable, restore marine ecosystems in areas where they have been adversely affected. Furthermore, inputs into the marine environment are to be prevented and reduced, with a view to phasing out pollution, so as to ensure that there are no significant impacts on, or risks to, marine biodiversity, marine ecosystems, human health or legitimate uses of the sea (Art. 1 (2)). These Marine Strategies shall apply an ecosystem-based approach to the

management of human activities, including adoption of the precautionary principle, and should contribute to the overall coherence and integration of existing EU policies and legislation and the ongoing work of the Regional Sea Conventions.

6. The Directive requires Member States to determine the characteristics of GES, that is, 'what does GES look like', and to develop environmental targets and associated indicators. These environmental targets and associated indicators should help guide progress towards achieving and maintaining GES. Determining GES and setting environmental targets and associated indicators are to be coordinated with other Member States in their marine region or subregion (where practical and appropriate, using regional institutional cooperation structures, including Regional Sea Conventions) and should reflect closely the EU Commission Decision 2010/477/EU of 1 September 2010 on Criteria and Methodological Standards of Good Environmental Status.

7. Member States are also required to ensure that their Marine Strategies for each marine region or subregion are kept up to date (Art. 17) on a six-yearly basis. This will result in an adaptive management cycle, starting with the initial assessment (Art. 8), the determination of GES (Art. 9), and the establishment of environmental targets (Art. 10). This six-yearly management cycle means there will be regular opportunities for Member States to review the suitability and effectiveness of their determination of GES, their environmental targets and indicators, and their programs of measures taking into account the experience gained, the possible adoption of new norms and standards at the national and international level, as well as progress in scientific knowledge and instrumentation. The next assessment of environmental status is required in 2018 and will provide the basis for such a review.

GES and Environmental Targets for the Belgian marine waters: Initial considerations

8. Conform the Directive, GES and the environmental targets for the Belgian marine waters are defined on the basis of the eleven qualitative descriptors listed in Annex I of the Directive. This list in Annex I is a mixture of descriptors that refer to the state of the marine environment (biodiversity (D1), food webs (D4), sea-floor integrity (D6) and partially commercial fish stocks (D3)) and those that refer to the most important or relevant anthropogenic pressures (non-indigenous species (D2), partially fisheries (D3), eutrophication (D5), physical damage (D6 and D7), contaminants (D8 and D9), marine litter (D10) and energy including underwater noise (D11)). For each descriptor, the usefulness of 29 underlying criteria and 56 indicators from COM Decision 2010/477/EU were evaluated. However, there is a significant degree of overlap among the GES criteria and among the GES indicators. One criterion or indicator may be better handled under one descriptor than under another one, keeping the assessment of the state of the marine ecosystem as exhaustive as possible.

9. The definition of GES is expressed in a qualitative description of what GES would look like when achieved for each of the descriptors. This is then underpinned by a set of more detailed quantitative environmental targets based on established environmental thresholds/limits for state, pressure or impact (Art. 10). Where quantitative environmental targets could not be set, trend-based or qualitative targets were used. The complete package of GES and environmental targets needs to give a complete and balanced overview.

10. Defining GES and establishing environmental targets are a national duty, however the regional coherence should be as large as possible to enable a common assessment of progress and to support the implementation of the future measures to reach a regional GES

within the North Sea. In this version, the Belgian GES and environmental targets are determined at the level of the entire Belgian part of the North Sea, except for the descriptor 3 (commercially exploited fish and shellfish stocks) which needs to be implemented on a regional scale.

11. Belgium considers the coherence in the implementation of the different EU directives of high importance. Therefore equivalence at the Belgian marine scale between Good Ecological Status (WFD 2000/60/EC), Favourable Conservation Status (HD 92/43/EEC) and Good Environmental Status (MSFD) is justified. The GES en targets will constitute the reference framework for the assessment of environmental permits for the Belgian marine waters.

12. The definition of GES and targets are developed within the overall view that the associated indicators need to be measurable at reasonable cost – as these will be the precursor of the monitoring program in 2014 – and assessable with the support of good methodological standards.

13. It is worthwhile to note that the numerical values of the targets strongly depend on the methods, protocols and sampling strategies chosen. It is desirable to be in a position allowing the demonstration that the GES is reached (or not) and to avoid situations where no response is possible. Here, to appropriately cope with the natural variability remains a challenge. When the comparison between targets and observations will show that the GES is not reached, this warning signal will call for correct interpretation and investigations on the possible causes as well as, when confirmed, proper management actions at national and international levels, without prejudices of the exceptions foreseen in the MSFD.

14. The determination of GES and targets during this first cycle, as specified by the MSFD and the Commission Decision 2010/477/EU, is relying on existing assessments, methodologies and information from national and regional reports. Gaps that are encountered will be addressed during subsequent MSFD cycles through, for example, the development of new methodologies.

15. In case the reference condition or baseline is not explicitly mentioned within the target description, the reference state is considered to be the state as described in the Initial Assessment of 2012.

16. It is important to note that this expression of GES and targets for the Belgian marine waters, based on existing knowledge, is not indefinite but will need to evolve over time. It is necessary to be able to incorporate extending knowledge on background changes such as climate change and associated environmental problems, but also improvements in scientific knowledge and understanding and management experience.

17. **There must be expressly pointed out that the Belgian part of the North Sea is only a very small part (0.5%) of the North Sea, bordering the waters of three neighbouring countries. Consequently, some environmental goals can only be achieved on condition that there is a strong cooperation with these neighbouring countries. Several problems in the marine environment cannot be addressed thoroughly on a unilateral manner.**

Descriptors 1, 4 and 6.
Biodiversity, Food webs and Seafloor integrity

Background

I. "Biological diversity" is defined as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". This descriptor has a very broad biological and geographical scope.

To achieve Good Environmental Status a multi-species and multi-habitat approach will be needed, together with a robust assessment of human pressures (and impacts) upon each of these components. All activity in the marine environment affects biodiversity in some way, and so achieving GES in the other descriptors will ultimately help achieve GES for this descriptor. Defining GES is about defining the balance between our continued use of the environment and the amount of loss/change in biodiversity that results from that use (sustainable use, acceptable loss).

I. "Food webs" are networks of feeding interactions between consumers and their food. The species composition of food webs varies according to habitat and region, but the principles of energy transfer from sunlight and plants through successive trophic levels are the same. This descriptor addresses the functional aspects of marine food webs, especially the rates of energy transfer within the system and levels of productivity in key components.

II. "Sea floor" is interpreted as including both the physical and chemical parameters of the seabed - bathymetry, roughness (rugosity), substrate type, oxygen supply, etc; and biotic composition of the benthic community. "Integrity" is interpreted as both covering spatial connectedness, so that the habitats are not unnaturally fragmented, and having the natural ecosystem processes functioning in characteristic ways. Areas of high integrity on both of these standards are resilient to perturbations, so human activities can cause some degree of perturbation without widespread and lasting harms to the ecosystems.

Why Descriptors 1, 4 and 6 are dealt with together

Due to the strong link and overlap between the descriptors "Biodiversity" (D1), "Food webs" (D4) and "Seafloor integrity" (D6), they will be handled together.

Justification

The MSFD collates a series of descriptors, which are considered relevant evaluation criteria 'to protect and restore Europe's oceans and seas and ensure that human activities are carried out in a sustainable manner so that current and future generations enjoy and benefit from biologically diverse and dynamic oceans and seas that are safe, clean, healthy and productive.' It is generally accepted that some of these descriptors particularly target a desired state of the ecosystem, while other descriptors target some most prominent human-induced pressures (Table 1).

Table 1. State- and or pressure-orientation of the eleven MSFD descriptors.

		State-oriented	Pressure-oriented
Descriptor 1	Biodiversity	X	
Descriptor 2	Non-indigenous species		X
Descriptor 3	Commercial fish stocks	X	
Descriptor 4	Marine food webs	X	
Descriptor 5	Eutrophication		X
Descriptor 6	Seafloor integrity	X	X
Descriptor 7	Hydrographical conditions	X	X
Descriptor 8	Contamination		X
Descriptor 9	Contaminants in seafood		X
Descriptor 10	Marine litter		X
Descriptor 11	Energy, including underwater noise		X

State indicators are indicative for the state of the ecosystem. Pressure indicators are indicative for the pressures onto the ecosystem. As Good Environmental Status explicitly refers to the state of the ecosystem, state indicators and their respective targets are to be used to assess GES *sensu stricto* (i.e. whether or not a desired state has been achieved). Pressure indicators and their respective targets then refer to the level of human-induced pressure, allowing to attain the desired state. In other words, a pressure indicator and its target should be directly linked to a desired state, as described by a state indicator and its target.

The desired state of the ecosystem can be described by e.g. its biodiversity (D1). As biodiversity covers the structural and functional aspects of all levels of biological organization, it also comprises the state of commercial fish stocks (D3) and food webs (D4). While D3 specifically targets sustainable fisheries, with clear references to be taken from present day fisheries management, D4 rather highlights the importance of food webs within biodiversity considerations. D4 should hence be firmly embedded in D1, justifying a common handling of both descriptors.

Seafloor integrity (D6) explicitly refers to both the physico-chemical and biological assets of the seafloor, including its structure and functioning. While the biological assets (incl. ecosystem functioning) are – by nature – firmly embedded within biodiversity (D1), the physico-chemical aspects highlight the importance of an integer abiotic environment within a sustainability context. As this abiotic integrity is defined by/closely linked to human activities (cf. criteria from Commission Decision 2010/477/EU, below), such as marine aggregate extraction, large scale developments and bottom trawling, D6 takes a particular position in which both state and pressure indicators can be defined. The close match between D6 and D1 was taken as a justification for common handling.[a]

Assessment criteria from Commission Decision 2010/477/EU

The following assessment criteria, linked to D1, D4 and D6, were listed by the European Commission and might help (not mandatory) steering the GES-definition process.

1.1 Species distribution
1.2 Population size
1.3 Population condition
1.4 Habitat distribution

[a] One should however be aware that, contrary to D6 only referring to the benthic environment, both D1 and D4 also cover the pelagic environment.

1.5 Habitat extent[b]
1.6 Habitat condition
1.7 Ecosystem structure
4.1 Productivity (production per unit biomass) of key species or trophic groups
4.2 Proportion of selected species at the top of the food web
4.3 Abundance/distribution of key trophic groups/species
6.1 Physical damage, having regard to substrate characteristics
6.2 Condition of benthic community

Good environmental status (literally from MSFD, Art. 9)

I. Biological diversity is maintained. The quality and occurrence of habitats and the distribution of abundance of species are in line with prevailing physiographic, geographical and climate conditions.
II. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
III. Seafloor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

GES for biodiversity, food webs and seafloor integrity would be achieved when:

- D1: The habitat types[c] and constituting species' populations extent, distribution and condition minimally reflect the conditions described in the Initial Assessment of Belgian waters (2012). State

- D1, D6: Good conditions according to the Water Framework Directive (i.e. good ecological status), Habitats and Birds Directives (i.e. favourable conservation status) and OSPAR (i.e. ecological quality objectives) are attained. Rare and threatened habitat types and species, included in existing legislation and conventions, are protected to the level envisaged by that legislation or convention. *State*

- D1: Diversity within the different ecosystem components (i.e. plankton, benthos, fish, seabirds and marine mammals) is maintained. *State*

- D1, D4: Viable species populations are maintained for the key long-lived, slowly reproducing species, as well as for the top predator species in all habitat types. *State*

- D6, D4, D1: The habitat types are structurally and functionally diverse and productive. *State*

[b] Extent is here defined as surface area, in conjunction with the Habitats Directive definition.
[c] A habitat type is here defined as a uniform landscape type inhabited by typical species. For the benthic environment, habitat types are the ecologically-meaningful entities, as identified by habitat suitability modelling (i.e. four subtidal soft sediment biotopes and *Lanice conchilega* aggregations) or probability calculation (gravel beds) (Degraer *et al.*, 2008, 2009). For the pelagic environment, current direction and habitat heterogeneity are believed to be the most important factors structuring the planktonic communities. Onshore there is a clear estuarine/neritic influence with high levels of suspended matter leading to high densities of meroplankton. Community composition alters with distance from the shore and holoplanktonic species increase in abundance and diversity. Two major pelagic habitats are hence discerned: an onshore habitat, with high suspended matter loads and an offshore habitat with lower suspended matter loads.

- D6: Physical disturbance of the seafloor is minimised to a sustainable level, taking account of the relative sensitivity of habitat types. *Pressure*

Environmental targets and associated indicators (Art. 10)

- Integral marine environment (benthic and pelagic environment combined)

  Seabirds

  - Changes in breeding seabird abundance remain within target limits for 75% of the species monitored (OSPAR EcoQO 2012)[d]

  - The 5 year running mean species density is not below the long-term mean annual population size for 5 consecutive years for minimally half of the non-scavenging seabird species[e] (Table 2.A).

  - The 5 year running mean species density is not above the long-term mean annual population size for 5 consecutive years for minimally two of the scavenging seabird species[f] (Table 2.B).

  - For each of the scavenging seabirds species (Table 2.B), are the mean densities over 5 consecutive years not below the minimum defined by the Birds Directive favourable conservation status.

Table 2. Key seabird species with their respective long-term mean density and standard deviation in the Belgian part of the North Sea.

Species	Long-term mean density (ind/km²)	Standard deviation
A. Non-scavenging seabird species		
Podiceps cristatus (great-crested grebe)	0.370	0.200
Gavia spp. (divers)	0.219	0.110
Melanitta spp. (scoters)	1.399	1.074
Sula bassana (northern gannet)	0.458	0.163
Hydrocoloeus minutus (little gull)	0.232	0.132
Sterna hirundo (common tern)	0.130	0.101
Uria aalge (common guillemot)	1.649	0.584
Alca torda (razorbill)	0.372	0.207

[d] Applicable at the scale of the Greater North Sea, in coordination with all the North Sea countries.

[e] Non-scavenging seabirds are all seabirds of which 10% or less is present behind fishing vessels during ship or aerial counts, of which densities are acceptably high to determine a long-term trend and that have no erratic occurrence in the Belgian part of the North Sea (such as sandwich tern).

[f] Scavenging seabirds are all seabirds of which more than 10% is present behind fishing vessels during ship or aerial counts, of which densities are acceptably high to determine a long-term trend and that have no erratic occurrence in the Belgian part of the North Sea (such as northern fulmar).

Species	Long-term mean density (ind/km²)	Standard deviation
B. Scavenging seabird species		
Rissa tridactyla (kittiwake)	0.617	0.270
Larus canus (common gull)	0.425	0.211
Larus argentatus (herring gull)	0.164	0.064
Larus fuscus (lesser black-backed gull)	0.566	0.308
Larus marinus (great black-backed gull)	0.230	0.096

Marine mammals

- The yearly number of incidentally bycaught harbour porpoises *Phocoena phocoena* is less than 1,7 % of the best estimate of the population size. (OSPAR EcoQO)

Fish

- Positive trend in the number of individuals of thornback ray *Raja clavata.*

- Pelagic environment

Plankton: not considered because progress on eutrophication is considered as a prerequisite (see D5, Eutrophication). Further development of D1, D4 and/or D6-related indicators on plankton, based on recently developed expertise and collected data, will be considered during the first MSFD cycle (2012-2018).

- Benthic environment

Benthic habitat:

- The spatial extent and distribution of the EUNIS level 3 habitats[g] (sandy mud to mud, muddy sands to sands and coarse grained sediments), as well as that of gravel beds fluctuate - relative to the reference state as described in Initial Assessment - within a margin limited to the accuracy of the current distribution maps.

- Positive trend in sea floor surface area permanently devoid of bottom-contacting fishing gear disturbance within each of the benthic habitat types (= pressure indicator), as to allow a

[g] Ideally the spatial extent of habitat types instead of the spatial extent of EUNIS level 3 habitats (eunis.eea.europa.eu) would have been used here, as these would correspond to the ecologically-meaningful entities, as identified by habitat suitability modelling (i.e. four subtidal soft sediment biotopes and *Lanice conchilega* aggregations) or probability calculation (gravel beds) (Degraer *et al.*, 2008, 2009). As EUNIS level 3 habitats can however actually be mapped time- and cost-efficiently through remote sensing (e.g. multibeam back scatter analysis) – contrary to the habitat types – the former level of detail was chosen for this run of the MSFD implementation. Furthermore, although EUNIS level 3 habitats show less details than and do not have a one to one relationship to the ecologically-meaningful habitat types, the former classification is commonly used within the MSFD implementation of our neighbouring countries.

natural development of the benthic fauna and flora and as to minimise artificial fragmentation of the seafloor (= desired state).[h]

- Positive trend in sea floor surface area disturbed only by alternative, environment-friendly fishing gear which pursues a substantial reduction of bottom disturbance within each of the benthic habitat types (= pressure indicator), as to allow for an improved benthic habitat quality and as to minimise artificial fragmentation of the seafloor (= desired state).[h]

    - Soft substrates[i]:

        - The Ecological Quality Ratio as determined by BEQI (see Annex), indicative for benthic ecosystem structure and quality, has a minimum value of 0,60 in each of the habitat types (Commission Decision 2008/915/EC).

        - Positive trend in median adult density (or frequency of occurrence) of at least one species within the long-lived and/or slowly reproducing and key engineering benthic species groups in both mud to muddy sands and pure fine to coarse sands (Table 3).

        - Spring median benthic bioturbation potential (BP_c) (see Annex) in the *Abra alba* habitat type is higher than 100.

Table 3. Selected examples of long-lived and/or slowly reproducing and key engineering benthic species within mud to muddy sands and pure fine to coarse sands.

	Long-lived and/or slowly reproducing species	**Key engineering species**
Mud to muddy sands	Larger bivalves, such as *Venerupis senegalensis*, *Mya truncata* and *Lutraria angustior*.	Larger tube-building polychaetes, such as *Lanice conchilega*, *Owenia fusiformis* and *Pectinaria koreni*.
	Other larger organisms, such as *Buccinum undatum* and *Aphrodita aculeata*.	Larger gallery-dwelling organisms, such as *Callianassa* spp.
Pure fine to coarse sands	Larger bivalves, such as *Laevicardium crassum*, *Glycymeris glycymeris* and *Dosinia exoleta*.	Larger gallery-dwelling organisms, *Upogebia deltaura* and *Corystes cassivelaunus*.

[h] Progress towards this target will basically be achieved through spatially-explicit management actions related to the sectors concerned (i.e. delineation of areas devoid of bottom disturbance and areas open only for environmental-friendly bottom-contacting gear), geographical information and observations on bottom disturbances being considered here as meta-information only.

[i] In Belgian waters, soft substrates are composed of muddy to coarse sandy sediments and are inhabited by both in- and epifauna. Hard substrates are those geogenic substrates prone to colonization by biofouling epifauna. Natural hard substrates are restricted to gravel beds in the Belgian part of the North Sea, while a variety of man-made hard substrates (e.g. offshore wind farms, ship wrecks, coastal defense infrastructure and drop stones) also occur. Gravel beds are those areas with a developed or potential development of hard substrate communities (Habitats Directive precursor). In Belgian waters, gravel beds always consist of stones (= hard substrate) embedded in a sandy to coarser sediment matrix (= soft sediment).

	Other larger organisms, such as *Cancer pagurus*, *Echinocardium cordatum* and *Branchiostoma lanceolatum*.	

- Gravel beds:

Several targets to be selected among the following ones, depending on the availability and statistical characteristics of the pertinent reference values, as well as the definition of appropriate protocols and methods:

- Positive trend in median colony/body size of the sessile, long-lived and/or larger benthic species *Buccinum undatum*, *Mytilus edulis*, *Flustra foliacea*, *Haliclona oculata* and *Alcyonium digitatum*.

- Positive trend in frequency of occurrence and median adult density of at least half of the key and long-lived species *Ostrea edulis*, *Sabellaria spinulosa*, *Mytilus edulis*, *Buccinum undatum*, *Haliclona oculata*, *Alcyonium digitatum* and *Alcyonidium* spp.

- No loss or positive trend in species richness within all key hard substrate taxa, i.e. Porifera, Cnidaria, Bryozoa, Polychaeta, Malacostraca, Maxillopoda, Gastropoda, Bivalvia, Echinodermata and Ascidiacea.

- Decreasing relative frequency of occurrence of damaged *Asterias rubens* (2+ cm arm length) and tube clusters of *Pomatoceros triqueter*, indicative for physical disturbance of the bottom (= pressure indicator), as to enhance natural development of the gravel bed ecosystem (= desired state).

- Within the test zones in the gravel beds, the ratio of the hard substrate surface area (i.e. surfaces that are colonized by hard substrate epifauna) over soft sediment surface area (i.e. surfaces overtopping hard substrates and preventing hard substrate fauna development) does not show a negative trend.

Descriptor 2.
Non-indigenous species introduced by human activities

Background

This descriptor targets introduced species i.e. those non-indigenous species introduced by human activities. Many terms are used to deal with such species: e.g. exotic, alien and even the terms non-indigenous species or allochthonous species are simply used for introduced species, implicitly assuming a human mediated introduction. For the purpose of the MSFD, and to avoid any misunderstanding, only the term introduced species should be used.

In fact, the descriptor is specifically targeting invasive introduced species (also called IAS – Invasive Alien Species).

Assessment criteria from Commission Decision 2010/477/EU

1.1 Abundance and state characterisation of non-indigenous species, in particular invasive species
1.2 Environmental impact of invasive non-indigenous species

Good environmental status (literally from MSFD, Art. 9)

Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.

GES for non-indigenous species would be achieved if:

No significant increase in the relative abundance of non-indigenous species in relation to the 2012 baseline occur. Species for which there are taxonomic disputes and for which the changes of permanent introduction, including reproduction are negligible are not taken into consideration.

No new introduction of introduced species is directly linked to the monitoring effort. Here we speak of a no-introduction on the basis of 50 samples per year adequately distributed in space.

Environmental targets and associated indicators (Art. 10)

- Introduction of new human induced non-indigenous species of macrofauna and macroflora (>1 mm) in relation to the 2012 baseline is prevented. Species for which there are taxonomic disputes and for which the changes of permanent introduction, including reproduction are negligible are not taken into consideration.[j]

[j] The extension of this target to all the ecosystem components will be considered for the following MSFD cycles.

Descriptor 3.
Commercially exploited fish and shellfish

Background

Commercial fishing is the activity of capturing fish and other seafood for commercial profit, using a variety of fishing methods. Commercially exploited fish and shellfish include all living marine resources targeted for economic profit. Under this descriptor all commercially exploited marine vertebrate (bony fish and elasmobranches) and invertebrate taxa (crustaceans and mollusks).

Gemeenschappelijk Visserijbeleid (GVB) (see Annex)

The Common Fisheries Policy (CFP) is the European instrument for management of fisheries and aquaculture. The CFP ensures a sustainable exploitation of living aquatic resources. The EU uses a precautionary approach where possible to protect and conserve these resources and to keep the impact of fishing activities on the marine ecosystem as low as possible.

The objective is to determine the fisheries policy by the state of the ecosystem (bottom-up approach), and not by the needs of humans (top-down approach). In the long term this should result in more efficient fishing activities within an economically viable and competitive fisheries and aquaculture. Hereby sought a fair standard of living for everyone who is dependent on fisheries and with attention to the interests of consumers.

To ensure that the fishing pressure is not greater than what fish stocks can sustain, there are conservation measures developed in the framework of the CFP, such as Total Allowable Catches (TAC), limiting fishing effort and technical measures. The fishermen are also obliged to report their catches and their supply.

The CFP also includes measures to limit the environmental impacts of the fisheries. It involves the protection of non-target species (marine mammals, vulnerable stocks, non-commercial species, juvenile fish, etc. ...) and vulnerable habitat. This can e.g. by preventing and limiting the bycatch and discards. Protecting vulnerable habitat can be done via the imposition of measures to eliminate destructive fishing methods or into less destructive methods. A reform of the CFP is running.

The Data Collection Framework (DCF EC no. 199/2008)

Under the EC Regulation EC no. 199/2008, every Member State has the obligation to collect and manage biological, technical, environmental and socio-economic data concerning the fisheries sector; and to use these data in the framework of the Common Fisheries Policy (hereinafter referred to as the CFP), for the purpose of scientific analysis. Every MS needs to design and implement a National Programme for this purpose, whereas it describes how these data will be collected and managed.

Assessment criteria from Commission Decision 2010/477/EU

3.1 Level of pressure of fishing activity
3.2 Reproductive capacity of the stock
3.3 Population age and size distribution

Good environmental status (MSFD, Art. 9)

Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age or size distribution that is indicative of a healthy stock (size distributions known for all species; age distributions only for the main commercial species).

GES for commercially exploited fish and shellfish species will be evaluated according to the following scheme:

- Fishing mortality
  - Situation 1 – F_{MSY} known: the level of stock mortality generated by fishing activity (F) is equal to or lower than F_{MSY}
  - Situation 2 – F_{MSY} not known, but F_{pa} known: the level of stock mortality generated by fishing activity (F) is equal to or lower than F_{pa}
  - Situation 3 – F_{MSY} & F_{pa} not known: a catch/biomass ratio that is consistent with a sustainable exploitation will be used as a proxy reference point
  - Situation 4 – biomass not known: trends of survey CPUE (catch per unit of effort) will be evaluated as a proxy for fishery mortality

- Spawning stock biomass: the spawning stock biomass (SSB) is at a level capable of delivering MSY.
  - Situation 1 - B_{MSY} known: the level of spawning stock biomass (SSB) is equal to or higher than B_{MSY}
  - Situation 2 – B_{MSY} not known, but B_{pa} known: the level of spawning stock biomass (SSB) is equal to or higher than B_{pa}
  - Situation 3 – B_{MSY} & B_{pa} not known: trends of survey abundance will be evaluated as a proxy of stock biomass

Environmental targets and associated indicators (Art. 10)

- All commercial fish stocks managed through the CFP are being managed in a way that minimally meets the maximum sustainable yield. This assessment should be performed on the basis of regional fish stocks, and not on a national level.

- All commercial fish and shellfish stocks are within safe biological limits, with an age (when available) or size (if ages not available) distribution indicative for a healthy stock, and the stocks should be exploited on a stable, long term, with full reproductive capacity.

- Shellfish stocks are being managed sustainably.

- All commercial fish and shellfish stocks have complete reproductive capacity.

- Fishing mortality values and spawning stock biomasses are within safe biological limits (F below or egual to reference points for fishery mortality; SSB above or equal to reference points for spawning stock biomass) or show positive of stable trends in survey abundance and negative or stable trends in survey CPUE.

- Stocks that are not within safe biological limits yet should at least show trends of movement in the direction of the reference points.

- When data on a stock are even insufficient to evaluate trends in survey CPUE and abundance, these stocks will be placed in the category of 'data deficient stocks' and discussions will be initiated regarding alternative evaluation methods. This category will be revised after each 6 years.

Data on F and SSB are only available for a limited number of commercially exploited fish species, and therefore assessments to the criterium of level of pressure of fishing activity and the criterium on

reproductive capacity of the stock cannot be done for all stocks. For some stocks that are at an unsustainable level, there is no information available for a MSY approach.

There has been a decline in the length composition of demersal fish in the North Sea over the period 1975-2005.

Present status in terms of EcoQO's varies depending on the species. There has been a positive development with an increased number of stocks in favourable conditions within the precautionary values, but there has also been an increase in the number of stocks outside the limits. At present, 5 of the 26 fish stocks are assessed to meet the EcoQO criteria on spawning stock biomass. For 11 stocks, reference points could not be set. The biomass of eight fish stocks is outside safe biological limits.

Selected commercial fish species[k] for Belgian marine waters (this list of species will be revised after every 6 years)

Categorie 1: soorten met analytisch assessment, referentiewaarden voor biomassa (SSB) en visserijsterfte (F) gekend:
Kabeljauw (*Gadus morhua*)
Wijting (*Merlangius merlangus*)
Schol (*Pleuronectes platessa*)
Tong (*Solea solea*)

Categorie 2: soorten met niet-analytisch assessment of zonder assessment:
Grijze Garnaal (*Crangon crangon*)
Hondshaai (*Scyliorhinus canicula*)
Stekelrog (*Raja clavata*)
Blonde Rog (*Raja brachyura*)
Gevlekte Rog (*Raja montagui*)
Schar (*Limanda limanda*)
Bot (*Platichthys flesus*)
Tongschar (*Microstomus kitt*)
Tarbot (*Psetta maxima*)
Griet (*Scophthalmus rhombus*)

[k] De selectie van deze soorten gebeurt op basis van volgende criteria: (1) commercieel gegeerde soorten; (2) soorten waarvan een deel van de Noordzeepopulatie regelmatig voorkomt in het Belgisch deel van de Noordzee (dus geen soorten waarvan wel eens een verdwaald individu wordt aangetroffen, of die enkel als migrant onze wateren aandoen); (3) voor soorten waarvoor survey-gegevens gebruikt worden: enkel soorten die tijdens de Belgische boomkor-surveys kwantitatief bemonsterd kunnen worden (dus bv. geen soorten waarvan het hoofdaandeel kan ontsnappen door de mazen die op de surveys worden gebruikt (40mm)).

Descriptor 5.
Eutrophication

Background

Eutrophication is the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. Anthropogenic euthrophication can occur in certain conditions when nutrients inputs of nitrogen and phosphorus from point sources (e.g. sewage effluents and industrial processes) and diffuse sources (e.g. agricultural run-off) enter the coastal and marine environment. Increased levels of algae can lead to anoxic conditions when they die and decompose, which may result in the death of benthos and fish.

Assessment criteria from Commission Decision 2010/477/EU

5.1 Nutrient levels
5.2 Direct effects of nutrient enrichment
5.3 Indirect effects of nutrient enrichment

Good environmental status (literally from MSFD, Art. 9)

Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

GES for eutrophication would be achieved if:

Firstly the criteria for a Good Ecological Status defined in the framework of the Water Framework Directive are achieved. If the first target is reached, the criteria defined in the OSPAR Common Procedure need to be achieved.

Environmental targets and associated indicators (Art. 10)

5.1 Direct effects of nutrient enrichment

- A) The 90 percentile of chlorophyll *a* concentration (in the growing season and over 6 years) is less than 15 µg/l. (Commission Decision 2008/915/EC)

- B) If target A is reached, less than 17 % of monthly samples contain more than 10^6 *Phaeocystis* cells/l. (Commission Decision 2008/915/EC)

5.2 Nutrient levels

- Complementary target: winter DIN concentrations are less than 12 µmoles/l (offshore)[l] or 15 µmoles/l (coastal)[l] and winter DIP concentrations are less than 0,8 µmoles/l. (OSPAR COMP)

[l] Offshore : where salinity is higher than 34,5 PSU ; coastal : where salinity is between 34,5 and 30 PSU.

Descriptor 7.
Hydrographical conditions

Background

Development in the coastal and marine zone can be broadly categorized into urban and residential (e.g. houses), infrastructure (e.g. ports, harbours, windfarms), tourism and leisure, and resources (e.g. aggregate extraction). Developments in these areas can, if poorly managed, drastically alter hydromorphological conditions, resulting in significant impacts on both the coastal and marine environments. Permanent alterations to hydrographical conditions such as temperature, salinity, pH, and hydrodynamics resulting from human activities may result in further changes to tidal regimes, sediment and freshwater transport, currents or wave action, etc. Such changes have the potential to affect marine ecosystems at a broad scale and their assessment may provide an early warning of possible significant impacts on the ecosystem.

Assessment criteria from Commission Decision 2010/477/EU

7.1 Spatial characterisation of permanent alterations
7.2 Impact of permanent hydrographical changes

Good environmental status (literally from MSFD, Art. 9)

Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

GES for hydrographical conditions would be achieved if:

- The nature and scale of any long-term changes to the prevailing hydrographical conditions from anthropogenic activities (individual and cumulative) in the marine environment do not lead to significant negative impacts at a species, population or ecosystem level.

- This at least implies that the changes in flow patterns resulting from concerned human activities are in such a way that erosion and sedimentation remain balanced.

Environmental targets and associated indicators (Art. 10).

- An impact demands consideration if one of the following conditions – related to the bottom stress on a 14 days spring tide/neap tide cycle as computed by validated mathematical models – is met:

  (i) there is an increase of more than 10% of the mean bottom shear stress
  (ii) the variation of the ratio between the duration of the bottom shear stress and the duration of the erosion is outside the "- 5%, + 5%" range

- This consideration demanding impact remains within a distance equal to the root square of the surface occupied by this activity and taken from its external limit.[m]

[m] For cumulative effects, see "Descriptor 1, 4 and 6" / Environmental Targets / Benthic Habitat / First dot.

- All developments must comply with the existing regulatory regime (e.g. EIA, SEA, and Habitats Directives) and regulatory assessments must be undertaken in such a way that takes into consideration any potential impacts arising from permanent changes in hydrographical conditions, including cumulative effects, at the most appropriate spatial scales following the guidance prepared to this end.[n]

[n] OSPAR common language.

Descriptor 8.
Contamination

Background
Contaminants are defined as substances (i.e. chemical elements and compounds) or groups of substances that are toxic, persistent and liable to bioaccumulate, and other substances or groups of substances which give rise to an equivalent level of concern. This definition is in line with the definition of hazardous substances used in the Water Framework Directive 2000/60/EC (WFD), and by OSPAR and HELCOM.

Pollution effects are defined as direct and/or indirect adverse impacts of contaminants on the marine environment, such as harm to living resources and marine ecosystems, including loss of biodiversity, hazards to human health, the hindering of marine activities, including fishing, tourism and recreation and other legitimate uses of the sea, impairment of the quality for use of sea water and reduction of amenities or, in general, impairment of the sustainable use of marine goods and services.

Assessment criteria from Commission Decision 2010/477/EU

8.1 Concentration of contaminants
8.2 Effects of contaminants

Good environmental status (literally from MSFD, Art. 9)

Concentrations of contaminants are at levels not giving rise to pollution effects.

GES for contamination would be achieved if:

- Environmental concentrations of contaminants (in water, sediment and biota) are within agreed levels (EQS from WFD, EAC developed in OSPAR).
- The effects of contaminants on selected biological processes and taxonomic groups are within agreed levels (relevant OSPAR EcoQO).

Environmental targets and associated indicators (Art. 10)

8.1 Concentration of contaminants

- Water: concentrations of the WFD substances are equal to or less than their EQS. (Directive 2008/105/EC)
- Biota: concentrations of Hg, Hexachlorobenzene and Hexachlorobutadienne are equal to or less than their EQS. (Directive 2008/105/EC)
- Bird eggs: no difference is measured between Hg concentrations in bird eggs from impacted and non-industrial zones.
- Bird eggs: concentrations of PCB, DDT, HCB and HCH in bird eggs are equal to or less than their OSPAR threshold values. (OSPAR EcoQO)

- Biota and sediments: substances for which OSPAR has defined EAC's, even on a provisional basis, have concentrations that are equal to or less than their EAC's. (OSPAR JAMP)

8.2 Effects of contaminants[o]

- Biota and oil: the average proportion of oiled common guillemots (zeekoet - *Uria aalge*) is below 20 % of the total number found dead or dying on the beaches. (OSPAR EcoQO)

- Effects: the average level of imposex is consistent with an exposure to TBT concentration less than the EAC. (OSPAR EcoQO)

- Effects: for externally visible fish diseases, the fish disease index is below the environmental assessment criterium (EAC) set in the OSPAR JAMP guideline on Integrated Guidelines for the Integrated Monitoring and Assessment of Contaminants.

- Effects: the level of EROD (Ethoxyresorufin-O-deethylase) induction is below the background assessment level set in the OSPAR JAMP guideline on Integrated Guidelines for the Integrated Monitoring and Assessment of Contaminants.

- Pressure: trend towards no illegal discharges from ships for the MARPOL Annex I, II and V substances, observed by air monitoring patrols.

- Acute pollution: risks induced by maritime accidents which may cause a release of more than 1000 tons oil or have a comparable impact are kept at their present level and, to do so, new human activities at sea are subject to appropriate measures of risk mitigation.

- Acute pollution: occurrence and extent of significant acute pollution events (e.g. slicks resulting from spills of oil and oil products or spills of chemicals) and their impact on biota affected by this pollution should be minimised through appropriate risk based approaches.[n]

[o] If general toxicity tests (such as whole organism tests or alert system or biosensors) are more developed by 2018 and clearly procedurally settled, they could be used in the second cycle of MSFD. The advantage would be that these tests examine the degree of contamination of a full cocktail of contaminants, without measuring the substances separately. Similarly, techniques such as passive sampling (the "thermometer" of the contamination) will be operationally put in place.

Descriptor 9.
Contaminants in seafood for human consumption

Background

Contaminants in fish and other seafood for human consumption might arise from numerous anthropogenic sources such as land-based industrial activity, discharge, municipalities, pesticide use, nuclear accidents and discharge, aquaculture, heavy shipping lines, petrogenic sources, but natural oceanographic and geological factors might also be responsible for elevated levels of contaminants in fish and seafood.

Assessment criteria from Commission Decision 2010/477/EU

9.1 Levels, number and frequency of contaminants

Good environmental status (literally from MSFD, Art. 9)

Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.

GES for contaminants in seafood would be achieved if:

All measured contaminants in fish and shellfish for human consumption have concentrations below regulatory levels (Commission Regulation 1881/2006 and Directive 2006/113/EC).

Environmental targets and associated indicators (Art. 10)

9.1 Levels, number and frequency of contaminants

All measured contaminants in fish and shellfish for human consumption have concentrations below regulatory levels (Commission Regulation 1881/2006 and Directive 2006/113/EC).

Descriptor 10.
Marine litter

Background
Marine litter is any persistent, manufactured or processed solid material discarded, disposed of, abandoned or lost in the marine and coastal environment and includes items entering via rivers, sewage outlets, storm water outlets or winds.

Litter is found everywhere in the marine and coastal environment: on beaches, on the seabed and suspended in the water column. A large proportion of marine litter is made up of glass, tin and plastics, all of which persists in the environment for significant time periods. Almost 90 % of all floating litter items are estimated to be plastic or polystyrene while some 70 % of litter in the North Sea ends up on the seabed.

Assessment criteria from Commission Decision 2010/477/EU

10.1 Characteristics of litter in the marine and coastal environment
10.2 Impacts of litter on marine life

Good environmental status (literally from MSFD, Art. 9)

Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

GES for marine litter would be achieved if:

- The amount of litter, and its degradation products, do not cause harm/damage (direct or indirect) to marine life and habitats.

- The amount of litter, including its degradation products[p], on coastlines and in the marine environment is decreasing over time and are at levels which do not result in harmful effects to the coastal or marine environment.[n]

Environmental targets and associated indicators (Art. 10)

10.1 Characteristics of litter in the marine and coastal environment

- Negative trend in the annual evolution of the quantities of stranded litter, following the guideline for Monitoring Marine Litter on the Beaches in the OSPAR maritime area (2010).

- Negative trend in the annual evolution of the quantities of litter collected at sea. (OSPAR recommendation 2010/19)

- Overall reduction in the total number of visible litter items on coastlines by 2020 (e.g. based on a five year moving average).[n]

[p] Degradation products of litter include small plastic particles and micro-plastic particles.

10.2 Impacts of litter on marine life

- Less than 10 % of the northern fulmars (Noordse stormvogel - *Fulmarus glacialis*) contain more than 0,1 g plastic in their stomach. (OSPAR EcoQO)

Descriptor 11.
Energy, including underwater noise

Background

Water is an ideal medium for sound since acoustic waves travel four times faster in water than in air. Sources of anthropogenic sound in the marine environment may be either of a short duration e.g. seismic surveys, piling and explosions, or long-lasting/continuous e.g. dredging, shipping and industrial installations (such as operational wind farms).

Assessment criteria from Commission Decision 2010/477/EU

11.1 Distribution in time and place of loud, low and mid frequency impulsive sounds
11.2 Continuous low frequency sound

Good environmental status (literally from MSFD, Art. 9)

Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

GES for underwater noise would be achieved if:

- Impulsive sounds and regional sound budgets do not adversely impact marine organisms.
- Loud, low and mid frequency impulsive sounds and continuous low frequency sounds introduced into the marine environment through human activities do not have adverse effects on marine ecosystems.[n]

Environmental targets and associated indicators (Art. 10)

- The level of anthropogenic impulsive sound is less than 185 dB re 1 µPa (zero-to-peak SPL) at 750m from the source.[q] (Commission Decision 2010/477/EU made explicit)
- No positive trend in the yearly mean ambient noise level within the 1/3 octave bands 63 and 125 Hz. (Commission Decision 2010/477/EU)[r]

[q] Not applicable in case of urgent need of elimination of ammunitions at sea.

[r] Based on two as continuous as possible autonomous measuring stations, one in coastal waters and the other one in open sea (exact location still to be defined). The use of a propagation model would be appropriate starting from the second cycle.

Abbreviations

BEQI: Benthos Ecosystem Quality Index

CFP: Common Fisheries Policy

DDT: dichlorodiphenyltrichloroethane

DIN: dissolved inorganic nitrogen

DIP: dissolved inorganic phosphorus

EAC: environmental assessment criteria

EQS: environmental quality standards

EUNIS: European Nature Information System

GES: Good Environmental Status

HCB: hexachlorobenzene

HCH: Hexachlorocyclohexane

HD: Habitats Directive 92/43/EEC

HELCOM: Baltic Marine Environment Protection Commission

Hg: mercury

MARPOL: International Convention for the Prevention of Pollution from Ships

MSFD: Marine Strategy Framework Directive 2008/56/EC

MSY: maximum sustainable yield

OSPAR: The Convention for the Protection of the marine Environment of the North-East Atlantic

OSPAR COMP: OSPAR Common Procedure

OSPAR EcoQO: ecological quality objectives:
http://www.ospar.org/content/content.asp?menu=00690302200000_000000_000000

OSPAR JAMP: OSPAR Joint Assessment and Monitoring Programme

PCB: Polychlorinated biphenyl

SPL: sound pressure level

TBT: tributyltin

WFD: Water Framework Directive 2000/60/EC

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Degraer S., Braeckman U., Haelters J., Hostens K., Jacques T., Kerckhof F., Merckx B., Rabaut M., Stienen E., Van Hoey G., Van Lancker V., Vincx M. (2009). Studie betreffende het opstellen van een lijst met potentiële Habitatrichtlijn gebieden in het Belgische deel van de Noordzee. Eindrapport in opdracht van de Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu, Directoraat-generaal Leefmilieu. Brussel, België. 93 pp.

Legislative and policy documents

92/43/EEG: Richtlijn 92/43/EEG van de Raad van 21 mei 1992 inzake de instandhouding van de natuurlijke habitats en de wilde flora en fauna

2000/60/EG: Richtlijn 2000/60/EG van het Europees Parlement en de Raad van 23 oktober 2000 tot vaststelling van een kader voor communautaire maatregelen betreffende het waterbeleid

2008/56/EG : Richtlijn 2008/56/EG van het Europees Parlement en de Raad van 17 juni 2008 tot vaststelling van een kader voor communautaire maatregelen betreffende het beleid ten aanzien van het mariene milieu (Kaderrichtlijn mariene strategie)

2008/915/EG: Beschikking van de Commissie van 30 oktober 2008 tot vaststelling van de indelingswaarden voor de monitoringsystemen van de lidstaten die het resultaat zijn van de intercalibratie, overeenkomstig Richtlijn 2000/60/EG van het Europees Parlement en de Raad

2008/105/EG: Richtlijn 2008/105/EG van het Europees Parlement en de Raad van 16 december 2008 inzake milieukwaliteitsnormen op het gebied van het waterbeleid tot wijziging en vervolgens intrekking van de Richtlijnen 82/176/EEG, 83/513/EEG, 84/156/EEG, 84/491/EEG en 86/280/EEG van de Raad, en tot wijziging van Richtlijn 2000/60/EG

2010/477/EU: Besluit van de Commissie van 1 september 2010 tot vaststelling van criteria en methodologische standaarden inzake de goede milieutoestand van mariene wateren

OSPAR Recommendation 2010/19 on the reduction of marine litter through the implementation of fishing for litter initiatives: http://www.ospar.org/documents/dbase/decrecs/recommendations/10-19e_fishing%20for%20litter.pdf

Guideline for Monitoring Marine Litter on the Beaches in the OSPAR maritime area (2010): http://www.ospar.org/documents/dbase/decrecs/agreements/10-02e_Beachlitter%20Guideline_english%20only.pdf

ANNEX

Benthos Ecosystem Quality Index – BEQI

The use of a benthic indicator (cf BEQI, www.beqi.eu) to evaluate the condition of the benthic habitat is a good way to evaluate the community structure. Such indicator has to focus on different parameters of the community such as species richness, species composition, density and biomass. The indicator is accepted under WFD, but some research (reference, pressure link, monitoring) is needed to adapt it for evaluating the benthic community structure on BPNS scale.

Benthic bioturbation potential – BP_c

This indicator links several attributes of the macrofaunal communities, with the functions of the marine sediments, including the mineralisation of organic matter deposited on the seafloor. These mineralisation processes provide the water column with the necessary nutrients needed for the next phytoplankton bloom (see Kristensen 1988). It is well-accepted that benthic fauna, through bioturbation and bio-irrigation, play a key role in the processing of this pool of organic matter and nutrient cycling at the sediment-water interface (Hansen and Kristensen 1998, Mermillod-Blondin & Rosenberg 2006, Braeckman et al. 2010, 2011b) especially in areas where physical disturbance is low (Kristensen and Kostka 2005, Meysman et al. 2006).

The BPc links the biological communities (macrofauna) with the ecosystem functioning, by calculating the Bioturturbation Potential for every individual species (BPi), and integrating this in the present macrofaunal communities.

Braeckman U, Provoost P, Gribsholt B, Van Gansbeke D, Middelburg JJ, Soetaert K, Vincx M, Vanaverbeke J (2010) Role of macrofauna functional traits and density in biogeochemical fluxes and bioturbation. Marine Ecology-Progress Series 399:173-186.

Braeckman U, Provoost P, Moens T, Soetaert K, Middelburg JJ, Vincx M, Vanaverbeke J (2011b) vs. Physical Mixing Effects on Benthic Food Web Dynamics. PLoS One 6:e18078.

Hansen K, Kristensen E (1998).The impact of the polychaete *Nereis diversicolor* and enrichment with macroalgal (*Chaetomorpha linum*) detritus on benthic metabolism and nutrient dynamics in organic-poor and organic-rich sediments. Journal of Experimental Marine Biology and Ecology 231:21-223.

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Kristensen E, Kostka JE (2005) Macrofaunal burrows and irrigation in marine sediment: Microbiological and biogeochemical interactions. In: Kristensen E, Haese RR and Kostka JE (Eds.) Interactions between macro- and microorganisms in marine sediments, Coastal and Estuarine Studies vol. 60, American Geophysical Union, New York p. 125-157.

Mermillod-Blondin F, Rosenberg R (2006) Ecosystem engineering: the impact of bioturbation on biogeochemical processes in marine and freshwater benthic habitats. Aquatic Sciences-Research Across Boundaries 68:434-442.

Meysman FJ, Middelburg JJ, Heip CH (2006a) Bioturbation: a fresh look at Darwin's last idea. Trends in Ecology and Evolution 21:688-695.

Maximum Sustainable Yield – MSY

The application of F_{MSY} for advices in 2011 and the transition to F_{MSY}:

From 2010 the European Union applies the F_{MSY} approach by adopting a step-by-step introduction of an F_{MSY} policy aimed to adapt fishing mortality levels that levels that match F_{MSY} in 2015.

Because in many cases the fishing mortality for EU fish stocks lies above the F_{MSY}, the Commission has requested ICES to calculate the advices to make a smooth transition to the new approach possible.

The ICES F_{MSY} framework established in 2009 means a change in the ICES advice: the philosophy to take the precautionary principle as advisory standard strove to prevent an undesirable outcome, in particular the reduction in recruitment. The F_{MSY} framework is focused on achieving a desired result, which is a high sustainable long-term yield.

According to ICES, F_{MSY} is the framework in accordance with the precautionary principle, as well as with the national and international policies and agreements. According to ICES, the application of F_{MSY} should result in a lower fishing mortality, and lead over the long term to a larger size of the stocks according to the precautionary principle.

The F_{MSY} approach uses both the fishing mortality as the biomass reference points: F_{MSY} and $B_{trigger}$. F_{MSY} is the fishing mortality resulting in a maximum average yield over the long term and is generally lower than the precautionary F_{pa}. To date, this was used as the main reference point for advice. The $B_{trigger}$ is a biomass reference point which gives a signal when the stocks drops below a certain level. $B_{trigger}$ has evolved from the reference point B_{pa} (precautionary principle) and is designed to ensure that the stocks are managed within the desirable extent within which a stock may vary. In practice, this means that when the size of the biomass for a particular stock drops to the trigger level, the advice will be given to reduce fishing mortality to or below F_{MSY}. The F_{MSY} principle still has the possibility of a zero-advice for a certain fishery in those cases where a stock is in a particularly precarious situation.

- Fishery reference points
    - F_{pa} = fishing mortality at the precautionary level
    - F_{lim} = fishing mortality at limit level (stock collapse)
    - F_{MSY} = fishing mortality at "maximum sustainable yield" (Johannesburg conventie)
    - Biomass reference points
    - B_{pa} = Biomass at precautionary level
    - $B_{trigger}$ = Limit biomass needed for sustainable exploitation (F_{MSY})
    - B_{lim} = Biomass at limit level (stock collapse)

A transition towards the F_{MSY} principle is proposed, because it will take some time to collect all the necessary information, for example, to establish reference points for all stocks.
On a proposal from the European Commission, ICES has therefore proposed a transitional arrangement for a gradual reduction in fishing mortality in the course of the years 2011, 2012, 2013, 2014 and 2015.

Colofon

This document is a translation of the two official documents:

French version :

État belge, 2012. Définition du Bon état écologique et définition d'Objectifs environnementaux pour les eaux marines belges. Directive-cadre Stratégie pour le milieu marin – Art 9 & 10. UGMM, Service Public Fédéral Santé publique, Sécurité de la Chaîne alimentaire et Environnement, Bruxelles, Belgique, 32 pp.

Dutch version :

Belgische Staat, 2012. Omschrijving van Goede Milieutoestand en vaststelling van Milieudoelen voor de Belgische mariene wateren. Kaderrichtlijn Mariene Strategie – Art 9 & 10. BMM, Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu, Brussel, België, 34 pp.

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