OSPAR COMMISSION

MSFD Advice Manual and Background document on Good environmental status - Descriptor 5: Eutrophication

A living document - Version 5 January 2012

Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptor 5

Eutrophication Series

2012

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998.
Les Parties contractantes sont l'Allemagne, la Belgique, le Danemark, l’Espagne, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède, la Suisse et l’Union européenne.

Version of 5 January 2012

Prepared by (and under the auspices of) the OSPAR Committee of Hazardous Substances and Eutrophication (HASEC)

Disclaimer

This Advice Document is a living document and reflects the state of discussion at expert level at the time of its drafting. The document is of a non-binding nature and aims at facilitating coordination between EU Member States that are parties to the OSPAR Convention, with regard to developing indicators and targets for MSFD Descriptor 5. It does not prejudice the ongoing decision making process in Contracting Parties and their final conclusions in 2012.

Contents

Advice summary

- The OSPAR Common Procedure for the identification of the eutrophication status of the OSPAR maritime area provides a good framework for assessing eutrophication and should be used as the basis for determining characteristics, targets and indicators for GES descriptor 5 in the North East Atlantic Ocean.
- The harmonised assessment parameters of the Common Procedure are suitable, and comparable with those of other frameworks, to act as area-specific indicators for the descriptor 5 criteria. The most used indicators for monitoring and assessment are winter nutrients (DIN/DIP, N/P ratio), chlorophyll a/chlorophyll, phytoplankton indicator species (such as nuisance species), macrophytes (*e.g.* opportunistic macroalgae and seagrass) and oxygen. Additional indicators such as total nitrogen/phosphorus, carbon, zooplankton and primary production could be considered, subject to demonstrating their added value. Assessment of biological elements such as phytoplankton indicator species, macrophytes and possibly zooplankton and primary production could provide links to GES descriptors 1 and 4.
- The methodology used for threshold setting in the Common Procedure is based on the definition of area-specific background values which function as reference points for the assessment. Accordingly, area specific thresholds (assessment levels) are defined as a deviation from those area-specific background concentrations, thereby taking account of natural variability. The approach is therefore comparable with other frameworks, such as the Water Framework Directive.
- The pilot application of the integrated set of North Sea EcoQOs for eutrophication has been useful and countries will build on knowledge and experiences gained in future work. The future definition of the overall desired state with respect to eutrophication is to obtain non-problem area status, as assessed under the Common Procedure.
- Eutrophication status is the starting point from which to assess the distance to the desired state. From that, specific environmental targets, consisting of both state and pressure targets, can be derived to improve the eutrophication status with the ultimate aim to achieve the status of non-problem area. State targets can be based on an integrated set of harmonised assessment parameters of the Common Procedure. Pressure targets can be set for nutrient inputs and relevant important nutrient sources. Trend information collected by OSPAR on riverine inputs and direct discharges and atmospheric deposition, complemented by atmospheric models and nutrient sources monitoring (under development), provide suitable pressure indicators.
- Contracting Parties are reviewing the Common Procedure in relation to environmental target setting for eutrophication state and pressure related targets with respect to eutrophication. Reduction of human-induced nutrient enrichment is critical to minimising eutrophication effects. It is therefore considered likely that pressure related targets seem to be essential for achieving GES descriptor 5 where there are problem areas.
- The following are relevant nutrient sources for pressure targets in relation to programmes of measures: agriculture; urban wastetwater; industry; aquaculture; households not connected to public sewerage, and forestry (for Sweden and Norway).
- The harmonised assessment parameters of the Common Procedure, and the way they are combined together , provide a well-tested assessment procedure to judge whether eutrophication is occurring. The Common Procedure is ‘fit for the purpose’ of assessing descriptor 5 and supports the setting of targets and indicators under MSFD.
- Building on the hydro-morphological criteria of the Common Procedure, Contracting Parties are still considering geographic assessment scales for the purpose of the MSFD. A risk-based approach, emphasising efforts on problem areas, as currently applied in OSPAR, would seem an appropriate approach to eutrophication monitoring and assessment of the OSPAR maritime area.
- There are relevant links between criteria and indicators for GES descriptor 5 with various other descriptors which may ultimately need to be taken into account in developing GES targets and indicators and associated monitoring programmes.

Concise summary of congruence of Contracting Parties' approaches to Eutrophication (D5)

The following table show the GES indicators and the advice on parameters, targets and preferred approach. Colours indicate the level of consensus between OSPAR CPs:
Green = high; Orange = some; Red = none; black = not enough information

GES descriptor 5: eutrophication - The overall objective for OSPAR is to have no problem areas, as assessed by the Comprehensive Procedure

Criterion	Indicator	Area specific assessment parameters (indicators)	Area specific Assessment level (threshold)	Monitoring	Advice/consideration
5.1 Nutrient Levels	5.1.1 Nutrient concentrations in water	Nutrient concentrations (area-specific) DIN, DIP	Elevated level(s) of winter DIN and/or DIP not exceeding 50% from background	Eutrophication monitoring programme (CEMP)	There is consensus between contracting parties on the approach to this indicator. It is a robust indicator that will help meet the requirements of the MSFD.
	5.1.2 nutrient ratio (silica, Nitrogen, Phosphorus), where appropriate	N/P ratio (area-specific)	Elevated winter N/P ratio (Redfield N/P = 16)	Eutrophication monitoring programme (CEMP)	There is consensus between contracting parties on the approach to this indicator. It is a robust indicator that will help meet the requirements of the MSFD.
5.2 Direct effects	5.2.1 Chlorophyll concentration in the water column	Chlorophyll a/chlorophyll concentration (area-specific)	Justified area-specific % deviation from background not exceeding 50% (see Table 2.3 in Annex 1 for metrics)	Eutrophication monitoring programme (CEMP)	There is consensus between contracting parties on the approach to this indicator. It is a robust indicator that will help meet the requirements of the MSFD.
	5.2.2 Water transparency related to increase in suspended algae, where relevant	Not used as an assessment parameter but as a supporting parameter		Not covered under the Eutrophication Monitoring Programme	There is consensus between contracting parties on the approach to this indicator.

	5.2.3 Abundance of opportunistic macroalgae	Macrophytes including macroalgae (area-specific)	Shift from long-lived to short-lived nuisance species (*e.g. Ulva*). Elevated levels (biomass or area covered) of opportunistic green macroalgae).	Eutrophication monitoring programme (CEMP)	There is consensus between contracting parties on the approach to this indicator. It is a robust indicator that will help meet the requirements of the MSFD.
	5.2.4 Species shift in floristic composition such as diatoms to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (*e.g.* cyanobacteria) caused by human activities	Diatoms to flagellate ratio Phytoplankton indicator species (such as area-specific nuisance species)	Elevated levels of nuisance/toxic phytoplankton indicator species (and increased duration of blooms)	Eutrophication monitoring programme (CEMP)	There is consensus between contracting parties on the approach to this indicator. In general, it is a robust indicator that will help meet the requirements of the MSFD.
5.3 Indirect effects	5.3.1 Abundance of perennial seaweeds and seagrasses (*e.g.* fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency	Macrophytes including macroalgae (area-specific)	Shift from long-lived to short-lived nuisance species (*e.g. Ulva*).	Eutrophication monitoring programme (CEMP)	There is consensus between contracting parties on the approach to this indicator. It is a robust indicator that will help meet the requirements of the MSFD.
	5.3.2 Dissolved oxygen *i.e.* changes due to increased organic matter decomposition and size of the area concerned	Oxygen deficiency	Decreased oxygen levels Lowered % saturation	Eutrophication monitoring programme (CEMP)	There is consensus between contracting parties on the approach to this indicator. It is a robust indicator that will help meet the requirements of the MSFD.

NOTES

The Comprehensive Procedure contains all the parameters required to deliver the indicators in the Commission Decision for GES D5 and in addition contains further assessment parameters (*e.g.* macrozoobenthos, organic carbon) and a suite of supporting environmental parameters, including for example transparency. The colour indicators in the summary table show all parameters, assessment levels and monitoring schemes to be green as a result of the Comprehensive Procedure being a harmonised assessment scheme.

The above table shows state targets, the COMP contains also pressure targets *e.g*. nutrient inputs. OSPAR also address various sources of inputs. These pressure targets in addition to the state targets are important in relation to programmes of measures to achieve GES 5.

(…)

Background Document:

OSPAR MSFD Advice Document on Eutrophication (MSFD Descriptor 5)

Contents

1. Introduction

This document has been prepared by the OSPAR Hazardous Substances and Eutrophication Committee and provides advice to the OSPAR Commission on approaches to determining good environmental status in relation to eutrophication (descriptor 5) and some starting points for a discussion on the setting of targets and indicators. Its purpose is to support regional coordination by OSPAR EU Member States in the implementation of the Marine Strategy Framework Directive.

1.1 Legal context

The Marine Strategy Framework Directive (MSFD) requires EU Member States to achieve and maintain good environmental status of their marine waters, *i.e*. 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 (Art. 3(5) MSFD). EU Member States shall, in respect of each marine region or sub-region, determine a set of characteristics for good environmental status on the basis of the qualitative descriptors listed in Annex I to the MSFD. Member States shall, when implementing their MSFD obligations, take due account of the fact that their marine waters form part of the marine regions or sub-regions as referred to in Art. 4 MSFD.

The qualitative descriptor 5 at Annex I to the MSFD requires that:

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

The implementation of the MSFD and achieving good environmental status requires EU Member States inter alia:

- to make an initial assessment of their marine waters (Art. 8 MSFD);
- by reference to the initial assessment, to determine a set of characteristics for good environmental status, on the basis of the qualitative descriptors listed in Annex I to the MSFD (Art. 9 MSFD). The criteria and methodologies which EU Member States should use for determining GES characteristics in a consistent and (sub)regionally comparable way are set out in Commission Decision 2010/477/EU;
- on the basis of the initial assessment, to establish a comprehensive set of environmental targets and associated indicators for their marine waters so as to guide progress towards achieving good environmental status in the marine environment, taking into account the indicative list of pressure and impacts set out in Table 2 of Annex III and of characteristics set out in Annex IV (Art. 10 MSFD).

1.2 Development of the advice

The advice has been developed in response to the request of the Intersessional Correspondence Group (ICG) on the MSFD (ICG MSFD 2010 Summary Record, Annex 4, as amended) to deliver, specifically in relation to qualitative descriptor 5 (eutrophication), the following advice:

- a clear understanding of how (individual or a set of) indicators for the criteria of the individual GES descriptors might be determined;
- development of a common approach to determining thresholds for GES criteria and their indicators within OSPAR;
- documentation of how existing thresholds for GES criteria and their indicators have been determined in the MSFD region “North-East Atlantic Ocean” with particular focus on its sub-regions in order to identify as possible follow-up activities;
- a detailed consideration of approaches for target setting, including setting suitable and operational state and pressure targets (Art. 10 MSFD);

- a description of appropriate scales of assessment related GES targets, not only from a point of view of characteristics of GES but also in relation to pressures and indicators (fit for management purposes) in the marine region (OSPAR maritime area) or sub-region (OSPAR Region I-V).

The advice follows the appraisal of existing approaches undertaken by the JRC/ICES/EU Task Group for descriptor 5 (TG 5) and refers to the TG5 report as the required documentation of existing approaches: http://circa.europa.eu/Members/irc/env/marine/library?l=/implementation_coordinat/working_environmental/reports_management/final_reports_2010/tg5_reportpdf/_EN_1.0_&a=d. For further documentation of methodologies reference is made to

- the OSPAR Common Procedure for the identification of the eutrophication status of the OSPAR maritime area (the "Common Procedure") – OSPAR agreement 2005-3;
- the second OSPAR integrated report of the eutrophication status of the OSPAR maritime area (publication 372/2008);
- the Guidance Document No.23 on eutrophication assessment in the context of European water policies, adopted under the Water Framework Directive (WFD) Common Implementation Strategy, which provides a comparison of European eutrophication assessment frameworks and methodologies.

The WFD guidance document and the TG5 report show considerable commonalities in existing approaches to assessing marine eutrophication and both include an appraisal of the OSPAR Common Procedure. It is noted that despite some differences at technical level, the assessment frameworks of the OSPAR Common Procedure, Water Framework Directive (eutrophication assessment) and the HELCOM eutrophication assessment tools (HEAT) are based on a common conceptual understanding of eutrophication assessments and use similar approaches.

Contracting Parties consider in principle the criteria and methodologies of the Common Procedure appropriate for assessments of marine waters for the purpose of GES descriptor 5 (*cf.* Commission Decision 2010/477/EU) and indicate to use the Common Procedure as one of the starting points for the national process to develop characteristics, targets and indicators for GES descriptor 5. The Common Procedure has therefore been used as the basis for developing this advice. In the evaluation of the Common Procedure for MSFD purposes, the focus was on a comparison of the Common Procedure with:

- the approaches of the Water Framework Directive and experiences gained by Contracting Parties in its implementation, noting the need to ensure comparability of the WFD regime in the overlapping areas (*i.e.* coastal waters) with the regime of the MSFD and in the marine waters beyond the WFD regime (*cf.* Descriptor 5 in Part B of the Annex to Commission Decision 2010/477/EU). For the geographic application of the different water policies see Figure 1.1;
- the HELCOM HEAT tool, noting the need to achieve inter-regional coordination;
- the recommended criteria and methodologies of the TG5 report;
- the experience of national eutrophication assessments.

The advice also builds on the exchange of national information on the different approaches of Contracting Parties to determine characteristics for GES for eutrophication and for setting targets and indicators for GES. It should be noted that Contracting Parties are at different stages in the preparation of their initial assessments, which will inform the activities under Art. 9 and 10 of the MSFD, and in the discussion of the implementation of descriptor 5. In many cases Contracting Parties are still developing their understanding of the requirements and concepts of the MSFD in parallel with the OSPAR coordination process. Statements of Contracting Parties' understanding of the various MSFD concepts, which are reflected in this advice document, are therefore preliminary and only indicative of the current state of discussion.

There is a need for clarification of the terminology used in the MSFD in general and to develop a common understanding for its use in relation to eutrophication in particular. This activity should inter alia aim at bridging the use of different terms used for eutrophication assessments under the frameworks of OSPAR

and MSFD, noting the contribution of ICG COBAM to the development of a glossary (*cf.* Inter-MSFD 1004). It is the intention to expand the glossary to reflect also on eutrophication aspects.

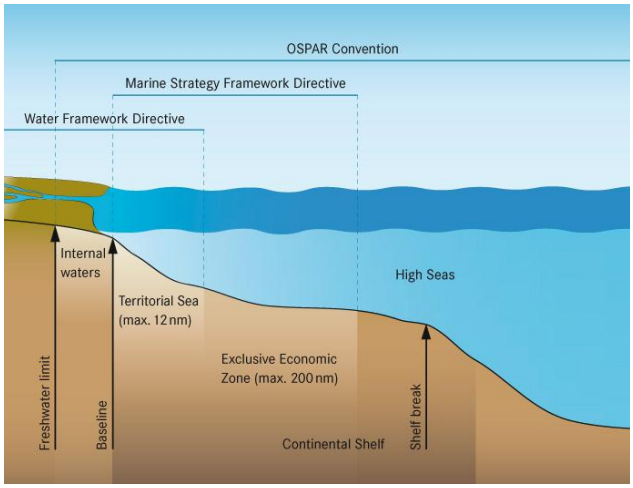

Figure 1.1 Jurisdictional zones of the United Nations Convention on the Law of the Sea, the OSPAR Convention, the EU Water Framework Directive and the EU Marine Strategy Framework Directive. The jurisdictional rights of coastal states over the water column extend up to 200 nautical miles (nm) from the baseline. Their jurisdictional rights over the Continental Shelf, relating to the seabed and subsoil, can extend beyond 200 nm.

2. Approaches to determining indicators for the criteria of descriptor 5

Commission Decision 2010/477/EU requires assessments of eutrophication in marine waters to combine information on nutrient levels and on a range of those primary effects and secondary effects which are ecologically relevant. The Decision sets out eight indicators to describe those three criteria (see Table 2.1).

The Common Procedure is based on a holistic scheme of qualitative assessment criteria which combines aspects of nutrient enrichment with aspects of direct, indirect and other possible effects of excessive nutrient enrichment on water quality and ecosystem components (see checklist for a holistic assessment, Annex 1 to the Common Procedure). The Common Procedure selects a set of 10 qualitative criteria for harmonised area-specific use. They are made operational through measurable parameters with associated area-specific assessment levels (‘thresholds’). Those assessment parameters act as simple indicators for the qualitative criteria. In combination, the assessment parameters provide an integrated means for judging the eutrophication status of marine waters.

The Common Procedure, as well as other relevant assessment frameworks, differentiates assessment parameters in a way comparable to the criteria groups of Commission Decision 2010/477/EU. The Common Procedure sets out at least three categories: (i) nutrient enrichment, (ii) direct effects and (iii) indirect effects (Table 2.1). The criteria and associated parameters (‘indicators’) covered by the Common Procedure, HEAT and WFD go beyond the list of criteria listed by Commission Decision 2010/477/EU and include adverse effects on marina fauna (benthic species and fish) and cover the characteristics listed in MSFD Annex III, Table 1 (biological features): “information on angiosperms, macro-algae and invertebrate bottom fauna, including species composition, biomass and annual/seasonal variability.”

Table 2.1 Overview of criteria for assessing eutrophication status under different frameworks and current OSPAR monitoring

Criteria Commission Decision 2010/477/EU	Criteria Water Framework Directive 2000/60/EC, Annex V	Criteria HELCOM HEAT (publication BSEP 115B)	Harmonised criteria (area-specific) OSPAR Common Procedure (agreement 2005-3, Table 1)	OSPAR monitoring in relation to criteria (agreement 2005-4)
5.1 Nutrient levels	**Nutrient condition**	**Nutrient enrichment**	**Nutrient enrichment**	*PA: problem area* *PPA: potential problem area* *NPA: non-problem area*
5.1.1 Nutrient concentration in water	Nutrient concentrations in water	Nutrient concentrations in water	Nutrient concentrations in water	NH_4-N, NO_2-N, NO_3-N, PO_4-P, SiO_4-Si (PA, PPA only), salinity, temperature PA, PPA: annually; NPA: about every 3 years
5.1.2 Nutrient ratios (silica, nitrogen, phosphorus), where appropriate		N/P ratio	N/P ratio	
			Riverine inputs and direct discharges	OSPAR RID programme: ammonia and nitrates (expressed as N), orthophosphates (expressed as P), Total N, Total P, suspended particulate matter
5.2 Direct effects	**Quality elements**	**Primary symptoms**	**Direct effects**	
5.2.1 Chlorophyll concentration in the water column	Phytoplankton biomass (chlorophyll a)	Chlorophyll a concentrations in water	Chlorophyll a concentrations in water	PA, PPA: phytoplankton chl a
5.2.2 Water transparency related to increase in suspended algae, where relevant	Water transparency	Water transparency	Used as supporting parameter	
5.2.3 Abundance of opportunistic macroalgae	Composition of macroalgae and angiosperm taxa, change in macroalgal cover and angiosperm abundance	Depth range of submerged aquatic vegetation	Shift in macrophyte/ macroalgae species composition, change in abundance and area coverage, especially of nuisance and opportunistic species	PA, PPA: biomass PA: species composition, coverage, and reduced depth range
5.2.4 Species shift in floristic composition such as diatoms to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities	Phytoplankton composition and bloom frequency (*Phaeocystis*)	Primary production Phytoplankton species composition, and bloom frequency, intensity and spatial and temporal extent	Increased bloom and duration of area-specific phytoplankton indicator species, shift in species composition	PA, PPA: species composition (genera and nuisance/potentially toxic species) PA: TOC and POC
5.3 Indirect effects	**Quality elements**	**Secondary symptoms**	**Indirect effects**	
5.3.1 Abundance of perennial seaweeds and seagrasses (e.g. fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency	See 5.2.3	See 5.2.3	See 5.2.3	See 5.2.3
5.3.2 Dissolved oxygen *i.e.* changes due to increased organic matter decomposition and size of the area concerned	Oxygen balance	Oxygen concentration and saturation	Oxygen deficiency	PA, PPA: O_2 concentration, including % saturation
			Increased organic carbon/organic matter	See 5.2.4
	Fish fauna: species composition and abundance Benthic invertebrate fauna: diversity and abundance of taxa	Abundance and structure of benthic invertebrate communities	Kills in fish and zoobenthos, shift in zoobenthos biomass and species composition	PA, PPA: biomass, species composition PA: eutrophication indicator species
			Other possible effects	
			Algal toxins (incidence of DSP/PSP mussel infections). See 5.2.4	See 5.2.4

The approach of the Common Procedure is reflected in other existing eutrophication assessment frameworks, such as the Water Framework Directive or the HELCOM HEAT tool. Similar indicators and integrating steps are used across existing assessment frameworks (Table 2.2).

Table 2.2 Methods of eutrophication assessment and examples of biological and physic-chemical indicators used, and integration capabilities (pressure-state, and overall). Source: TG5 report

Method	Biological indicators	Physico-chemical indicators	Nutrient load related to impairments	Integrated final rating[1].
TRIX	Chl	DO, DIN, TP	No	Yes
EPA NCA Water Quality Index	Chl	Water clarity, DO, DIN, DIP	No	Yes
ASSETS	Chl, macroalgae, seagrass, HAB	DO	Yes	Yes
LWQI/TWQI	Chl, macroalgae, seagrass	DO, DIN, DIP	No	Yes
OSPAR Common Procedure	Chl, macroalgae, seagrass, phytoplankton indicator species, benthic indicator species**	DO, TP*, TN*, DIN, DIP	Yes	Yes
Water Framework Directive	Phytoplankton, Chl, macroalgae, benthic invertebrates, seagrass	DO, TP, TN, DIN, DIP, water clarity	No	Yes[2]
HELCOM Eutrophication Assessment Tool	Chl, primary production, seagrass, benthic invertebrates, HAB, macroalgae	DIN, DIP, TN, TP, DO, C, water clarity	No	Yes
Ifremer	Chl, seagrass, macrobenthos, HAB	DO, water clarity, SRP, TP, TN, DIN, sediment organic matter, sediment TN, TP	No	Yes
STI	Chl, primary production	DIN, DIP	No	No

** Note from ICG COMP: Recommended parameters but not part of the harmonised set of assessment parameters*
*** Benthic indicator species added by ICG COMP*

TRIX: Trophic Index (TRIX); EPA NCA: US Environment Protection Agency National Coastal Assessment; ASSETS: Assessment of Estuarine Trophic Status, LWQI: Lagoon Water Quality Index, STI: Trophic Status Index. Different approaches are described in Zaldívar, J.-M., Cardoso, A.C., Viaroli, P., Newton, A., de Wit, R., Ibanez, C., Reizopoulou, S., Somma, F., Razinkovas, A., Basset, A., Holmer, M. and N. Murray (2008). Eutrophication in transitional waters: an overview. Transitional Waters Monographs 1(2008), 1-78.

While the 10 assessment parameters selected by the Common Procedure for use as indicators mostly correspond with the criteria set by Commission Decision 2010/477/EU and compare with other assessment frameworks, there are differences in the metrics used. This is described in detail in section 3 of the TG5 report. A summary of metrics used for the Common Procedure, WFD and HEAT is given in Table 2.3 at Annex 1.

Table 2.3 at Annex 1 shows that except for water clarity, the OSPAR set of harmonised assessment parameters provides tested indicators and methodologies for assessing the eight descriptor 5 criteria. Water clarity is covered by the holistic checklist of the Common Procedure through light availability (irradiance, turbidity, suspended load). The best monitored and used assessment parameters by OSPAR Contracting Parties are: winter DIN/DIP, N/P ratio, chlorophyll, phytoplankton indicator species, macrophytes and oxygen.

According to Art. 10 MSFD, environmental targets should take into account the list of pressures and impacts of Table 2 of Annex III, suggesting a need to distinguish two types of environmental targets: state targets and pressure targets. GES descriptor 5 focuses on nutrient levels and eutrophication effects in the marine environment (MSFD Annex III, Table 1) and includes organic enrichment (inputs of nutrients and organic matter) as pressures in the assessment (MSFD Annex III, Table 2). In contrast, the Common Procedure includes a qualitative appraisal of (trends of) riverine inputs and direct discharges as indicator for nutrient enrichment. The holistic checklist of the Common Procedure also includes consideration of fluxes and

[1] In the context of this document, integration is defined as in the OSPAR Common Procedure (see Table 4.1)

[2] It was agreed that whilst WFD does achieve integration, this is not in alignment with the definition of integration used for the OSPAR Common Procedure.

nutrient cycles in the status assessment, taking into account for example atmospheric nitrogen deposition and transboundary transport of nutrients from adjacent or remote areas.

To better appraise eutrophication and to provide a link with wider biodiversity considerations as well as with impacts of climate change, additional assessment parameters such as change in zooplankton and spatial distribution and temporal trends of primary production would provide useful additional indicators. Some Contracting Parties monitor those parameters and use them in eutrophication assessments (see Table 2.4 at Annex 2). It is noted that measuring primary production might not be fully operational as indicator by 2012. An evaluation of the added value of those indicators is proposed to decide whether they should be included in the Common Procedure and used as indicator for descriptor 5.

Most of the assessment frameworks include total nitrogen (TN) and total phosphorus (TP) and some include total organic carbon (TOC) as parameters. While part of the holistic checklist of the Common Procedure and included in the OSPAR Eutrophication Monitoring Programme (TN and TP for all waters, TOC for problem areas only), TN, TP and TOC are not part of the set of 10 harmonised parameters under the Common Procedure for assessment of problem areas. It is noted that:

- the spatial and temporal distribution of TN, TP and TOC are included as chemical characteristics in Table 1 of Annex III to the MSFD. Spatial and temporal maps for TN and TP may be becoming available through EMODNET services;
- inputs of organic matter *(i.e*. TOC/POC) are included as pressures and impacts in Table 2 of Annex III to the MSFD;
- TN, TP and TOC are relevant for example for the calculation of nutrient budgets; TOC is relevant in eutrophication assessments in sedimentation areas.

Some Contracting Parties monitor and assess the chemical parameters TN, TP and TOC (see Table 2.4 at Annex 2) in problem areas. The use of those parameters as indicators for eutrophication is being explored by work under the remit of the OSPAR Hazardous Substances and Eutrophication Committee.

In view of their general relevance for monitoring and assessing the ecological functioning of marine ecosystems, some of the biological parameters of the Common Procedure (mentioned in the holistic checklist) such as:

- primary production;
- zooplankton;
- macrozoobenthos.

offer the possibility to link with some other GES descriptors.

There are relevant links between the criteria for GES descriptor 5 and other GES descriptors. This includes GES descriptors:

- 1 (biodiversity): e.g. phytoplankton indicator species, macrophytes, macrozoobenthos;
- 2 (non-indigenous species): e.g. any identified non-indigenous toxic phytoplankton species;
- 3 (commercially exploited fish and shellfish): affected e.g. by algal toxins, and fish kills due to oxygen deficiency;
- 4 (food chain): e.g. primary production, zooplankton;
- 6 (sea-floor integrity): e.g. benthic life, in particular macrozoobenthos;
- 7 (hydrographic aspects): e.g. stratification, frontal systems, upwelling;
- 8/9 (hazardous substances): hazardous substances possibly interfering with eutrophication effects.”

3. Approaches to determining thresholds for GES criteria and their indicators

All existing approaches use reference conditions in relation to which thresholds are set. The methodologies for calculating thresholds vary between the assessment frameworks (see section 3 of the TG5 report).

The current status of national discussion indicates that Contracting Parties consider the approach under the Common Procedure appropriate as method for setting assessment levels ('thresholds'). The methodology is based on the recognition of area-specific environmental conditions and defines thresholds in a generic quantitative manner, which allows setting local thresholds in a comparable and consistent way (Table 3.1). Thresholds are defined as deviation from area-specific background conditions, allowing a 'slight disturbance', which has a direct link to 'good status' for the Water Framework Directive.

Table 3.1 Overview of deriving indicator thresholds under the Common Procedure for assessment criteria

	Assessment parameter (Indicator)	**Assessment level (Threshold)**	**Background condition (Reference condition)**
Nutrient enrichment	Riverine inputs	No threshold. Comparison with previous years (trends)	No background.
	Nutrient concentrations (DIN/DIP)	Justified area-specific % deviation from background not exceeding 50% For values see Table 4.1 at Annex 4 of OSPAR publication 372/2008	Salinity-related and/or area-specific concentrations derived from data relating to a particular (usually offshore) area or from historic data
	N/P ratio	50% above Redfield ratio (*i.e.* 24) for offshore waters (salinity >34.5). For other areas, the deviation from Redfield ratio is to be defined according to salinity	Salinity-related and/or area-specific concentrations derived from data relating to a particular (usually offshore) area or from historic data
Direct effects of nutrient enrichment	Chlorophyll a concentrations	Justified area-specific % deviation from background not exceeding 50% For values see Table 4.2 at Annex 4 of OSPAR publication 372/2008	Salinity-related and/or area-specific concentrations derived from data relating to a particular (usually offshore) area or from historic data
	Phytoplankton indicator species	Cell concentrations of area-specific nuisance and toxic species, in combination with bloom duration and area coverage, are at levels which cause adverse effects (nuisance, foam, oxygen deficiency, fish kills, PSP/DSP mussel infection) For values see Table 4.4 at Annex 4 of OSPAR publication 372/2008 Shift in phytoplankton species: Deviation from area-specific ratio of diatoms/flagellates	Based on general and physiological information of various phytoplankton indicator species. Comparison with bloom duration and levels in previous years Area-specific reference conditions for the composition of phytoplankton
	Macrophytes	Reduced depth distribution: % deviation from background Increased area coverage of nuisance species: % deviation from background	Area-specific background conditions for the composition and distribution of macrophytes
Indirect effects of nutrient enrichment	Oxygen deficiency	Deficiency in mg/l: <2mg/l: acute toxic, 4-6 mg/l: deficiency (under review; proposed use of percentile) Lowered % saturation: (under review; proposed -15%) For values see Table 4.3 at Annex 4 of OSPAR publication 372/2008	Area-specific background concentrations
	Changes/kills in zoobenthos and fish	No kills No threshold available for changes in zoobenthos	
	Organic carbon/ organic matter (area specific)	Elevated levels	
Other effects	Algae toxins	No occurrence of DSP/PSP mussel infection events	

There are differences in terminology between the Common Procedure and Marine Strategy Framework Directive regarding descriptor 5 which need to be elaborated in a glossary as a part of the review of the Common Procedure.

4. Approaches to setting targets for descriptor 5

There is a need to develop a common understanding on relevant aproaches to setting targets for eutrophication by Member States at pan-European level, including regional seas conventions, on specific terms of the MSFD.

4.1 General considerations of target setting for descriptor 5

Annex 3 provides a tentative illustration for developing an understanding how the different levels and types of objectives, targets and indicators for eutrophication required under the MSFD and available in existing approaches in OSPAR, HELCOM and the Water Framework Directive could possibly be set in relation to each other. The results of this analysis were incorporated into the following considerations and approach.

Art. 3(7) MSFD defines environmental targets as “a qualitative or quantitative statement on the desired condition of the different components of, and pressures and impacts on, marine waters in respect of each marine region or sub-region”.

According to Art. 10 of the MSFD, environmental targets are needed to guide progress towards achieving good environmental status and shall take into account Annex III, Table 2 (lists of pressures and impacts). This suggests a need to distinguish two types of environmental targets: State targets and pressure targets. State information with regard to eutrophication forms the basis for assessing the distance to the desired state. From that, specific targets can be derived to improve the eutrophication status with the ultimate aim to achieve the status of non-problem area. These are concrete reduction targets for nutrient inputs and are pressure targets. HASEC suggests that, therefore, environmental targets are likely to relate directly to quantifiable reductions in the pressures that hinder achievement of good environmental status (*i.e*. “pressure targets”) as well as state targets.

The strategic objective with regard to eutrophication is described in the OSPAR North-East Atlantic Strategy: “To combat eutrophication in the OSPAR maritime area, with the ultimate aim to achieve and maintain a healthy marine environment where eutrophication does not occur”. This objective is supported by a North Sea Ecological Quality Objective (EcoQO) for eutrophication.

The pilot application of the North Sea EcoQO for eutrophication has been useful and countries will build on knowledge and experiences gained in future work. Based on this, the EcoQO is simplified and rephrased as follows: “The overall desired state with respect to eutrophication is to obtain non-problem area status, as assessed under the Common Procedure”.

Art. 10 (1) MSFD requires that the comprehensive set of environmental targets shall take into account the indicative list of characteristics set out in Annex IV MSFD and takes as its basis the Initial Assessment outcome. Annex IV (2) MSFD describes the need to set three types of targets:

(a) targets establishing desired conditions based on the definition of good environmental status (*e.g*. the adverse effects of eutrophication are minimised);

(b) measurable targets and associated indicators that allow for monitoring and assessment (*e.g*. nutrient concentrations do not pose a risk of adverse effects); and

(c) operational targets relating to concrete implementation measures to support their achievement (*e.g*. nutrient reduction targets, with targets set for each sector).

In the following subsections, the three different types of target described above in a-c are addressed.

4.2 Targets establishing desired conditions based on the definition of good environmental status

The target establishing GES is laid down in the qualitative description according to descriptor 5 (MSFD Annex I): “Human induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.” This describes in a qualitative way what has to be minimised in order to achieve or maintain the desired conditions based on GES with regard to eutrophication. This is compatible with work in OSPAR that has established that the desired condition that all parts of the North-East Atlantic should have non-problem status.

The Common Procedure is the assessment tool that can provide quantitative information with regard to eutrophication.

The reflection to date has been restricted to eutrophication *per se* without consideration of either inter-linkages with other aspects of the MSFD or cumulative and synergistic effects with other pressures and impacts (e.g. contaminants). There might be a need for a more integrated analysis at a later stage taking account of considerations related to other MSFD descriptors.

4.3 Measurable targets and associated indicators that allow for monitoring and assessment

‘State targets’ for descriptor 5 are understood to relate to the environmental status for eutrophication and to the objective to minimise human-induced eutrophication and its effects and to achieve non-problem area status in the North-East Atlantic Ocean.

Measurable targets and indicators according to Annex IV (2) MSFD are reflected in the set of ten agreed area-specific harmonised assessment parameters, listed in Table 1 of the Common Procedure and supplemented with associated quantitative area-specific background conditions and assessment threshold values. The assessment parameters (indicators) of the Common Procedure reflect the qualitative indicators of the MSFD, but are more quantitative in their design. Also, additional parameters can be taken into account in the assessment. All selected parameters could function as indicators and, through their integration, as a measurable target. Together they allow monitoring and assessing the state in relation to descriptor 5.

The outcome of assessments under the Common Procedure (which includes trends in nutrient inputs as pressure indicator), Water Framework Directive and the MSFD will, as a minimum, allow classification of the area assessed as a problem area (less than good status) or as a non-problem area (good status). This is predominantly in line with the established common boundary between good/moderate of the Water Framework Directive and problem/non-problem area of the Common Procedure. The Common Procedure has a defined way of combining the outcome of assessments of groups of parameters for the causes and direct and indirect effects of nutrient enrichment (Table 4.1).

Table 4.1 Examples of the integration of categorised assessment parameters (see Table 1) for an initial classification. Source: OSPAR Common Procedure

	Category I Degree of nutrient enrichment Nutrient inputs Winter DIN and DIP Winter N/P ratio	Category II Direct effects Chlorophyll *a* Phytoplankton indicator species Macrophytes	Categories III and IV Indirect effects/other possible effects Oxygen deficiency Changes/kills in zoobenthos, fish kills Organic carbon/matter Algal toxins	Initial Classification
a	+	+	+	problem area
	+	+	-	problem area
	+	-	+	problem area
b	-	+	+	problem area[1]
	-	+	-	problem area[1]
	-	-	+	problem area[1]
c	+	-	-	non-problem area[2]
	+	?	?	Potential problem area
	+	?	-	Potential problem area
	+	-	?	Potential problem area
d	-	-	-	non-problem area

(+) = Increased trends, elevated levels, shifts or changes in the respective assessment parameters in Table 1
(-) = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters in Table 1
? = Not enough data to perform an assessment or the data available is not fit for the purpose
Note: Categories I, II and/or III/IV are scored '+' in cases where one or more of its respective assessment parameters is showing an increased trend, elevated level, shift or change

[1]For example, caused by transboundary transport of (toxic) algae and/or organic matter arising from adjacent/remote areas.

[2]The increased degree of nutrient enrichment in these areas may contribute to eutrophication problems elsewhere.

4.4 Operational targets relating to concrete implementation measures to support their achievement

Operational targets can be set for a parameter that is measureable and relates to a pressure or a state.

'Pressure targets' are understood to aim to reduce, minimise or avoid pressures and their resultant impacts on the marine waters. The desired conditions should be achieved or maintained through the implementation of measures to meet the pressure target. The pressure target for descriptor 5 could be a quantifiable reduction in the input of nutrients and organic matter into the sea to minimise human induced eutrophication and achieve non problem area status. There is a close link to the environmental state and related state targets. A combination of state and pressure targets are likely to be required to achieve, and to demonstrate progress towards GES.

In this context, operational targets are understood to relate to concrete implementation measures that are aiming at the causes of eutrophication, *e.g.*:

(i) nutrient inputs (cf. OSPAR RID monitoring programme); and

(ii) different relevant sources for nutrient releases (cf. reporting under PARCOM Recommendation 88/2).

OSPAR Contracting Parties have already engaged in a process to identify the 'distance to target' in terms of nutrient reductions needed for problem areas to move to non-problem area status. These targets can act, in the terminology of the MSFD, as operational targets relating to the concrete implementation of measures to support their achievement.

Deriving such targets and following up progress made towards achieving them will need to be supported by a monitoring and data collection system which provides indicators, covering nutrient sources and the pathway of nutrients to the sea, *i.e.*:

(i) riverine and direct inputs of nitrogen and phosphorus;

(ii) atmospheric inputs of nitrogen; and

(iii) transboundary transport of nitrogen and phosphorus from adjacent and remote areas, including transitional storage in sediment.

Based on that information, as described in the following subsections, it is possible to derive the maximum allowable loads for the relevant input sources (*e.g*. 45% reduction of the input of the main rivers draining into the area) from state information of an area affected by eutrophication. The resulting need for reduction measures could be taken up by WFD river basin management plans. With regard to atmospheric nitrogen deposition and transboundary nutrient inputs other mechanisms would need to address adequate measures, such as under the relevant EU and UNECE air policies, *e.g.* the EU NEC Directive and the UNECE Convention on Long-range transport of atmospheric pollutants (LRTAP). For nitrogen emissions from shipping, IMO is the appropriate regulatory body.

Nutrient sources

Annex III Table 2 MSFD lists as pressure the inputs of fertilisers and other nitrogen- and phosphorus-rich substances and inputs of organic matter from different point and diffuse sources. Since programmes of measures to achieve GES have to address the relevant sources, a source target approach is necessary.

Information on sources of nutrient inputs and the reduction of nutrient inputs at source, as assessed and evaluated through PARCOM Recommendation 88/2, provide a good insight into the progress made to reduce nutrient releases and towards achieving non-problem area status of receiving marine waters. The relevant sources in relation to programmes of measures include:

a. agriculture
b. urban wastewater
c. households not connected to public sewerage, stormwater
d. industry
e. aquaculture
f. sources of nutrients that are deposited onto catchments and water bodies
g. forestry (only Sweden and Norway).

Quantification of nutrient sources could be achieved either by an adequate inventory of relevant sources (e.g. PRTR and similar registers including atmospheric nitrogen emissions) or source apportionment for the nutrient loads. It has to be clarified whether the OSPAR RID Programme would cover the MSFD requirement for source apportionment and for inputs of organic matter (MSFD Annex III, Table 2).

Riverine and direct inputs of nitrogen and phosphorus

Trends in riverine inputs and direct discharges (from sewage, industry and aquaculture) measured under OSPAR Comprehensive Study on Riverine Inputs and Direct Discharges (RID) provide an indicator to measure temporal change of input loads of nitrogen, phosphorus and suspended particulate matter to the OSPAR area. Together with trends in nutrient concentrations and chlorophyll concentrations in water, this could provide good indication of progress to minimise human-induced nutrient enrichment and primary eutrophication effects.

Atmospheric inputs of nitrogen

Model estimates of atmospheric deposition of nitrogen provide a means to measure pressures from the atmosphere (MSFD Annex III, Table 2). This information has to be validated by measurements at coastal stations (see OSPAR Comprehensive Atmospheric Monitoring Programme, CAMP) or on the sea. Model estimates of atmospheric nitrogen emissions including their fate in the OSPAR area help identifying relevant potential for nutrient reduction. EMEP model estimations, including validation by coastal measurements, have been used in the past by both OSPAR and HELCOM.

Transboundary transport of nitrogen and phosphorus

It has been acknowledged for a number of years that some marine areas (e.g. the sedimentation areas of the Oyster Ground in the Dutch offshore part of the North Sea, the German Bight, and the Skagerrak) are affected or likely to be affected not only by direct discharges and riverine inputs, but also by nutrient fluxes from adjacent (maritime) areas. This occurs through transboundary nutrient inputs and related effects (nutrient inputs via transport of nutrient enriched water masses from one maritime area to another).

OSPAR Contracting Parties have already engaged in OSPAR work to assess transboundary nutrient transport.[3] The further harmonisation of the assessment of transboundary inputs to specific sea areas should be strengthened in order to help quantifying, and determining the significance, of the anthropogenic and non-anthropogenic components of nutrient inputs. One way could be to divide the sea area into boxes, based on their inherent physical characteristics (temperature, salinity, flushing times) and to calculate their internal nutrient and water budgets, taking into account nutrient inputs via all significant pathways and sources and the transboundary fluxes between them. This work should include further development of scientifically accepted modelling tools directed towards spatial and temporal integration of nutrient fluxes.

Nutrient budgets for areas concerned are the basis for identification of relevant inputs of nutrients and organic matter. There are examples for simplistic approaches available from the last OSPAR integrated eutrophication assessment. Modelling can be of good assistance in this respect.

5. Appropriate scale for assessment

5.1 Characterisation of waters

The geographic scale for eutrophication assessments is dependent on hydro-morphological conditions of an area, in particular its freshwater impacts (e.g. river plumes), salinity, frontal systems, upwelling and stratification. Contracting Parties are currently reviewing their characterisation of assessment areas and there is opportunity to seek coordination of the areas at the boundaries with neighbouring countries. The hydro-morphological conditions, in particular salinity, form the basis for the choice of assessment parameters (indicators) and the setting of assessment levels (thresholds) in the OSPAR area.

Some Contracting Parties are still in the process of defining their assessment areas as part of their initial assessments. Some Contracting Parties intend to continue with the characterisation used in the last Common Procedure, others consider reviewing those areas, in particular where so far under the Common Procedure only inshore waters have been assessed. A sketch of a possible division of waters under national jurisdiction is at Annex 3; this reflects the current status of discussion and may still change.

5.2 Spatial scale of monitoring and assessment

Geographic scales are extensively discussed by the TG5 report. In line with this discussion and the risk-based approach of the MSFD Commission Decision 2010/477/EU, the OSPAR Common Procedure used a screening procedure when the Common Procedure was set up. By this one-off exercise, Contracting Parties identified in 2001 the areas which were obvious non-problem areas and those that required detailed assessment under the Comprehensive Procedure of the Common Procedure. Those areas have been further divided into smaller assessment units for the national eutrophication assessments during the first application of the Common Procedure. For the second application some Contracting Parties changed their assessment units; details can be found in their national reports.

The OSPAR Eutrophication Monitoring Programme gives more emphasis to monitoring in areas which show eutrophication problems compared with non-problem areas. For the purpose of the MSFD, monitoring effort of eutrophication parameters near land-based nutrient sources such as river inputs and direct discharges should be high. In areas far from direct nutrient sources, monitoring effort could be less, while ensuring sufficient spatial and temporal coverage to allow assessments. For remote areas with certain characteristics,

[3] Cf. draft 2009 Workshop report at HASEC 11/6/Info.1

such as sedimentation areas where nutrients and organic matter from several sources concentrate, monitoring should be comparable to that near nutrient sources.

Novel observation tools, such as buoys, ferry boxes, remote sensing and modelling, could complement ship monitoring and improve results of traditional monitoring. An important prerequisite is the adequate validation of results from novel observation tools through sufficient ground truth data.

For atmospheric nitrogen deposition from land-based sources and shipping, modelling and validation through measurements at coastal stations provides a solution.

Further consideration needs to be given by Contracting Parties to the need and scope of assessment of areas which have been classified as non-problem areas. According to the OSPAR Eutrophication Monitoring Programme, non-problem areas have to be investigated for nutrient concentrations about every three years. In addition, some countries see a need to demonstrate that their wider waters are not affected by eutrophication through screening procedures. There is a general intention by most Contracting Parties to undertake simplified assessments ('screening') in non-problem areas for the purposes of the MSFD.

5.3 Achieving expression of GES descriptor 5 at (sub)regional level

There are currently no methods in place for the aggregation of national assessment results under the Common Procedure to achieve expression of GES at (sub)regional level except maps illustrating results of national assessments in the OSPAR area or its Regions. With regard to eutrophication, the added value of aggregation at regional level is not clear in particular because EU Member States are responsible for the achievement of GES in their waters.

Given the risk-based approach which will mean limitations in monitoring and assessment effort in areas not affected by eutrophication, the usefulness to seek such an aggregation methodology is unclear.

The Quality Status Report process has shown the difficulties in achieving a regional quantification of eutrophication status and the best achievable was a description of many, some or no problems. Adequate presentation of the assessment results could support a differentiated regional description. For management purposes it seems to be sufficient to elaborate on the national assessment results and to improve harmonisation at the borders with neighbouring states.

For the time being and subject to ongoing discussion on the implementation of the MSFD, it is suggested that a qualitative description of the region might be sufficient for the purposes of the MSFD and that the GES descriptor 5 and associated actions are directed to those areas affected by eutrophication.

Annex 1

Table 2.3. Overview of MSFD criteria for descriptor 5 and relevant indicators/metrics used by WFD, HEAT and the Common Procedure

MSFD Commission Decision 2010/477/EU: Criteria		**Water Framework Directive: Indicator/metrics relevant for eutrophication**		**HELCOM HEAT: Indicator/metrics**		**OSPAR Common Procedure: Indicator/metrics Shaded are 4 of the 5 specific North Sea EcoQOs**		**Comment on Common Procedure**
Nutrient levels	5.1.1 Nutrient concentration in water	Nutrient condition		Nutrient enrichment		Nutrient enrichment	Riverine inputs and direct discharges (trend)	Qualitative assess-ment. Used by all CPs
			DIN, DIP, TN and TP concentrations		Winter surface DIN, DIP, TN and TP concentrations (µmol/l)		Winter DIN and DIP concentrations (µmol/l)	Used by 9 of 11 CPs
	5.1.2 Nutrient ratios (silica, nitrogen and phosphorus), where appropriate				N:P ratio (Redfield)		N/P ratio (Redfield)	Used (partly) by 9 of 11 CPs
Direct effects of nutrient enrichment	5.2.1 Chlorophyll concentration in the water column	Phytoplankton	Phytoplankton biomass expressed as chlorophyll a concentrations	Primary symtoms	Chlorophyll *a* concentrations (expressed as µg/l and Ecological Quality Ratio – EQR)	Direct effects of nutrient enrichment	Mean, 90-percentile and maximum concentrations of chlorophyll *a* during growing season (µg/l)	Used by all CPs. Under review. In the last assessment, there was preference to use 90th percentile in combination with mean chlorophyll concentrations
	5.2.2 Water transparency related to increase in suspended algae, where relevant	Transparency	Water transparency (measured as Secchi depth)	Secondary symtoms	Water transparency (measured as Secchi depth)	Indirect effects of nutrient enrichment	*(Water transparency measured as Secchi depth – supporting parameter)*	*(Used by 3 of 11 CPs. This is part of the assessment process but not of the set of 10 harmonised parameters.)*
	5.2.3 Abundance of opportunistic macroalgae	Macroalgae and angiosperms	Composition of macroalgal communities and extent of macroalgal cover (expressed e.g. through relationship between % coverage and biomass of opportunistic species of macroalgae such as *Ulva* and *Entermorpha*	Primary symptoms		Direct effects of nutrient enrichment	Shift of macrophytes/macroalgae from long-lived species to short-lived nuisance species (e.g. *Ulva*). Measured as biomass of nuisance species, increased area coverage of nuisance species, or reduced depth distribution of macrophytes	Used by 7 of 11 CPs. Not relevant for 2 CPs. 2 CPs have limited monitoring data.
			Taxonomic composition and abundance of angiosperm (expressed e.g. through index and shifts in community status from one dominated by angiosperms to one dominated by macroalgae)					

MSFD Commission Decision 2010/477/EU: Criteria		Water Framework Directive: Indicator/metrics relevant for eutrophication		HELCOM HEAT: Indicator/metrics		OSPAR Common Procedure: Indicator/metrics Shaded are 4 of the 5 specific North Sea EcoQOs		Comment on Common Procedure
	5.2.4 Species shift in floristic composition such as diatoms to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities	Phytoplankton	Phytoplankton biomass (Chlorophyll-a concentration), composition and bloom frequency (*Phaeocystis*)		Measurement of phytoplankton in terms of: (1) primary production, (2) biomass (chlorophyll-*a* concentration or carbon biomass), (3) species composition, and (4) bloom frequency, intensity, and spatial and temporal extent		Increased bloom (measured in cell concentrations as cells per litre) and increased duration of bloom (measured in comparison with previous years expressed in days) of area-specific phytoplankton indicator nuisance/toxic species	Used by 9 of 11 CPs. 1 CP made a qualitative assessment, 1 CP used a phytoplankton index
							Shifts in area-specific species composition from diatoms to flagellates expressed by their ratio	
						Other effects	Incidence of DSP/PSP mussel infection events	Used by 7 of 11 CPs. 2 CPs have limitations in monitoring
Indirect effects of nutrient enrichment	5.3.1 Abundance of perennial seaweeds and seagrasses (e.g. fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency	Macroalgae and angiosperms	See macroalgae and angiosperms		Depth distribution of bladderwrack (*Fucus vesiculosus*) as the main indicator, supported by distribution characteristics of eelgrass (*Zostera marina*), and by proportion of opportunistic species in the SAV community as the two supporting indicators	Direct effects of nutrient enrichment	Shift of macrophytes/macroalgae from long-lived species to short-lived nuisance species (e.g. *Ulva*). Measured as biomass of nuisance species, increased area coverage of nuisance species, or reduced depth distribution of macrophytes	See 5.2.3
	5.3.2 Dissolved oxygen, *i.e*. changes due to increased organic matter decomposition and size of the area concerned	Oxygenation conditions	Dissolved oxygen (expressed as concentration and saturation)	Secondary symptoms	Area and length of seasonal oxygen depletion (measured as mg/l and % saturation of dissolved oxygen)	Indirect effects of nutrient enrichment	Oxygen deficiency expressed as deficient oxygen concentrations (measured as mg/l) Oxygen saturation expressed as lower % saturation of dissolved oxygen	Used by all CPs

Annex 2

Table 2.4 Overview of national practice in monitoring and assessing certain non-harmonised parameters in eutrophication assessments

Contracting Party	TN, TP – marine concentrations MSFD Annex III, Table 1	Organic matter TOC: MSFD Annex III, Table 1	Zooplankton	Primary production
Belgium				
Denmark (numbers of stations only for the OSPAR part of the Danish marine areas)	Assessed in all areas. Used for e.g. budgets and cause-effect relationships	Not included in the monitoring programme	1 station in Kattegat and 3 stations in fjords. Data used for ecological modeling.	2 stations in Kattegat 3 stations in fjords 1 station in the Wadden Sea area. Data used for ecological modeling.
France	Not used	Not used	Not used	Not used
Germany	Assessed in all areas, used for budgets, river time series, µM, kt/y	Assessed in all areas in spite of insufficient sampling, integrating eutrophication parameter, µM	Not used up to now, helpful for explaining non-linear response of phytoplankton	Not used up to now, improving confidence of phytoplankton data
Ireland	Only used in river time series. Will consider using in future monitoring of estuaries and coastal waters.	Biochemical Oxygen Demand (BOD) measured in both estuaries and coastal waters and used for assessment purposes as WFD Environmental Quality Standard (EQS). Will consider adding TOC in future if feasible.	Not used, but would consider using, if indicator species were available. Also likely to be needed for MSFD descriptor 4 on food webs.	Not used, apart from specific research programmes.
Netherlands	Used in Dutch North Sea waters and estuaries, Wadden Sea; however, added value in comparison with additional monitoring tools should be examined	TOC and POC are used in Dutch North Sea waters, estuaries and Wadden Sea; especially relevant for sedimentation, silty areas	Used in Dutch North sea waters, but not yet examined for indicator species in relation to eutrophication or other pressures, such as climate change, fisheries, and food web (MSFD GES 4). We would like to make use of CPR data of UK if possible	Not used, and not useful for in depth assessment of eutrophication status; But it could be useful for other GES descriptors of the MSFD (GES 4), and for modelling purposes
Norway	Used in Skagerrak*	Used in Skagerrak. Important for understanding run-off from land (climatic change)*	Not used**	Macroalgae monitoring used in Skagerrak*
Portugal				
Spain	It is being used when assessing eutrophication in Mediterranean waters. Some data are available for Atlantic waters from WFD assessments.	It is not being used, although it is foreseen in the future.	Systematic measurements of taxonomy and biomass are included in our programme for the Mediterranean Sea. For the Atlantic Waters only punctual data are available.	Only punctual data are available, in any case useless for initial assessments. Its usefulness for descriptor 5 purposes should be well stated before proposing it as eutrophication parameter.

Contracting Party	TN, TP – marine concentrations MSFD Annex III, Table 1	Organic matter TOC: MSFD Annex III, Table 1	Zooplankton	Primary production
Sweden	Used in Kattegat	Not used. POC found difficult to handle	Used. Monitoring stations (2 in Skagerrak, 1 in Kattegat) for fisheries purpose	Used. Regularly monitored in fjords, coordinated project in Kattegat with DK
UK	Not used in the eutrophication monitoring programme. Measurements made for specific research programmes.	Not used in the eutrophication monitoring programme. Measurements made for specific research programmes.	Not currently used in the monitoring programme. Data available from the CPR. [CPR information on phytoplankton used as supporting information in assessment; developments underway.]	Not currently used in the monitoring programme. Value of this parameter for eutrophication monitoring is under investigation. Methods based on remote sensing of relevant waters

** Sugar kelp monitoring program (inner coastal areas)*
*** The Coastal Monitoring Programme (KYO) which was carried out 1990-2010.*

Annex 3

	MSFD 2008/56/EU	OSPAR Commission	Helsinki Commission	WFD 2000/60/EC
Vision	Good Environmental Status Providing diverse and dynamic, clean, healthy and productive oceans and seas	A clean, healthy, and biologically diverse North-East Atlantic, used sustainably	A healthy Baltic Sea environment, with diverse biological components functioning in balance, resulting in a good environmental/ ecological status and supporting a wide range of sustainable human economic and social activities	Good surface water status
Eutrophication objective	Human induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters	To combat eutrophication in the OSPAR maritime area, with the ultimate aim to achieve and maintain a healthy marine environment where eutrophication does not occur	A Baltic Sea unaffected by eutrophication	Good ecological status*
Operational objective		(i) To minimise eutrophication (ii) To ultimately achieve non-problem area status as assessed by the Common Procedure		
Characteristics / status assessment	GES criteria and associated indicators (Art. 9)	Common Procedure area specific assessment framework, including harmonised assessment criteria (indicators) with assessment levels (thresholds) for the assessment of the eutrophication status (problem area/non-problem area)	HEAT assessment tool, including the core set of indicators with assessment levels (thresholds) for the assessment of eutrophication status (high, good, moderate, poor, bad)	Quality elements (phytoplankton, macrophytes/ angiosperms, benthic invertebrate fauna, nutrient concentrations, temperature, oxygen balance, transparency). Assessment of ecological status (high, good, moderate, poor, bad)
Environmental targets and indicators	Environmental targets and indicators (Art. 10 and § (2) of Annex IV) (1) Targets establishing desired conditions based on the definition of good environmental status *Example descriptor 5 criteria 5.1-5.3:* • *Nutrient concentrations in relation to descriptor 5* • *Chlorophyll concentrations in relation to descriptor 5* • *etc.* (2) Measurable targets and associated indicators that allow for monitoring and assessment *Example descriptor 5 criteria 5.1-5.3:* • *DIN/DIP concentrations below threshold* • *Chlorophyll concentrations below threshold* • *etc.* (3) operational targets relating to concrete implementation of measures to support their achievement *Example: nutrient reduction target in relation to descriptor 5*	*Common Procedure containing 10 area specific cause-effect related harmonised assessment parameters with their area specific assessment levels* Nutrient reductions targets for individual problem areas to move to non-problem area status (under development)	Ecological objectives ▪ Concentrations of nutrients close to natural levels ▪ Natural level of algal blooms ▪ Clear water ▪ Natural distribution and occurrence of plants and animals ▪ Natural oxygen levels Parameter/metrics level ▪ DIN, DIP, TN and TP concentrations / thresholds ▪ Chlorophyll concentration / thresholds ▪ Water transparency (Secchi depth) ▪ Depth range of submerged aquatic vegetation/threshold ▪ Abundance and structure of benthic invertebrate communities / threshold ▪ Area and length of seasonal oxygen depletion/thresholds Nutrient reduction targets per Contracting Party laid down in the Baltic Sea Action Plan 2007 (under revision/update)	Quality objectives (High status) – Annex V WFD *Example:* • *Nutrient conditions remain within the range normally associated with undisturbed conditions* • *The level of macroalgal cover and angiosperm abundance are consistent with undisturbed conditions* Parameter/metrics level (see EU Guidance document 23, recommending parameters and their thresholds for monitoring and assessing the quality objectives) *Examples:* • *DIN, DIP, TN, TP below threshold* • *Depth range of macroalgae/ angiosperm below threshold* EU Member State's programmes of measure (Art. 4 WFD)
Pressure indicators	Monitoring of progress towards GES Annex III, Table 2: • Inputs of fertilisers, nitrogen and phosphorus-rich substances • Inputs of organic matter	*Example:* • *Trends in waterborne inputs of nutrients and organic matter* • *Trends in air borne inputs of N*	*Example:* • *Trends in waterborne inputs of nutrients and organic matter* • *Trends in air borne inputs of N*	

* The scope of 'good ecological status' is broader than eutrophication as it takes account of other pressures than nutrient enrichment.

Figure 4.1 Possible starting point for a tentative example how objectives, targets and indicators of MSFD and existing frameworks could be linked

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OSPAR's vision is of a clean, healthy and biologically diverse North-East Atlantic used sustainably

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