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Institute for Environment and Sustainability
Water Resources Unit

Review of the Commission Decision 2010/477/EU concerning MSFD criteria for assessing good environmental status

Descriptor 5

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

This report represents the result of the scientific and technical review of Commission Decision 2010/477/EU in relation to Descriptor 5. The review has been carried out by the EC JRC together with experts nominated by EU Member States, and has considered contributions from the GES Working Group in accordance with the roadmap set out in the MSFD implementation strategy (agreed on at the 11th CIS MSCG meeting).

The report is one of a series of reports (review manuals) including Descriptor 1, 2, 5, 7, 8, 9, 10 that conclude phase 1 of the review process and, as agreed within the MSFD Common Implementation Strategy, are the basis for review phase 2, towards an eventual revision of the Commission Decision 2010/477/EU.

The report presents the state of the technical discussions as of 30 April 2015 (document version 6.0), as some discussions are on-going, it does not contain agreed conclusions on all issues.

The views expressed in the document do not necessarily represent the views of the European Commission.

Foreword

The MSFD Committee (Art. 25 of the MSFD) discussed and concluded an approach and an outline for the process of a review and possible revision of Commission Decision 2010/477/EU on GES criteria and of MSFD Annex III (see Committee/07/2013/03rev for details). Based on the template in the annex to the mandate of the MSFD Committee, a more detailed manual for the technical phase relating to the review of Commission Decision 2010/477/EC has been developed to guide the parallel preparatory process and discussions per descriptor. The review will aim to define GES criteria more precisely, including setting quantifiable boundaries for the GES criteria where possible and specifications and standardised methods for GES assessment in particular as regards temporal and spatial aggregation. The review of Annex III will be carried out as a parallel process. The review of the Common Understanding Document is also taking place alongside these two processes. Close coordination between these three processes should be ensured.

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1. Approach

1.1 General guiding principles for the review

The review aims to analyse the results from the first MSFD reporting round on Articles 8, 9, and 10 with a view to update/improve and simplify the implementation of the Com Decision 2010/477/EU.

Based on the Information in the Art 12 assessment reports (COM(2014)97 final) and the JRC in-depth assessments (Palialexis et al., 2014) a template has been pre-filled by Milieu Ltd for the DG ENV, commented by DG ENV and completed by JRC which should enable the experts group to analyse current shortcomings, propose ways forward, such as e.g. needs for further guidance and development, but eventually also to develop proposals for amending the Decision 2010/477/EU, based on new scientific knowledge and experience in the implementation process.

The current review should lead to a new GES Decision which is:

- Simpler
- Clearer
- Introducing minimum requirements (to be enhanced by regions and MS, if necessary)
- Self-explanatory
- Coherent with other EU legislation
- Coherent with regional assessment methods (where EU does not exist)
- Have a clear and minimum list of criteria and methodological standards and related characteristics (Table 1, Annex III)

- Ensure that criteria and methodological standards are adequately addressing the Descriptors are covered by the proposed criteria, to lead to complete assessments
- Coherent with the MSFD terminology

This review should lead to a more coherent approach to the definition of GES based on agreed criteria and methodological standards that allow for determining the distance of the current state from GES. Figure 1 shows an example on the link between MSFD terminology and existing practical approach taken from EU and RSCs legislations. This figure aims to streamline the discussion to be carried out through the review process.

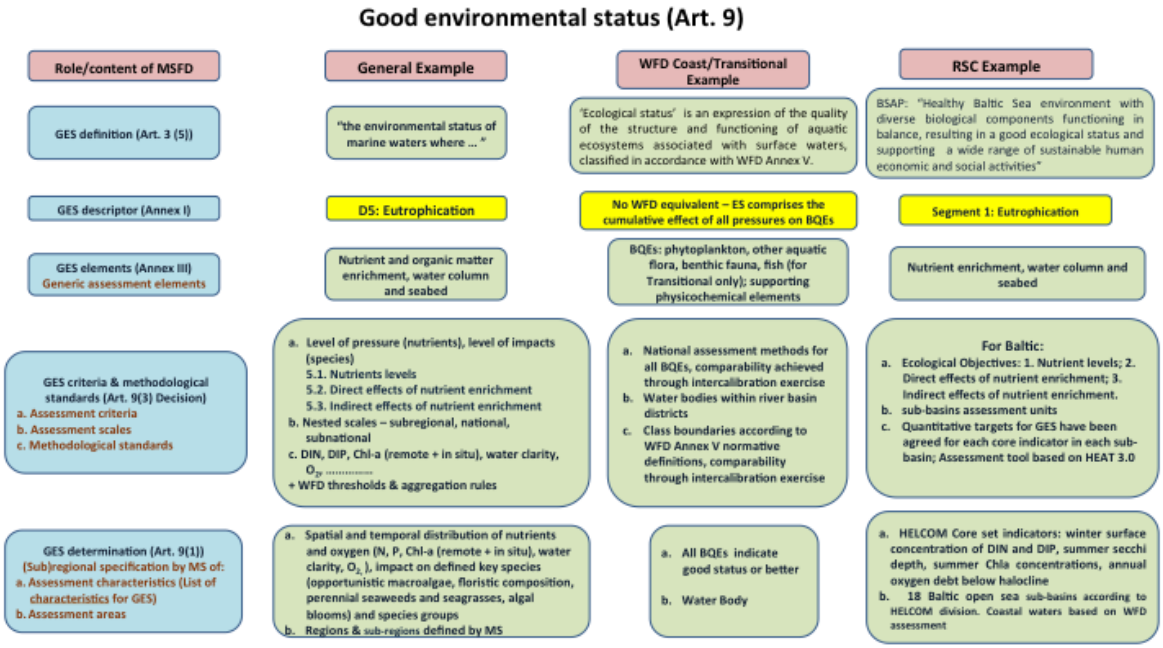

Figure 1. Interpretation of Art. 9 of the MSFD for Descriptor 5[1].

The following points are summarising the role of GES in MSFD. According to the Directive, GES is:

- starting and end point of MSFD
- reference point for the other MSFD provisions
- determined at the level of marine (sub)regions
- specified by common criteria and methodological standards
- legally time bound (2020) and subject to legally defined exceptions where this is not feasible

GES should be supported by quantified/ quantifiable indicators to allow determining the distance of the current state from GES and for defining targets to guide progress towards GES. Furthermore, the review should strengthen and clarify the link across the Articles 8, 9 and 10.

[1] Modified from DG ENV's presentation in June's 2014 DG GES group: https://circabc.europa.eu/w/browse/f3953f48-f965-43d4-93a5-075f82cc1f12

1.2 Overall reflection of the type of descriptor and descriptor criteria (e.g. state/pressure, quantitative/qualitative) and its relationship with Article 3(5).

The main cause of human-induced (anthropogenic) eutrophication is nutrient enrichment. This can have a severe negative effect on marine ecosystems and is, therefore, a key threat to achieving GES in some parts of EU marine waters. The main nutrients concerned are nitrogen (N) and phosphorus (P) compounds which are naturally present in our seas, but additional and excessive inputs of N and P come from diffuse and point sources, such as agriculture and waste water and, to some extent, caused by ammonia and NOx emissions, mainly from agriculture, aquaculture but also from ship and road traffic and industry via precipitation.

Eutrophication[2] (JRC 2010, Ferreira et al. 2011) is defined as: a process driven by the enrichment of water by nutrients especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of organisms in pelagic as well as in benthic habitats; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services. The assessment of eutrophication starts with a description of the levels of nutrients present in the marine environment (assessment of pressure), and then by addressing nutrients direct and indirect effects on the marine environment.

GES with regard to eutrophication has been achieved when the biological communities remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive algal blooms, low dissolved oxygen, declines in seagrasses, kills of benthic organisms and/or fish) and where there are no nutrient-related impacts on sustainable use of ecosystem goods and services (JRC 2010).

The Commission Decision thus identified three criteria for Descriptor 5: (5.1) nutrient levels, (5.2) direct effects of nutrient enrichment and (5.3) indirect effects of nutrient enrichment. Descriptor 5 is considered a pressure-based descriptor, scientifically and operationally mature compared to other MSFD Descriptors and attributed with quantitative means. The scientific and applied background for D5 gained through the long standing work of RSCs and the Water Framework Directive assessment of ecological status are well developed (relative to other descriptors), something that was partially reflected in the first phase of the MSFD implementation.

1.3 Linkages with existing relevant EU legal requirements, standards and limit values, such as the WFD, and the identification of potential incoherence.

A number of rules already exist at EU level that supports MS in the control of marine eutrophication. The MSFD explicitly mentions several legislative tools and among them, the most closely related to eutrophication are the Water Framework Directive (WFD, 2000/60/EEC), the Nitrates Directive (ND, 91/676/EEC), and the Urban Waste Water Treatment Directive (UWWTD, 91/271/EEC) (see also Table 7 of the TG 5 report[3]).

[2] MSFD Task Group 5 Report on Eutrophication. Joint Research Centre (2010) See http://ec.europa.eu/environment/marine/pdf/5-Task-Group-5.pdf

WFD is not considering explicitly 'eutrophication'. However, WFD provides the definitions for high, good and moderate ecological status of biological quality elements (e.g. phytoplankton, macroalgae, angiosperms) using physico-chemical indicators as supporting quality elements (e.g. nutrient concentrations, oxygenation conditions and transparency). These quality elements are used for the assessment of eutrophication. In accordance with Commission Decision 2010/477/EC, the assessment of eutrophication in marine waters needs to take into account the assessment for coastal and transitional waters under the WFD and related guidance[3], in a way which ensures consistency. The main issues addressed in the guidance document are i) a unified conceptual framework to understand eutrophication in all water categories, ii) a conceptual read across EU directives (mainly Water Framework, Urban Wastewater and Nitrates Directives) and international policies (e.g. OSPAR and HELCOM) addressing eutrophication and iii) an in-depth understanding of eutrophication in the context of WFD ecological status assessment. The guidance also includes an overview of current assessment methods and recommendations for harmonisation of classification criteria. Note that no specific nutrient threshold levels (boundaries) are specified in the WFD. MSs have to establish their own nutrient boundaries. However, the WFD CIS ECOSTAT- Nutrient steering group has started to work on better harmonization of these nutrient boundaries, including in transitional and coastal waters. WFD Ecological Status is limited in coastal waters to 1 nautical mile, representing a spatial overlap with the MSFD. As such, MSFD methodological standards and parameters, thresholds and reference points could differ for the offshore areas.

The Nitrate Directive includes eutrophication as one of the criteria to identify waters affected by pollution or at risk of pollution. The other criteria for the identification of those waters are nitrate concentration (50 mg/l) in groundwater and surface water. The Directive requires the establishment of mandatory measures at least in those areas (nitrate vulnerable zones) which drain into polluted waters or waters at risk of pollution.

The Urban Waste Water Directive (UWWTD) aims to protect the environment from the adverse effects of urban waste water and certain industrial discharges. UWWTD defines eutrophication and requires "more stringent treatment" for waste water discharges to eutrophic waters or waters that may become eutrophic in the near future.

The lack of a common definition of eutrophication across all Directives makes difficult the harmonization of its assessment. Although the Directives, specifically WFD and MSFD, have different assessment methodology (e.g. biological quality elements and supporting indicators for WFD) and classification schemes (WFD 5 classes *vs* MSFD 2 classes), they are generally consistent in identifying eutrophication problems and mitigating them. The Commission Decision should set the basis for better compatibility between both Directives.

1.4 Linkages with international and RSCs norms, standards and indicators.

Regional Sea Conventions (RSCs) have implemented their own methodological approaches for eutrophication assessment (HELCOM HEAT, OSPAR COMMON PROCEDURE, TRIX for UNEP/MAP,

[3] Guidance Document on the Eutrophication Assessment in the Context of European Water Policies, Document No 23. European Commission (2009). See http://circa.europa.eu/Public/irc/env/wfd/library

BEAST[4] for Black Sea Convention). Generally, all methods include chlorophyll-a (Chl-a) and nutrient measurements but differ in the way indicators are combined (JRC 2014a).

In the OSPAR region, eutrophication status is assessed by using the OSPAR Common Procedure (COMP, OSPAR 2013) which comprises two steps: a Screening Procedure to identify areas that are obvious non-problem status for eutrophication, and a Comprehensive Procedure applied in those areas not identified as non-problem areas. The initial screening procedure is risk-based and requires consideration of relatively few parameters related to hydrodynamic characteristics and proximity to nutrient sources. If the initial screening or successive Comprehensive procedure assessments show the waters not to be impacted by eutrophication, a more robust assessment of its trophic status is not required. In the Comprehensive Procedure, variables/indicators to be monitored are grouped into four categories: 1) the degree of nutrient enrichment (riverine inputs/direct river discharges, nutrient concentrations, N:P ratio); 2) direct effects of nutrient enrichment (water column chlorophyll-a, phytoplankton, macrophytes); 3) indirect effects of nutrient enrichment (oxygen deficiency, zoobenthos and fish, organic carbon); and 4) other possible effects (e.g. algal toxins although this is recognised as not strongly linked to eutrophication). Each of these parameters may be considered area-specific or season-specific. The assessment parameters are integrated along a cause/effect scheme including all categories for a classification as 'problem areas', 'potential problem areas', and 'non-problem areas'. The integration is followed by an overall assessment of all relevant information related to harmonised assessment criteria, their corresponding assessment levels and supporting environmental factors to reach the final area classification.

HELCOM's thematic assessment of eutrophication 2007-2011 (HELCOM 2014) was adjusted to the MSFD and Commission Decision 477/2010/EU. The assessment of the open sea sub-basins is based on the integration of commonly agreed core indicators, grouped into three criteria: nutrient levels (indicators: inorganic nitrogen and phosphorus concentration), direct effects (indicators: chlorophyll-a and Secchi depth), and indirect effects (indicator: deep bottom oxygen debt). The assessment is done using the HEAT 3.0 assessment tool, which averaged indicators within criteria (allowing weighting), and using the one-out-all-out principle between criteria for determining final eutrophication status. Ecological status resulting from WFD is used where available to describe the state of coastal waters. HELCOM EUTRO-OPER group recently recommended extending the HEAT 3.0 assessment procedure to coastal waters to adequately cover the requirements of MSFD descriptor 5. HELCOM assesses nutrient levels (DIN and DIP) in relation to scientifically based and commonly agreed targets of good environmental status for eutrophication for specific Baltic areas: Maximum Allowable Inputs (MAI) and Country Allocated reduction Targets (CART) of the Baltic Sea Action Plan (HELCOM 2013)[5].

The Barcelona Convention: MEDPOL's eutrophication monitoring strategy consists of identifying sites that are eutrophic or sensitive to eutrophication (together with reference sites) and the development of biological parameters/indicators of eutrophication to support the existing monitoring strategy. The list of mandatory monitoring parameters includes nutrients, transparency, chlorophyll, dissolved oxygen and phytoplankton (total abundance, abundance of major groups, bloom dominance) parameters. Other parameters such as macrophytes, organic matter in sediment and zooplankton are recommended. Recently (UNEP/MAP 2012) the Contracting Parties to the Barcelona Convention have adopted the ecosystem approach to the management of human

[4] BEAST is based on HELCOM assessment tool HEAT and expected to be useful in providing harmonized assessments of the eutrophication status in the entire Black Sea.

[5] http://www.helcom.fi/Documents/Ministerial2013/Associated%20documents/Supporting/Summary%20report%20on%20MAI-CART.pdf

activities that may affect the Mediterranean marine and coastal environment. Its implementation is based on a 6-years management cycle, relying on common strategic goals and the development of Ecological Objectives aligned with MSFD descriptors. Accordingly, Ecological Objective 5 (EO 5) is defined as: "*Human induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms, and oxygen deficiency in bottom waters* ". EO 5 is associated with 3 operational objectives (nutrients, direct and indirect effects) and 6 indicators similar to MSFD.

The Black Sea Convention has developed the Black Sea Integrated Monitoring and Assessment Programme (BSIMAP), within which each country is obliged to carry out ecological monitoring on marine stations, with particular emphasis given to eutrophication. BSIMAP has been developed according to BSAP (Black Sea Strategic Action Plan) and its EcoQO 3: Reduce eutrophication. The list of mandatory parameters from BSIMAP includes nutrients, transparency, dissolved oxygen, chlorophyll-a, phytoplankton and macrophytobentos. Note that the Black Sea Convention has recently developed its own assessment tool (BEAST) using similar methodological approach than HELCOM's HEAT 3.0.

Coordinated activities such as the EU Baltic2Black project are examples of good practices towards harmonized assessment of the eutrophication status in European seas.

1.5 Clarification of the relevant scientific, technical and policy terminology in relation to the descriptor.

In addition to the definition of eutrophication (section 1.2), the Task Group report on the Descriptor 5 (JRC 2010) provides a set of scientifically agreed terms and processes (e.g. the definition of eutrophication and GES definition in, respectively, Table 6 and 8 of the report) in relation to eutrophication and provides a guidance for the interpretation and application of Descriptor 5.

A glossary of terms commonly used in the Marine Strategy Framework Directive, including terms related to D5, has been presented and published in the frame of the HARMONY project (2010-2011; Andersen et al. 2013). The glossary is based upon existing definitions from the Directive and takes into account terms related to qualitative descriptors, characteristics, and pressures and impacts, as well as generic terms associated with the implementation of the Directive.

The revision of the Common Understanding document is taken forward through the drafting group GES (WG GES 12/2014)[6]. The revision includes a new section on 'Basic understandings', which aims at a common interpretation of MSFD concepts and terminology. Annex 1 of the document is an expanded glossary of MSFD terms.

[6] https://circabc.europa.eu/d/a/workspace/SpacesStore/d0c8db99-676b-4e79-937f-4bee634e8daf/GES_12_2014_06_Common_Understanding_final.doc

1.6 Descriptor specificities should be highlighted and justified (e.g. if it is recommended to combine several descriptors together).

Eutrophication is a well-defined pressure-based descriptor with clear causative factors and focuses on the determination of the cause-effect relationship between anthropogenic nutrient inputs and ecosystem functioning. D5 should be assessed in isolation, as eutrophication represents a main threat in some of the European regional seas, e.g. the Baltic Sea. As assessment parameters move further away from direct measurements of nutrient loads and concentrations (i.e. biological parameters), however, interactions with other descriptors become significant.

D5 is strongly linked with D1, as a pressure on biodiversity; with D6, as eutrophication effects are seen at the sea floor; and with D3 and D4 as eutrophication also affects fish and shellfish populations. Impacts from D5 should be taken into account in assessing status under these descriptors (i.e. cumulative impact assessment). Due to the strong links between the descriptors, and due to pragmatic considerations of having only a limited number of operational indicators available, it would be wise to allow the use of single indicators in several linked descriptors (such as bottom oxygen in D5 and D6, or macrophytes in D5 and D1), and when doing so, the possibility of double counting should be eliminated when making the initial assessment.

1.7 An analysis of whether the criteria and/or indicators and/or methodological standards for the particular descriptor are likely to be common across the EU or need aspects to be specific at region or other scales.

In general, the evaluation of the first phase of the MSFD implementation showed that criteria, and to some extent indicators and methodological standards, were commonly used across the EU. There is a differentiation in the assessment methods developed and applied by the RSCs (see Table 1 in Chapter 3, p.61 in Palialexis et al., 2014), which reflects certain particularities on regional level in line with an ecosystem-based approach, but also different levels of ambition to achieve GES. Even if the existing criteria could commonly be applied across EU, the methodological standards might have operational limitation depending on the regions' specificities, e.g. the same nutrient level resulting in different effects depending on the regional hydromorphology and tolerance of the ecosystems in place.

1.8 The "climate sensitivity" per descriptor (or per criterion).

Eutrophication is mainly caused by anthropogenic nutrient inputs. However, tolerance of the ecosystems to nutrient pollution can also be modified by climate change. With global warming, the maximum oxygen concentrations in warmer water would be lower than for colder waters, thus increasing the likelihood of oxygen depletion. Similarly, the intensification of the thermal stratification would favour oxygen depletion at depth (Rabalais et al. 2009). Climate change can affect the annual water flow of rivers potentially increasing or otherwise altering nutrient inflow into marine waters. Both changes in water temperature and salinity as a result of climate change will

affect the overall species composition in the pelagic and benthic environment, interacting thus with the eutrophication process. There is evidence that degraded water quality from increased nutrient inputs promotes the development and persistence of specific blooms, including harmful algal blooms (Heisler et al. 2008). However, under certain environmental conditions, higher water temperature could also favour the development of cyanobacteria and other planktonic algae, increasing the likelihood of toxic/anomalous blooms in offshore areas.

Climate sensitivity issues in the Baltic include changes in CDOM (Colored Dissolved Organic Matter) loads from land, which affect water transparency but also the relative importance of the pelagic and bacterial food webs. The major driver is the timing and frequency of large inflows, which affects the deep-water oxygen concentration and the availability of phosphorus for upwelling from the deep anoxic pool.

More research is needed on how climate change can affect eutrophication, particularly at the level of the different criteria/indicators.

1.9 An indication of whether a quantitative GES definition for the descriptor will be possible or whether a qualitative/normative definition only should be used (on the basis of Article 3(5)).

According to CIS-WFD Guidance document on eutrophication assessment (§ 279), *" it is a challenge to find quantitative expressions for the response in abundance and taxonomic composition for the different biological quality elements along the nutrient gradient"*. In addition, we can expect increasing difficulties when establishing concrete quantitative targets as going from criteria 5.1 (nutrients) to 5.3 (indirect effects), with difficulties to differentiate between natural variations and human impact on the associated criteria elements. For D5, it is thus appropriate to keep a normative definition of GES at the descriptor level.

2. Analysis of the implementation process

2.1 Based on the Commission/Milieu Article 12 reports and the JRC in-depth assessments, a detailed summary of the findings of Article 12 relating to the determination of GES and specifically the use of the Decision criteria and indicators should be made.

Findings per criterion and indicators for Descriptor 5

All Member States defined GES for Descriptor 5 and most covered all three criteria of Commission Decision 2010/477/EU in their GES definition in a clear way. Only one Member State made no reference to these criteria. However, with the exception of one MS, none of the definitions could be

considered adequate. The main deficiencies relate to incomplete coverage of indicators, a lack of specificity and threshold or reference values, a lack of clarity on links with the WFD, including a lack of clarity on the relationship between Good Ecological Status (GEcS) under the WFD and GES under the MSFD (Palialexis et al., 2014).

Criterion 5.1 Nutrient levels

The majority of Member States covered nutrient concentrations while nutrient ratios were one of the indicators most often excluded. The nutrient measurements used most frequently by Member State were dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorous (DIP).

Criterion 5.2 Direct effects of nutrient enrichment

All Member States included an indicator based on chlorophyll a (Chl-a) levels in the water column and the majority of the Member States also covered water transparency. A few excluded water transparency from their GES definitions due to the low proportion of variability in water (coastal, at least) that can be attributed to changes in chlorophyll levels. In the HELCOM area the indicators based on the abundance of opportunistic macroalgae, shifts in floristic composition, effects on macrophytes, are mostly covered. In the North East Atlantic (NEA), Member States referred to OSPAR's phytoplankton indicator species rather than benthic-pelagic shifts. A limited number of NEA countries also use a bottom invertebrate index in addition to or as an alternative to dissolved oxygen status. No standard approaches to cover indicators 5.2.3 and 5.2.4 were found in the Mediterranean although all Mediterranean Member States covered all three criteria of the Commission Decision, some only used pelagic indicators. In the Black Sea, both Member States covered all criteria but only one covered benthic indicators.

Criterion 5.3 Indirect effects of nutrient enrichment

Most of the MSs provided GES determinations for criterion 5.3. Dissolved Oxygen was the most common indicator reported under this criterion. This could contribute to a EU-wide list of potential methods for eutrophication assessment.

Regional coherence and coherence with EU pieces of legislations for descriptor 5

More than one third of the MS did not mention the WFD in each of the MSFD Articles (8, 9 and 10). Considerably fewer references have been made on Nitrate Directive and Urban Waste Water Treatment Directive. The type of reference varies across MS, from a detailed definition (e.g. reduction of 75% of nitrogen and phosphorus loads) to a more general reference. A direct link between the two Directives and MSFD Articles 8, 9 & 10 was not observed. Globally, 10% of the MS considered the Nitrate Directive and 25% the Urban Waste Water Treatment Directive.

References to assessment methods under Regional Sea Conventions were made by most Member States either in their GES definition or in the accompanying text (Palialexis et al., 2014). The relatively good level of regional coherence can be explained by the fact that a majority of Member States based their approaches on established methodologies developed by the Regional Sea Conventions. However the RSCs have different indicators, assessment methods, and threshold values and so are not fully compatible. For the Baltic Sea region, reference was made to the HELCOM

eutrophication assessment tool (HEAT) by all Baltic Member States except of two. For the North East Atlantic region, nearly all Member States made reference to the OSPAR Comprehensive Procedure. Certain Member States have defined GES in terms of achieving OSPAR's 'eutrophication non-problem' status and most countries appear to have adopted the OSPAR nutrient baseline/threshold levels, at least for offshore waters (OSPAR sets limits for winter DIN and/or DIP, which should not exceed 50% from background levels). For the Mediterranean region, only one Member State mentioned explicitly the MEDPOL approach, while the OSPAR approach appears to have been followed by two Member States. Romania and Bulgaria did not refer to the Black Sea Convention, since the Convention had not developed a regional assessment approach for eutrophication at that time (SWD 2014/49[7]).

Only seven Member States incorporated quantitative thresholds into their definition of GES and therefore in the majority of cases it is impossible to know whether GES is actually achieved. Overall, the level of coherence for Descriptor 5 was relatively high in the Baltic and North East Atlantic regions and moderate in the Black Sea and Mediterranean regions, although differences at sub-region level were noted (SWD 2014/49).

Findings on methodological standards

As shown on Table 1, there is a great variation in the number of methods reported per indicator. A total of 16 methodological approaches have been reported for the indicator 5.1.1, while only two for 5.2.2. The nutrient concentration (5.1.1) and Chl-a concentration (5.2.1) in the water column have been reported by all MS. The lowest proportion of MS references concern the indicator of abundance of opportunistic macroalgae (5.2.3) and nutrient ratios (5.1.2). Table 1 is a good indication for the criteria and indicators that require more research, or data or those that are not frequently used by the MS and could be eliminated to increase the coherence in the implementation process. The consistency in reported methods across articles 8, 9 and 10 is limited to the most well studied and widely applied methodologies.

Table 1. *Number of reported methods and percentage of MS reported per indicator and criteria. The last column shows the most frequent reported method per indicator (table from Palialexis et al., 2014).*

Criteria	Indicator	No. Methods Reported	Percentage of MS reporting indicator	Most frequent
5.1	5.1.1	16	100	DIP & DIN
	5.1.2	2	50	N:P_ratio
5.2	5.2.1	3	100	Chlorophyll-a
	5.2.2	2	70	Water transparency
	5.2.3	3	40	Opportunistic macroalgae
	5.2.4	11	70	Pelagic shifts
5.3	5.3.1	6	75	Perennial seaweeds
	5.3.2	8	80	Dissolved Oxygen

[7] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014SC0049

At least one indicator per criterion with an EU-wide range of functionality was reported such as nutrient concentration (indicator 5.1.1), Chl-a (indicator 5.2.1), water transparency (indicator 5.2.2) and dissolved oxygen (indicator 5.3.2). This could be the basis for a common EU-wide assessment framework (i.e. core set of indicators), possibly adjusted to account for regional specificities. This framework would improve the coherence and comparability of MS' assessment. For eutrophication, indicators, such as Chl-*a*, water transparency and nutrients concentration (particularly DIN & DIP) presented high frequency of use (Palialexis et al., 2014).

2.2 Identification of any questions/issues arising from the application of the current Decision, including those identified by the Article 12 assessment.

Q1: Heterogeneity of methodological approaches, thresholds and limits
Possible Answer: Common agreed and comparable methodological standards on a EU-wide level, but it should not be so strict that it prevents adaptive management and flexibility to regional and sub-regional conditions.

Q2: Different indicators reported per criterion
Possible Answer: Core set of indicators commonly used across RSCs to ensure the minimum level of coherence, even if thresholds may need to reflect regional specificities.

Q3: Spatial inconsistency within and between MS regarding coastal-offshore distinction or number of subregions reported.
Possible Answer: Assessment of both coastal and open-sea water with clear boundaries and thresholds. Coastal waters are assessed using WFD water bodies (using thresholds for biological quality elements and supporting elements). Several options can then be considered regarding the assessment of D5 in coastal waters (i.e. WFD waters overlapping with MSFD), according to whether WFD assessment of ecological status is or is not recognized as a full assessment of D5 (see section 5.3). Synergies in the definition of scales and assessment period between both Directives would facilitate common monitoring programmes.

Q4: Need to screen standards at EU level or national level.
Possible Answer: For example, the standard NF EN 15972 deals with temporal frequency to monitor phytoplankton (recommendation for a monthly or bimonthly sampling strategy at the minimum and a higher frequency during periods of main blooms)

Q5: How to deal with local variations and local hydrodynamic effects in the proposed methodological standards.
Possible Answer: A Pan European framework to assess eutrophication is possible at least using a common core set of parameters / indicators as minimum requirement, with potential adjustment to reflect regional and sub-regional differences in both the pressures and impacts. These differences need to be considered. RSCs have outstanding experience in dealing with eutrophication problems and identified methodological standards for their respective basin. Examples of good practices can be taken from their work.

Q6: Are the assessments of pressures and impact that derived from other EU legislations suitable for MSFD requirements for eutrophication?

Possible Answer: The assessment of ecological status under WFD (2000/60/EC) is not an assessment of eutrophication as required by MSFD D5. However, WFD was also designed to reflect the main anthropogenic impacts in the coastal zone, including biological elements of direct relevance to eutrophication. MSFD assessment can then take advantage of these elements assessed under WFD (new Directive 2014/101/EU amending Annex V of the WFD), and it is most desirable that the WFD class boundary 'good/moderate' be in agreement with the MSFD GES boundary. In other words, where assessment of ecological status in coastal waters results in less than good status due to nutrient concentrations, this should be taken into account in carrying out MSFD assessment for D5.

2.3 Relevant data from other sources, specific to every descriptor and recent findings from MS should also be considered.

- WFD assessments

- Assessments of status, pressures and impacts pursued in Regional Sea Conventions

- Data from some relevant EU or regional monitoring programs should be considered in the assessment to contrast the link between pressures and impact. In particular EMEP (atmospheric pollution) and RID (river discharges)

- ICES Database: The ICES oceanographic database holds long time series of field observations from ICES member Countries (HELCOM COMBINE, OSPAR CEMP), of particular importance to eutrophication assessment.

- MED POL Database, particularly relevant for nutrient and oxygen in the Mediterranean Sea

- EMODNET / SeaDataNet

- Specific types of data (e.g. Earth Observation from satellite) at low and moderate resolution (1-4km) are freely available for all European Seas through different geoportals such as the Copernicus marine Monitoring Service[8], and the JRC Environmental Marine Information System (EMIS)[9]. EMIS provides the users with basic navigation and data interrogation tools with a range of time-series and statistical analyses.

Under contract with DG ENV, Deltares Institute (The Netherlands) reported a study for *"Development of a shared data and information system between the EU and the Regional Seas Conventions"*. The report includes a summary of major database in the 4 RSCs and EEA that could be used to support the reporting objectives under MSFD (incl. D5 eutrophication)[10].

[8] http://marine.copernicus.eu
[9] http://emis.jrc.ec.europa.eu
[10] https://circabc.europa.eu/d/a/workspace/SpacesStore/aff9880d-df5e-44ec-854e-8f098fcff2e5/DIKE_10-2014-05b_RSCDataReporting_Report.pdf

2.4 Good examples and approaches applied by MS, especially if used by multiple Member States, and shortcomings should be listed systematically.

- Good example: very specific reference about using WFD thresholds for good/moderate status to define MSFD GES in those coastal water bodies currently achieving High Ecological Status under the WFD.
  Shortcoming: only in one MS report in the 2012 MSFD reporting

- Good example: report stating in the GES definition that for MSFD GES to be achieved, the WFD coastal water bodies must be at least of 'good quality' for the WFD biological quality element 'phytoplankton' (but not 'phytobenthos').
  Shortcoming: only in one MS report

- Good example: some Member States have defined GES in terms of achieving OSPAR eutrophication non-problem status.

- Good example; Chl-a concentration and dissolved oxygen are the most frequent methods covering 5.2 and 5.3 criteria that were applied by most of the MS, indicating data availability and achieving a comparable and coherent implementation.

- Good example: Consideration of assessment methods developed and tested by RSCs.

  Shortcoming: different approaches in each region with difficulties for countries sharing waters in several regions.

2.5 Differences and similarities between the regions should be highlighted, where applicable.

There are a number of reasons to observe major differences in sensitivity and vulnerability of coastal areas to anthropogenic loading of nutrients. Nutrient seasonal regime and consequently timing of the annual peak of phytoplankton differ among regions. Different coastal morphology and water dynamics will affect the functioning of a coastal unit with respect to nutrient inputs, and thus, their impacts on the ecosystem (Hakanson 2008). In addition, pressure levels (nutrient contaminant discharges) can be subjected to strong seasonal fluctuations depending of variations in economic activity (e.g. population level in the Mediterranean littoral fringe abruptly increases in summer). Consequently, each region and sub-region requires specific thresholds of the parameters that should take into account the time variability.

The Baltic Sea and the Black Sea are semi-enclosed water environments, which makes them very different from "true marine" seas like e.g. North Sea or North Atlantic, and very vulnerable to eutrophication. In addition, there is in the Baltic a pronounced salinity gradient from high salinities in the western part bordering the Skagerrak to very low salinities in the eastern parts. The differences

comprise physicochemical conditions as well as species composition. This is taken into account by HELCOM and WFD approaches for the Baltic Sea.

On the other hand, the continental shelf of Northeast Atlantic is largely open to ocean dynamics restricting eutrophication issues to coastal waters covered for a large proportion by the WFD boundaries. In countries with narrow continental shelf (e.g. Portugal), eutrophication assessment out of the WFD boundaries may not be a target for eutrophication assessment according to OSPAR COMP and its Screening Procedure.

3. Analysis of the current text of the Decision

3.1 Analysis of the current text of the Decision, identifying in particular those parts which are best placed in guidance, those parts which are interpretative or explicative information and those parts which need to be kept in the Decision in accordance with the mandate provided by the Directive.

The current text of the Decision, concerning D5, is very succinct, including a definition of eutrophication, some general considerations (interpretative and explicative) on the practical implementation of the Directive with respect to D5, and the list of criteria and indicators relevant to assess whether GES has been achieved.

"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 part of the Decision is the objective for Descriptor 5 (see MSFD Annex I). This normative definition has to be kept in the Decision as there is no scope for revising Annex I MSFD.

The general consideration regarding the implementation of the Directive in relation to D5 is an attempt to recapture elements of Part A of the Decision that are essential to D5. Part of this text may need to be adjusted to new legislation documents, whereas other parts could benefit from more detailed guidance and/or slightly modified such that it becomes clearer that what is needed is a pan-European approach which can accommodate regional specificities. Such an approach should aim at a quantitative definition of GES at the level of the criteria or indicator, allowing regionally adjusted specifications on the assessment methodology within the criteria as long as they are ecologically justified. In addition, assessment and quantitative targets should draw upon the effort made in the frame of other EU legislations (specifically WFD) and the experience of the RSCs, recognizing that RSCs are engaged since many years, through regional Action Plans, to achieve healthy conditions in their respective seas.

The list of criteria and associated indicators has been set according to physical and chemical features listed under Annex III Table 1 of MSFD that are strongly related to eutrophication. Some elements of this list are not presently reported in the Decision under the criteria for D5 (e.g. TOC, invertebrate

bottom fauna) in spite of their relation to eutrophication (see section 5.2 for further comments on criteria and associated indicators).

3.2 The analysis should then include an overall identification of needs for guidance.

The general description for the implementation of Descriptor 5 as provided in the Commission Decision is rather brief and could therefore benefit from additional guidance on specific issues.
The compatibility and consistency between the MSFD GES and the Good Ecological Status (GEcS) under the WFD in the zone where these two Directives overlap should be clarified with additional guidance, also considering the WFD CIS Eutrophication Guidance document No. 23[11]. Analyses and discussion on a common approach to handle WFD water bodies in MSFD assessment are on-going within RSCs through specific working group (e.g. HELCOM EUTRO-OPER, OSPAR ICG EUT). Conclusion on this issue is promptly required to enable reflection in revised Decision.
Assessment scales and data integration/aggregation are not so well defined in 2010/477/EU. Guidance is needed to ensure coherence on the identification of assessment units[13]. Work by Deltares Institute[12] under Service Contract with DG ENV aims at EU guidance for coherent geographical scales in assessment and monitoring GES and for sets of aggregation rules.
Transboundary issues[13] and cooperation with landlocked MSs and/or non-EU countries need to be further addressed in the context of MSFD taking into consideration on-going analysis under RSCs (e.g. OSPAR ICG-EMO modelling studies, HELCOM analysis on atmospheric transboundary loads).

3.3 An analysis of what to keep should be made, including specification on what may be outdated or may need to be aligned with other or new legislations

The text of the Commission Decision regarding D5 could benefit from additional references to new Commission guidance documents (i.e. Guidance Doc. #23 on Eutrophication Assessment in the context of European Water Policies), and other policy documents (e. g. COM DEC 2013/480/EC) and RSCs best practices (e.g. OSPAR 2013, HELCOM 2014).
The number and nature of criteria should be kept as derived from commonly agreed conceptual models of eutrophication in coastal and marine waters, and adopted or in way to be adopted by RSCs, However, methodological standards and associated indicators within criteria may be revised such as to reflect Art. 12 assessment, and ensure better harmonization among MSs, while keeping enough flexibility of process with respect to regional characteristics.

4. Identification of issues

[11] https://circabc.europa.eu/sd/a/9060bdb4-8b66-439e-a9b0-a5cfd8db2217/Guidance_document_23_Eutrophication.pdf
[12] http://ec.europa.eu/environment/marine/publications/pdf/Analytical%20report.pdf
[13] Outcome from MSFD GES workshop on D5, D8 and D9, JRC 23-24/10/2012

4.1 Main findings and information that will be used in the next step of the revision process

A harmonization process between coastal and open sea assessments is required. Moreover, RSCs should further work on their integration with WFD (for coastal water) and consequently with MSFD for eutrophication assessment. OSPAR and HELCOM initiatives to create common indicators and assessment methods, in line with EU legislations (WFD) could be seen as good practices. The identification of discrepancies in eutrophication assessment should be prioritized as well as the effort to align RSCs and EU approaches. A harmonization in MS actions for the MSFD implementation (e.g. HELCOM TARGREV) will reduce the transboundary deviations in the quantification of GES and targets (Palialexis et al., 2014).

The starting point for a better harmonization would be a consistent and agreed pan-European common approach (in a broader sense) for the eutrophication assessment with a core set of commonly used indicators and, possibly, similar aggregation rules. Methodological adjustments (e.g. optional indicators) at different spatial (e.g. marine regions/subregions, inshore/offshore, ecosystems) and temporal scales (e.g. seasonality) should be applied (e.g. baseline and threshold) by RSC/MS in order to reflect the different environmental characteristics (Palialexis et al., 2014) and notably as regard to the effect of hydromorphology on the eutrophication vulnerability.

The flexibility in the interpretation of MSFD implementation leads MS to select different approaches in their initial assessment, the definition of GES and the targets. Particularly, the GES and the targets are reported on pressure level, on impact or on a combination of both. In most cases, especially when GES and targets are applied on pressures, there are no measurable methodological approaches accompanied by thresholds and limits. This causes a twofold complication to the assessment of MSFD implementation: the incomparability to set GES/targets between neighbouring MS and the inability to assess whether the GES or the targets are achievable. In relation to GES and targets, MS presented different levels of ambition in the implementation of MSFD, which was clearly reflected in the number of targets, the precise qualitative metrics and the strict or loose definition of GES. Differences in ambition levels led to incoherence in the implementation of MSFD, even within the same region. In order to overcome these inconsistencies, more synergies amongst MS at a regional level are necessary, taking into account the dissimilarities in ecosystems, infrastructures and extent of marine waters under each MS jurisdiction (Palialexis et al., 2014). RSCs can play a crucial role in the development and application of coherent and consistent assessments and methodological standards.

Clear links should be made between pressures and impacts (Annex III, Table 2 of MSFD) and criteria and methodological standards (COM DEC 2010/477/EU) and thereafter between Art. 8, 9 and 10, taking into account the connection with Table 1 in Annex III of MSFD. This should be done in a way that any pressure or impact will be connected to specific methodological standards that consequently will be associated with the state elements affected.

Descriptor 5 assessments should be built on (i) fulfilment of WFD and MSFD requirements to produce, respectively, assessment of Good Ecological Status and D5 assessment for coastal water bodies; (ii) fulfilment of MSFD requirements to produce an assessment for offshore waters; (iii)

compilation of the information from the previous steps into a regional/national eutrophication assessment.

There is some degree of consistency in parameters used across the four regions (N, P, O2, Chl-a, water transparency) and these should be retained in the Decision, even though analytical methods to determine these parameters need better harmonization among MSs. There is much less consistency in the use of plankton and benthos indicators so that these should be further reconsidered as part of the D5 assessment methodology, bearing in mind the normative definition of MSFD Annex I.

The thresholds and limit values for assessing eutrophication status are largely dependent on the regional and sub-regional conditions. This requires appropriate threshold setting at certain scale. Such thresholds depend primarily on physico-chemical conditions and at different level on hydro-morphological conditions. Maps of shallow ocean vulnerability from the hydro-physical perspective and of chlorophyll-a (as a proxy for phytoplankton biomass) may guide the monitoring strategy towards hot spots of eutrophication (Druon et al. 2004, JRC 2005). These hydro-physical variables (e.g. vertical mixing and stratification, residence time and current intensity) can be extracted from validated ocean models at EU scale. As a first phase of its Common Procedure, OSPAR has adopted a Screening Procedure to identify non-problem areas with regard to eutrophication using less information related to hydrodynamic characteristics and proximity of nutrient sources. A full assessment is then conducted on areas that are not screened out using the screening procedure.

Currently most GES definitions in MS reports lack specific thresholds/reference conditions and therefore whether GES has been achieved can often not be determined. However, thresholds for the coastal waters are set for the WFD in the intercalibration exercise. The challenge is to find a common approach for a eutrophication assessment for all relevant regimes (EU and RSCs), where WFD thresholds (water body type) have their appropriate place and relevance also under the MSFD with its (sub)regional focus.

HELCOM and OSPAR have developed eutrophication assessment methodologies that provide a basis for defining and assessing GES within the Baltic and North East Atlantic. However their approaches differ and need further consideration on their relative merits. These approaches can provide the basis for assessing offshore eutrophication. The OSPAR approach is used for the entire OSPAR maritime area including estuaries (transitional waters), coastal and marine waters.

Commission Decision 2013/480/EU establishes boundaries for GES, e.g. for Chl-a for coastal/transitional waters and can be a starting point for setting thresholds for offshore waters in a comparable sense. Any updates derived from the intercalibration exercise should be considered by MSFD, accordingly.

5. GES criteria (in accordance with Art. 9(3))

5.1 Conclude on the use of the existing Decision criteria and indicators, in the light of the "refined" common understanding, the findings of Art.12 assessment and relevant international, EU and RSCs legislations and approaches

The three existing criteria are adequately covering the assessment of eutrophication, although there is no direct link with the assessment of the pressures (e.g. assessment of sources of nutrient and organic matter enrichment).
The general character of the current COM DEC 2010/477/EU criteria is not easy to be quantified, leading to GES definitions on a lower level (indicators and methodological standards). The evaluation of significance of the current criteria and indicators for the D5 MSFD implementation and for the review process should also consider the results from the Art. 12 in-depth assessment (Palialexis et al., 2014) on the frequency of their use. The implementation of the eutrophication Descriptor for the 2012 MSFD reporting was more complete and coherent compared to other Descriptors, due to the maturity of the relevant scientific approaches and established assessment frameworks in RSCs and EU. The criteria and indicators in the COM DEC 2010/477/EU proved to be very important for the MS. Thus, we are framing our proposal for the review on the basis of the existing criteria and indicators for Descriptor 5. However, the evaluation of the implementation (Art. 12 reports and JRC's in-depth assessment) revealed that there is still room for a more coherent and comparable implementation towards GES achievement. The review process and particularly the following proposals are intending to cope with the aforementioned issues.

5.2 Recommendation on which criteria to retain, which to amend and any to remove.

Proposed criteria and methodological standards:

Criterion 5.1: Nutrients enrichment

GES definition: Nutrient concentrations should not exceed those boundaries leading to eutrophication in nearby coastal and marine areas, and elsewhere (transboundary effects).

Methodological standards and GES boundaries:
The analysis of the methodological standards reported for the first phase of the MSFD implementation (Palialexis et al., 2014) showed that all MS are assessing nutrient concentrations (5.1.1). Winter DIN and DIP are the most frequently assessment elements for nutrient concentration (although annual concentrations is used by some MSs). It is recommended to retain these concentrations (seasonal or annual means) in the methodology and to have defined thresholds at suitable scales.
In the frame of WFD, nutrient boundaries in coastal and transitional waters are established by each MS. WFD CIS ECOSTAT group is now working on evaluating whether these boundaries are consistent with biological boundaries set through the intercalibration process.

The ratio N:P (5.1.2) is also a commonly assessed indicator as it is readily derived from previous nutrient estimates (5.1.1). Its usefulness, however, may need additional investigation at regional

level before being used within operational assessment methods. There is evidence of high natural variability of N:P at different scales and large diversion from the standard "Redfield ratio". The natural processes affecting this ratio cannot be easily separated from anthropogenic eutrophication effect, making this indicator less useful for management purpose. Suggestion is to remove it from the assessment methodology or to use it as supporting indicator.

Criterion 5.2: Direct effects of nutrient enrichment

GES definition: Direct effects of nutrient enrichment in the water column should not exceed thresholds established for the elements identified in the methodological standards

Methodological standards and GES boundaries:
Chlorophyll-a (5.2.1) is an important element of the assessment, sufficiently reported by MSs and more detailed guidance on this approach can be developed acknowledging the existing guidance and approaches for WFD (document No 23). In coastal waters, thresholds are set up for chlorophyll-a in the frame of WFD intercalibration. These thresholds need to be applied, and thresholds set up for Chlorophyll-a outside coastal waters should be harmonized with WFD. Satellite remote sensing, buoys and ships of opportunity should also be considered as cost-effective approaches for the estimation of chlorophyll-a concentration in the open waters.

Water transparency (5.2.2) is also used by most of the MSs in their initial assessment. Many evidences showed that water transparency is inversely related to phytoplankton biomass (Fleming-Lehtinen and Laamanen 2012). However, transparency is also depending on total suspended (inorganic) matter (TSM) and chromophoric (or colored) dissolved organic matter (CDOM). Water bodies loaded with material other than algae are not productive due to the reduction of light availability by, e.g., suspended sediments (e.g. Gironde estuary and main plume, rivers main plumes after a coastal flood). Caution should then be taken to assess water transparency only in relation to chlorophyll levels, provided a threshold can be identified. It is thus recommended to keep this indicator in the Decision revision, with option to use it as supporting element.

Abundance of opportunistic macroalgae (5.2.3): Less than 50% of MSs used this element in their assessment of eutrophication, even though this biological element should be fully covered by WFD in coastal waters. For consistency with WFD, it is recommended to keep this element in the MSFD assessment of D5 in coastal waters, and use WFD boundaries. The extension of this element in offshore waters depends on (sub)regional characteristics (e.g. nature of substrate, bathymetry, light penetration).

Species shifts…anomalous bloom events… (5.2.4): This indicator of D5 is not well defined and clarified in the Commission Decision. As a result, a large number of methods and parameters were reported, decreasing assessment comparability and consistency between MS. It is recommended to amend that element of the Decision on the basis of further guidance on specific methods and metrics that should be used.

Note: WFD considers Chl-a as one of the constituents of the biological quality element Phytoplankton in coastal and transitional waters; it also includes (or should consider to include) species shifts in floral composition and events of nuisance/toxic blooms. Specific and agreed thresholds in COM Decision 2013/480/EU cover this only partly, and work is on-going in WFD Intercalibration to fill the gap covering the full Phytoplankton BQE.

Criterion 5.3: Indirect effects of nutrient enrichment

GES definition: Indirect effects of nutrient enrichment should not exceed thresholds established for the elements identified in the methodological standards

Methodological standards and GES boundaries:
Abundance of perennial seaweeds and seagrasses are adversely impacted by decreases in water transparency (5.3.1): This element has been reported by a substantial proportion of MSs. It is also an element within WFD assessment of Good Ecological Status. Commission Decision 2013/480/EU defines specific and agreed ecological quality ratio limits for national Macroalgae and Angiosperm evaluation methodologies. A better connection and identification of the overlaps between 5.3 criterion and WFD is needed. As for indicator 5.2.3, its application in offshore waters depends on (sub)regional characteristics.

Dissolved oxygen (5.3.2) concentration is an important element of the assessment in relation to D5, and was reported by most of the MS in the first phase of MSFD implementation. It should be kept in the Commission Decision, but better harmonisation of the methods/metrics between MSs is recommended. Oxygen in bottom layer is an important measurement as it controls the state of the fauna at the seabed. Note, however, that vertical profile of oxygen is also recommended to assess bottom/surface difference.

5.3 Proposals for new criteria, if needed.

No new criteria are required. However proposal is to have a core set of indicators to be commonly used at EU level (pan-European approach) for operational assessment: nutrient concentrations (5.1.1), Chlorophyll-a (5.2.1), water transparency (5.2.2), oxygen level in bottom layer (5.3.2). Even though thresholds for these indicators may reflect regional specificities, their measurements and metrics should be better harmonized among MS.

In coastal waters (i.e. MSFD waters overlapping with WFD water bodies), MSFD assessment should be implemented so as to ensure consistency and complementarity with WFD. A number of quality elements used under WFD are highly relevant for eutrophication assessment such that WFD results can be directly adopted to provide D5 assessment (see also the Guidance Document # 23 on eutrophication assessment in the context of European water policies). This implementation option reflects the MSFD directive stating that coastal waters should be covered by MSFD only *in so far as particular aspects of the environmental status of the marine environment are not already addressed through the WFD*. On the other hand, WFD does not explicitly refer to eutrophication in the MSFD

sense, and its implementation cycle is different than for MSFD. Therefore, a direct use of WFD results in coastal waters would definitively require strengthening the coordination of implementation between WFD and MSFD. The on-going work of ECOSTAT to evaluate the compatibility between nutrient boundaries and biological elements, including in coastal waters, can be seen as a step toward consistency between both Directives.
Other implementation options in coastal (WFD) waters would be to use all marine observations made under WFD (in isolation or combination with offshore observation) and to re-assess these waters under MSFD, recognizing that the assessment of ecological status under WFD is not an assessment of eutrophication as required by MSFD, but it is nonetheless desirable that WFD and MSFD reach to a comparable assessment concerning eutrophication.
Independently of implementation options, it should be noted that this issue to handle WFD water bodies need further analysis/guidance taking into account the respective requirements of the two Directives in coastal waters such that duplication of work can be avoided in this extensive area of overlap.

Suggestions for criteria elements (not part of core set of indicators):
- Combining total nitrogen (TN) and total phosphorus (TP) with DIN and DIP as indicators in the assessment of criteria 5.1 may strengthen confidence in the eutrophication assessment. These are robust parameters that can be monitored throughout the year and with spatio-temporal variability complementing that of DIN and DIP.
- Proposal to better focus indicator 5.2.4 on anomalous/toxic bloom events (frequency, duration), as long as a direct relationship with excess of nutrient inputs can be established.
- Pelagic shifts are difficult to assess (long-term changes *vs* short-term and local events) and would require significant monitoring efforts. This indicator should not be kept in the assessment of D5.

It is recommended not to use zoobenthos or macrozoobenthos in the assessment of D5, as this indicator can react to other pressures than eutrophication (Kotta et al. 2009). In case the state of zoobenthos is indeed linked to eutrophication, it is directly associated with oxygen levels in bottom layer, and thus not so essential to be considered as an additional element of the assessment.

5.4 Rationale and proposal, where appropriate, for defining GES threshold values and reference points, based on established and agreed scientific methods for quantifying and applying GES boundaries, or for a normative definition of GES

MSFD criteria are partly consistent with the existing WFD elements/parameters, and ideally MSFD can take advantage of the WFD tools and thresholds and should use these observations for the MSFD GES assessment in coastal waters (i.e. overlapping waters between the two Directives), though additional parameters and harmonization in assessment methodology might be needed to fulfil also MSFD requirements for D5.

Annex V of the WFD (2000/60/EC) lists 6 European standards covering the biological and physic-chemical monitoring in transitional and coastal waters. A new Commission Directive (2014/101/EU)

amending this Annex V now includes 20 published standards that will be maintained and updated on a regular basis through the Harmonization work programme (2015-2021) and collaboration with the European Committee for Standardization (CEN).

More work on establishing thresholds is required for offshore assessment of eutrophication. In adapting to MSFD requirements, RSCs assessment methodologies are based (or will be based) on similar criteria structure. However, the way thresholds are set and aggregation/ integration is achieved slightly differ. Better alignment of these assessment procedures (e.g. aggregation rules) and threshold setting between MSs within their respective sea-areas or sub-basins is recommended to ensure harmonization and similar level of motivation to achieve GES.

Methods covering great spatial areas and providing low-cost comparable data (e.g. remote sensing,) could be applied for offshore eutrophication assessment.

5.5 Link to possible future EEA indicator.

EEA maintains and updates two eutrophication indicators at a Pan-European scale:
CSI021 – Nutrients in transitional, coastal and marine waters – The indicator currently uses oxidized nitrogen (nitrite + Nitrate) and orthophosphate winter concentrations.
CSI023 – Chlorophyll in transitional, coastal and marine waters – The indicator considers the mean summer concentration of chlorophyll-a in the uppermost 10m of the water column.

For both indicators, the use of RSCs data and assessment methodology and WFD boundaries in their classification has been proposed as an improvement to the indicators.

6. GES methodological standards (in accordance with Art. 9(3))

6.1 Proposals for (new) methodological standards to be applied to the criteria in order to assess whether GES has been achieved for the descriptor (e.g. aggregation/integration methods across the criteria and across the quality elements).

The cross-cutting workshop (January 2015) of the review process concluded on some general directions on aggregating assessments and scales[14]. It was suggested to assess GES through a number of building blocks and aggregate them at descriptor or other appropriate level. The building blocks for D5 are the criteria that would be initially assessed whether they are in GES or not by the

[14] https://circabc.europa.eu/w/browse/75f0a8e9-ec48-4957-bdb5-58169b934cc7

associated methodological standards. There are two levels within the D5 where aggregation rules have to be applied: I) across the criteria and II) within each criterion across the methodological standards. For both levels, a number of different approaches can be used for combining indicators or criteria into an overall assessment of eutrophication (see Borja et al. 2014 for review of aggregation/integration methods). Within criteria, averaging or weighted averaging of indicators may be considered, as it is a simple method and commonly used. Across criteria, the One-Out-All-Out (OOAO) approach is commonly used by HELCOM CPs to assess eutrophication status for the Baltic Sea from the HEAT assessment tool (see below). Its application undeniably results in a worse case, as depending on the criteria with the lowest status, and thus reflects high ambition to achieve GES. Being also used in WFD, OOAO could contribute to a better harmonization between the two Directives.

As concluded in the cross-cutting workshop however, a general application of OOAO particularly within pressure-based descriptor is not straightforward, highly dependent on the quality of the data and with tendency to underestimate the 'real' status of the water body (Davey and Bewes 2011; Borja et al. 2014, Moe et al. 2015). Further guidance would be needed on aggregating scheme within each pressure-based descriptor, including D5.

RSCs example

HELCOM and its CPs use a transparent, commonly agreed assessment method that combines nutrient levels, direct and indirect eutrophication effects. The method is based on a revised version of the HELCOM Eutrophication Assessment Tool (HEAT 3.0; Fleming-Lehtinen et al. 2015). Assessment is carried out according to three steps:

- Step 1 (indicator level) with estimate of a 'eutrophication ratio' (ER) for each indicator element based on a defined indicator target and measured indicator status.
- Step 2 (criteria level) aggregation of indicator ratio for each D5 criterion using a weighted average of ER values within the criteria
- Step 3 (descriptor level) new criteria ER values are then combined into an integrated assessment of eutrophication status using the one-out-all-out principle

The method is applied for each assessment unit in the Baltic, and supplemented by a Final Confidence Rating by scoring the adequacy of the data used for estimating indicator targets and status[9].
Recent testing and comparative exercise (EUTRO-OPER 4-2015) showed that HEAT 3.0 could also be used in coastal waters as most discrepancies with WFD assessment occur between the lower classes (i.e. moderate, poor and bad). Recommendation for these waters, however, is to combine HEAT assessment with the same parameters as those required by WFD. For the North Sea, a similar assessment tool based on HEAT has been developed by the HARMONY project – NEAT (North Sea Eutrophication Assessment Tool) – and is in principle ready for application in OSPAR maritime area.

7. Specifications and standardized methods for monitoring and assessment (in accordance with Art. 11(4))

7.1 Proposals for specifications on methods for monitoring (i.e. the collection of data needed for assessment of each criterion, including parameters, units of measurement and data quality requirements), which aim at ensuring the comparability of monitoring results, on the basis of JRC / ICES / RSC survey protocols, relevant European/international standards (e.g. ISO/CEN) and Article 12 findings.

Monitoring should provide relevant data to support suitable indicators in order to assess if GES has been achieved or is maintained, as well as to measure progress towards environmental targets and evaluate the effectiveness of measures to achieve or maintain GES. A specific guidance document (JRC 2014b) summarizes minimum standards and concepts to be considered in developing monitoring programmes with a series of agreed recommendations to be applied. One of the recommendations is that monitoring programmes have to be coordinated, compatible, coherent, consistent and comparable.

In 2013, three Pilot-Projects (BALSAM in the Baltic, IRIS-SES in the Mediterranean and Black Sea, JMP NS/CS in the North Sea) were launched as part of DG ENV initiative for coordination and support action to support coherent and comparable implementation of MSFD with focus on monitoring programmes. The objectives are to show benefits and challenges of joint monitoring network and multi-use of existing platform, increasing efficiency and reducing costs, and promote cooperation among research institutions within selected regions. A specific objective (e.g. IRIS-SES) is to elaborate guidelines for sampling across the various disciplines in order to meet MSFD requirements. Although IRIS-SES is mainly focused on monitoring programme, significant effort is being done in analyzing the methodological standards used by the several European Mediterranean countries implied in this cooperative project. It is expected that these projects (ending in May 2015) will provide recommendations for better harmonization and coordination of monitoring efforts and collection of data to support MSFD needs.

Some RSCs have already established coordinated monitoring plans (e.g. OSPAR 2014[15], HELCOM Joint Coordinated Monitoring System[16]) applying the basic monitoring principles set out by a group of experts and consultation with WG GES[17] and summarized in JRC monitoring guidance (JRC 2014b)..

7.2 Proposals for specifications on methods for assessment, which aim at ensuring comparability of assessment results, including aggregation of monitoring data within an assessment area for a particular criterion and if necessary aggregation across assessment areas up to larger areas (e.g. (sub) region scales), and based on general guidance prepared on scales and aggregation rules and taking account of JRC / ICES / RSC inventories and Article 12 findings.

[15] OSPAR 2014. OSPAR Coordinates Monitoring in the North-East Atlantic. OSPAR Commission, Publication # 622/2014.
[16] http://helcom.fi/action-areas/monitoring-and-assessment/monitoring-and-assessment-strategy
[17] https://circabc.europa.eu/d/a/workspace/SpacesStore/6902dba0-53e4-4cf4-8483-689fc1daffdb/Recommendation%20for%20monitoring%20-%202%20May%202013.doc

The cross-cutting workshop outcome on **assessment scales**[18], in relation to elements, is that multiple scales would need to be selected so that data being collected ensures appropriate coverage of the needs and no data gaps are observed. Overall, one scale does not fit all elements, and there is a need for a system that address the different needs.

Define scales at each stage of process:

	Process	Scale
1	Define GES	(sub)Region
2	Define 'indicators' for assessment	(sub)Region and possibly EU level
3	Collect the data (monitoring)	National, considering WFD for coastal waters and MSFD offshore
4	Process the data for use in indicator assessment	National, considering WFD for coastal waters and MSFD offshore
5	Aggregate the data and assess indicator	Sub(Regional) and 'national' sub-basins

For eutrophication, geographical scaling and spatial data aggregation may reflect regional differences in the DPSIR relationships. The degree of nutrient enrichment usually varies at the level of sub-region or even locally and its impact on the coastal zone and marine waters depends on the morphology and hydrodynamic characteristics of the area. Geographic scales for assessment of D5 should then consider all these aspects and need to be chosen to ensure that local impacts remain detectable, in order to inform measures (see Deltares 2013).

A risk-based approach (as referred in the Commission Decision 2010/477/EU) should be effective for D5 assessment, enabling geographical prioritization and efficient monitoring schemes over small and medium-scale areas impacted by nutrient enrichment. OSPAR Screening Procedure is identifying obvious non-problem areas with regard to eutrophication, allowing to better concentrate assessment and monitoring plans on other areas. It is important however that such 'screening procedure' be repeated at regular time intervals to ensure that the risk of eutrophication is not increasing. In the case of HELCOM, eutrophication is a regional issue affecting the entire Baltic. Contracting Parties have thus agreed to use a common nested, hierarchical approach allowing assessment at different scales depending on the needs (sub-basin scale for D5).

The report by Deltares Institute (Deltares 2013) analyses the different schemes adopted by regions and MSs, following the initial assessment reporting. This analysis should be followed by a guidance document on how to deal with spatial scales and aggregation in the context of MSFD.

[18] https://circabc.europa.eu/w/browse/75f0a8e9-ec48-4957-bdb5-58169b934cc7

8. Rational and technical background for proposed revision

8.1 Justification and technical background justifying the above proposals.

The proposed revision of the Commission Decision with respect to D5 should focus on clarifying specific aspects of its implementation to ensure that a similar level of ambition to achieve or maintain GES is applied by all MS, taking into consideration recent/on-going exercises and methodological improvements conducted in the frame of RSCs.

Eutrophication is a well-defined environmental issue with clear causative factors. D5 is specifically focusing on the determination of the functional relationship between anthropogenic nutrients and ecosystem functioning. For this reason and on the basis of many years of studies, the criteria for D5 have been structured from the pressure (nutrients) to the direct and indirect effects. This structure reflects a well-established and commonly accepted conceptual model of eutrophication in coastal and marine waters (JRC 2010, Ferreira et al. 2011). There are no basic reasons to modify or revise this overall structure of the descriptor.

Resulting from the MS initial reporting and Article 12 assessment, a core set of indicators commonly applied at EU level and covering the three criteria can be identified, even though better harmonization of the metrics and measurements is needed. In coastal waters, MSFD assessment needs to consider WFD assessment elements, selecting best option for integrating WFD observations/ecological elements. In offshore waters, RSCs assessment methodological standards would be the basis for D5 assessment integrating the core set of indicators, possibly supported by additional indicators reflecting regional specificities. Aggregation rules and threshold setting need to be better harmonized among RSCs.

9. Other related products (e.g. technical guidance, reference in Common Understanding document)

9.1 Where aspects are identified which should be usefully laid down but not as part of the decision, these elements should be specified and a proposal should be made in which way they should be laid down, e.g. interpretative guide for the application of the future Decision or CU guidance document or technical background document.

A eutrophication assessment template could be laid down in a technical background document (e.g. HELCOM is currently preparing a HEAT assessment manual that could be generalized).

10. Background documents

- Review of the GES Decision 2010/477/EU and MSFD Annex III Approach and outline for the process, (EC- Committee/07/2013/03rev, 2013);
- First steps in the implementation of the Marine Strategy Framework Directive - Assessment in accordance with Article 12 of Directive 2008/56/EC, (CSWD, 2014);
- Article 12 Technical Assessment, (Milieu ltd, 2014);
- Marine Strategy Framework Directive - Descriptor 3, (ICES, 2012);
- Common Understanding of (Initial) Assessment, Determination of Good Environmental Status (GES) & Establishment of Environmental Targets (Articles 8, 9 & 10 MSFD), (DG GES, 2014);
- In-depth assessment of the EU Member States' Submissions for the MSFD under articles 8,9 and 10, EUR26473EN (JRC 2014)
- Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status (JRC, 2011)
- Guidance / Terms of Reference for the task groups 'criteria and methodological standards for the Good Ecological Status (GES) descriptors' (JRC, 2010)
- CSWP (2011) on the Relationship between the initial assessment of marine waters and the criteria for good environmental status.
- COM DEC (2013/480/EU). COMMISSION DECISION of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC. Official Journal of the European Union, L 266
- HELCOM, 2014. Eutrophication status of the Baltic Sea 2007-2011 - A concise thematic assessment. Baltic Sea Environment Proceedings No. 143

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