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In-Depth Assessment of the EU Member States' Submissions for the Marine Strategy Framework Directive under articles 8, 9 and 10

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Introduction to the In-Depth Assessment

Context and available material

The Marine Strategy Framework Directive (MSFD) foresees that by 15 July 2012, Member States had to provide information on the initial assessment (article 8 of the directive), on the determination of good environmental status (GES - article 9) and on the establishment of environmental targets and associated indicators (article 10). An In-Depth Assessment (IDA) of the Member States (MS) reports for Article 8, 9, and 10 of the MSFD was undertaken by Joint Research Centre (JRC) at the request of DG Environment.

JRC's IDA is based on reporting from the following Member States (MS): Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Netherlands, Portugal, Romania, Slovenia, Spain, Sweden, and United Kingdom. The source of information was mainly based on the updated reporting sheets uploaded by MS before September 2013 (Portugal provided only the national paper report by that time). The reports prepared for DG ENV by Milieu Ltd (consultant's reports) for the article. 12 assessment and the MS' paper reports were also consulted.

Aims of the IDA

This IDA was done by the JRC on the request of DG ENV and its aims were:

i) evaluate comparability and coherence of methods and in particular their relation to the assessments under other European and international frames and the latest scientific evidence;

ii) provide recommendations for improved implementation of the MSFD in the second cycle (2018) and

iii) support the possible revision of the COM "Decision on criteria and methodological standards" (COM Dec 2010/477/EU)

Descriptors considered

The IDA covers all MSFD descriptors expect D3 and D7 and is presented in six chapters, i.e.:

1. Biodiversity: descriptors 1, 4 and 6
2. Non indigenous species: descriptor 2
3. Eutrophication: descriptor 5
4. Contaminants: descriptors 8 and 9
5. Marine litter: descriptor 10
6. Underwater noise and other forms of energy: descriptor 11

In-Depth Assessment Approach

The different nature of the assessed descriptors creates a wide heterogeneity in the level of detail of the information made available, the appropriate methodologies, and the kind of outcomes expected. For this reason, the IDA is presented as a compendium of different reports, each one with its own introduction, results, discussion, conclusions and recommendations. However, a strong attempt has been made to harmonize the individual reports, therefore a number of issues have been analysed across all descriptors in a systematic manner adopting a common set of criteria.

The first issue tackled in the IDA is the level of integration between the MSFD implementation and other legislative requirements and agreed standards, namely: i) level of integration with other Directives (Water Framework, Habitat, Bird and, where applicable (e.g. D5), Nitrate and Urban Wastewater); ii) level of integration with standards agreed within Regional Sea Conventions (HELCOM, OSPAR, Barcelona and Bucharest); iii) gaps in knowledge and definition of targets and standards. An additional issue for D2 was the lack of consistency/reliability of the information reported on non-indigenous-species.

The second issue analysed in the IDA includes the indicators and methodological standards adopted across countries, in terms of availability, consistency (conceptual, spatial, etc) and completeness of description.

The third issue analyzed is related to the quality of the reporting process itself: i) differences between MS' paper reports and reporting sheets, ii) lack of completeness in either or both, iii) inconsistencies in the link between pressures/impacts and indicators, iv) deficiencies in the quality of the information reported and data accessibility.

At the end of each section, conclusions are drawn on each descriptor including a set of recommendations for improved implementation in the second MSFD cycle and support the review and the possible revision of the COM Decision on criteria and methodological standards. Thus, taken as a whole, this IDA attempts to presents a cohesive set of suggestions that can be pursued to strengthen the implementation of the MSFD.

Table of Contents for the Descriptors

IN-DEPTH ASSESSMENT OF MEMBER STATES' SUBMISSIONS FOR MSFD ART. 8, 9 & 10 ON BIODIVERSITY DESCRIPTORS D1, 4 & 6

BIODIVERSITY DESCRIPTORS

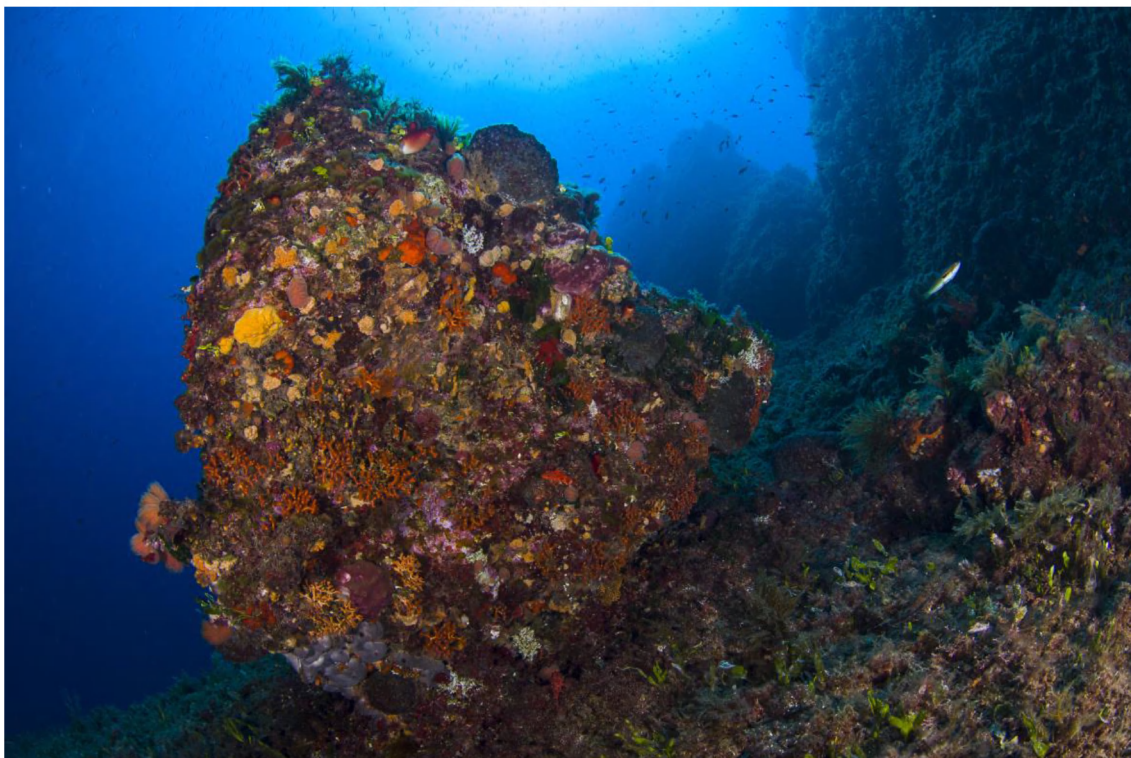Photo by Yiannis Issaris (www.yissaris.com)

Contents for Biodiversity

1. Introduction

According to the Marine Strategy Framework Directive (MSFD), biological diversity should be maintained. Specifically, the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. The Directive covers the whole range of species, habitats and associated pressures in all European marine regions (from coastal waters to open seas). The COM Decision[1] sets certain criteria and indicators to define Good Environmental Status (GES) on species, population, habitat and ecosystem level. It is widely recognized that there are links between D1 (biodiversity per se), D4 (food-webs) and D6 (sea-floor integrity) and these are frequently referred together as the "biodiversity theme" since the data and information requirements for these descriptors overlap to a considerable degree, although there are separate description of what GES is for each one of them. It is also recognized that although aspects of these descriptors are, to some extent, already addressed by other EU pieces of legislation the MSFD implementation requires further scientific and technical developments to better set the conceptual frame of biodiversity, define GES, set meaningful targets and achieve an operational capacity for a meaningful monitoring and assessment.

1.1 Aim of the in-depth assessment

On request of DG ENV, the JRC performed the D1, 4 and 6 in-depth assessment (IDA) of the Member States' reports for Article 8, 9, and 10, as a follow up of the MSFD Art 12 assessment. The aim of the IDA is to provide a holistic view of the implementation of the MSFD rather than to comment on Member States' practices. Particularly IDA aimed to:

- o Identify the level of integration between the MSFD implementation and other legislation assessment requirements (Habitat Directive-HD, Bird Directive-BD, Water Framework Directive-WFD, Regional Sea Conventions-RSC etc.) and agreed standards.
- o Evaluate coherence of methods across Member States (MS) and within RSC.
- o Provide recommendations for improved implementation in the second MSFD cycle.
- o Support the review and possible revision of the COM Decision[1] on criteria and methodological standards.

1.2 Biodiversity related pieces of legislation and agreements on EU and RSC level

Here only a succinct definition of the biodiversity requirements in related legislation and agreements on EU and RSC is presented. Detailed information can be found in Piha and Zampoukas (2011) and Zampoukas et al. (2012). The first reviews existing methodological standards developed and agreed in the framework of European or international conventions in relation to the MSFD needs, including

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[1] Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (COM Dec; 2010/477/EU).

those related to implementation of Art. 8, 9 and 10. The second analyses monitoring requirements across EU legislation and international agreement in relation to the MSFD monitoring requirements aiming at supporting integration and harmonization of monitoring efforts.

In the Habitats Directive (HD) there is no definition of biodiversity but reference to the need to maintain it. It requires that EU MS take measures to ensure that the listed species and habitats "of community interest" are protected so as to be in "favourable conservation status" and report every six years the measures taken and their impact on the conservation status of concerned habitats and species. The Birds Directive (BD) does not define biodiversity either but refers to the need for a sufficient diversity and area of habitats for listed bird species. It requires the establishment of measures to maintain the population of the listed species. These measures should be reported every three years. Establishment of conservation measures should take into account trends and variations in populations.

In the marine environment, the WFD covers coastal waters at the water body scale. The WFD does not explicitly mention biodiversity. However, taxonomic composition of phytoplankton, macrophytes and zoobenthos and their abundance/biomass are assessed as indicators of ecological status.

In respect of the RSC, the HELCOM CORESET project is developing a set of core indicators[2] for the Baltic Sea. These indicators should, amongst others, support the assessment and the monitoring of GES as defined by the MSFD. The core indicators have been developed using the common principles agreed by HELCOM (HOD 35/2011). Currently, 18 core indicators have been developed for biodiversity, covering a range of aspects for D1, 4 and 6.

OSPAR considers biodiversity assessment a key issue that should be tackled on a regional base. The ICG COBAM (Intersessional correspondence Groups Coordination of Biodiversity Assessment and Monitoring) produced a list of 43 potentially common regional indicators including related Ecological Quality Objectives. The ICG COBAM continues the work on improving regional coordination for assessing and monitoring biodiversity descriptors under OSPAR.

Black Sea Convention has not yet agreed on common biodiversity indicators to support MSFD implementation. UNEP/MAPs EcAp (Ecological Approach) process has agreed on indicators to follow the MSFD COM Decision but these are not yet operational. Some MS reported species and habitats with reference to these two conventions.

2. Materials and Methods

2.1 Source of information

The JRC's assessment was based on the reporting sheets, reported by the MS. The IDA for the biodiversity descriptors was performed on the updated reporting sheets that were uploaded on September 2013. By that time 19 MS had uploaded reporting sheets (XML files). The consultant's reports prepared for DG ENV by Milieu (the versions that became available to JRC on August and September of 2013), including 19 MS and Portugal (only paper report), for the Art. 12 assessment were also consulted and were particularly useful as they identified cases where the reporting sheets were incomplete compared to the MS' paper report. In such cases information missing from the

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[2] HELCOM, 2012. Development of a set of core indicators: Interim report of the HELCOM CORESET project. PART B: Descriptions of the indicators. Balt. Sea Environ. Proc. No. 129 B.

reporting sheets was retrieved from the MS' paper reports. Chapter 6 includes the sources that JRC used or consulted for the D1, 4 & 6 IDA.

2.2 Methodological framework

The assessment was focused on:

1. screening the reported information and identifying methodological approaches.
2. scoring the degree of integration of the reported information with other EU legislation and RSC agreements
3. summarizing conclusions at the regional and European level
4. providing specific suggestions that could improve the MSFD implementation for Art. 8, 9 and 10, including the reporting process.

2.2.1 Screening and assessment of methodological approaches

The methodological evaluation was performed by extracting all required information at the highest detail from the reporting sheets, the consultant's reports and in some cases from the MS' paper reports. This information was organized in multiple tables (depending on the type of the assessment) based on the methodological approaches identified, level of integration and Initial Assessments' biological characteristics. These have been used to analyze the data reported for the following purposes:

- to provide an overview of the methodological approaches that the MS applied
- to extract the most frequently used methodological approaches per indicator, criteria and descriptor
- to identify the frequency of use of indicators amongst criteria and criteria amongst descriptors
- to check the level of methodological coherence in both pan-European and regional levels
- to identify MS' similarities in their MSFD reporting regarding the level of integration with EU legislations and RSC
- to check degree of adoption of the biological features, habitats and ecosystems defined in the CSWD (SEC, 2011)1255 final

The assessment aims to highlight:

- The most frequently applied methodological approaches, especially if these are regionally coherent
- The approaches that are characterized by high level of integration with other EU and RSC biodiversity methods or derived by them
- The most frequently used indicators and criteria
- The best practices on RSC level
- Problematic issues in reporting
- Inconsistence in the reporting across Art. 8, 9 and 10, focusing on the methodological approaches

2.2.2 Scoring methodology for assessing the level of integration between MSFD and other EU legislations or RSC' agreements

Due to the heterogeneous nature of the reported data in both the reporting sheets and the MS' paper reports there was a need to develop, as much as possible, objective classification criteria defining broad classes of integration across policies for the evaluation of the MSFD implementation for Art. 8, 9 and 10.

Three classes were created for ranking the level of integration based on the data reported in the electronic sheets:

1. No reference (direct or indirect) to the compared EU legislation or RSC' agreement
2. Reference to related EU legislation or RSC' agreement without any methodological information, threshold, baseline, etc.
3. EU legislation or RSC' agreement are mentioned and relevant methodologies are applied

The scoring system has been applied on a criteria/indicator level and for each biodiversity descriptor per MSFD article to evaluate the methods reported in a multi-level approach. The highest score amongst the reported methods at each level of analysis defines the MS' level of integration for a particular indicator. Additionally, a similarity analysis was conducted to identify the MS with similar degree of integration and identify possible regional patterns.

2.2.3 Assessing the level of heterogeneity in reported state characteristics

State characteristics reported by MS were compared with the list of habitats and functional groups defined in the Table 1 of Annex III of MSFD taking also into account the more detailed list of the Commission Staff Working paper SEC (2011) 1255. In particular, the reported characteristics were grouped in four classes: individual species, species groups/functional groups (of highly mobile species), habitat types and ecosystems and were quantified per class based on the information reported by each Member State. Characteristics were ranked according to MS' consideration and clustered in three categories based on the quality and quantity of the reported information by the MS: i. characteristics not reported, ii. low and iii. high number of characteristics, as defined by the relative numbers reported compared to the average reported characteristics across the MS.

In addition, we quantified the number of reported habitats and species functional groups based on the list included in the Commission Staff Working Paper "Relationship between the initial assessment of marine waters and the criteria for good environmental status" SEC (2011) 1255 final. This CSWD also includes a list with relevant functional groups of highly mobile and widely dispersed species of marine birds, mammals, reptiles, fish and cephalopods and a list of predominant habitat types. These have been compared with the reported state characteristics.

3. Results

3.1 Methodological approaches and standards in the implementation of MSFD Articles 8, 9 & 10

An overview of the methodological approaches that have been applied by the MS for Art. 8, 9 and 10 at the descriptor, criterion and indicator level is provided as well as an overview of the most

frequently reported methods (Table 1). The Descriptor and Criteria rows present the number of methods reported at that level (either Descriptor or Criterion) under column "Reported at descriptor/criterion level" and the total number of methods reported, including also methods reported on lower level (e.g. indicators), under the column "Total number of reported methods in each level". A method/indicator reported for different species (e.g. distributional range of species X and Y) was accounted as two methods. Often MS reported the same method under different indicator/criterion. The total number of reported methods at criteria/descriptors level is not always the sum of the methods reported at lower level, because of the removal of duplicated entries. This number reflects the actual methods reported and not a count of them across MS' reports. As shown on Table 1, there is a great variation on the number of methods reported per indicator.

Table 1. Number of different reported methods per indicator and criteria. The last column shows the most frequently reported method per indicator.
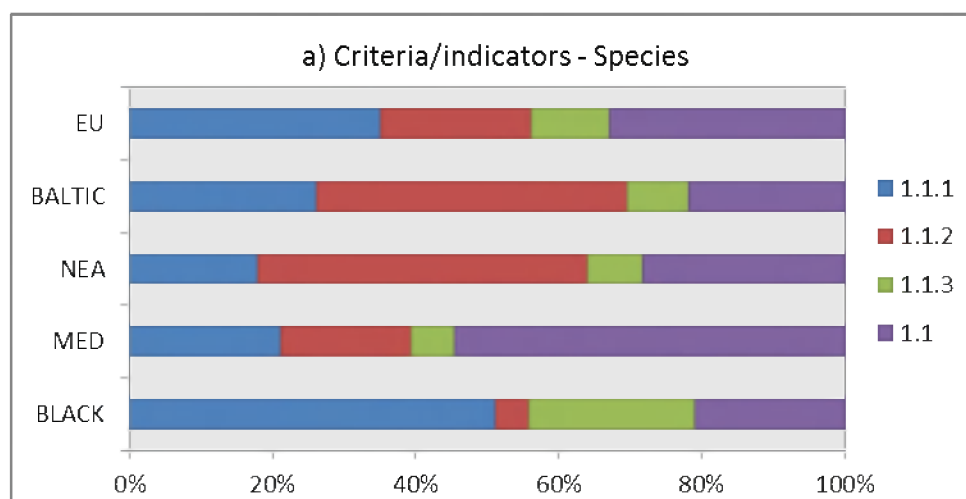
Descriptors	Criteria	Indicators	Reported at descriptor/criterion level	Total number of reported methods in each level	Most frequent reported methodology
1			49	488	Abundance of species; maintaining good conservation status of habitats
	1.1		42	122	Location and distribution of species or species groups
		1.1.1		45	Distributional range of species or species groups
		1.1.2		27	Distributional pattern of species or species groups
		1.1.3		14	Area covered by species or species groups
	1.2		42	98	Size (biomass, number, coverage) of the population of individual species or species groups
		1.2.1		56	Abundance (mostly number of individuals) and/or biomass of species or species groups
	1.3		21	63	Population demographic characteristics
		1.3.1		40	Productivity, survival rate, breeding success
		1.3.2		4	Genetic structure of the population
	1.4		16	52	Spatial distribution of habitats
		1.4.1		23	Distributional range (e.g. depth) of habitats
		1.4.2		18	Distributional pattern of habitats
	1.5		22	56	Spatial extent of habitats
		1.5.1		33	Area occupied by habitat
		1.5.2		5	Sites or volume of species

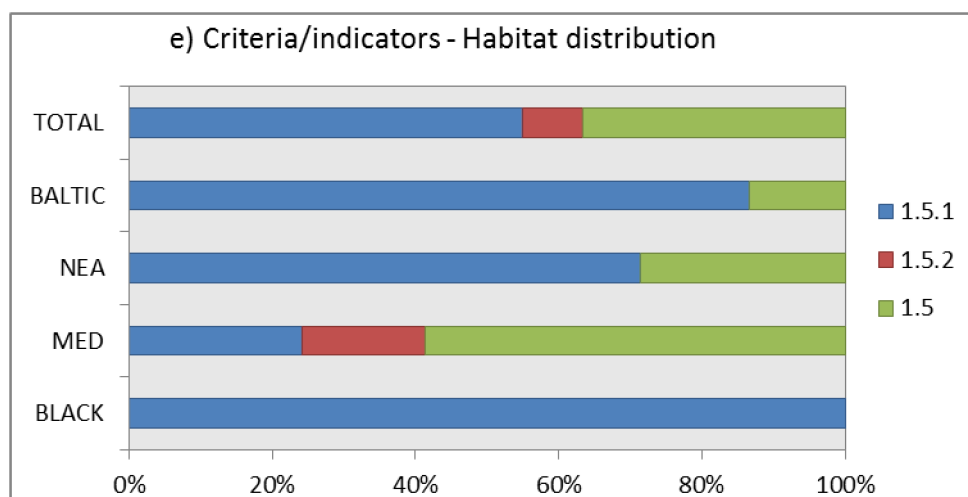|				
				habitats (e.g. Posidonia meadows)
	1.6		36	109	
		1.6.1		52	Benthic Quality Index (BQI), species ratios
		1.6.2		21	Abundance or biomass of species or groups of species
		1.6.3		17	Oxygen saturation
	1.7		15	31	Ecological Quality Ratio (BEQI), Diversity indices (e.g. Shannon index H')
		1.7.1		16	Ecological Evaluation Index (EEI), BENTIX, PREI, species diversity indices (e.g. Hill's N1)
4			12	122	
	4.1		7	31	-Reproductive performance (success, ability, rate) of bird, marine mammals, etc. -Biomass and abundance of higher trophic level. -Structure of population of main trophic group
		4.1.1		24	
	4.2		6	26	-Different measures or index related to the proportion of large fish (by length or weight) -Proportion of fish at the top of the food web (no reference to fish size and/or length)
		4.2.1		20	
	4.3		17	59	-Abundance and biomass of different components of the food web (zooplankton, fish, dolphins, sharks, birds) -Analysis of size structure of fish populations -Species-specific trends in relative abundance of species -Composition of phytoplankton and zooplankton assemblages
		4.3.1		43	
6			31	180	
	6.1		13	48	
		6.1.1		9	Spatial extent of area of biogenic structure.
		6.1.2		26	Spatial extent of area affected by dumping, major construction, trawling,
	6.2		22	102	
		6.2.1		34	Presence of sensitive species (different species list for MS),

6.2.2	46	Benthic Quality index (BQI), Shannon index, Ecological Evaluation Index (EEI), MAMBI, Brackish Water Benthic Index (BBI), Zoobenthos Community Index (ZKI), PREI
6.2.3	1	Proportion of biomass or number of individuals in the macrobenthos above some specified length/size
6.2.4	1	Median colony/body size of the species *Buccinum undatum, Mytilus edulis, Flustra foliacea, Haliclona oculata* and *Alcyonium digitatum*

We quantified the number of methodologies reported for each indicator and criterion for Descriptors 1, 4 and 6, respectively (see Table 1), in order to evaluate the frequency of use of indicators and criteria in the MSFD implementation (Fig. 1). The total percentage is the count of methods reported under each criterion and the associated indicators. E.g. for criteria 1.1 the number of reported methods at this level, where MS did not allocate methods to specific indicators are 42, 45 reported under indicator 1.1.1, 27 under 1.1.2 and 14 under 1.1.3. It should be noted that some methods could be reported under more than one indicator, or under both the criterion and some indicators. The methods are also presented regionally, by grouping them according to the region that each Member State belongs to.

b) Criteria/indicators - Population

c) Criteria/indicators - Population

d) Criteria/indicators - Habitat distribution

e) Criteria/indicators - Habitat distribution

f) Criteria/indicators - Habitat condition & Ecosystems

g) criteria/indicators - Habitat condition & Ecosystems

h) Criteria/indicators - Food webs

i) Criteria/indicators - Food webs

j) criteria/indicators - Food webs

Figure. 1. Relative distribution of methodologies reported by Member States (19 MS) for each criterion and indicator.

3.2 Level of integration between MSFD Art. 8, 9 and 10 and EU relevant legislation, international agreements and RSC agreements

The following charts were generated based on the information of the reporting sheets as reported by 19 MS. They show the level of integration between MSFD and WFD, BD, HD and RSC per article by classifying the MS into the three categories that are described in Chapter 2.2.2. Additional pieces of legislation (e.g. Common Fisheries Policy, Environmental Impact Assessment Directive 2011/92/EU), common agreed methodologies (ICES), Bonn convention and national assessments have been considered in the IDA and are grouped in Fig. 2 as "OTHER". The barplots in Fig. 2, Fig. 3 and Fig.4 were generated by the approach described in section 2.2.2 and refer to Descriptors 1, 4 and 6, respectively. The length of each bar (100%) corresponds to 19MS.

Descriptor 1
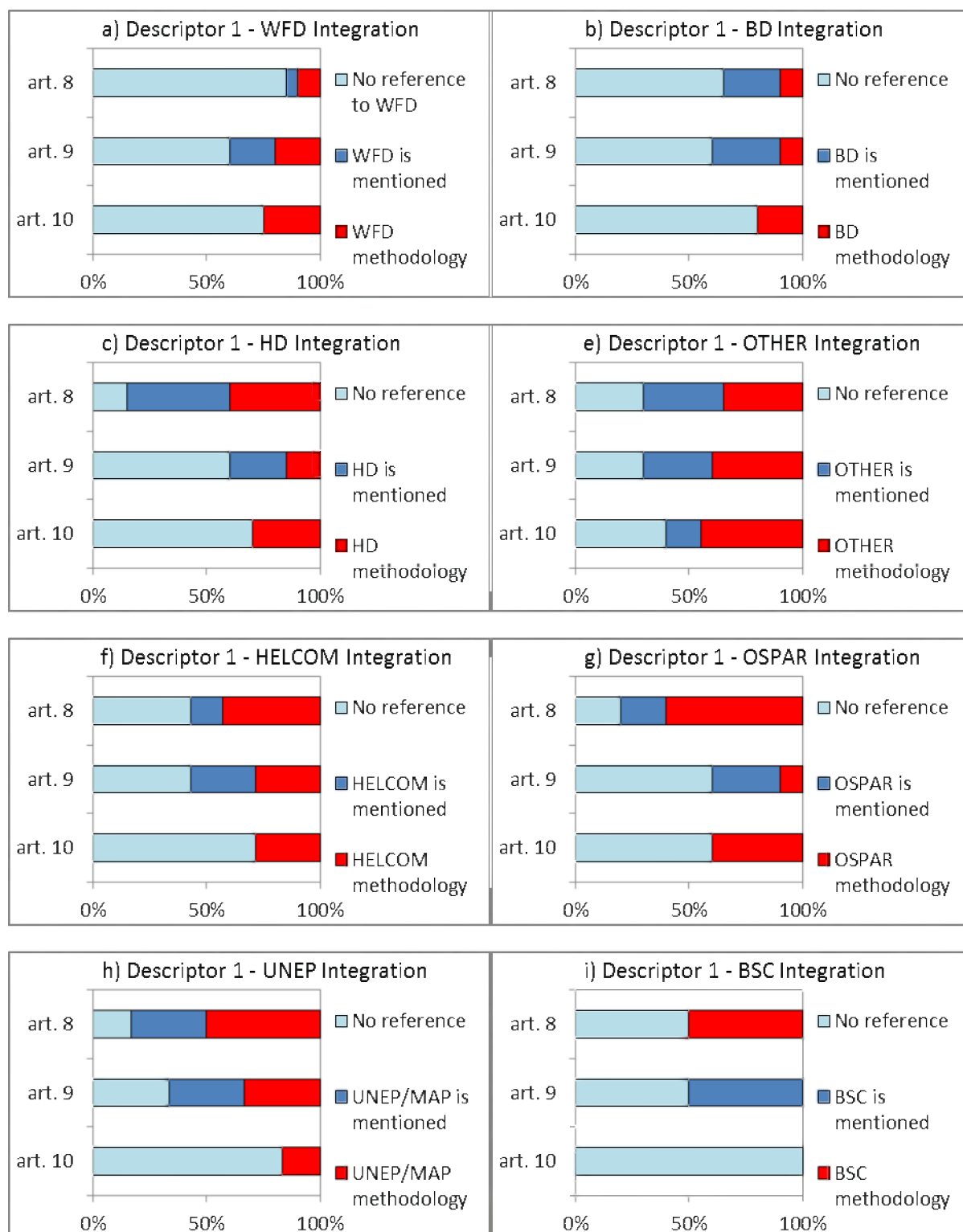
Figure 2. Level of integration among Member States' reports (19 MS) for article 8, 9 and 10 and EU relevant legislation, international agreements and RSC for Descriptor 1.

Descriptor 4
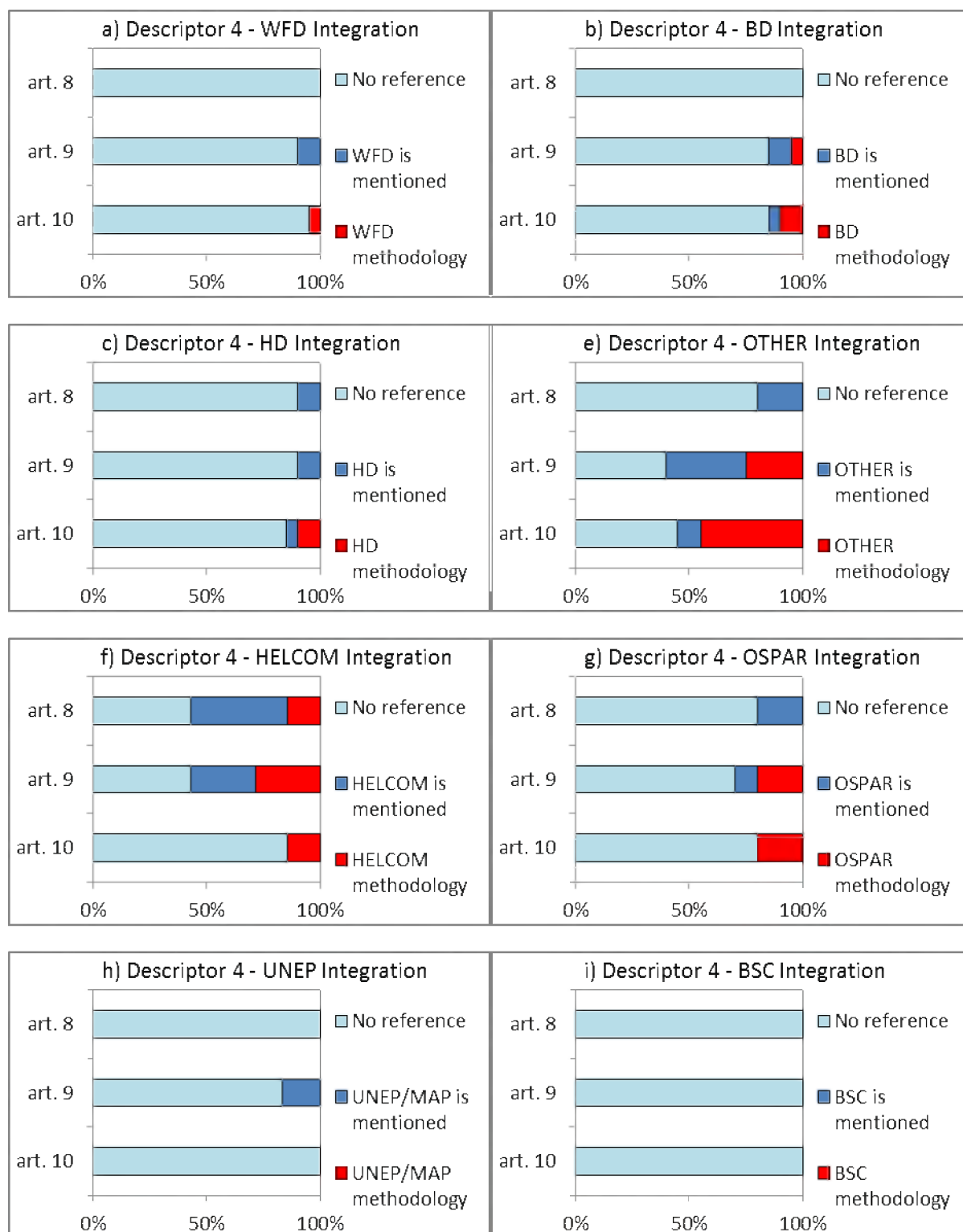
Figure 3. Level of integration among Member States reports (19 MS) for article 8, 9 and 10 and EU relevant legislation, international agreements and RSC for Descriptor 4.

Descriptor 6
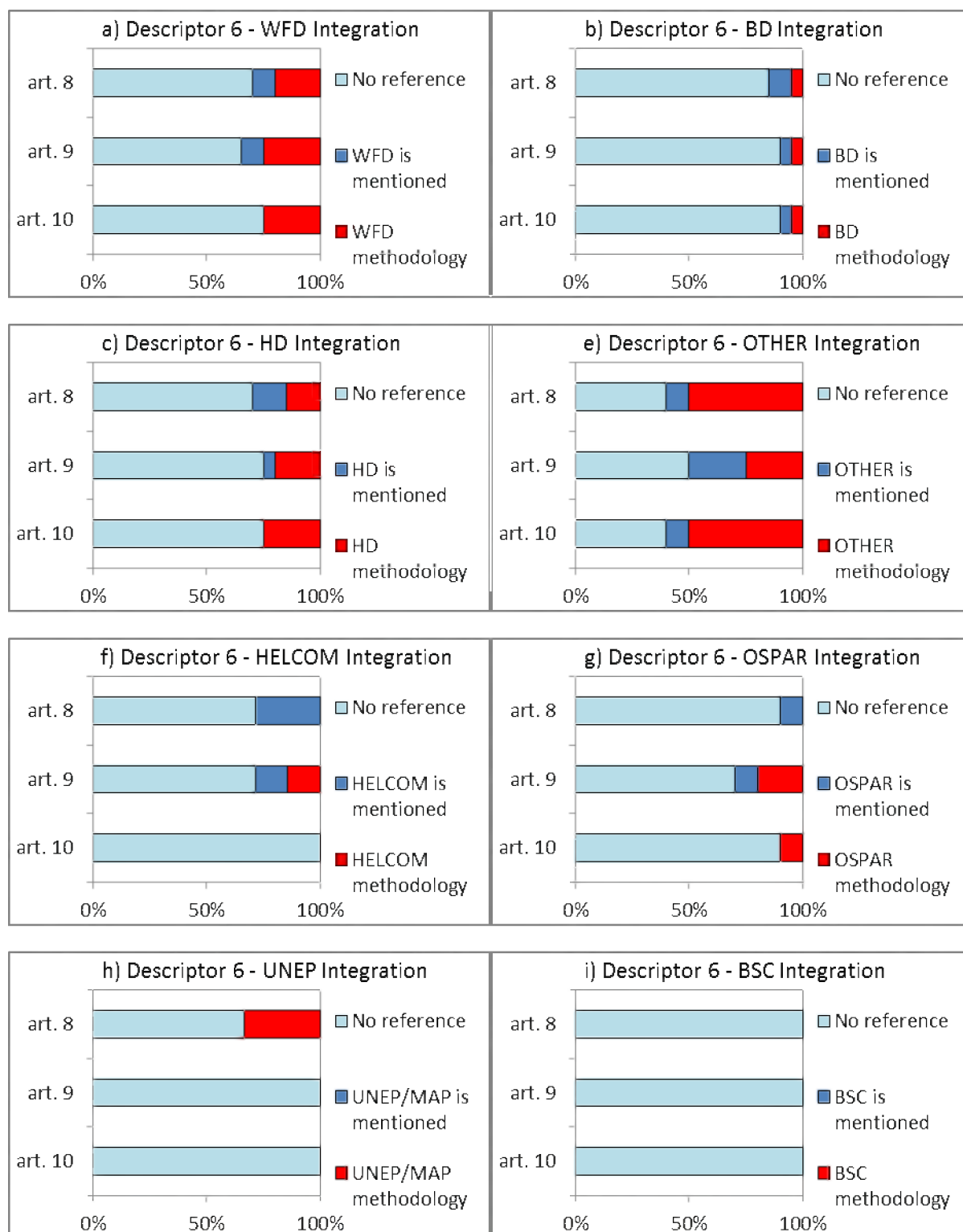
Figure 4. Level of integration among Member States reports (19MS) for article 8, 9 and 10 and EU relevant legislation, international agreements and RSC for Descriptor 6.

The similarity plot (Fig. 5) shows a gradient of proximity among MS belonging to different RSC. The plot is based on the level of integration of each Member State with policies and agreements. The plot was generated by accounting the similarities in a matrix containing the MS on one axis and the

reported policies and agreements on the other. The closer the MS are on the plot, the more common policies and agreements have reported. This is a relative metric of the coherence on regional level regarding the consideration of policies and agreements, since it clearly depicted a regional clustering.
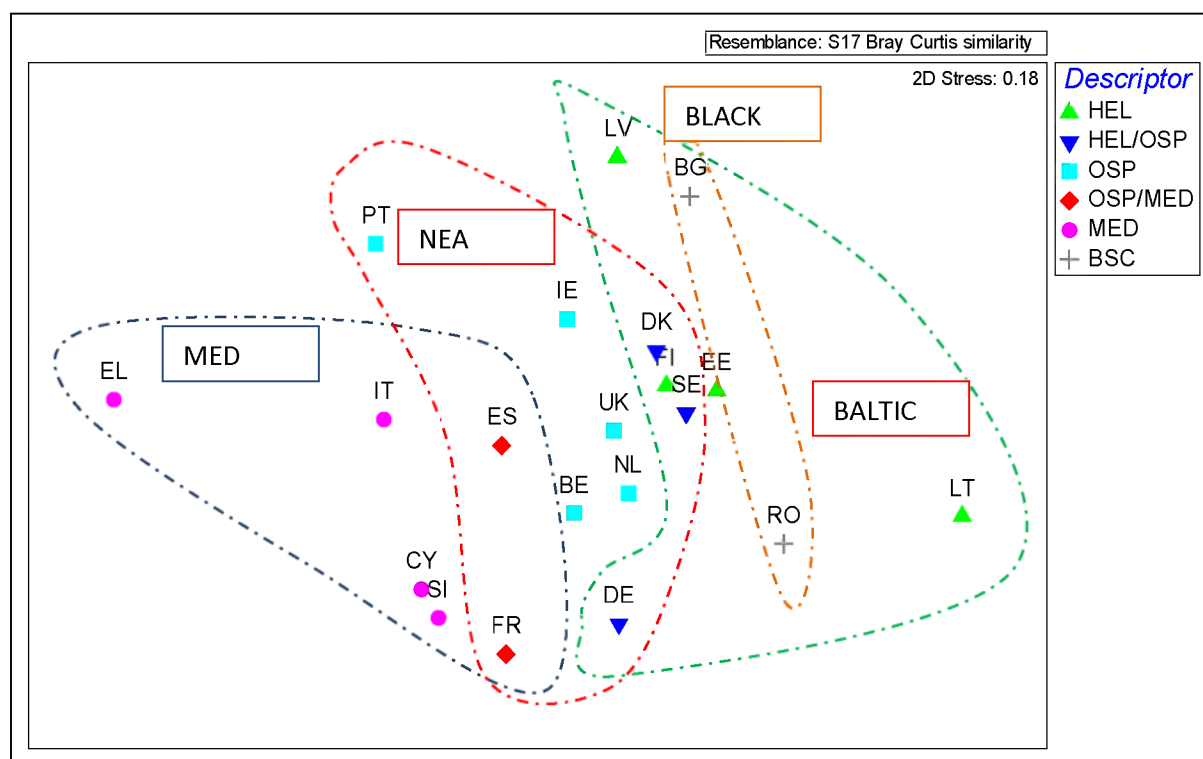
Figure 5. Similarity among level of Integration of Member States reports for article 8, 9 and 10 and EU relevant legislation, international agreements and RSC for Descriptor 1, 4 & 6. MS were allocated to the RSC they participate in order to regionalize the similarities amongst the MS and explain the position of MS participating in two RSC.

3.3 Assessing the level of heterogeneity in reported state characteristics

In the frame of the Initial Assessment (Art. 8) MS have to report state characteristics of the marine environment including biological features (species and species groups and/or functional groups), habitats and ecosystems. An indicative list of state characteristic is contained in Table 1 of Annex III of the MSFD. In this analysis we quantified the reported characteristics to assess the coherence within and between the RSC at the level of:

    a. individual species
    b. species groups/functional groups (of highly mobile species)
    c. habitat types and
    d. ecosystems

Figure 6 shows the distribution of the state characteristics reported by MS on a regional level. These show that reporting on the base of species and habitats was very limited while reporting on the base of functional groups and ecosystems more often, although regional differences do exist.
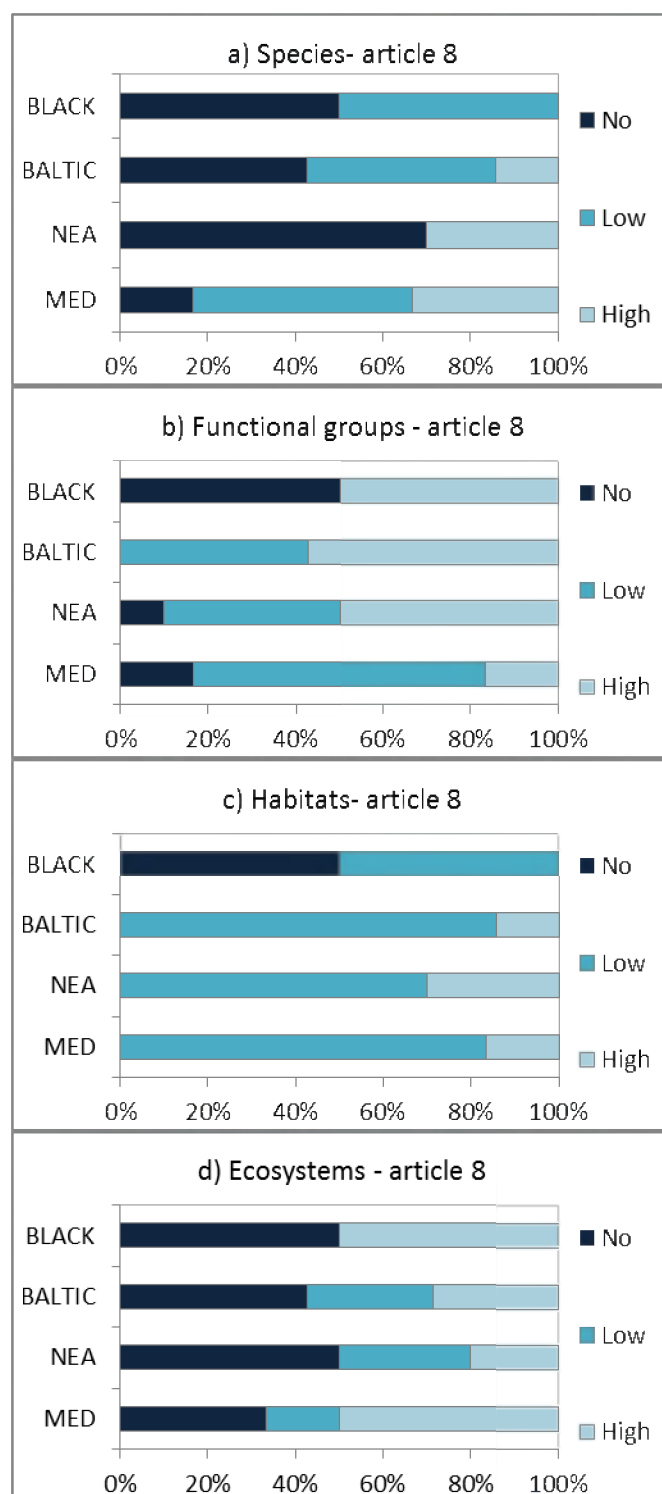
Figure 6. Number of reported biological features, habitats and ecosystems in the four marine regions (19 MS).

Fig. 7 and Fig. 8 highlight the habitats and the functional groups (*sensu* CSWD (SEC, 2011)1255 final) more frequently reported by the MS. Sublittoral and littoral benthic habitats are more frequently reported while pelagic ones are rarely reported. Fish (particularly demersal ones) seems to be the most frequently reported functional groups.
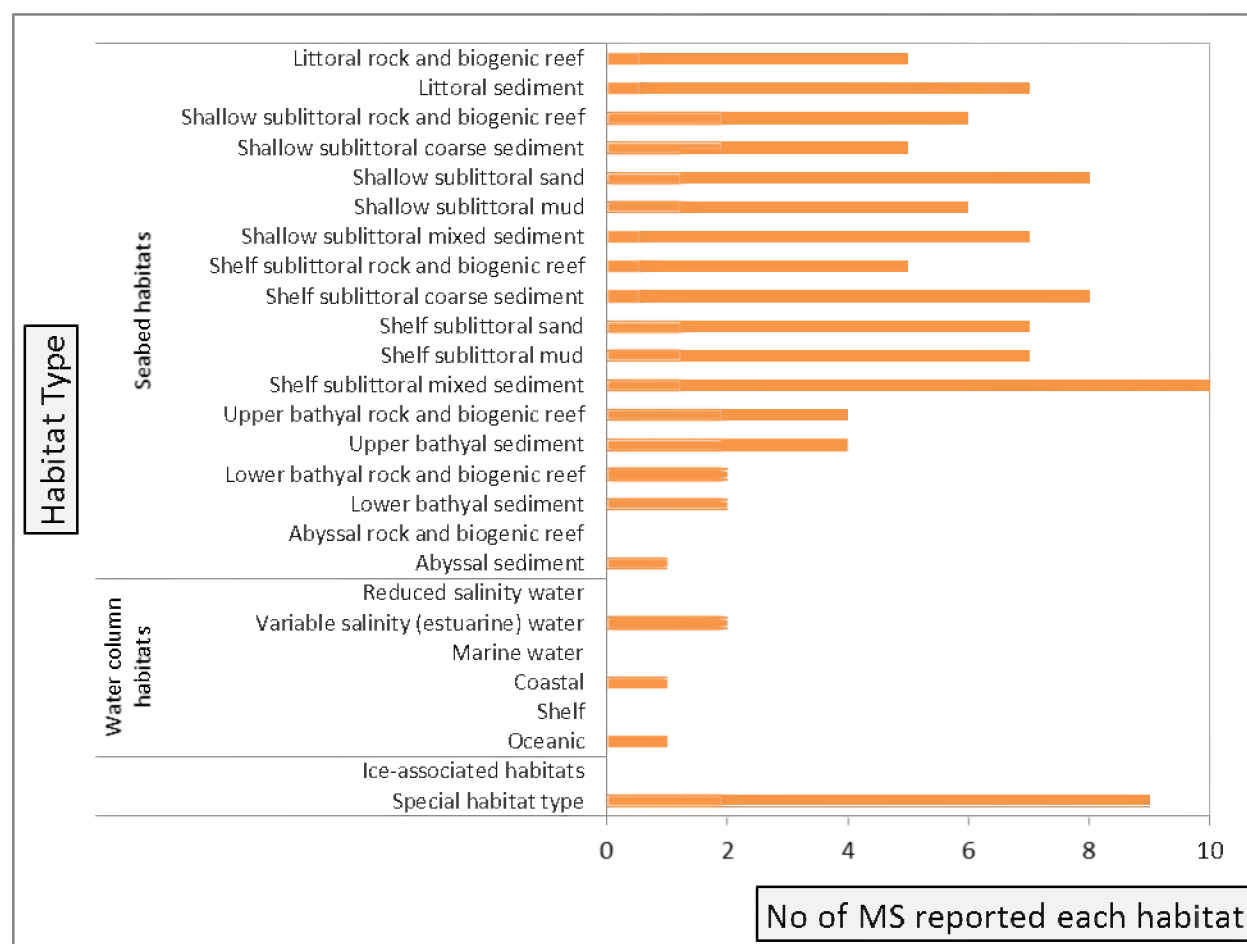
Figure 7. Number of Member States (total=19) reporting on each of the predominant habitat types listed in the Commission Staff Working paper SEC (2011) 1255.
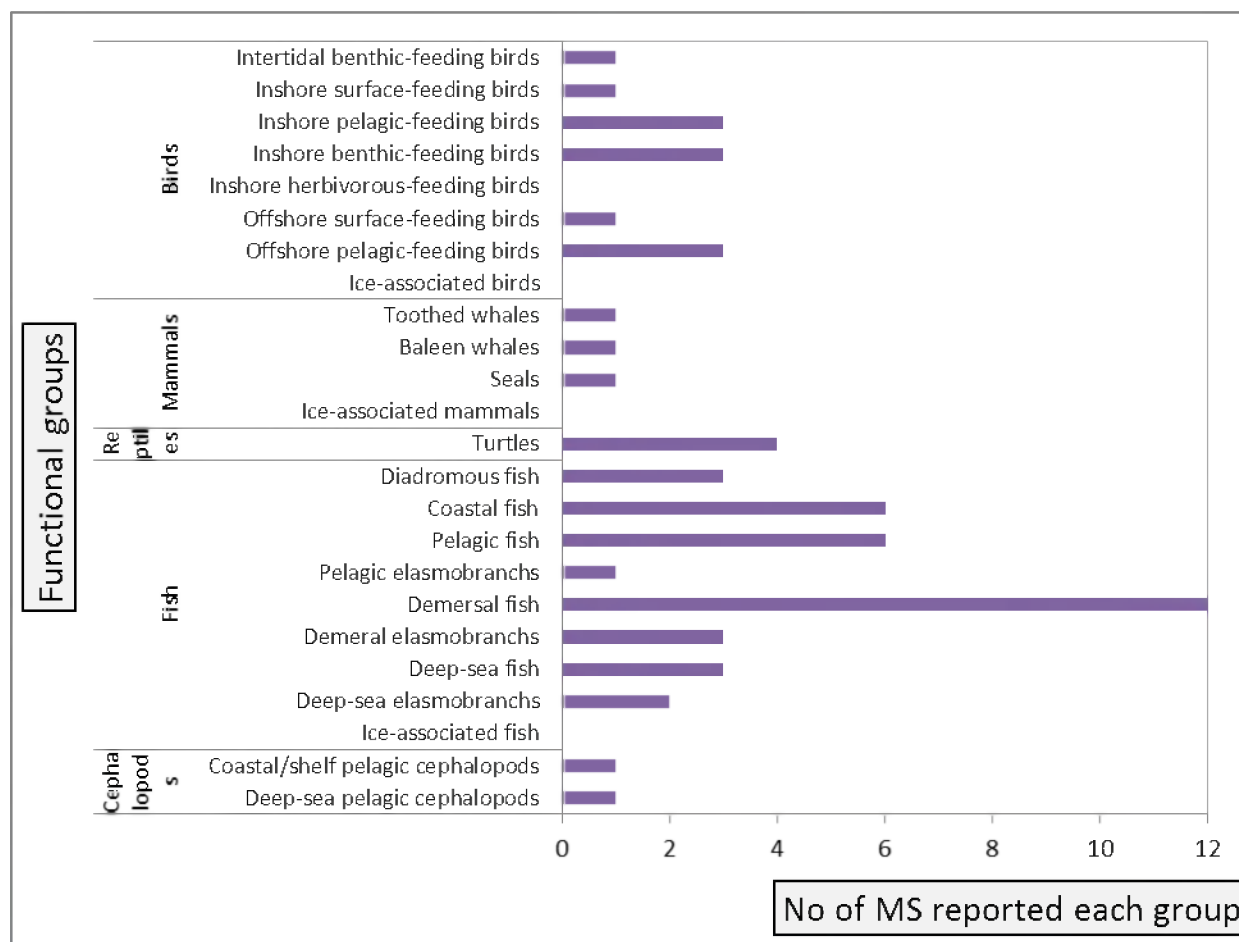
Figure 8. Number of Member States (total=19) reporting on each of the species' functional groups listed in the Commission Staff Working paper SEC (2011) 1255.

4. Discussion

4.1 Level of MSFD biodiversity integration with pieces of EU legislation, RSC and other international agreements

Descriptor 1

The level of integration between MSFD D1 and other EU legislations (i.e. HD, BD, WFD), other international agreements (e.g., conventions – Bern, CITES, Bonn) and RSC agreements was assessed and it is characterized by a wide variation, as presented in Fig. 2. The HD was considerably more often taken into account compared to other legislations and agreements but the general overview of the level of integration is relatively low, despite the overlap between MSFD and the assessed legislation and agreements and the associated data availability.

Regarding the RSC, it is obvious that MS tend to follow the corresponding agreements especially in the RSC that are more advanced on assessing biodiversity. MS should be encouraged to further support the RSC actions for a harmonized biodiversity assessment on a regional scale, since there is still room for improving the level of integration in this perspective.

Descriptor 4

The rather low level of integration between D4 and EU legislation is partially explained by the indirect links between them. HELCOM seems more advanced in developing and agreeing D4 related methodologies and this is clearly reflected in the high level of integration compared with other RSC. As such HELCOM should be highlighted as a good practice for the high level of coherence between its contracted parties and could set the methodological scheme for the other RSC.

Descriptor 6

WFD and HD overlap with MSFD D6 more than other EU legislations and agreements, as shown in Fig. 4, but not at the expected level, since approximately only one third of the MS have considered them in their implementation. There is very low integration between D6 and RSC and this shows a gap in the development of agreed methods for the implementation of D6 on regional level.

The similarity plot (Fig. 5) provides an overview of the correlations amongst MS regarding their level of integration with EU legislations, RSC and other international agreements and conventions. It clearly depicts some clusters of MS as resulted by their integration with RSC but on the other hand, it reveals the heterogeneity amongst them, particularly when the relative distances between neighbour countries are taken into account.

In the frame of the initial assessment (Art. 8) MS have reported state characteristics of the marine environment, including biological features (species, functional/species groups), habitats and ecosystems. An indicative list of state characteristic is in Table 1 in Annex III of the MSFD. The analysis of the reported state characteristics provides an insight on the priorities of MS in respect to habitats, species and ecosystems, their level of ambition in the MSFD implementation and the diversity of their marine environment (both related to the reported number of state characteristics). The reporting of state characteristics also shows the differences amongst the MS' interpretation and

implementation of MSFD Art. 8. The predominant habitat types and functional groups listed in SEC (2011) 1255 final (table 7 and table 3, respectively) were compared with the reported characteristics. Not all MS report in the reporting sheets habitats, species and functional groups. A wide range of characteristics (e.g. 3 to 84 for habitats) was reported by the MS. Compared to the indicative habitats and functional groups lists, some MS reported only a proportion of them, while others much more than the listed ones. The observed differences and the variation in approaches could be, to some extent, due to biogeographical differences but may also indicate considerable heterogeneity in the implementation of Art 8 for the biodiversity descriptors.

The comparison of the reported habitat types and functional groups with the ones lists in SEC (2011) 1255 final (table 7 and table 3, respectively) confirmed the variety in the initial assessment approaches. In Fig. 7 it is shown that a few habitat types were not reported by any Member State, mostly those related with the water column. Habitats on the continental shelf are mostly reported as well as special habitat types defined by the MS. Concerning the functional groups, most of the MS reported demersal fish, since this group is also related with other state (1, 3) or pressure (2, 7, 9) descriptors. Fish are generally reported more than other functional groups and this is also related to data availability, probably because of the Data Collection Framework (DCF) of the Common Fishery Policy (CFP).

Recommendations: MS should be encouraged to further support the RSC actions for a harmonized biodiversity assessment on a regional scale, since there is still room for improving the level of integration in this perspective. Inter-RSC cooperation to bridge the differences, knowledge transfer and to increase coherence is needed. Descriptors 1, 4 and 6 differ in maturity regarding methods and related data requirements and this is reflected in the level of integration with existing pieces of legislation and agreements. The related legislations and agreements acquis and their overlap with MSFD is able to set a consistent base on which MSFD is implemented, at least on a regional level. The differences in state characteristics resulted, inter alia, to the different MS' priorities in respect of habitats, ecosystems, species and functional groups. A minimum level of state characteristics should be established to ensure a certain level of coverage within the MSFD, followed by specifications to increase the consistency and comparability between MS (e.g. demersal species and the related indicators should be reported by all MS, since data are collected from all MS for the CFP).

4.2 Methodological approaches

The room allowed for interpretation in the implementation of MSFD creates a complexity on reported indicators. The number of reported methodologies from MS is clearly influenced by the level of detail of the indicator description. This issue determined the high level of heterogeneity in the number of methods for each indicator (Table 1). The number of methods proposed for indicators with a generic description (indicator 1.1.1: Distributional range of species) is greater compared to an indicator with specific description (6.2.4: Parameters describing the characteristics (shape, slope, intercept) of the size spectrum of the benthic community).

The reported indicators per Member State do not cover all the indicators listed in COM Decision (2010/477/EU), and the combination of the final reported indicators generates an additional level of complexity/incoherency while reducing comparability. An additional element of complexity in the assessment of the reports is the association of a method either to an indicator, criterion or descriptor level. MS should, ideally, report at the same level (indicator or criterion) in order to reduce the heterogeneity in reporting and the possibilities of different views amongst the MS. Similarities across indicators and different MS' interpretations (or not commonly agreed definitions) led some methods to be reported into more than one indicator. The Task Group 1 Report – Biological diversity (Cochrane et al., 2010) suggested that the quantification of targets may also be set for desired levels of a pressure or activity. In the reporting sheets few examples of pressure-based targets were provided. Most of the targets (and GES) are state or impact based. A direct link between biodiversity related pressures (as reported for Art. 8) and indicators is also required to improve the consistency across the three articles and develop more concrete indicator-based targets that may also include pressure-related targets.

Descriptor 1

The analysis of the methods reported for D1 revealed a vast number of methods. Some indicators are very specific (e.g. 1.2.1 Population abundance and/or biomass) having a straight-forward implementation, compared to other more sophisticated and general (e.g. 1.7.1 Composition and relative proportions of ecosystem components), that include several methods and models. This is reflected in the times each method reported for each indicator, a number which is also increased by the implementation of one method to different species, habitats, functional groups or ecosystems. Indicators from the species distribution criterion are reported more compared to other criteria. Habitat related criteria (1.4 – 1.6) are reported less often, and the ecosystem structure criterion (1.7) is the least applied criterion within D1. Fig. 1 presents the frequency of use of the indicators per marine region. For D1 the three groups of indicators (species, population, habitats/ecosystems) present a variation in the frequency of use amongst the regions. The most frequently used indicator is 1.2.1 (population abundance and/or biomass).

Descriptor 4

This descriptor includes three specific indicators which have been reported considerably less than D1 showing that the level of maturity and/or the data availability of D4 are less compared to D1. The 4.3.1 indicator (abundance trends of functionally important selected species and functional groups) is reported almost twice as frequently compared to 4.2.1 and 4.1.1.

Descriptor 6

The two criteria belonging to D6 are not equally reported. 6.2 (condition of benthic communities) and particularly indicator 6.2.2 (multi-metric indexes assessing benthic community conditions and functionality) are more often reported, probably due to the long scientific tradition of assessing marine quality based on macrobenthos and particularly the use of such multimetric indices in the WFD (for zoobenthos and macrophytes in coastal waters).

In general, it seems that the contribution of each indicator into the implementation of MSFD differs, depending mostly on the data availability. The fact that different MS relate the one methods to different indicators show the different interpretations of the indicators and the need for a more

clear framing of indicators. Indicators reported for D1, D4 and D6 are mostly state indicators and as such could not directly be linked with the pressures reported in the initial assessment.

Recommendations: *A core set of indicators for biodiversity would be a step to increase coherence and comparability between MS. The core set should at least have one indicator per criteria for D1, 4 and 6. The selection of the indicators and the associated common methodological approaches require experts' consultation and taking into account the IDA. The JRC's review of methodological standards related to MSFD criteria on GES (Piha & Zampoukas, 2010) provides an adequate base for comparable approaches by the MS, while it could be further updated and possibly include experts' consultation representing each region. The analysis of the targets showed that there is a wide variety in the perspectives of the MS, the number and the nature of the targets (pressure or impact related) and their link with specific and measurable methods. A first step to a homogenous definition of targets (more focused on pressures and impacts) that would improve the GES assessment would be the establishment of a target-indicator-method connection. Another step to that direction would be the definition of a minimum set of state characteristics on regional level, in order to ensure that MSFD covers the priority parts of each ecosystem, especially when these are included in other legislations.*

4.3 Reporting and assessing issues

The IDA revealed several critical issues in relation to the reporting process of Articles 8, 9 & 10. It was very surprising that the reporting sheets did not contain the same information as the MS' paper reports. In some cases the two reports were complementary, while in others dissimilarities were noticed even on the methodological level. In several cases, differences in crucial elements of the MSFD implementation were found, such as in the definition of GES and targets. Furthermore, there seems to be various interpretations of the MSFD that led to heterogeneous reporting of similar information, while the provided information is often not comparable (some MS reported qualitative information and others quantitative, information reported in different scales, units, etc.). Moreover, there are references to gray literature, national legislations and RSC' documents that further reduce clarity and transparency, etc. The issues above undermine the validity of the reporting spreadsheets and the paper reports and limit the possibilities for a meaningful IDA by possibly leading to an underestimation of the actual level of integration between MSFD and other agreed documents and thus, to a biased IDA .

The flexibility in the interpretation of the Directive and the related COM Decision led to considerably different approaches in initial assessment, GES definition targets setting for different MS. Particularly, GES definition and 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 two-fold complication to the assessment of MSFD implementation because of the incomparability between the GES and targets between neighbouring MS and the inability to assess whether the GES or the targets are achievable. In relation to GES and targets, MS present different levels of ambition, reflected in the number of targets, the precise qualitative metrics and the strict or loose definition of

GES. Differences in ambition lead to incoherence in the implementation of MSFD, even within the same region. More synergies and coordination between MS are necessary, taking into account the dissimilarities environmental conditions, economies, human resources, infrastructures and extent of marine waters under each Member State's jurisdiction.

Recommendations: Clear links should be made between pressures and impacts (Annex III, Table 2 of MSFD) and criteria and indicators (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 indicators accompanied by common agreed measurable methodologies.

Reporting sheets should reflect the MS' paper reports, since they consist an electronic way of reporting the qualitative and quantitative data and not an independent one. The required information in the reporting sheets could be significantly reduced and the process could be automated by using drop-down boxes with specific option, where appropriate, to reduce the different perspectives of the MS.

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5. Conclusions

Table 2 includes the key findings of the in-depth-assessment for the MS' reports on Art. 8, 9, 10 and D1, 4 & 6, based on the data included on the electronic sheets, the consultant's reports and partially on the MS' papers reports. Each addressed issue is followed by a suggestion and potential actions and actors, where appropriate.

Table 2. List of key issues derived from the in-depth assessment for D1, 4 and 6, suggestions and potential actions to be dealt with.

Issues on implementation	Suggestion	Potential actions/actors
Low integration with WFD and BD, relatively higher with HD.	Better exploitation of methods, data and features derived from other legislations.	MS
Low/Moderate integration between MSFD and RSC.	Active involvement of the RSC or the MS on regional level in the establishment of coherent and comparable with WFD and RSC' indicators, methods and thresholds.	Links between MSFD-WFD-RSC / MS & RSC
Reporting on biodiversity (from species to ecosystems) considering a minimum list of state characteristics common for neighbour MS.	Adaptation of methodologies, indicators, state characteristics on regional level.	RSC could supervise the adaptation / RSC & MS
Heterogeneity in definition of GES and targets both at European level and at RSC level.	Links between definition of GES and targets, through predefined methods.	RSC / MS
HELCOM could be considered as a good practice of MSFD-RSC integration.	HELCOM approach to be adopted or to inspire other RSC, if applicable.	RSC
Gaps in biodiversity knowledge	Encourage bilateral and regional cooperation to set a more comprehensive background on biodiversity taking into	Scientific and pilot project at regional and sub-regional level / MS and RSC

	account the environmental similarities.	and the Commission
Issues on methods	***Suggestion***	***Potential actions/actors***
High heterogeneity in the number and type of methodological approaches, thresholds and limits in MS reports.	Common agreed and comparable methodological standards on a regional or EU scale.	Starting for the frequently used methods / MS & RSC
Inconsistency on indicators reported per criterion.	Core set of biodiversity indicators to ensure the minimum level of coherence, without degrading the value of MSFD.	JRC led network of experts / COM Decision revision
High heterogeneity in the indicator definition: generic indicators (e.g. 1.2.1) to methodological-like description (e.g. 1.6.3).	Improve the interpretation of indicators by linking them with specific methods on a pan-European or regional level, if possible.	JRC led network of experts / COM Decision revision
Definition of GES and targets are based on state or impact indicators. Lack of pressure-based indicators for biodiversity.	Define pressure indicators for biodiversity based on MS initial assessment.	JRC led network of experts / COM Decision revision
Issues on reporting	***Suggestion***	***Potential actions/actors***
Differences between paper reports and electronic sheets; missing or not adequately reported information; similar information is reported under different fields; Different level of detail in the reported information.	Electronic reports should reflect paper reports to facilitate the assessment of Art 8, 9 and 10 implementation and not to be presented as a second report that completes or covers the first one. The required information in the electronic reports could be significantly reduced and the process could be automated by using drop-down boxes with specific option.	Updated guidance on reporting with reduced and more specific fields/ ENV
Inconsistency in reports regarding Article 8, 9 & 10 implementation, the use of pressures and impacts in them and their link with criteria and indicators.	Clear links between pressures and impacts (Annex III, Table 2 of MSFD) and criteria and indicators (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.	JRC led network of experts / COM Decision revision
Improving the efficiency and homogeneity of reporting sheets; improve data access and data management for the MS evaluation of MSFD implementation (Art. 12).	Coherence in reporting to allow for accurate and meaningful IDA.	Improve electronic forms, data & metadata availability / MS & ENV

6. References/Sources

- Reporting sheets
- Milieu reports (1- national level, 2- regional level, 3- Analysis of Regional Sea Convention needs)
- National paper reports (in some cases)
- Cochrane et al. 2010. MSFD - Task Group 1 Report – Biological diversity
- Rogers et al. 2010. MSFD - Task Group 4 Report – Food webs
- AA.VV. Common Understanding of (initial) Assessment, Determination of Good Environmental Status (GES) & Establishment Targets
- Zampoukas et al. 2012. Monitoring for the MSFD: Requirements and Options
- UNEP-WCMC / MRAG-Ltd / URS. 2013. "Streamlining and harmonisation of reporting requirements under EU instruments and Regional Seas Conventions"
- Commission Decision (2010/477/EU)
- The Habitats Directive marine species and habitats
- The Birds Directive Marine Species
- The OSPAR list of Threatened and/or Declining Species and Habitats
- The OSPAR ecological quality objectives
- The HELCOM biodiversity CORESET indicators
- The WFD agreed boundaries for macroalgae, angiosperms, benthic invertebrate fauna (and possibly also for phytoplankton taxonomic composition)
- The JRC report on existing methodological standards for MSFD GES (Piha & Zampoukas, 2011)
- The Commission staff working paper (SEC(2011) 1255 final) on the "Relationship between the initial assessment of marine waters and the criteria for good environmental status".

Annex I. Member States included in the analysis.

Member State	Abbreviation	RSC
Belgium	BE	OSPAR
Bulgaria	BG	Black Sea
Cyprus	CY	UNEP/MAP
Denmark	DK	OSPAR/ HELCOM
Estonia	EE	HELCOM
Finland	FI	HELCOM
France	FR	OSPAR - UNEP/MAP
Germany	DE	OSPAR- HELCOM
Greece	EL	UNEP/MAP
Ireland	IE	OSPAR
Italy	IT	UNEP/MAP
Latvia	LV	HELCOM
Lithuania	LT	HELCOM
Netherlands	NL	OSPAR
Portugal [3]	PT	OSPAR
Romania	RO	Black Sea
Slovenia	SI	UNEP/MAP
Spain	ES	OSPAR - UNEP/MAP
Sweden	SE	HELCOM- OSPAR
United Kingdom	UK	OSPAR

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[3] Portugal provided only the national paper report and not the reporting sheets, by the time IDA was taking place.

IN-DEPTH ASSESSMENT OF MEMBER STATES' SUBMISSIONS FOR MSFD ART. 8, 9 & 10 ON NON-INDIENOUS SPECIES, DESCRIPTOR D2
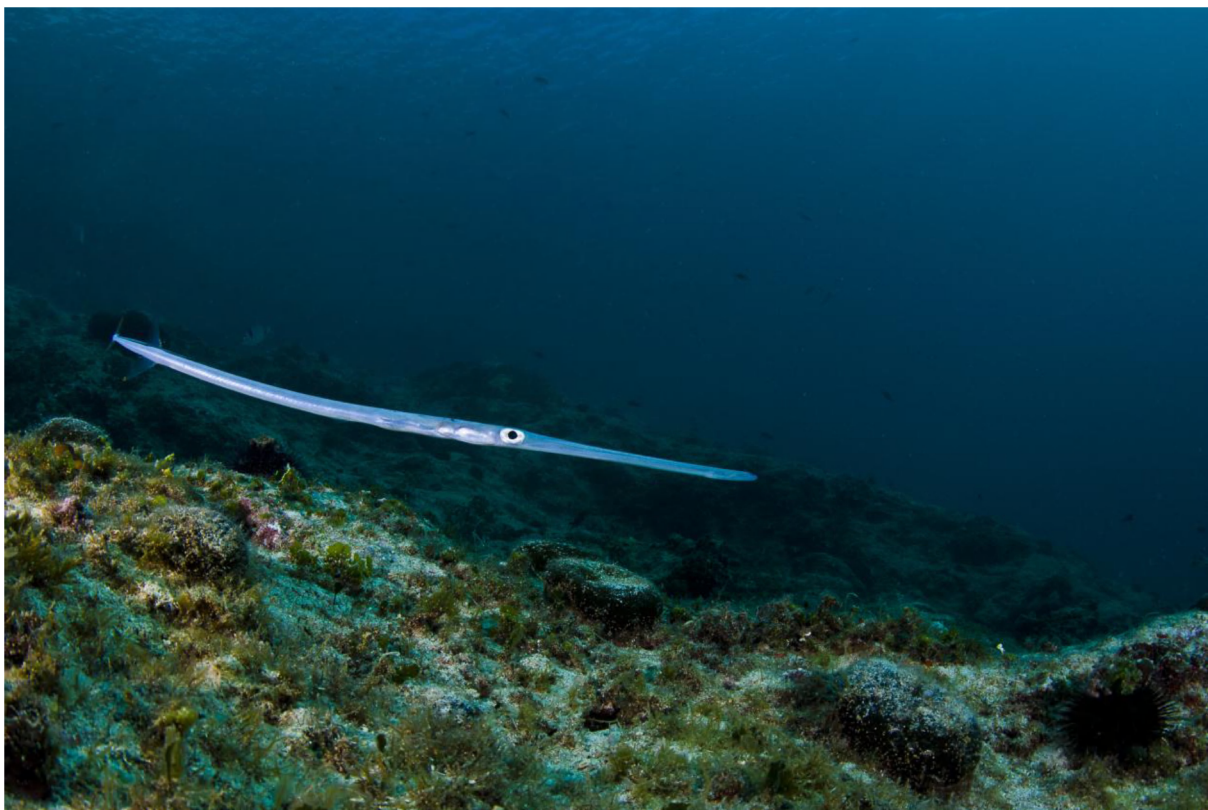
NON-INDIGENOUS SPECIES

Photo by Yiannis Issaris (www.yissaris.com)

Contents for D2

1. Introduction

The COM DEC (2010/477/EU) defines Descriptor 2 as "**Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem**". The Descriptor focuses on the identification and the assessment of pathways and vectors that are responsible for spreading non-indigenous species (NIS) as a result of human activities. It is recognized that there is only limited knowledge about the effects of the NIS on the environment, which implies additional scientific and technical development focused on new potentially useful indicators. Descriptor 2 includes two criteria and three associated indicators (COM DEC 2010/477/EU):

Criterion 2.1. Abundance and state characterization of non-indigenous species, in particular invasive species

— Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species (**Indicator 2.1.1**)

Criterion 2.2. Environmental impact of invasive non-indigenous species

— Ratio between invasive non-indigenous species and native species in some well-studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species) (**Indicator 2.2.1**)

— Impacts of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible (**Indicator 2.2.2**).

For the purposes of this analysis and in order to clarify the grouping of species into non-indigenous and invasive the TG2 (Olenin et al., 2010) definition has been adopted:

Non-indigenous species (NIS; synonyms: alien, exotic, non-native, allochthonous) are species, subspecies or lower taxa introduced outside of their natural range (past or present) and outside of their natural dispersal potential. This includes any part, gamete or propagule of such species that might survive and subsequently reproduce. Their presence in the given region is due to intentional or unintentional introduction resulting from human activities. Natural shifts in distribution ranges (e.g. due to climate change or dispersal by ocean currents) do not qualify a species as a NIS. However, secondary introductions of NIS from the area(s) of their first arrival could occur without human involvement due to spread by natural means.

Invasive alien species (IAS) are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere, and have an adverse effect on biological diversity, ecosystem functioning, socio-economic values and/or human health in invaded regions. Species of unknown origin which cannot be ascribed as being native or alien are termed cryptogenic species. They may also demonstrate invasive characteristics and should be included in IAS assessments.

1.1 Aim of the in-depth assessment

On request of DG ENV, the JRC performed the D2 in-depth assessment (IDA) of the Member States reports for Article 8, 9, and 10, as a follow up of the MSFD Art 12 assessment. The aim of the IDA is to provide a holistic view of the implementation of the MSFD rather than to comment on MS' practices. Particularly IDA aims to:

- Identify the level of integration between the MSFD implementation and other legislations, assessments, requirements and agreed standards

- Evaluate coherence of methods and practices across MS and within RSC

- Identify and evaluate the gaps and discrepancies in the implementation of Articles 8, 9 and 10

- Provide recommendations for improved implementation in the second MSFD cycle

- Support the review and possible revision of the COM DEC (2010/477/EC) on criteria and methodological standards

1.2 Non-indigenous species related legislation and agreements on EU and RSC level

1.2.1 EU legislation and agreements related to NIS

Recently, the European Commission has published a proposal for a EU regulation to tackle IAS (COM(2013) 620 final). This proposal seeks to provide a comprehensive and holistic framework for the assessment, management and prevention of NIS among other by building on existing instruments and increase their coordination. The proposal was published after the MSFD reporting of MS for Articles 8, 9 and 10 but consideration of the COM(2013) 620 final and the potential related regulation should be prerequisite in the next phase of the MSFD implementation. Other EU legislations related to NIS include: (i) The Regulation on the use of alien and locally absent species in aquaculture (2007/708/EC), which addresses the release of alien species for aquaculture purposes, (ii) the Birds Directive (2009/147/EC), (iii) the Habitats Directive (92/43/EC), (iv) the Phytosanitary Directive (2000/29/EC), (v) the Regulation on wild species trade (1997/338/EC) and (vi) the Water Framework Directive (2000/60/EC). The latter four legislative instruments are not focused on NIS but partly cover this issue by requiring NIS consideration in the frame of restoration of biodiversity conservation status and ecological conditions.

1.2.2 International agreements related to NIS

The Convention on Biological Diversity (CBD) stipulates, *interalia*, the policy background regarding alien species, which is adopted by the Communication from the European Commission for an EU biodiversity strategy with the aim of halting biodiversity loss by 2020 (COM(2011) 244 final). One of the objectives is the reduction of the impact of IAS and alien genotypes. An agreement with extreme relevance to marine IAS is the IMO International Convention on the Control and Management of Ships' Ballast Water and Sediments (BWMC) which aims to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. However, the BWMC will only enter into force 12 months after ratification by at least 30 States, representing more than 35 per cent of world

merchant shipping tonnage. As of 9th January 2013, 38 States had ratified the Convention, representing 30.4 per cent of the world merchant shipping tonnage; hence BWMC may not yet be adopted. Ballast water from ships is recognized as an important anthropogenic vector transferring species to other locations and the IMO BWMC has been already or is going to be endorsed on regional level (e.g. HELCOM).

1.2.3 RSC agreements related to NIS

Barcelona convention: In 2005 the Regional Activity Center/Specially Protected Areas (RAC/SPA) crafted an Action Plan on Invasive Species to deal with their growing number in the Mediterranean. This Plan aimed at strengthening the capacities of the Mediterranean countries as regards the prevention and control of introductions of species into the Mediterranean Sea, and coordinating their efforts to this end. Another initiative related to NIS included in the UNEP-MAP's Mediterranean Strategy (UNEP-MAP-RAC/SPA, 2005) for the management of ships' ballast waters and sediments, within the framework of the Barcelona Convention and according to the standards of the IMO BWMC.

HELCOM: Recently HELCOM countries have agreed to ratify the BWMC after a HELCOM Ballast Water Road Map that was adopted by the HELCOM Ministerial Meeting (2007) in Krakow to facilitate the ratification of the BWMC in the region. A list of non-indigenous, cryptogenic and harmful native species in the Baltic Sea was compiled for the needs of HELCOM Ballast Water Road Map, HELCOM HABITAT and MONAS and is continuously edited and updated by various HELCOM subsidiary bodies, expert workshops and projects. Since 2008 the list has been modified by HELCOM HABITAT (11/2009 and 12/2010), HELCOM MONAS (12/2009), the HELCOM HOLAS project and, most recently, by the HELCOM CORESET project. HELCOM ALIENS projects are focused on NIS (ALIENS 3 is on-going and aims to support the ratification of BWMC).

The HELCOM CORESET project aims to develop a set of core indicators in the Baltic Sea. These indicators should, amongst others, support the assessment and the monitoring of GES as defined by the MSFD. The core indicators have been developed on the common principles agreed by HELCOM (HOD 35/2011). Currently, 18 core indicators were developed for biodiversity, covering significantly the needs of MSFD. Table 1 shows the D2 HELCOM proposed indicators in relation to the COM DEC (2010/477/EC) indicators and criteria.

Table 1. Comparison of the proposed HELCOM core indicators with the indicators of the EC Decision 477/2010/EC. (Table modified from: HELCOM, 2013).

COM DEC (2010/477/EC) D2 indicators	Proposed HELCOM core indicators
2.1.1 Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species	Trends in arrival of new non-indigenous species (Baltic Sea Environmental Fact Sheets: Abundance and distribution of Round goby (*Neogobius melanostomus*); Abundance and distribution of the Zebra mussel (*Dreissena polymorpha*); Abundance and distribution of *Marenzelleria* species in the Baltic Sea
2.2.1 Ratio between invasive non-indigenous species and native species in some well-studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species)	(Baltic Sea Environmental Fact Sheets: Observed non-indigenous and cryptogenic species in the Baltic Sea)
2.2.2 Impacts of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible	(Baltic Sea Environmental Fact Sheets: Biopollution level index)

OSPAR: The Quality Status Report (QSR, 2010) provides a detailed list of NIS including their taxonomic group, common names, regions affected, vector, first reported and probable impacts. The list includes species belonging to plants, algae, phytoplankton, invertebrates and protozoa. Over 160 NIS have been identified in OSPAR area. The QSR (2010) highlights the necessity of the OSPAR countries to ratify and implement the IMO BWMC and to assess the risk of new species introduction. OSPAR is taking action to ensure the early application of standards consistent with the IMO BWMC acknowledging ships' ballast water as a main vector of NIS and is also addressing the Regulation on the use of alien and locally absent species in aquaculture (2007/708/EC). The indicator "rate of new introductions of NIS per defined period" included into OSPAR COBAM candidate indicators related to NIS. The ICG COBAM (Intersessional correspondence Groups Coordination of Biodiversity Assessment and Monitoring) produced a list of 43 potentially common regional indicators including related Ecological Quality Objectives.

Black Sea Convention: The Black Sea Biodiversity and Landscape Conservation Protocol to the Convention on the Protection of the Black Sea Against Pollution includes a reference to prevent NIS. Particularly, encourages the Contracting Parties to take all appropriate measures to regulate an intentional introduction and prevent an accidental introduction of NIS or genetically modified organisms to the wild flora and fauna and prohibit those that may have harmful impacts on the ecosystems, habitats or species in the area to which this Protocol applies. In 2010, the International Maritime Organization (IMO) and the Black Sea Commission (BSC) signed a Memorandum of Understanding (MOU) to increase mutual support on several environmental aspects of shipping including ballast water management.

RSC parallel activities: A fruitful cooperation was achieved between the Barcelona Convention, the OSPAR Commission and HELCOM on ballast water management to avoid the introduction of NIS

species between their ports. General Guidance documents were produced to support this purpose until the BWMC comes into force by all parties.

1.2.4 NIS databases

A number of databases for marine NIS are organized in several spatial scales:

- EASIN (European Alien Species Information Network; http://easin.jrc.ec.europa.eu/) aims to facilitate the exploration of existing alien species information in Europe from distributed sources, and to assist the implementation of European policies on biological invasions. This is planned to be the information support mechanism in relation to the new regulation on IAS.
- Global Biodiversity Information Facility (GBIF; http://www.gbif.org/) – general biodiversity database, including also alien species.
- Global Invasive Species Information Network (GISIN; http://www.gisin.org).
- The European Network on Invasive Alien Species (NOBANIS; http://www.nobanis.org/).
- The Global Invasive Species Database (GISD; http://www.issg.org/database/welcome/).
- Hellenic Centre for Marine Research - European Environment Agency (HCMR-EEA) – offline database available through EASIN.
- Regional Euro-Asian Biological Invasions Centre (REABIC; http://www.reabic.net/Aquainv.aspx).
- DAISIE (Delivering Alien Invasive Species Inventories for Europe; http://www.europe-aliens.org/), which was developed under the EU Framework Programme 6.

HELCOM and CIESM (http://www.ciesm.org/online/atlas/intro.htm) are maintaining NIS databases for the Baltic and the Mediterranean Sea respectively, while national marine NIS databases have been developed and updated (e.g. Greece –ELNAIS - https://services.ath.hcmr.gr/, Sweden-www.frammandearter.se).

2. Materials and Methods

2.1 Source of information

As for the D5 & biodiversity IDA, the JRC assessment for D2 is based on the reporting sheets. The IDA for the NIS descriptor was performed on the updated reporting sheets that were uploaded on September 2013. By that time 18 MS had uploaded electronic sheets (XML files). The reports (consultant's reports) prepared for DG ENV by Milieu (the versions that became available to JRC on August and September of 2013), including 18 MS and Portugal (only national paper report), for the Art. 12 assessment were also consulted and were particularly useful as they identified cases where the reporting sheets were incomplete compared to the MS' paper report. In such cases information missing from the reporting sheets was retrieved from the MS' paper reports. Chapter 6 includes the sources that JRC used or consulted for the D2 IDA.

2.2 Methodological framework

The assessment was focused on:

- screening the reported information and identifying common methodological approaches

- screening the lists of NIS reported by the MS and comparison with the EASIN database

- assessing the degree of integration of the reported information with other EU legislations and RSC agreements

- summarizing conclusions at the regional and European level

- providing specific suggestions that could improve the MSFD implementation for Art. 8, 9 and 10, including the reporting process, based on the lessons learnt in the first phase

2.2.1 Screening and assessment of methodological approaches

The methodological evaluation performed by extracting all required information at the highest detail from the reporting sheets, the consultant's reports and in some cases from the MS' paper reports. This information was organized in multiple tables (depending on the type of analysis performed) related to either the identified methodological approaches or the level of integration. The extracted tables and data were analyzed to provide input to the following issues:

- overview of the methodological approaches that the MS applied
- identification of the vectors that are transferring NIS to new locations
- extraction of the most frequently used methodological approaches per indicator, criteria and descriptor
- identification of the frequency of use of indicators amongst criteria and criteria amongst descriptors
- exploration of the level of methodological coherence in both pan-European and regional levels
- identification of MS similarities in their MSFD reporting regarding the level of integration with EU legislations and RSC
- determination of the similarities of the listed NIS amongst the MS and comparison of the listed species with the EASIN database to evaluate the quality of the data reported
- assessment of the level of NIS impact on regional ecosystems based on the prioritization of NIS in MS reports

The assessment aims to highlight:

- How MS prioritize NIS amongst the pressures.

This information is extracted from the reporting sheets and quantified to provide a regional overview of the impact of NIS as a pressure and the level of consideration of NIS across the MS. This information is also associated with the reported NIS vectors.

- Spatial coherence regarding the reported NIS and quality of information compared to the EASIN database.

This process was based on the elaboration of the NIS lists reported by the MS (dedicated reporting sheet). The outcome was analyzed to provide a similarity matrix across the MS, to reveal regional patterns on NIS distribution and highlight potential regional and bilateral cooperation for NIS assessment. Additionally, the reported list of NIS was compared with a list of NIS extracted by the EASIN database per Member State. The comparison aimed to evaluate the quality of the reported MS' NIS lists in terms of completeness.

- Assessment of the vectors related to NIS.

Due to the particular information included for D2, a screening was also performed on the reported vectors related to NIS (part of Art. 8) that were quantified on a Pan-European and regional level. The identification of the most frequent vectors reported is strongly linked to the NIS prevention strategies and the targets defined by the MS (Art. 10).

- The level of consideration of EU and RSC methods, approaches and concepts in the MS reporting.

The reported information was screened to identify links with EU regulations, international and RSC agreements. According to the MSFD (2008/56/EC) the MS have to consider any relevant EU legislation for the implementation of Art. 8, 9 and 10.

- The most frequently applied methodological approaches per indicator or criteria and the most frequently reported indicators.

The methods identified were grouped per criteria and indicator to assess the level of usage of each method across the MS. The added value of this process is to identify the most common methods applied per indicator and to highlight possible gaps and drawbacks in the implementation of other D2 indicators. Methodological approaches that are coherent across MS, especially on a regional level, are highlighted as good practices, since they can provide comparable and coherent results. The evaluation of the frequency of use of indicators and criteria is performed analogously to the methods, but instead of evaluating the methods per indicator, the evaluation is based on the frequency of reporting on each indicator per se. The results will highlight the value the indicators in each criterion or the need to further associate methodological standards into them in order to improve their applicability.

- Problematic issues in reporting

Such issues came up during the extraction of the necessary information from the reporting sheets, the MS' paper reports and the consultant's reports. These issues related to the reporting are identified to improve the implementation of MSFD in the second phase, to improve the data reported in terms of coherence and comparability and to allow a better evaluation of the reported information regarding the achievement of GES and the applicability of targets.

3. Results

In this chapter the results of the in-depth analysis for D2 are presented, either on quantitative or qualitative basis, depending on the reported information by the MS for the MSFD Art. 8, 9 and 10.

3.1 Impact of NIS as a pressure on marine ecosystems

Some MS have prioritized NIS as a pressure on their marine ecosystems, of these eighteen were included in the analysis (no electronic reporting by PT and late reporting by BG). Five MS prioritized NIS as the most important pressure at least in one subregion, three as a second most important pressure and six as the third (Fig. 1). Viewing these data from a regional perspective (Fig. 2), it is obvious that for the Mediterranean and the Black Sea NIS are considered to have high impact into these ecosystems when compared to other pressures.
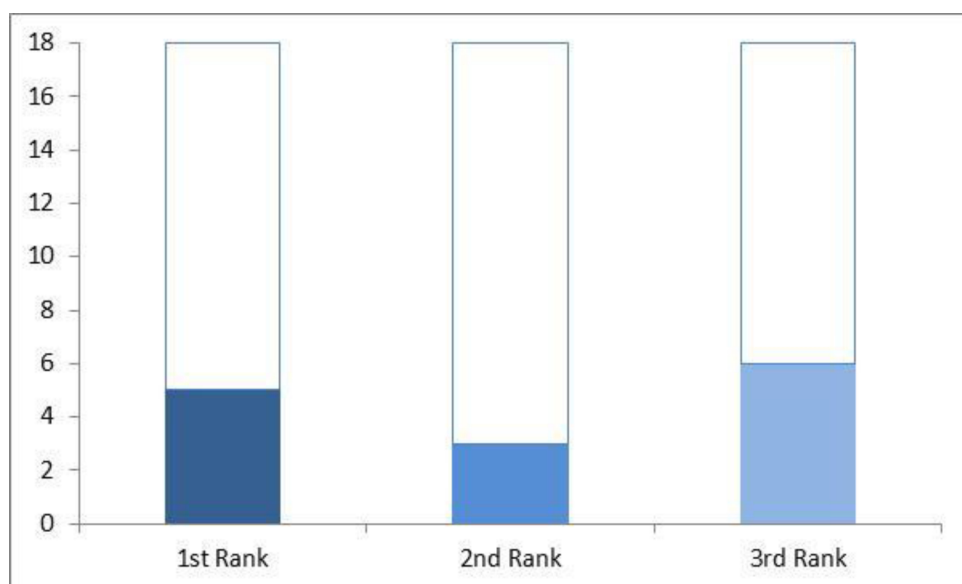

Figure 1. Ranking of NIS pressure across the MS, compared to other MSFD pressures (18MS).
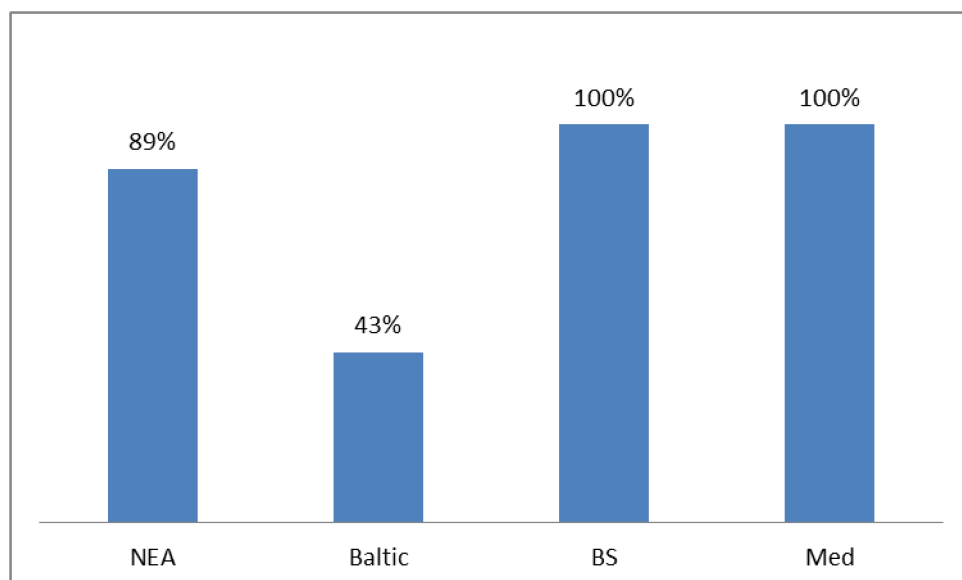

Figure 2. Percentage of the MS per regional Sea (North East Atlantic, Baltic, Black and Mediterranean Sea, respectively) that have considered NIS in the top three pressures across the MS. The MS that participating in two RSC were allocated to both of them (18MS).

3.2 Reported NIS and comparison with the EASIN database

There is inconsistency within some MS on the number of NIS reported in the Initial Assessment and those reported in the dedicated reporting sheet, as shown in Table 2. In order to quantitatively evaluate the number and species reported from the MS, marine NIS from the EASIN database were downloaded per Member State and their numbers are listed in Table 2. For most MS EASIN database includes more records of NIS, while a deeper insight in the species revealed that both databases have unique species records.

Table 2. Number of NIS reported by MS in the IA, the reporting sheets, the EASIN database and the difference in number of species between the latter two.

MS	Species reported in the IA	Reporting sheets	EASIN	Difference EASIN/reported
DK	43	62	102	40
EE	NA	32	15	-17
EL	NA	236	293	57
FR	457	402	299	-103
IE	79	90	131	41
LT	14	13	2	-11
LV	NA	35	7	-28
NL	47	47	146	99
RO	NA	10	11	1
SE	75	34	94	60
UK	>60	153	197	44
IT	270 NIS; 134 Invasive	307	315	8
CY	15	1	145	144
BE	~100	23	107	84
DE	98 NIS; 76 established	76	112	36
SI	16	16	32	16
FI	NA	92	23	-69
ES	249	336	214	-122

An average number of NIS reported for each region (North East Atlantic, Baltic, Black and Mediterranean Sea) was estimated revealing a higher number of NIS in the Mediterranean Sea compared to other RSC. NIS records are increasing as reported by the MS and Table 3 aims to provide a relative picture of the distribution of NIS across the EU Seas.

Table 3. Average number of NIS reported by RSC members in the reporting sheets and the associated number derived by EASIN.

Region	Electronic reporting	EASIN
BALTIC	49	50
NEA	136	155
MED	216	216
BS	10	11

The reported NIS data were analyzed per Member State to identify spatial patterns and similarities. The resulted similarity plot (Fig. 3) clearly highlights the regional effect on NIS distribution.
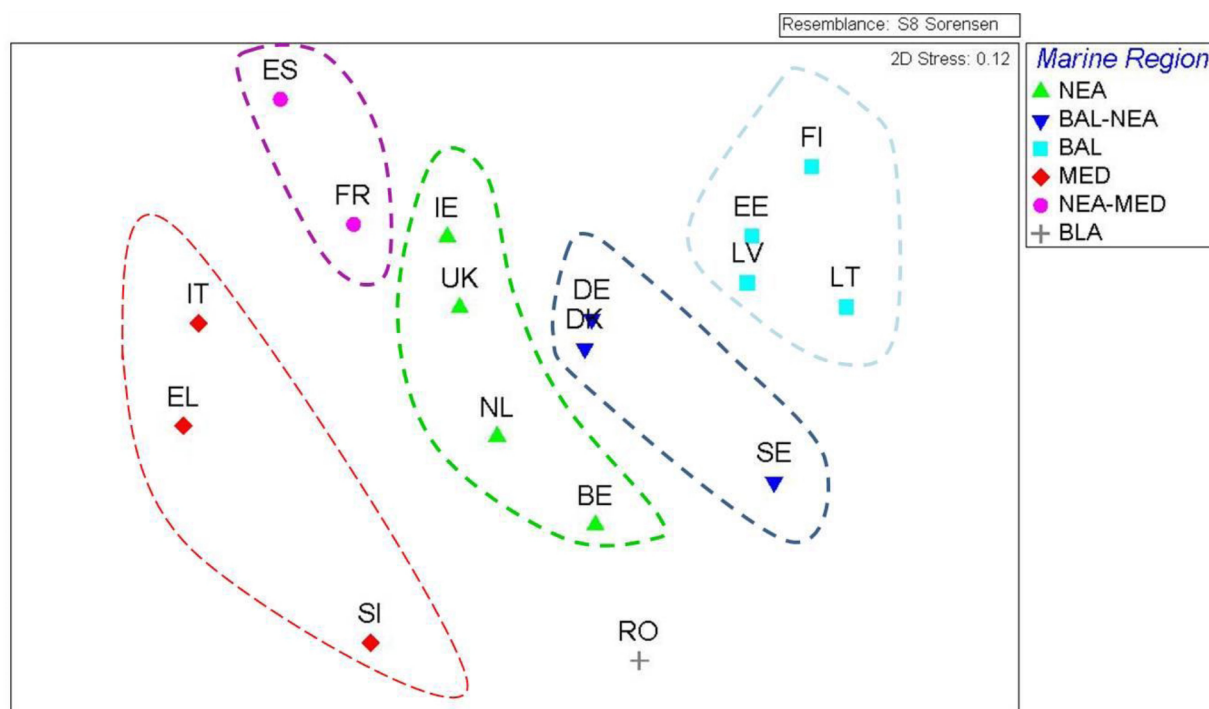

Figure 3. Similarity plot depicting the relative similarity distances amongst the MS based on the species reported. CY is not included in the analysis since they reported 1 NIS in the reporting sheets.

3.3 Methodological approaches in D2 implementation

In contrast with Eutrophication and Biodiversity Descriptors, D2 reports are poor in detailing the methodological approaches. MS focused on listing NIS, in only some cases assessing their impact and on particular ecosystems, and addressing the important vectors related to NIS. It is widely acknowledged that further research is needed to create the required knowledge for developing methods related to the MSFD indicators. Monitoring programmes should take account of this need and be planned appropriately to acquire the necessary data (Zampoukas et al. 2014). These gaps are also acknowledged by a number of MS reporting that the indicators will only be functional in the future. An exemption is the biopollution index (BPI, Olenin, 2007), which uses basic information on abundance and distribution of NIS. The index classifies the impact NIS on native species. It was applied by HELCOM for estimating the magnitude of the alien phytoplankton species effects on local phytoplankton community, pelagic habitat and ecosystem functioning in the Baltic Sea (Olenina et al., 2009). BPI was reported by most of the HELCOM members (where it is already functional) and from a few non-HELCOM members that are going to evaluate BPI's utility in other regions. BPI was linked to all reported MSFD Articles (8, 9 and 10) at least once and to Criteria 2.2 of the COM DEC (2010/477/EC). Other methodological approaches include trends in the arrival of NIS, changes in the abundance of established NIS, biomass of particular NIS (e.g. *Mnemiopsis leidyi*), ratio of non-indigenous/indigenous and spatial distribution of NIS.

3.4 Level of integration between MSFD NIS reports and EU legislations, RSC and other international agreements

It should be noted that by the time MS delivered their reports there was no EC legislation to cover holistically NIS. This explains why most of the associated agreements and directives were considered individually, not in coordination, and by only a few MS. In particular, the most frequent reference was made on IMO's BWMC (Fig. 4). BWMC is ratified or in progress to be ratified by the RSC, and a number of MS reports are in line with BWMC. Bathing Water and Shellfish Directives are exclusively linked with pathogens and are reported by the MS that included pathogens into D2. The Regulation on the use of alien and locally absent species in aquaculture (2007/708/EC), which addresses the release of alien species for aquaculture purposes was reported by only one Member State (Fig. 4), which is in contradiction to the number of MS that considered aquaculture as a main vector of NIS (see paragraph 3.5.1).
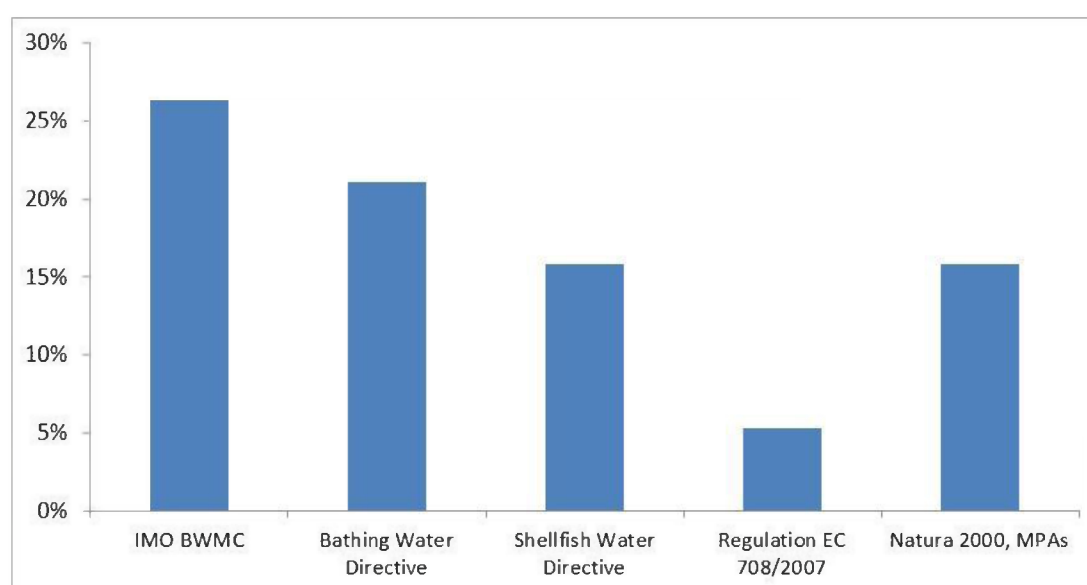

Figure 4. Level of integration between D2 reports and EU legislations, RSC and other international agreements (18MS).

3.5   Assessing MS' reports on Art.8, 9 and 10 from a methodological point of view

A number of issues related to Art. 8, 9 and 10 (adequacy in reporting, completeness, etc.) have already been covered by other assessments (DG EVN on Art. 12, consultant's reports). The following paragraphs are focused on methodologies, good practices and discrepancies across MSFD Articles and NIS assessment in relation to the reported information. Specific dataset such as the level of reporting (on criteria/indicator) and vectors of NIS introduction were quantified.

3.5.1 Assessing MS' reports on Art.8

As shown in Fig. 5 half of the MS linked parts of their initial assessment to indicator level. When MS reported in both Indicator and Criteria level, the lower lever was accounted for the pie chart in Fig. 5. Despite the tendency of MS to report in the lower level (compared to Art. 9, Fig. 8) just three MS

provided (or tend to establish) baseline and thresholds in their IA. EE could be characterized as a good practice on the way they linked well defined metrics into each indicator accompanied by specific thresholds. In addition, they presented high level of consistency in the way they reported for the three MSFD Articles (8, 9 & 10), they facilitated the evaluation of the Impact Assessment, the definition of GES and the targets.
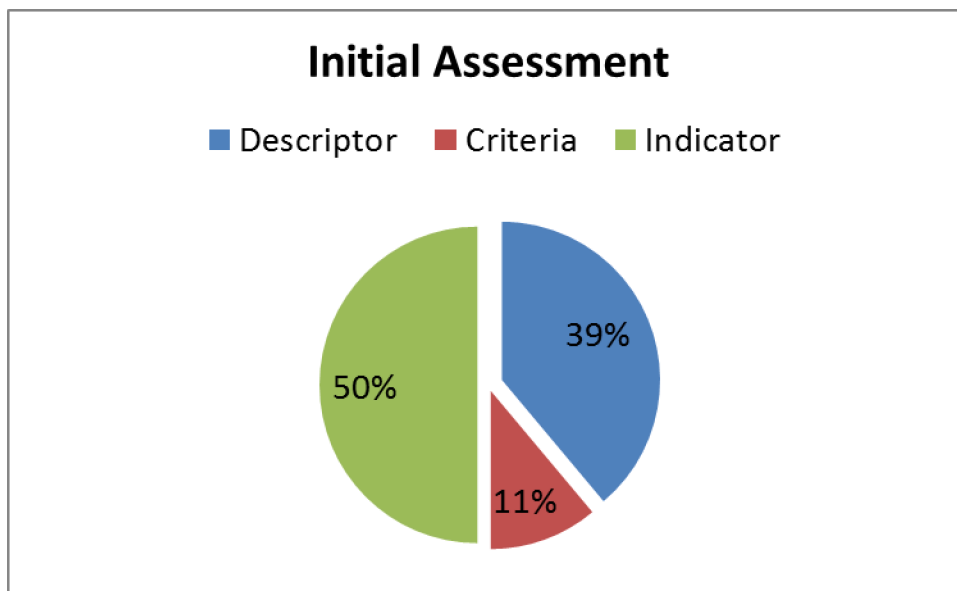
Figure 5. Proportion of MS reported for the initial assessment (Art.8) on Descriptor, Criteria or indicator level (18MS).
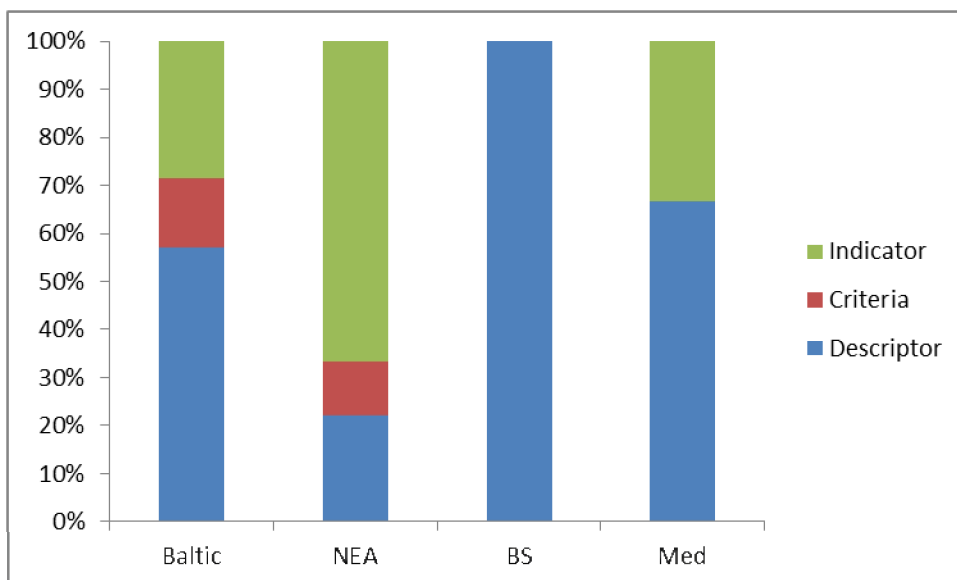
Figure 6. Proportion on regional scale of MS reported for the initial assessment (Art.8) on Descriptor, Criteria or indicator level (18MS).

The Initial Assessment of D2 included the reporting of NIS (discussed in previous paragraph) and the prioritisation of the activities/vectors that are increasing the number of NIS (Fig. 7). Based on the MS' reports, shipping and aquaculture are the two main vectors contributing to the increase of NIS in the European waters. The impact of these pathways in the unintentional introduction of NIS in the European Seas does not present any regional pattern, imposing a common plan across MS to cope with these pressures.
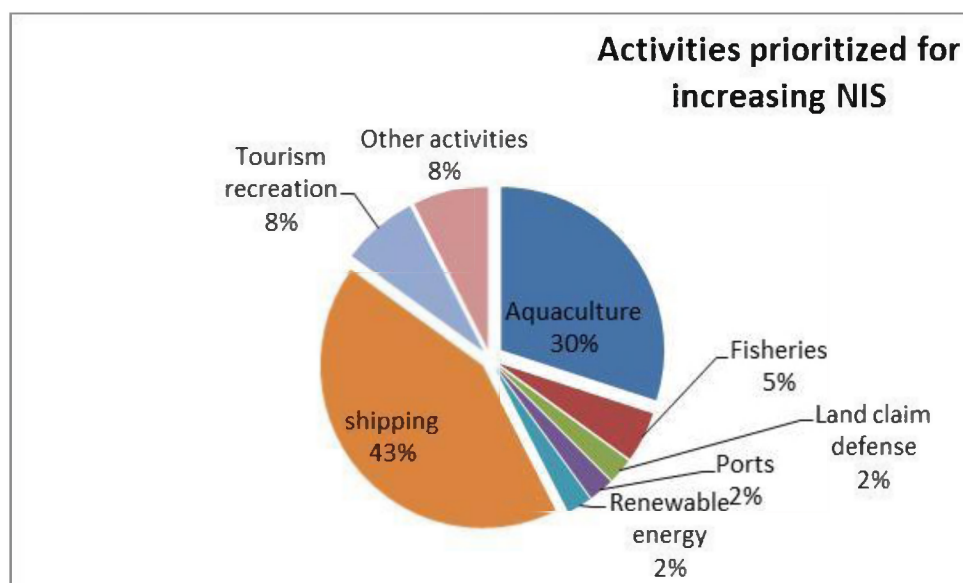
Figure 7. Percentage of activities/vectors contribute to NIS increase as were prioritized by the 18 MS.

EL is considered as a good practice in respect to the NIS reported, because of the detailed information provided including NIS recorded in Greek waters, year of the first record, origin of NIS, pathways of introduction, population status (e.g. established, occasional, unknown) and NIS' taxonomic group.

3.5.2 Assessing MS' reports on Art.9

Comparison of Fig. 8 & Fig. 9 with the associated Figures from the Initial Assessment (Fig. 5 & 6) indicates that MS reported on different level within these articles. GES is generally reported on higher level (Descriptor or Indicator). Most of the MS did not link GES with the COM DEC (2010/477/EC) indicators, consequently they did not provide measurable magnitudes for the definition of GES and relative thresholds. Differences in the level of details reported for GES complicate any homogenous approach in assessing GES on regional level. In addition, GES definitions vary in the features reported: in some cases GES is defined through vectors and pressures, elsewhere through quoting the D2 definition in the MSFD or COM DEC (2010/477/EC) indicators. In this variety of GES definitions for NIS it should be mentioned that a Member State included genetically modified organisms (GMOs), or organisms whose genetic properties are otherwise altered, which may adversely affect biological diversity, expanding the D2. The MS that included microbial pathogens under D2 reported that the status has been assessed in relation to the Bathing Water Directive and/or the Shellfish Directive. FI report on Art. 9 could be characterized as good practice, since they provide a variety of GES statements covering pressures, impacts, number, frequency and ratio of NIS, as well as vectors. BPI is associated to GES definition by some MS, indicating its applicability in some regions and the need for better developed indicators related to NIS.
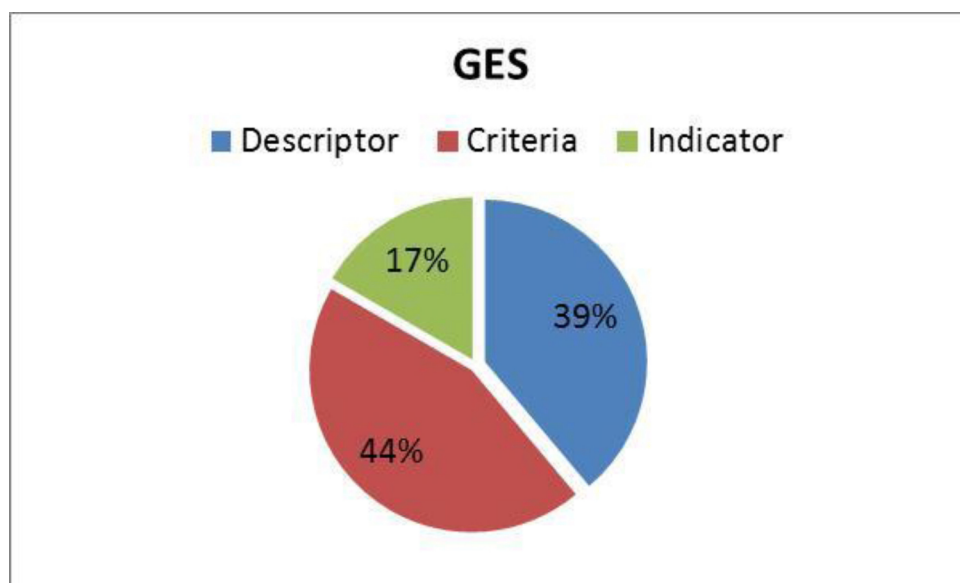
Figure 8. Proportion of MS (18) reported for GES (Art.9) on Descriptor, Criteria or indicator level.
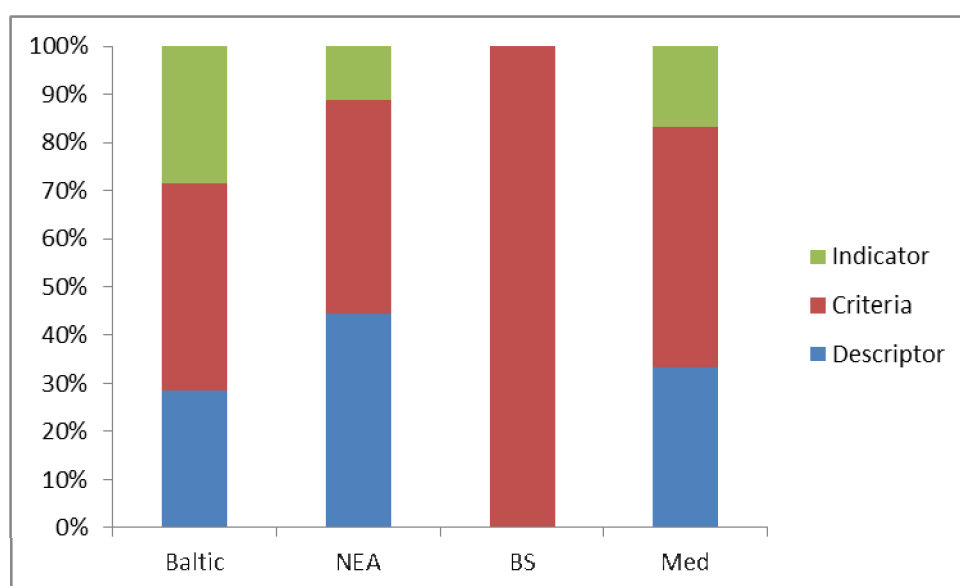
**Figure 9. Proportion on regional scale of MS (18) reported for GES (Art.9) on Descriptor, Criteria or indicator level.**

3.5.3 Assessing MS' reports on Art.10

Not all MS defined targets for Art. 10. In particular, nineteen MS were assessed (no data from BG by the time the analysis was conducted) sixteen of them have reported targets (one out of the 16 MS reported targets only in the paper report). Fig. 10 presents the distribution of targets and associated indicators across MS (no input for Black Sea). The number of target could be linked with the level of ambition of each Member State, while the number of descriptors could be linked with the available tools to support the targets.

Figure 10. Average number of targets and associated indicators as were reported for Art. 10 per region (17MS, no targets from RO).

The majority of targets and associated indicators lack specification and quantification which prevents the assessment of their achievement. In respect to the methodologies listed in Art. 10 reports, BPI is referred by HELCOM members, while HELCOM is the only RSC that is referred in this article. Early warning system is mentioned amongst the targets and could be an efficient NIS prevention approach. FI could be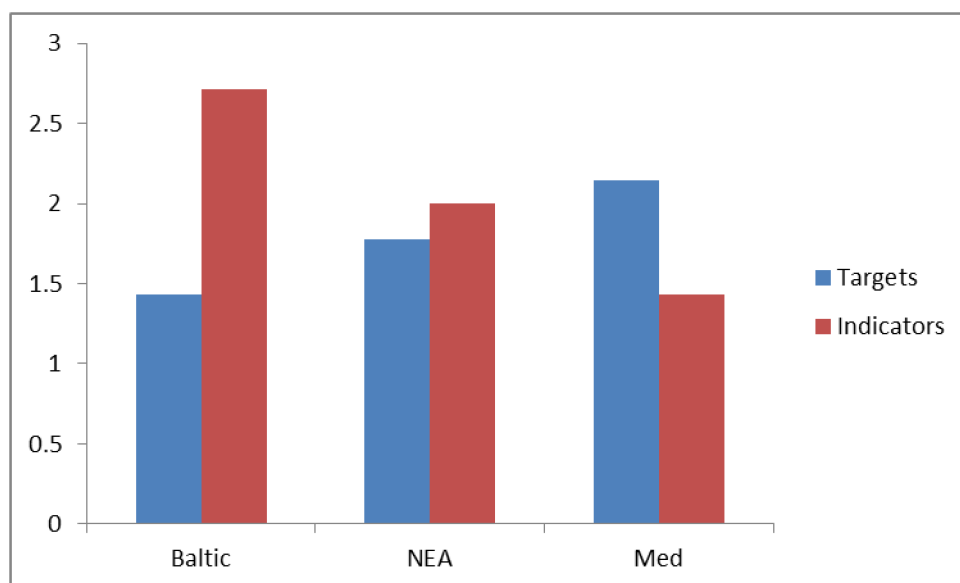 highlighted as good practice due to the linkage they created between targets and pressure/state indicators. In general, the reports on Art. 10 are characterized by a great variance of coverage between targets and indicators:

- No targets, no indicators
- Targets but no indicators
- Targets and/or indicators covering some of the criteria and/or indicators of the COM DEC (2010/477/EC) or indirect coverage
- Only pressure indicators included
- Pressure, state, impact and targets on future studies to cover the gaps are reported

This heterogeneity creates difficulties in the assessment of the reports and more over in the interpretation of targets on a regional level.

4. Discussion

4.1 In-depth analysis on NIS reported and vectors

The in-depth assessment of D2 on MS' reports for Art. 8, 9 & 10 revealed, inter alia, that most of the MS consider NIS as a main pressure in defined regions. Even in areas with good environmental status on NIS, the potential impact of new invasive species on the ecosystem is highly considered and the monitoring programmes should be planned accordingly. The main vectors reported from the majority of the MS are shipping and aquaculture and both of them are covered by existing

agreements and the regulation frame (The Regulation on the use of alien and locally absent species in aquaculture (2007/708/EC) and the IMO International Convention on the Control and Management of Ships' Ballast Water and Sediments, respectively). On regional level, Mediterranean and Black Sea prioritized NIS higher compared to the other regions (Fig.2). Black Sea experienced the catastrophic impacts of IAS (e.g. *Mnemiopsis leydi*) on the ecology, society and economy in a great magnitude. This event has alerted MS from the Mediterranean and the Baltic that included and prioritize the particular species in their assessments. As shown in Table 3 Mediterranean MS reported on average more NIS than other MS. It should be noted that the assessment of NIS should not only focus on vectors but also on pathways, since for the Mediterranean the main cause for the species introductions is the lack of sufficient control in Suez Canal (and to a lesser extend in Gibraltar). The Suez Canal pathway is the most important pathway of alien species introductions in the Mediterranean Sea (Zenetos et al. 2012), being linked to the introduction of 510 species in the Mediterranean, according to EASIN.

The inconsistencies in the number of species reported in the reporting sheets and the MS' paper reports for more than 80% of the MS indicates that NIS identification in most MS is problematic and they do not have clearly assessed their marine ecosystems in terms of number of species. Due to the increasing number of NIS, the need for rapid identification and early notification on NIS is an endless process leading to dynamic lists of NIS that should be regularly updated. The comparison of the NIS reported by the MS and the EASIN revealed that at least two thirds of the MS reported less species than those identified in their waters. Baltic MS are generally better updated in comparison to EASIN, probably because the latter is not linked with the HELCOM NIS database. The inconsistencies on the number of the reported NIS are questioning the credibility of the assessment on both national and regional level. The number of international, regional and national NIS databases that are not clearly interrelated and the methods applied to species reporting and verification obfuscate the pragmatic status of NIS and highlight the necessity for a common reference point to serve management purposes, at least regionally.

The spatial pattern revealed by the similarity plot (Fig. 3) on the NIS reported by MS indicates the transboundary character of NIS and the need for bilateral, regional and interregional collaborations.

> **Recommendations**: *Both vectors and pathways should be assessed in relation to NIS on regional and interregional, given the transboundary nature of NIS pressure. Regional and national NIS inventories should be linked and ideally a common reference NIS database should be consulting the MS, working on agreed standards for NIS identification, validation and early notification. EASIN should include MS reports and should be advised by MS.*

4.2 Level of MSFD D2 integration with EU legislations, RSC and other international agreements

The assessment of the level of integration between MS' reports for D2 and EU legislations, international and RSC agreements is serving several purposes:
- Consideration of such legislations is an MSFD prerequisite as for the MS to be in line with existing regulations

- It promotes the coherence, consistency and comparability across the MS, by the time they are following common agreements
- It can ensure that achievement of GES in one Member State would not prevent this to another. Additionally, the interpretation of GES definition would be analogous, so that neighbouring countries would simultaneously achieve – or not - GES in neighbouring marine regions
- When MS are in line with overlapping regulations they are able to organize cost-effective related activities, without duplicating expenditures and effort
- Existing information or methodologies available from other regulations can be applied to MSFD, when appropriate or can be harmonized according to the MSFD requirements

The existing gap of a comprehensive EU instrument to tackle NIS will be covered by the adoption of the COM (2013) 620 final on a proposed regulation for the prevention and management of the introduction and spread of invasive alien species. Relative legislations (The Regulation on the use of alien and locally absent species in aquaculture (2007/708/EC)), international and RSC agreements (BWMC) that cover specific issues related to NIS are moderately considered. Microbial pathogens are either assessed in D2 reports or for the bathing and shellfish Directives, while in one case they were assessed in D9. This inconsistency in reporting microbial pathogens implicates the evaluation of MSFD implementation.

On regional scale, HELCOM has already done some progress on assessing, monitoring and managing NIS, as well as on harmonizing these activities according to the MSFD. This is clearly reflected in the HELCOM's MS that are also characterized by high level of coherence.

> **Recommendations**: *On a regional level HELCOM is highlighted as a good practice in the way they adopt MSFD and their progress in developing relevant indicators. The COM (2013) 620 final on a proposed regulation for the prevention and management of the introduction and spread of invasive alien species partially covers MSFD on NIS and a coordination amongst them should facilitate the easier and efficient NIS management.*

4.3 Methodological approaches

Comparing D2 with more "mature" descriptors (Eutrophication, Biodiversity) in terms of reported methodological approaches showed that further resources and research is required to reach the ambitions and that mandates of MSFD. Under D2 and in respect to the initial assessment, definition of GES and targets several groups of methodological approaches could be reported covering:

- identification of NIS species (taxonomic identification based on experts or on genomics) and estimation of their spatial and temporal distribution

- population characteristics of NIS, changes in abundance and/or biomass, ratio of NIS to indigenous on a taxonomic or ecosystem level

- identification of potential NIS habitats

- NIS assessment methodologies

- eradication or deterioration methods for invasive NIS

- management of vectors/pathways for the reduction of un-intentional spreading of IAS

- early notification systems (including genomics)

Some of the aforementioned are not covered in the MS' reports, while others are covered partially. A common characteristic in MS' reports is the need for developing new methods or evaluating existing according and linked to the MSFD indicators. In that line, some EU funded projects focus on providing more appropriate tools for the needs of the implementation of MSFD on descriptor level (e.g. DEVOTES, MG4GES).

A high level of coherence is noticed on methodological view in respect to the use of the Biopollution level index that covers the MSFD criterion 2.2. BPI is proposed by HELCOM but is also considered and evaluated by other MS. Consequently BPI could be viewed as a good practice, especially on a regional level.

> **Recommendations**: *Biopollution level index should be tested beyond HELCOM's members, since is the most frequently used and better developed indicator covering Criteria 2.2. More research is needed on the methodologies and tools related to NIS.*

4.4 Reporting and reports' assessment issues

The flexibility in the interpretation of the MSFD and the related COM DEC (2010/477/EC) led to considerably different approaches in initial assessment, GES definition and target setting amongst the MS. In most of the reports there in no link between the three MSFD Articles (8, 9 & 10) and, as shown in Fig. 5 and 8, MS reported on different level between Art. 8 and 9 (moving from indicators to criteria). There is no any obligation for reporting at the same level, but such an approach would easier facilitate the establishment of associated thresholds and baselines. Most of the MS did not define measurable methodological approaches accompanied by thresholds and limits in any of the three Articles. This causes a twofold complication to the assessment of MSFD implementation because of the incomparability to set the GES/targets between neighbouring MS and the inability to assess whether the GES or the targets are achievable. In particular, Fig.10 which refers to the targets setting presents an opposite situation in the number of targets and associated indicators between HELCOM and Barcelona Conventions contracted parties, with OSPAR being somewhere in between. HELCOM's MS reported fewer targets in comparison to the Barcelona Convention but many more associated indicators. This could be attributed to the fact that the increased number of NIS and pathways require an increase number of target to cover NIS. On the other hand, the well organized and more comprehensive work on NIS performed by HELCOM is reflected to the number of indicators and available tools to support the targets defined for Art. 10. The transboundary nature of D2, probably in a greater level compared to other MSFD descriptors, imply for more synergies and coordination between MS, taking into account the dissimilarities in environmental conditions and socioeconomic characteristics.

A reporting issue that caused many problems to the assessment of the MSFD implementation is the differences between reporting sheets and MS' paper reports. Such differences include number of

targets, GES definition, information on the initial assessment and as shown in Table 2 number of NIS reported. In many cases important information is missing either from the reporting sheets or from the MS' paper report. These discrepancies and reporting failures undermine the efficient implementation of MSFD and deteriorate any evaluation/assessment attempt. In order to export a list of NIS reported for the MSFD (Annex II) significant effort is required for the correction (e.g. typos on scientific names, same species registered differently, in some cases scientific name is followed by the authors while elsewhere no), validation and analysis of the reported species. Consequently, the most straightforward process for the MS reporting on D2 (reporting list on NIS) became very complicated to be analyzed and including a lot of uncertainty. To overcome this reporting weakness on the list of NIS, a common reference point (e.g. common NIS database) should be established. The EASIN platform could serve as this common reference point.

Recommendations: *Clear links should be made between Art. 8 & 9 and 10 of MSFD and specific measurable methods and associated thresholds should be reported to facilitate the evaluation of GES achievement, of targets' efficiency and the implementation of MSFD in general.*

Reporting sheets should reflect the MS' paper reports, since they consist an electronic way of reporting the qualitative and quantitative data and not an independent one. The required information in the reporting sheets could be significantly reduced and the process could be automated by using drop-down boxes with specific option, where appropriate, to reduce the different perspectives of the MS. Consistency should also have to be achieved amongst the MS within the supplementary reported material e.g. the list of NIS in both the reporting sheet and the MS' paper reports.

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5. Conclusions

Table 4 includes the key findings of the in-depth-assessment for the MS' reports on Art. 8, 9 and 10 for NIS. Each addressed issue is followed by a suggestion and potential actions and actors, where appropriate.

Table 4. List of key issues derived from the in-depth assessment for D2, suggestions and potential actions to be dealt with.

Issues on implementation	Suggestion	Potential actions/actors
Level of MSFD D2 integration with the COM(2013) 620 final on a proposed regulation for the prevention and management of the introduction and spread of invasive alien species	Require coordination of the MSFD and the future NIS regulation to avoid duplicates and to ensure the achievement of GES and the prevention and management of NIS	Commission with MS
Vectors and pathways	*Assessment in relation to NIS on regional and interregional level, given the transboundary nature of NIS pressure.*	Encouragement of bilateral and regional cooperation/ RSC; ENV; MS
Inconsistency and uncertainty in reported list of NIS	*A common reference NIS database should be consulting the MS, working on agreed standards for NIS identification, validation and early notification* Adaptation of methodologies, indicators, state	EASIN could play the role of the EU NIS database / ENV & JRC

	characteristics on regional level	
HELCOM could be considered as a good practice on MSFD implementation for NIS	HELCOM approach to be adopted or to inspire other RSC, if applicable; HELCOM NIS indicators to be validated in other regions	RSC
Issues on methods	***Suggestion***	***Potential actions/actors***
Low availability and reporting on methods related to NIS	Development of new methods and tools covering both Criteria and the three COM DEC indicators for D2. Wider spatial exploitation of existing methods e.g. Biopollution level index	Follow relevant EU projects working on development and assessment of new or well established methods e.g. DEVOTES, MG4GES/ JRC CC4GES; ENV; R&I
Issues on reporting	***Suggestion***	***Potential actions/actors***
Differences between MS' paper reports and reporting sheets; missing or not adequately reported information; similar information is reported under different fields; Different level of detail in the reported information	Reporoting sheets should reflect the MS' paper report, since they consist an electronic way of reporting the qualitative and quantitative data and not an independent one. The required information in the reporting sheets could be significantly reduced and the process could be automated by using drop-down boxes with specific option	Updated guidance on reporting with reduced and more specific fields/ ENV
Inconsistency in reports regarding Article 8, 9 & 10 implementation	Clear links should be made between Art. 8 & 9 and 10 of MSFD and specific measurable methods and associated thresholds should be reported to facilitate the evaluation of GES achievement, of targets' efficiency and the implementation of MSFD in general.	Updated guidance on reporting with reduced and more specific fields; COM Decision revision; EU funded projects/ ENV; MS; JRC CC4GES
Improving the efficiency and homogeneity of electronic sheets; improve data access and data management for the MS evaluation of MSFD implementation (Art. 12)	Coherence in reporting to allow for accurate and meaningful IDA	Improve electronic forms, data & metadata availability / MS & ENV

6. References/Sources

- Reporting sheets
- Consultant's reports (1- national level, 2- regional level, 3- Analysis of Regional Sea Convention needs)
- National reports (in some cases)
- Olenin et al. 2010. MSFD - Task Group 2 Report – Non-indigenous species
- HELCOM, 2013. HELCOM core indicators: Final report of the HELCOM CORESET project. Balt. Sea Environ. Proc. No. 136
- Commission Decision (2010/477/EU)
- The Habitats Directive marine species and habitats
- The Birds Directive Marine Species
- The HELCOM biodiversity CORESET indicators
- Zampoukas et al. 2014. Technical guidance on monitoring for the Marine Strategy Framework Directive
- Siapatis et al., 2008. Modelling potential habitat of the invasive ctenophore *Mnemiopsis leidyi* in Aegean Sea. Hydrobiologia 612(1): 281-295, 2008.
- UNEP-MAP-RAC/SPA . 2005 . Action Plan concerning species introductions and invasive species in the Mediterranean Sea . Ed. RAC/SPA, Tunis . 30 pp
- Zenetos A, Gofas S, Morri C, Rosso A, Violanti D, García Raso JE, Çinar ME, Almogi Labin A, Ates AS, Azzuro E, Ballesteros E, Bianchi CN, Bilecenoglu M, Gambi MC, Giangrande A, Gravili C, Hyams-Kaphzan O, Karachle V, Katsanevakis S, Lipej L, Mastrototaro F, Mineur F, Pancucci-Papadopoulou MA, Ramos Esplá A, Salas C, San Martín G, Sfriso A, Streftaris N, Verlaque M, 2012. Alien species in the Mediterranean Sea by 2012.A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. *Mediterranean Marine Science* 13(2): 328–352.

Annex I Member States included in the analysis.

Member State	Abbreviation	RSC
Belgium	BE	OSPAR
Cyprus	CY	UNEP/MAP
Denmark	DK	OSPAR/ HELCOM
Estonia	EE	HELCOM
Finland	FI	HELCOM
France	FR	OSPAR - UNEP/MAP
Germany	DE	OSPAR- HELCOM
Greece	EL	UNEP/MAP
Ireland	IE	OSPAR
Italy	IT	UNEP/MAP
Latvia	LV	HELCOM
Lithuania	LT	HELCOM
Netherlands	NL	OSPAR
Portugal [4]	PT	OSPAR
Romania	RO	Black Sea
Slovenia	SI	UNEP/MAP
Spain	ES	OSPAR - UNEP/MAP
Sweden	SE	HELCOM- OSPAR
United Kingdom	UK	OSPAR

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[4] Portugal provided only the national paper report and not the reporting sheets, by the time IDA was taking place.

IN-DEPTH ASSESSMENT OF MEMBER STATES' SUBMISSIONS FOR MSFD ART. 8, 9 & 10 ON EUTROPHICATION DESCRIPTOR D5

EUTROPHICATION

Photo by Yiannis Issaris (www.yissaris.com)

Contents for D5

1. Introduction

In the Marine Strategy Framework Directive (2008/56/EC, MSFD) the qualitative descriptor 5 is defined as:

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

Task Group 5 (Ferreira et al., 2010) on MSFD arrived at the following definition of terms for Descriptor 5 and understanding of the key concept:

Eutrophication is a process driven by 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 nutrients causing changes to the balance of organisms; 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. These changes may occur due to natural processes; management concern begins when they are attributed to anthropogenic sources. Additionally, although these shifts may not be harmful in themselves, the main worry concerns 'undesirable disturbance': the potential effects of increased production, and changes of the balance of organisms on ecosystem structure and function and on ecosystem goods and services.

Ideally, it could be expected that Member States (MS) would be in position to provide complete, comparable and coherent assessments as well as GES definitions and environmental targets, given the existing background on eutrophication.

1.1 Scope of the in-depth assessment

On request from DG Environment the Joint Research Centre performed the In-Depth Assessment (IDA) of D5 based on the information reported by the Member States for Article 8, 9, and 10. The aim of this IDA is to present an overall image of the implementation of MSFD rather than to comment on particular Member States practices. Specifically, the IDA aimed:

- o To evaluate how the methodological approaches used relate to the assessments under other policy frames (including EU and Regional Sea Conventions) and the latest scientific evidence so as:

- o To provide recommendations for improved implementation in the second MSFD cycle

- o To support a possible review and revision of the COM Decision on criteria and methodological standards

1.2 Eutrophication related legislation and agreed documents on EU and RSC level

A number of legislations already exist at EU level and Regional Sea Conventions that support MS in the control of sea eutrophication (Ferreira et al., 2010; Table. 2). MSFD affirms in the art. 14 of the Directive that "This Directive shall contribute to coherence between, and aim to ensure the integration of environmental concerns into, the different policies, agreements and legislative measures which have an impact on the marine environment." MSFD explicitly mention several legislative tools and among them, the most closely related to eutrophication are the Water Framework Directive (WFD; 2000/60/EEC), the Nitrate Directive (ND; 91/676/EEC), and the Urban

Waste Water Treatment Directive (UWWT; (91/271/EEC). While the WFD goes in the direction of an overall enhancement of the status of aquatic ecosystems, the ND and the UWWT are aiming towards specific targets, namely the reduction and the prevention of further, water pollution caused or induced by nitrates from agricultural sources and the protection of the environment from the adverse effects of urban waste water and certain industrial discharges.

Eutrophication (MSFD Descriptor 5 - D5) is a well known pressure that impacts marine ecosystems and its causes and effects on species, communities and ecosystems have been extensively studied. Even though several EU policies (WFD, UWWTD, ND) address eutrophication in marine ecosystems, MSFD does it in a wider spatial scale including both direct and indirect effects. The WFD guidance n. 23 (GUIDANCE DOCUMENT ON EUTROPHICATION ASSESSMENT IN THE CONTEXT OF EUROPEAN WATER POLICIES) was developed to support the MS for a coherent and efficient implementation of the several Eutrophication related policies. This has set the conceptual framework for eutrophication assessment and, *interalia,* aimed to harmonize assessment methodologies and criteria for agreed eutrophication elements/parameters/indicators for rivers, lakes, transitional, coastal and marine waters. This is the context in which the MS should perform their initial assessments.

RSC have implemented their own methodological approaches for eutrophication assessment (HELCOM HEAT, OSPAR COMMON PROCEDURE, TRIX for UNEP/MAP5, BEAST for Black Sea Convention). Basically, all methods include Chlorophyll-a (Chl-a) but differ in the way additional indicators are combined (Table. 1). Both HELCOM HEAT and OSPAR COMP are based on a common conceptual framework of eutrophication assessments and use similar approaches. The notable differences between OSPAR COMP and HELCOM HEAT are the presence of an agreed pressure indicator in the former and some metrics used for the assessment (see Table 1). Moreover, both OSPAR and HELCOM have also produced their own agreed methods of pressures assessment, the OSPAR Riverine Inputs & Direct Discharges (RID) Programme and the HELCOM Pollution Load Compilations (PLCs). In Table 1, a list of methods of eutrophication assessment with the biological and the physic-chemical indicators is presented.

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[5] TRIX has been proposed by Italy but was not agreed at the level of the Mediterranean

Table 1. Methods for eutrophication assessment, examples of biological and physic-chemical indicators used and integration capabilities. (Modified from Ferreira et al., 2010 and from OSPAR, 2012).

Method Name	Biological Indicators									
	Benthic indicator species	Benthic Invertebrates	CHL	HAB	Macroalgae	Macrobenthos	Phytoplankton	Phytoplankton Indicator Species	Primary Production	Seagrass
TRIX			X							
EPA NCA Water Quality Index			X							
ASSETS			X	X	X					X
LWQI/TWQI			X		X					X
OSPAR COMPP	X*		X		X			X		X
WFD^		X	X		X		X			X
HELCOM HEAT		X	X	X	X				X	X
IFREMER			X	X		X				X
STI			X						X	

Method Name	Physico-chemical indicators									
	C	DIN	DIP	DO	Sediment organic matter	Sediment TN	SRP	TN	TP	Water clarity
TRIX		X		X					X	
EPA NCA Water Quality Index		X	X	X						X
ASSETS				X						
LWQI/TWQI		X	X	X						
OSPAR COMPP		X	X	X				X**	X**	
WFD^		X	X	X				X	X	X
HELCOM HEAT	X	X	X	X				X	X	X
IFREMER		X		X	X	X	X	X	X	X
STI			X	X						

Note: Only ASSETS and OSPAR COMPP have indicators of nutrient load. All the methods, except STI, produce an integrated final rating.

* Benthic indicator species added by ICG COMP

** Note from ICG COMP: Recommended parameters but not part of the harmonized set of assessment parameters

^ WFD does not provide exclusive methods for the eutrophication assessment. The aim is to assess the ecological status of coastal water bodies with the utilization of Biological Quality Elements (Biological indicators) supported by Physico-Chemical Quality Elements (Physico-chemical indicators).

1.3 Recent scientific developments

Eutrophication modelling and remote sensing can be considered as alternatives or in addition to in situ measurements, depending on the requirements with respect to data. In general, in situ measurements always remain necessary to validate and calibrate the models and data calculated from satellite measurements. In situ measurements provide 'sea-truth' information about the actual state of a given variable and its variability over time (e.g. daily, seasonal, annual). In comparison, model generated data are derived from mathematical/statistical relationships based on our current understanding of fluxes between different ecosystem components and the way they are affected by

physical and/or in some cases bio-geo-chemical processes. They commonly refer to a geographical grid, thus averaging to some extent the variability compared to a measured profile at a specific point. Models and satellite observation are able to generate data over an extensive area with high temporal and spatial resolution. This makes them particularly useful for large-scale studies and observations and/or for studies of temporal trends. However, both techniques require systematic calibration and validation exercises to ensure the quality of the data in a given region or sub-region.

Undoubtedly, observations and sampling of the marine environment, specifically off-shore waters, using traditional means (ship survey) remain a difficult and costly operation. The use of satellite remote sensing techniques is therefore a good option to complement the scarcity of field measurements. Cloud cover and low sun zenith angle may be, however, a limiting factor to the use of satellite data, particularly in winter and northern European seas. On average reliable satellite images can be obtained once a week in northern Europe and 1-2 times per day in southern Europe. Evidently, this high data frequency could not be implemented with the classical methods of *in situ* measurements and sampling. The ability to consistently acquire data over an area on a daily basis is essential if the goal is to analyse the day-to-day changes in the parameters and the factors causing these changes. Satellite data for European seas (e.g. ocean colour data, sea surface temperature) can be downloaded free of charge through portals linked to several projects, e.g. Copernicus/MyOcean (http://www.myocean.eu) and the JRC-based Environmental Marine Information System (http://emis.jrc.ec.europa.eu). It is important to note that the performance of satellite-based sensors to provide high-quality data is an on-going research activity through regional development of algorithms and calibration/validation exercises, especially in coastal zones where bio-optical characteristics of the water are highly variable.

2. Materials and methods for IDA

2.1 Sources of information

The JRC's IDA is based on the reporting sheets, reported by the MS. The IDA for the Eutrophication descriptors was performed on the updated reporting sheets that were uploaded on September 2013. By that time 19 MS had uploaded reporting sheets (XML files). The reports (consultant's reports) prepared for DG ENV by Milieu (the versions that became available to JRC on August and September of 2013), including the 19 MS and Portugal (delivered only paper report), for the Art. 12 assessment were also consulted and were particularly useful in identifying cases where the reporting sheets were incomplete compared to the MS' paper report. In such cases information missing from the reporting sheets was retrieved from the MS' paper reports. Milieu Ltd. also produced a report for Portugal based mainly on the text report. Preliminary material on the baseline assessment, such as maps of pressures, was provided by EEA but did not fit directly to the scope the IDA. Chapter 6 includes all the sources that JRC consulted for the D5 IDA.

2.2 Scoring methodology for assessing the level of integration between MSFD and other pieces of legislation or RSC agreements

Due to the heterogeneous nature of the reported data in both the reporting sheets and the MS' paper reports the development of an -as much as possible- objective classification rule for the IDA

was needed. Four classes of integration between MSFD and other pieces of legislation or RSC' agreements were considered, i.e.:

1. No reference (direct or indirect) to any piece of legislation or RSC agreements.
2. Legislations or RSC' agreements are only mentioned but without providing any methodological information.
3. Legislations or RSC' agreements methodologies are provided (without specifications on thresholds and baselines).
4. Legislations or RSC' agreements methodologies and related thresholds and baseline, where appropriate, have been provided.

The scoring system was applied on a criterion/indicator level. The highest score amongst methods defines the MS' level of integration (i. e. with other legislations or RSC' agreements) for a particular criterion/indicator. The overall level of integration is the sum of the level 2, 3 and 4.

2.3 Assessment of methodological approaches

The methodological evaluation was performed by extracting all required information at the highest detail from the reporting sheets and consultant's reports and in some cases from the MS' paper reports. This information was organized in a table from which it was possible to retrieve:

- an overview of the methodological approaches that the MS applied
- the frequency of use of each method in pan-European and regional level and
- the level of methodological coherence in both pan-European and regional levels.

The links between WFD parameters and MSFD indicators on which the analysis was based are presented in Table 2.

Table 2. WFD parameters and their associated indicators in MSFD (modified from Zampoukas et al., 2012).

WFD Parameter	Relevant Eutrophication MSFD indicator
Angiosperms Abundance	5.3.1
Angiosperms Composition	5.2.4
Macro-algae Abundance	5.2.3; 5.3.1
Phytoplankton 1) Abundance 2) Biomass	5.2.1
Phytoplankton Bloom Frequency/Intensity	5.2.4
Phytoplankton 1) Composition 2) Diversity	5.2.4
Ammonium	5.1.1; 5.1.2
Nitrates	5.1.1; 5.1.2
Nutrient Concentration	5.1.1; 5.1.2
Oxygenation	5.3.2; 1.6.3
Transparency	5.2.2

3. Results

The first part of the results concerns the level of integration between MSFD and other EU legislations and international agreement (i.e. RSC), either regionally or on pan-European level. The second part of the results provides an overview of the methods applied for the MSFD, identifies the level of methodological coherence between the MS and indicates the frequency of use of each method per MSFD indicator.

3.1 Level of integration across different pieces of legislation and agreements

3.1.1 WFD-MSFD level of integration per article amongst the MS

The following barplots (Fig. 1) were generated based on the information of the reporting sheets as reported by 19 Member States plus the national paper report from Portugal. They show the level of integration between MSFD and WFD per article at EU and at Marine Region level, by classifying the MS according to the four categories that are described in Chapter 2.2. It should be noted that each Marine Region includes different number of MS (Baltic Sea: 7; North East Atlantic Ocean: 10; Mediterranean Sea: 6; Black Sea: 2). Some MS are within more than one Marine Region (See Annex I for the countries list).
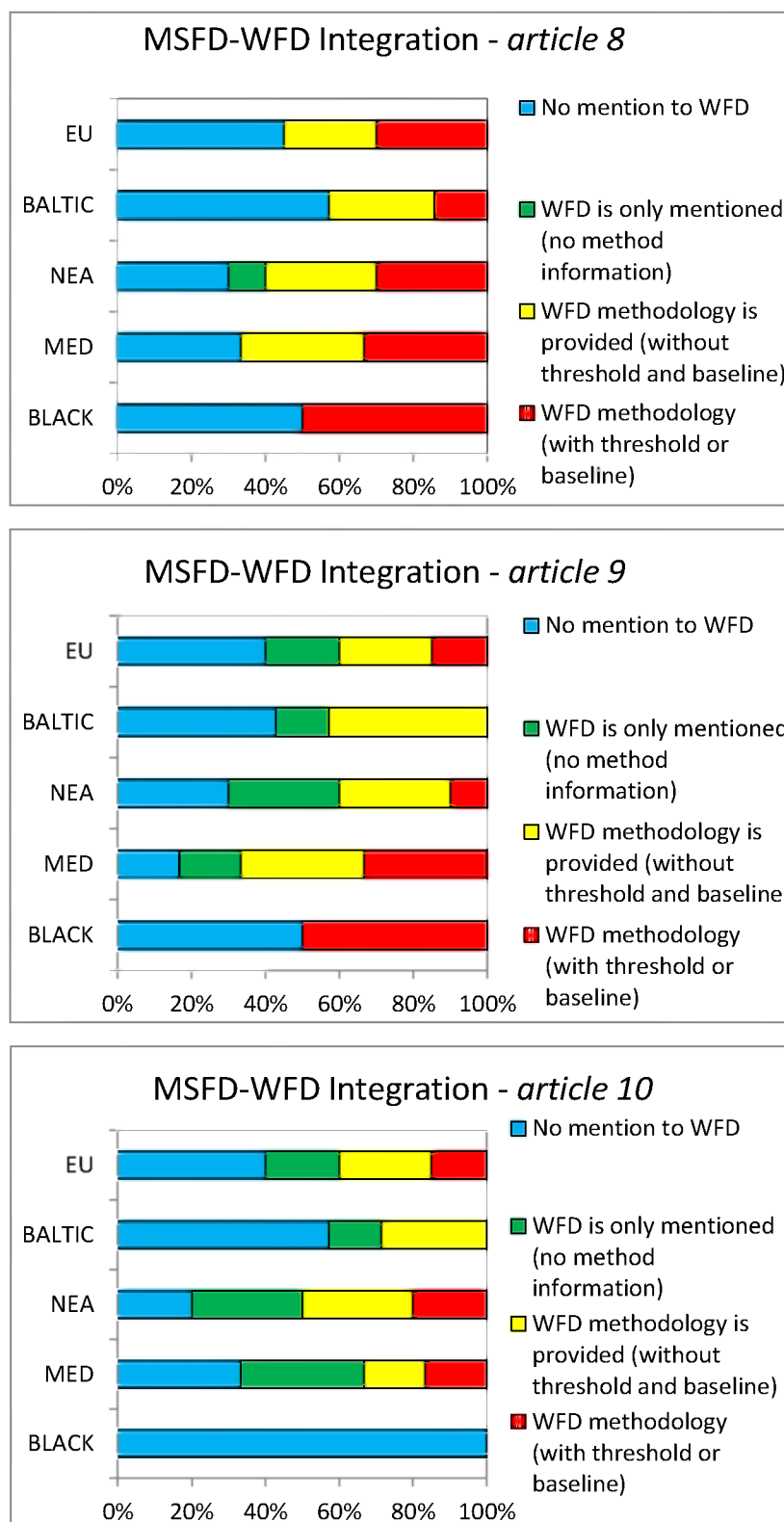
MSFD-WFD Integration - *article 8*

MSFD-WFD Integration - *article 9*

MSFD-WFD Integration - *article 10*

Figure 1. Barplots presenting the level of integration between MSFD and WFD for the MSFD Articles 8, 9 and 10 (20 MS).

More than one third of the MS did not mention the WFD in each of the MSFD Articles (8, 9 and 10). The Commission Decision of 1st September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU) states that for most criteria, the assessment methodologies required to take into account and, where appropriate, be based on those applicable

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under existing Community legislation. The level of integration between MSFD-WFD varies considerably amongst the Marine Region. Even if a level of consistency across MSFD Articles is noted for each Marine Region, WFD is less considered in Art. 10, compared to Art. 8 and 9.

3.1.2 Nitrate Directive and Urban Waste Water Treatment Directive - MSFD level of integration per article amongst the MS

Considerably fewer references have been made on Nitrate Directive and Urban Waste Water Treatment Directive. The type of references varies across MS, from a detailed definition (i.e. 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.

3.1.3 Chl-a concentration of coastal waters as an indicative example demonstrating the level of integration between a WFD parameter and an MSFD indicator

Chlorophyll-a concentration (Chl-a) is most suitable for examining the level of integration between MSFD and WFD implementation for the coastal waters (*sensu* WFD, i.e. points that are at a distance of 1 nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured). Indeed, although not explicitly required from MSFD, most of the MS considered a spatial division between *coastal* and *offshore* waters in their reporting activity for article 8, 9 and 10, probably for being coherent with Water Framework Directive. The results of the WFD intercalibration exercise (CD 2013/480/EU) have been recently published defining specific and agreed limits for Chl-a. We selected the information reported by all 20 MS relatively to the limits and thresholds for Chl-a as a metric of the 5.2.1 MSFD indicator. For the coastal waters, when a Member State explicitly mentioned or reported identical thresholds/boundaries as those in the intercalibration exercise, we considered it to be consistent to the WFD. When other thresholds/boundaries have been reported, it was considered an inconsistency. As shown in Fig. 2 for the different MSFD Articles, the consistency between the reported limits and those agreed under the WFD ranges from approximately 60% to 80%. Not all MS have reported limits and thresholds for the MSFD. Additionally the differences among the articles show inconsistency in the reporting across them, since some MS have provided WFD boundaries for one Article but not for the others.
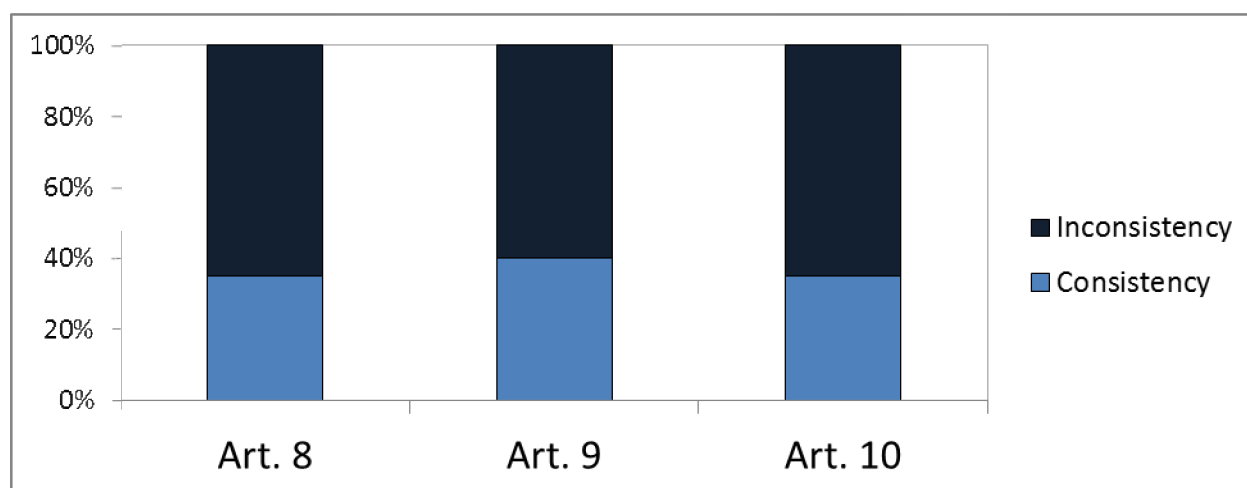
Figure 2. Level of consistency between the MSFD reported thresholds and the limits/boundaries derived by the intercalibration exercise (COM Decision 2013/480/EU) for Chl-a for the 20 Member States.

3.1.4 MSFD-RSC level of integration

This section presents the level of coherence between RSC agreed methods and MSFD implementation of Art. 8, 9 & 10. In principle, the level of RSC-MSFD integration is lower compared to WFD-MSFD. OSPAR members achieved the highest level of integration (they reported agreed thresholds in addition to methods; Fig. 3), while a low level of integration is observed within UNEP/MAP EU countries. Note that there is no real agreed methodology for eutrophication assessment in the BSC.
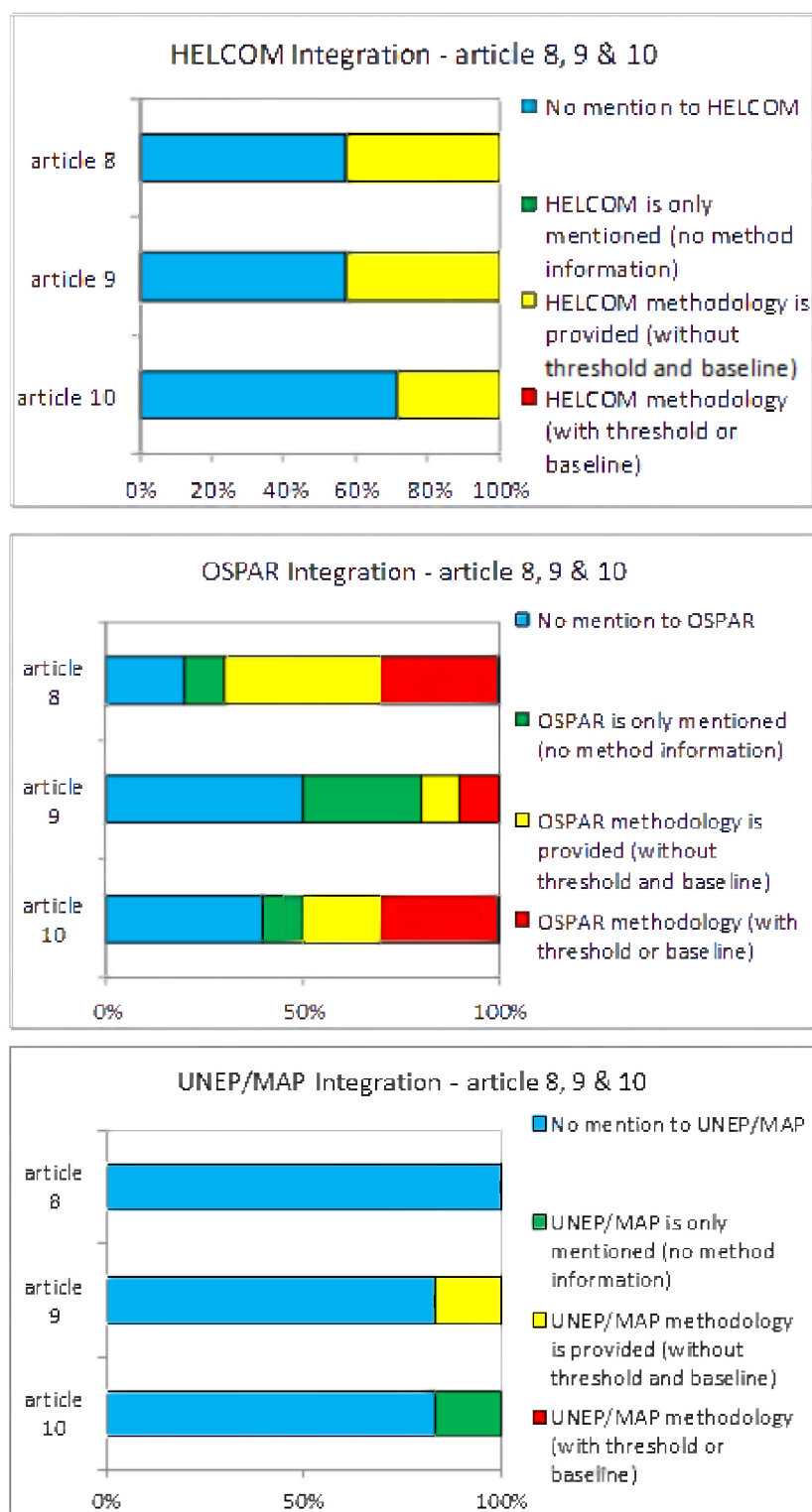
Figure 3. Level of integration between MSFD and RSC agreed methodologies for the MSFD Articles 8, 9, & 10. The 100% represents all Member States in each RSC.

3.2 Methodological approaches and standards in the implementation of MSFD articles 8, 9 & 10

As shown on Table 3, 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). The consistency in reported methods across articles 8, 9 and 10 is limited to the most well studied and widely applied methodologies. In fact, several methods were only reported for one article (Figure 4, left part of the plot).

Table 3. Number of reported methods and percentage of MS reported per indicator and criteria. The last column shows the most frequent reported method per indicator.

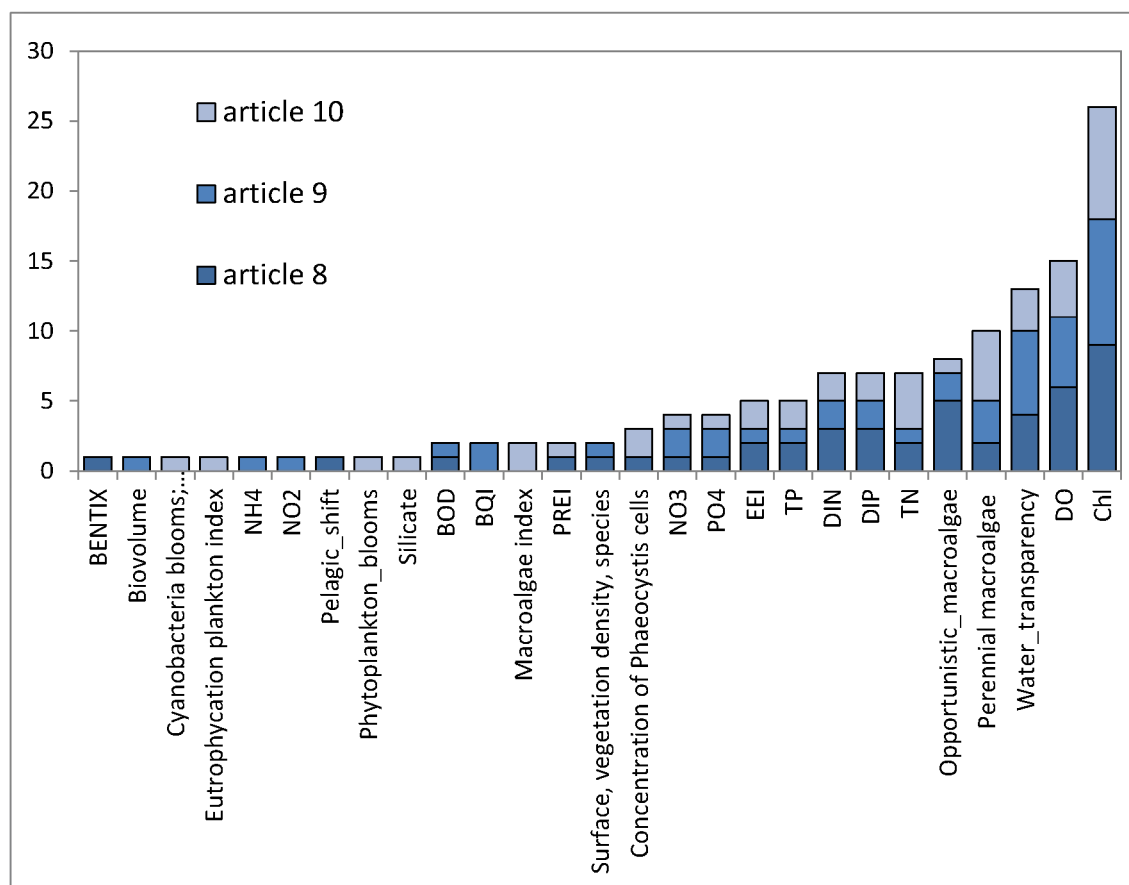| Criteria	Indicator	No. Methods Reported	Percentage of MS reporting indicator	Most frequent
5.1	5.1.1	16	100	DIP & DIN
	5.1.2	2	50	N:P_ratio
5.2	5.2.1	3	100	Chlorophyll-a
	5.2.2	2	70	Water transparency
	5.2.3	3	40	Opportunistic macroalgae
	5.2.4	11	70	Pelagic shifts
5.3	5.3.1	6	75	Perennial seaweeds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

Figure 4. List of the methodologies applied for D5 eutrophication and reported by Members States for MSFD Art. 8, 9 & 10. The length of the bar indicates the frequency of use.

Figure 5 displays the distribution and frequency of use of the reported methods across the criteria and indicators at EU level and for each Region (Baltic, North East Atlantic, Mediterranean and Black Sea). The methodological coherence on a regional level is presented by the colours corresponding to a different class of frequency of use. Some indicators were estimated by a single method while for others more than one method was reported.

European Marine Waters- Rank of Parameter utilization for article 8, 9 &10

Criteria	Indicator	Methods								
5.1	5.1.1	DIN	DIP	PO4	Nitrogen comp.	Nutrient conc.	TP, TN, NO3, Phosphorus comp.	DON, DOP, NH4, NO2, TOxN, POC, Silicate		
	5.1.2	N:P ratio				N:Si ratio				
5.2	5.2.1	Chl a				Phytoplankton biomass	Phytoplankton biovolume			
	5.2.2	Water transparency					Total suspended solids			
	5.2.3	Opportunistic macroalgae				EEI	Annual algae (macroalgae index)			
	5.2.4	Pelagic shift	Phytoplankton blooms	Toxic algae	% of Dinoflagellates	Phytoplankton quality	Phycocyanin	Eutro_plankt_index	Benthic shift	Cyanobact. blooms
5.3	5.3.1	Perennial seaweeds			Phytobenthos distributio	Seagrasses distrbution	Macroalgae abundanc	MMSkew index	Macroalgae condition	
	5.3.2	DO		Organic content	BOD5	BQI	M-AMBI	Anoxia	COD	Benthic mortality

Frequency
100-81 %
80-61 %
60-41 %
40-21 %
20-0 %

Baltic Sea - Rank of Parameter utilization for article 8, 9 &10

Criteria	Indicator	Methods								
5.1	5.1.1	DIN	DIP	TN	TP	Nitrogen comp.	Nutrient conc.	Phosphorus comp.	PO4	Silicate
	5.1.2	N:P ratio								
5.2	5.2.1	Chl a		Phyto biomass		Phyto biovolume				
	5.2.2	Water transparency								
	5.2.3	Annual algae (macroalgae index)		Opport macroalgae						
	5.2.4	Pelagic shift	Cyanobacteria bloom	Dinoflagellates blooms		Toxic algae	Benthic shift	Phycocyanin concentration		
5.3	5.3.1	Perennial seaweeds	Depth distribution phytobenthos		Condition of macroalgae		Seagrasses distrbution			
	5.3.2	DO		BQI		Organic content				

Frequency
100-81 %
80-61 %
60-41 %
40-21 %
20-0 %

		North East Atlantic sea - Rank of Parameter utilization for article 8, 9 &10								
Criteria	*Indicator*	Methods								
5.1	5.1.1	DIP	Nitrogen comp.	DIN	Nutrient conc.	Phosphorus comp.	TN	ToxN	PO4	TP
	5.1.2	N:P ratio								
5.2	5.2.1	Chl a				Phyto biovolume				
	5.2.2	Water transparency			TSS					
	5.2.3	Opport macroalgae			Annual algae (macroalgae index)					
	5.2.4	Phytoplankton blooms	Pelagic shift	Toxic algae	Phytoplankton quality		Benthic shift	Eutro plankt index		
5.3	5.3.1	Perennial seaweeds		Seagrasses distrbution		Macroalgae abundance				
	5.3.2	DO	BOD5		Benthic mortality		BQI	M-AMBI		

Frequency
100-81 %
80-61 %
60-41 %
40-21 %
20-0 %

		Mediterranean Sea - Rank of Parameter utilization for article 8, 9 &10								
Criteria	*Indicator*	Methods								
5.1	5.1.1	DIN	Nutrient conc.	NO3	PO4	Phosphorus comp.	Nitrogen comp.	TP	DON	POC
	5.1.2	N:P ratio				N:Si Ratio				
5.2	5.2.1	Chl a								
	5.2.2	Water transparency				TSS				
	5.2.3	EEI				Opport macroalgae				
	5.2.4	Pelagic shift	Benthic shift		IE	Phytoplankton blooms		Toxic algae		
5.3	5.3.1	Macroalgae abundance	MMSkew index		Perennial seaweeds		Seagrasses distrbution			
	5.3.2	DO	Organic content	Anoxia episodes		BOD5		COD	M-AMBI	

Frequency
100-81 %
80-61 %
60-41 %
40-21 %
20-0 %

Criteria	Indicator	Black sea - Rank of Parameter utilization for article 8, 9 &10					
		Methods					
5.1	5.1.1	PO4	NO3	NH4	NO2	DIP	DIN
	5.1.2	N:P ratio					
5.2	5.2.1	Chl a					
	5.2.2	Water transparency					
	5.2.3	Opport macroalgae					
	5.2.4	% of Dinoflagellates		Pelagic shift		Phytoplankton blooms	
5.3	5.3.1	Perennial seaweeds					
	5.3.2	DO		BOD5		Organic content	

Frequency
100-81 %
80-61 %
60-41 %
40-21 %
20-0 %

Figure 5. Explicit list of methods reported on a pan-European level and for each region (Baltic, North East Atlantic, Mediterranean and Black Sea), respectively, per criterion and indicator. Colours correspond to the frequency of use of each method across the MS in each region.

4. Discussion

4.1 Level of integration with other EU legislation and RSC agreements

The degree of MSFD-WFD integration presents some variation across MSFD Articles 8, 9 and 10. While the overall reference to the WFD vary from 58% for the article 8 and 63% for the article 9 and 10, the highest level of integration (where WFD methods and limits are reported) occurred in approximately one fourth of the assessed MS, which is much less than expected, considering the fact the WFD has entered into force 12 years ago. Additionally, there are just few references (but no indication on the methods or limits) on the Nitrate Directive (2 MS) and the Urban Waste Water Treatment Directive (5 MS). Chlorophyll-a is the most frequently applied indicator and, at least for some areas, the agreed boundaries between good and moderate status, according to the WFD intercalibration processes (COM Decision 2008/915/EC; COM Decision 2013/480/EC) have been considered. As such, it is the most suitable variable to be analyzed on an indicator basis for increasing MSFD-WFD integration. 60-80% of the MS that have included chlorophyll-a limits in their reports have considered the WFD limits for Chl-a.

The WFD-MSFD integration for all three MSFD Articles was also assessed on a marine region perspective and showed a great variance in the consideration of WFD. In particular, the highest integration values were observed for the North East Atlantic for Art. 8 (70%) and Art. 10 (80%) and for the Mediterranean Sea for Art. 9 (83%). The coherence between MSFD-RSC indicates that OSPAR assessment method was highly considered (73%) by the MS, followed by HELCOM (38%). On the

other hand, UNEP/MAP and Black Sea Convention presented lower and no integration, respectively. The high number of OSPAR members considering OSPAR's procedure in their first cycle of MSFD could be highlighted as a good practice of integration between MSFD and a RSC.

The consideration of different spatial scales for eutrophication assessment in EU legislations and RSC is a fundamental issue on the WFD-MSFD integration. In particular, considering EU legislations (i.e. WFD) and RSC, scales vary from the level of marine basins to local areas. In many cases the scale of the regions/sub-regions is too large for an accurate and representative assessment. Specifically, when large assessment units are delineated the pressure and associated impacts are spatially diluted and do not represent the real problems occurring at a much shorter scale. Smaller subdivisions may be therefore necessary, depending on the topic (Ferreira et al., 2010). According to Art. 4(2) MS may, in order to take into account the specificities of a particular area, implement subdivisions within the subregions. A recent document have approached and assessed the scales issue (SCALES, Deltares, 2013) based on the MS' reports for Art. 8, 9 & 10. This report showed that there seems to be a common understanding of the general principles for the definition of assessment areas and the definition of GES. Nevertheless, high level of heterogeneity is still obvious in the MS assessment. In particular, some MS used WFD coastal water bodies and offshore marine areas as assessment spatial units, while others defined larger assessment units. Several methods include routines for aggregating spatial subunits' assessment results such as: the One-out all-out, Averaging, Spatial scale rating and Minimum proportion achieving target (SCALES, Deltares, 2013). Regional Sea Conventions have also developed similar aggregating approaches with significant differences between them. For example, HELCOM developed spatial units at different hierarchical levels that are nested within each other, while OSPAR applied different assessment units on a case-by-case basis. UNEP/MAP defined sub-basins (similar to subregions; assessment areas at smaller scale are not defined) and for the Black Sea Convention territorial waters and open sea are distinguished (SCALES, Deltares, 2013).

As far as the level of integration is concerned, the overall picture derived from this IDA depicts that there is still some effort to be to achieve a high level of integration between MSFD and other existing political frames. The integration among different EU legislation and RSC could effectively reduce the burden on MS, avoid duplication of reporting, and enhance data usefulness (UNEP-WCMC / MRAG-Ltd / URS., 2013). The level of integration between WFD and MSFD, which in some cases could be considered as good, is not adequate to cover all the MSFD requirements. The spatial overlapping between MSFD and WFD only covers the coastal waters (up to 1 nautical mile).

Recommendation: *The low level of MS' consideration of EU pieces of legislation and RSC agreements in the first cycle of MSFD imposes an improved integration at the next phase that would secure a certain level of coherence and comparability across the MS. The related WFD acquis should be better considered in the MSFD implementation and this could be facilitated by the intercalibration of WFD methods and the establishment of a linkage between WFD methods and MSFD assessment. Moreover, RSC 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 RSC and EU approaches. A harmonization in MS actions for the MSFD implementation will reduce the transboundary deviations in the quantification of GES and targets.*

4.2 Methodological approaches

The diverse interpretation in the implementation of MSFD creates a complex situation with respect to the selected indicators by each Member State. The assessment reports for D5 per Member State do not cover all the indicators listed in COM Decision (2010/477/EU), and their aggregation for the final assessment of D5 generates an additional level of complexity/incoherence and reduces comparability. In addition, the use of a limited set of indicators (or only a single indicator such as Chl-a) is not enough to describe the eutrophication status, to identify the related pressures and to decide on effective measures and targets. As an example, an increase in Chl-a could be caused by natural processes such as upwelling, eddies, etc. It should be noted that in the reporting sheets almost no or limited details on the application of methodologies were reported. This issue prevents the direct comparison between reported thresholds, baseline and limits.

The results of the IDA for D5 showed that a considerable number of methods are reported by MS for the implementation of Art 8, 9 and 10. At least one method for each indicator with an EU-wide range of functionality was reported such as Chl-a (indicator 5.2.1), water transparency (indicator 5.2.2) and dissolved oxygen (indicator 5.3.2). This picture is also confirmed by the list of methods used by different eutrophication assessments tools provided in Table 1. A common EU-wide assessment framework for MSFD across areas, adjusted to the different ecosystems could improve the coherence and comparability of MS' assessment, GES and the achievement of targets. This framework should be characterized by an agreed core set of parameters, an agreed data format, and standard common assessment rules across parameters. For eutrophication, indicators, such as Chl-*a*, water transparency and nutrients concentration (particularly DIN & DIP) presented high frequency of use. Such indicators could be seen as a pan-European set of indicators to secure a minimum level of coherence, when the estimation of all COM DEC (2010/477/EC) indicators in not feasible. Numerical adjustments 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. It should be underlined that all D5 indicators are focused on measuring state and impact either directly or indirectly, in the water column and seabed. Except for the OSPAR COMMP, there are only few attempts to incorporate pressure indicators in the tools for the eutrophication assessment (Table 1). A potential revision on criteria/indicators should take into account the frequency of use of indicators (e.g. 5.2.1), related scientific work and experts' consultation, for an objective evaluation of the systematically underrepresented indicators in the MS' reports (e.g. 5.1.2, 5.2.3).

There is a variation on the number of sub-regions where Art. 8, 9 & 10 were applied, as well as on the distinction between coastal and offshore waters. Some MS have reported more than one sub-region; and the number of indicators, methods, definition of GES and targets differ among them generating more incoherence in the MSFD implementation. Some of the MS that have considered WFD in their D5 assessment, they also made the distinction between coastal and offshore waters. That could be highlighted as a good practice as long as the assessment in both zones is consistent. Such an approach would lead to a complete overlap between MSFD and WFD sharing agreed methods derived by the intercalibration exercise (Commission Decision 2013/480/EU). On the other hand, a significant proportion of the MS did not define limits, boundaries, targets and, in some cases, GES for the offshore waters assuming that eutrophication is only a coastal phenomenon.

Where both areas have been assessed, it was noticed that different methods have been applied for the same indicator resulting in reduced consistency and comparability.

Recommendations: *Considering significant flaws in achieving coherence among MS in D5 assessment with regard to both EU and RSC legislations, the starting point for a better harmonization would be a consistent and agreed pan European common approach for the eutrophication assessment (i.e. minimum core set of parameters). Numerical adjustments 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.*

The JRC's review of methodological standards related to MSFD criteria on GES (Piha & Zampoukas, 2010) provides an adequate base for comparable approaches by the MS. Most of the methods provided by MS and frequently reported are also included in this list, with the exception of the methods related to the utilization of macroinvertebrates (e.g. Benthix, BQI, etc).

4.3 Reporting and assessing issues

The IDA also revealed some problematic issues related to the reporting process of Articles 8, 9 & 10. It was very surprising that the reporting sheets of most MS did not contain the same information as the MS' paper reports. In some cases the two reports were complementary, while in others dissimilarities were noticed even on the methodological level. In several cases, differences in crucial elements of the MSFD implementation were found such as in the definition of GES and targets.

Furthermore, there seems to be various interpretations of the MSFD article 8, 9 and 10 from the MS. Indeed in several case MS have reported similar information under different database field or provided information often not comparable in the same field (qualitative or quantitative, different scales, different units of measure, etc.). Moreover, there are references to grey literatures, national legislations and RSC documents, written on national languages and not easily accessible that further reduces clarity and transparency, etc. The issues above undermine the validity of the reporting sheets and the MS reports and limit the possibilities for a meaningful IDA by possibly leading to an underestimation of the actual level of integration between MSFD and other agreed documents and thus, to a biased IDA.

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, because of 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 present different level of ambition regarding the implementation of MSFD, which is clearly reflected by the number of targets, the precise qualitative metrics and the strict or loose definition of GES. Differences in ambitions lead to incoherence in the implementation of MSFD, even within the same region. In order to overcome the inconsistency created from the

different ambitions or willingness to achieve the MSFD requirements, more synergies amongst MS are necessary, taking into account the dissimilarities in economies, human resources, infrastructures and extent of marine waters under each MS jurisdiction.

Recommendation: Clear links should be made between pressures and impacts (Annex III, Table 2 of MSFD) and criteria and indicators (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 indicators accompanied by common agreed measurable methodologies.

Reporting sheets should reflect the MS' paper reports, since they consist an electronic way of reporting the qualitative and quantitative data and not an independent one. The required information in the reporting sheets could be significantly reduced and the process could be automated by using drop-down boxes with specific option, where appropriate, to reduce the heterogeneity caused by the different approaches of the MS. This solution would have the advantages of reducing the MS' uncertainties in the process of reporting and of simplifying and making more feasible and meaningful the evaluation of the Commission (MSFD Art. 12).

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5. Conclusions

Table 4 includes the key findings of the D5 IDA on Art. 8, 9, 10. Each addressed issue is followed by a suggestion and potential actions and actors, where appropriate.

Table 4. List of key issues derived from the in-depth assessment for D5, suggestions, potential actions and actors.

Issues on implementation	*Suggestion*	*Potential actions/actors*
Limited integration with WFD.	Consideration of WFD elements (classification, assessment methods, thresholds, etc.) for coastal waters in MSFD definition of GES and Targets. Coherence between coastal and offshore boundaries. Integration with RSC. Results coming from the on-going intercalibration exercise should be integrated in the next phase of MSFD.	EU-wide assessment tools; strengthen the links between WFD and MSFD/ MS, RSC, EU
No integration with other European Law (e.g. ND, UWWTD)	Increasing incorporation of ND and UWWT tools could support utilization of pressure base targets	Revaluate the Targets reported by the MS (art. 10)/MS, RSC and EU
Low integration between MSFD and RSC	Active involvement of the RSC or the MS on regional level in the establishment of coherent and comparable limits with WFD and RSC. Development of an agreement on a minimum common set of indicators and related methodologies.	Links between MSFD-RSC / MS & RSC

Issues on methods	*Suggestion*	*Potential actions/actors*
Heterogeneity of methodological approaches, thresholds and limits	Common agreed and comparable methodological standards on an EU-wide level.	MS, RSC & EU
Different indicators reported per criterion	Core set of indicators to ensure the minimum level of coherence	JRC led network of experts/ recommendations for COM Decision revision
Spatial inconsistency within and between MS regarding coastal-offshore distinction or number of subregions reported. Differences in dataset spatial scales	Assessment of both coastal and offshore water with clear boundaries and thresholds. Synergies in the definition of scales, possible with common monitoring programmes	MS plus assessment scales guidance
Issues on reporting	*Suggestion*	*Potential actions/actors*
Differences between MS' paper reports and reporting sheets; missing or not adequately reported information; similar information is reported under different fields; Different level of detail in the reported information	Reporting sheets should reflect the MS'paper reports, since they consist an electronic way of reporting the qualitative and quantitative data and not an independent one. The required information in the reporting sheets could be significantly reduced and the process could be automated by using drop-down boxes with specific option	Updated guidance on reporting with reduced and more specific fields/ ENV
Differences in MS reports regarding the implementation across Articles, the use of pressures and impact in them and their link with criteria and indicators.	Clear links in between pressures and impacts (Annex III, Table 2 of MSFD) and criteria and indicators (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.	JRC led network of experts/ COM Decision revision
Improving the efficiency and homogeneity of reporting spreadsheets; improve data access and data management for the MS evaluation of MSFD implementation (Art. 12)	Coherence in reporting to allow for an accurate and meaningful IDA	Improve reporting sheets quality, data & metadata availability / MS & ENV

6. References/sources used or consulted

- Ferreira et al. 2010. MSFD - Task Group 5 Report – Eutrophication
- AA. VV. Perseus Deliverable 5.2
- AA.VV. Common Understanding of (initial) Assessment, Determination of Good Environmental Status (GES) & Establishment Targets
- Zampoukas et al. 2012. Monitoring for the MSFD: Requirements and Options
- Piha & Zampoukas 2011. Review of Methodological Standards Related to the MSFD Criteria on GES
- Commission Decision 2013/480/EU
- UNEP-WCMC / MRAG-Ltd / URS. 2013. "Streamlining and harmonisation of reporting requirements under EU instruments and Regional Seas Conventions"
- Commission Decision (2010/477/EU)
- WFD Guidance Document No. 23 on eutrophication assessment in the context of European water policies
- OSPAR COMMISSION (2012). MSFD Advice Manual and Background document on Good environmental status - Descriptor 5: Eutrophication
- Deltares (2013). "Coherent geographic scales and aggregation rules in assessment and monitoring of Good Environmental Status- Analysis and conceptual phase" Analytical report.

Annex I. Member States included in the analysis

Member State	Abbreviation	RSC
Belgium	BE	OSPAR
Bulgaria	BG	Black Sea
Cyprus	CY	UNEP/MAP
Denmark	DK	OSPAR/HELCOM
Estonia	EE	HELCOM
Finland	FI	HELCOM
France	FR	OSPAR - UNEP/MAP
Germany	DE	OSPAR- HELCOM
Greece	EL	UNEP/MAP
Ireland	IE	OSPAR
Italy	IT	UNEP/MAP
Latvia	LV	HELCOM
Lithuania	LT	HELCOM
Netherlands	NL	OSPAR
Portugal*	PT	OSPAR
Romania	RO	Black Sea
Slovenia	SI	UNEP/MAP
Spain	ES	OSPAR - UNEP/MAP
Sweden	SE	HELCOM- OSPAR
United Kingdom	UK	OSPAR

*No spreadsheet available – Consultant's report available

IN-DEPTH ASSESSMENT OF MEMBER STATES' SUBMISSIONS FOR MSFD ART. 8, 9 & 10 ON MARINE CONTAMINANTS DESCRIPTORS D8 & 9

MARINE CONTAMINANTS
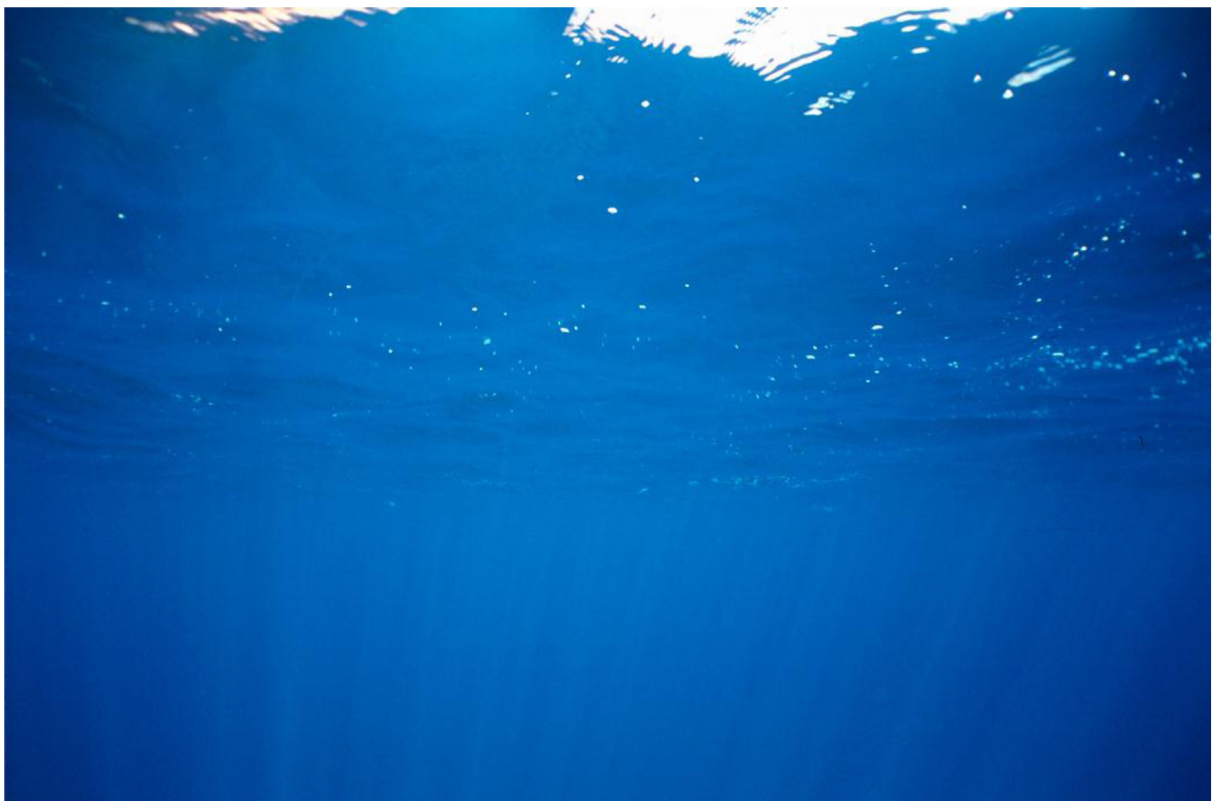
Photo by Georg Hanke

Contents for D8 & 9

1. Introduction

Contamination caused by hazardous substances is a major environmental concern in European waters and is addressed by a number of EU legislative measures and policies. The MSFD is the first EU directive that aims to provide an integrative marine environment status assessment and consider both coastal and offshore environment. MSFD Descriptor 8 "Concentrations of contaminants are at levels not giving rise to pollution effects" is very much linked to the assessments carried out under the Water Framework Directive (WFD). MSFD Descriptor 9 "Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards" also tackles the issue of marine chemical pollution but with the protection of human consumers as a goal. MSFD descriptors 8 and 9 are closely linked and have therefore been addressed together. Taking into consideration the data and assessments carried out within the WFD context, together with the approaches followed by the Regional Seas Conventions (RSC), it would be expected that Member States (MS) would be able to provide comprehensive, comparable and consistent assessments as well as Good Environmental Status (GES) definitions and environmental targets for those two descriptors as a part of the earliest stages of MSFD implementation.

1.1 Scope of the in-depth assessment

JRC has performed the D8 and 9 in depth assessment (IDA) of the Member States reports for MSFD Articles 8, 9, and 10, on the request of DG ENV as a follow up of the MSFD Art 12 assessment. The aims of the IDA are:

- o   To analyze the information and data that have been reported or collected by MS in order to assess its comprehensiveness and comparability across countries and regional seas and identify main problems and gaps.

- o   To evaluate the comparability of methods of assessment used by MS, in particular regarding to their relation with those of the WFD and RSC.

- o   To assess the consistency in data reporting.

- o   To provide recommendations for the possible revision of the Commission Decision on criteria and methodological standards as well as for improved implementation in the second MSFD cycle.

The aim of this report is rather to present a holistic assessment of the implementation of MSFD per Member State than to judge or comment on particular Member State practices.

1.2 Contamination related legislation and agreed documents

Assessment under MSFD descriptors 8 and 9 are very much linked to assessments of environmental pollution carried out within the WFD and RSC. Important work on chemical pollution assessment across different EU and other international policies has already been done by:

- Directive 2000/60/EC (WFD) and related EU legislation.
- The Coordinated Environmental Monitoring Programme (CEMP) adopted by the OSPAR Convention.
- The Programme for the Assessment and Control of Marine Pollution in the Mediterranean region (MEDPOL) of the Mediterranean Action Plan (MAP).
- The HELCOM Baltic Sea Action Plan for hazardous substances.
- The Commission Regulation (EC) No 1881/2006 and its amendments setting maximum levels for certain contaminants in foodstuffs.

A complete list of documents and legislations relevant for the IDA of D8 and 9 is compiled in the section 6.

2. Assessment methodology

2.1 Input for D8+9 IDA

The IDA for descriptors 8 and 9 has been carried out mainly by exhaustive scrutiny and analysis of the information contained in the MS' reports provided by the 20 MS listed in Annex I. To this end, and taking into account that most MS have reported in their respective languages, translations into English have been made using Google Translator. The reporting sheets obtained from the compilation of templates provided by MS (via EEA) have also been consulted in order to assess the consistency in data reporting by MS as well as to find supplementary information that was missing or difficult to extract from the MS' paper reports. Finally, the reports (consultant's reports) provided by the Milieu consultants (via DG ENV) have been also used for additional help in the assessment process. The goal is to gather information on the following key elements relevant to the descriptors under consideration:

- The hazardous substances assessed and/or considered.

- The environmental matrix(-ces) used in the assessments.

- The thresholds and baseline levels considered.

- The sources and inputs of contaminants.

- The current levels and trends of contaminants.

- The biological effects/impacts considered.

- The pollution events.

The analysis of the compiled data will provide results at country level and further at regional level, focusing on the integration with other EU legislation and RSC agreements. Obviously, results will depend on the nature and level of detail of the information included in the source documents and will help to identify gaps and needs for the implementation of MSFD descriptors 8 and 9.

2.2 Methodology for assessing the level of integration between MSFD and other legislations or RSC agreements

A system has been developed to objectively evaluate the performance of MS on implementing Art. 8, 9 and 10 of MSFD. Firstly, the different evaluation criteria considered in the initial assessments, GES definitions and environmental targets have been identified. Then, the integration between MSFD and other EU legislations has been assessed, mainly regarding to the use of the Environmental Quality Standards (EQS) of the WFD for descriptor 8 and the use of the limits established in the Commission Regulation (EC) No 1881/2006 for descriptor 9.

Hence, the following ranking categories have been established:

- No reference to those evaluation criteria.
- Evaluation criteria mentioned, but not used in the assessment.
- Evaluation criteria utilized to perform the assessment.

Moreover, the application of other environmental indicators by MS, such as the Environmental Assessment Criteria (EAC) and the Quality objectives (EcoQO) developed within OSPAR, is also assessed in the corresponding sections of this report.

3. Results

The first part of the results provides an overview of the mentioned selected key elements in order to compare the practices applied by MS for the MSFD. The second part of the results analyzes the level of consistency between MSFD and other EU legislations, either regionally or on Pan-European level.

3.1 Hazardous substances and environmental matrices

3.1.1 Hazardous substances and matrices in the initial assessments

The Art. 8 of the MSFD requires the assessment of the concentrations of contaminants in the relevant matrix (such as biota, sediment and water). The analysis of the information on synthetic and non-synthetic compounds provided by MS on implementing this article has revealed that, although most MS have reported data on the three different matrices (Figure 1), there is a high heterogeneity among countries in relation to both the substances and the matrices assessed.
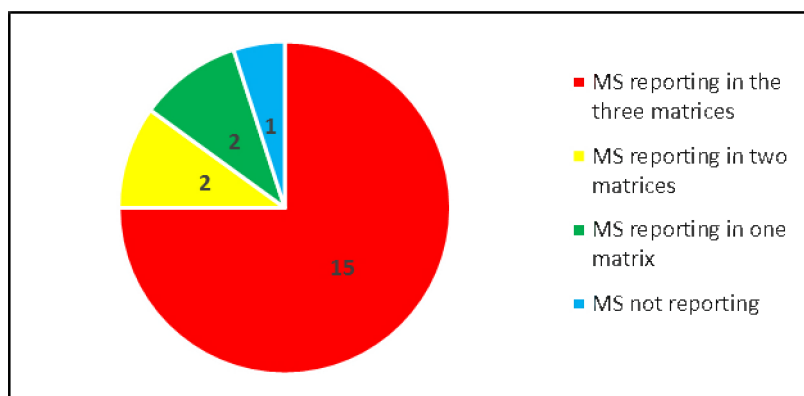
Figure 1. Number of MS reporting data on synthetic and non-synthetic compounds in the key matrices.

It is important to indicate that the particular species used to assess the concentrations of contaminants in biota has only been detailed by 10 countries.

Table 1 records the chemical contaminants (with special reference to the priority substances (PS) and other pollutants covered by the WFD) and the matrices for which assessments have been provided, indicating the number of MS in each particular category. After checking for inconsistencies amongst MS, the substances are provided as they have been named in the assessed reports.

Table 1. Number of MS per chemical contaminant and matrix.

Initial Assessment			
Substance	**Water**	**Sediment**	**Biota**
Hg*	10	15	18
Cd*	9	15	18
Pb*	10	14	17
Polychlorinated biphenyl (PCB)	6	10	13
Polycyclic Aromatic Hydrocarbons (PAH)*	8	9	9
Cu	6	12	7
γ-Hexachlorocyclohexane (lindane)*	8	9	7
pp'-DDE	5	8	10
Hexachlorobenzene (HCB)*	9	7	7
Tributylin compounds (TBT)*	6	8	9
Ni*	8	9	5
Zn	5	11	6
Benzo(a)pyrene*	4	8	9
Brominated diphenylethers (BDE)*[a]	3	5	11
Anthracene*	5	7	4
pp'-DDT*	5	5	6
PCB118**	2	4	10
pp'-DDD	5	4	6
Cr	3	9	2
PCB52	3	3	8
PCB138	3	3	8
PCB153	2	3	9
Dioxins and dioxin-like PCBs**	-	3	10
α-Hexachlorocyclohexane*	6	3	4
PCB101	2	3	8
Benzo[a]anthracene	2	7	3
Fluoranthene*	3	5	4
PCB28	3	2	7
PCB180	3	2	7

Dieldrin*	4	4	3
Indeno[1,2,3-cd]pyrene*	3	6	1
Aldrin*	4	2	4
Endrin*	4	2	4
Benzo[b]fluoranthene*	4	4	1
Benzo[g,h,i]perylene*	2	4	3
Chrysene	1	6	2
DDT*	3	2	4
Naphthalene*	3	5	1
Octylphenols*	4	3	2
Endosulfan*	4	2	2
Furans**	-	3	5
β-Hexachlorocyclohexane	3	2	3
Benzo[k]fluoranthene*	3	2	2
PCB105**	2	1	4
PCB156**	2	1	4
As	1	4	1
Perfluorooctane sulfonic acid (PFO)**	1	1	4
Phenanthrene	-	4	2
Pyrene	-	4	2
Heavy metals	4	-	1
Heptachlor epoxide**	3	1	1
Hexabromocyclododecanes**	1	1	3
Nonylphenols*	3	1	1
Fluorene	1	2	1
Atrazine*	3	1	-
Benzene*	3	1	-
1,2-dichloroethane (DCE)*	3	1	-
Dichloromethane*	3	1	-
Di(2-ethylhexyl)phthalate (DEHP)*	3	-	1
Diuron*	3	1	-
Drins	2	1	1
Isoproturon*	3	1	-
Pentachlorobenzene*	2	2	-
Petroleum hydrocarbons	1	3	-
PCB31	1	1	2
Chlordane	1	1	1
Fe	1	1	1
Hexachlorobutadiene (HCBD)*	3	-	-
Li	1	2	-
Nonachlor	1	1	1
Simazine*	2	1	-
Trichloromethane*	3	-	-
Al	1	1	-
Alachlor*	1	1	-
Chlorfenvinphos*	1	1	-
Chlorpyrifos*	1	1	-
Isodrin*	-	-	2
Mn	-	1	1
Organochlorine compounds	2	-	-
Organochlorine pesticides	1	-	1
Paraffins	1	-	1
PCB77**	-	-	2
PCB189**	-	1	1
Pentachlorophenol*	2	-	-

Terbutryn**	1	1	-
Tetrachloroethylene*	2	-	-
Trichlorobenzenes*	2	-	-
Acenaphthylene	-	1	-
Dibezo(a,h)anthracene	-	1	-
Co	1	-	-
Benzo[a]fluoranthene	-	-	1
Benzo[e]perylene	-	1	-
Bisphenol A	-	1	-
Chloroalkanes C10-13*	1	-	-
Carbon-tetrachloride*	1	-	-
Ethylbenzene	1	-	-
Methyl-Hg	-	-	1
Naphthalene/Pyrene	-	1	-
PCB128	-	-	1
PCB169**	-	-	1
PCB170	-	-	1
Trichloroethylene*	1	-	-
Xylene	1	-	-
Trifluralin*	-	-	-
Dicofol**	-	-	-
Quinoxyfen**	-	-	-
Aclonifen**	-	-	-
Bifenox**	-	-	-
Cybutryne**	-	-	-
Cypermethrin**	-	-	-
Dichlorvos**	-	-	-

* WFD Priority Substances and certain other pollutants (2008/105/EC)

** WFD Priority Substances Amendment (2013/39/EC)

It can be seen that most assessment have been carried out for legacy pollutants, such as toxic metals (Hg, Cd, and Pb), PCBs, PAHs, lindane, DDT metabolites, TBT, and HCB, while very few countries have reported on other priority and emerging pollutants. WFD PS constitute an important pollution parameter, as they are a means to assess the chemical quality of water bodies up to 12 nautical miles from the straightened coastline. It can be found that, although very limited for some of them, there are data for all PS and certain other pollutants listed in Annex I of the EQS Directive (2008/105/EC) but one. However, there are a number of PS of the amendment (2013/39/EC) that have not been considered yet by MS in the MSFD initial assessments.

Furthermore, River Basin Specific Pollutants (RBSP) form part of the quality elements for "good ecological status" within the WFD up to 1 nautical mile and provide a means to consider chemical pollutants which are no PS, but need to be considered also in the coastal waters. Only five MS have mentioned the number of pollutants they evaluate within the 1 nautical miles zone in accordance with WFD requirements, and only one of them has provided the list of those specific pollutants. Other information on this regard, however, is practically missing in the MSFD initial assessments.

On the other hand, there are also substances specifically relevant for RSC, such as those which the OSPAR Commission and the HELCOM Baltic Sea Action Plan have determined to require priority action. While ten out of the elven HELCOM priority substances are also WFD PS, it is interesting to point out that only three of them have been evaluated by all the HELCOM members in the MSFD initial assessments (Table 2).

Table 2. % of HELCOM MS per chemical contaminant (total number HELCOM members=7).

Priority list of the HELCOM Baltic Sea Action Plan	% HELCOM Members
Cd	100
Hg	100
Organic tin compounds	100
Dioxins, furans and dioxin-like PCBs	86
Hexabromocyclododecanes	57
Perfluorinated compounds	57
Brominated diphenylethers	43
Endosulfan	29
Octylphenols	29
Chlorinated paraffins	14
Nonylphenols	14

The OSPAR priority substances differ much more from the WFD PS, but, as before, for most of them, assessments have not been provided by all the OSPAR signatory countries, and even for more than a half, no assessments have even been provided at all (Table 3).

Table 3. Percentage of OSPAR MS per chemical contaminant (total number OSPAR members=10).

OSPAR list of chemicals for priority action	% OSPAR Members
Cd	100
Hg	100
Brominated flame retardants	100
PAHs	100
Pb	90
PCBs	90
HCHs	60
Organic tin compounds	60
Dioxins	50
Endosulfan	20
Furans	20
Polychlorinated naphthalenes	20
Cyclododecane	10
Isodrin	10
Nonylphenol	10
PFOs	10
Phthalates: DEHP	10
2,4,6-bromophenyl 1-2(2,3-dibromo-2-methylpropyl)	-
Clotrimazole	-
1,5,9 cyclododecatriene	-
Dicofol	-
4-(dimethylbutylamino)diphenylamin	-
Diosgenin	-
Ethyl O-(p-nitrophenyl) phenyl phosphonothionate	-
Flucythrinate	-
Heptachloronorbornene	-
Methoxychlor	-
Musk xilene	-
Octylphenol	-
Neodecanoic acid, ethenyl ester	-
Pentabromoethylbenzene	-
Pentachloroanisole	-
Pentachlorophenol	-
2-propenoic acid, (pentabromo)methyl ester	-
Short chained chlorinated paraffins	-
Tetrabromobisphenol A	-
Tetrasul	-
Trichlorobenzene	-
Trifluralin	-
2,4,6-tri-tert-butylphenol	-
3,3'-(ureylenedimethylene)bis(3,5,5-trimethylcyclohexyl) diisocyanate	-

Much less information has been reported on radionuclides than on trace elements and organic substances (Figure 2). Most MS have focused on the assessment of ^{137}Cs, although the variability in the radioisotopes and matrices chosen is very elevated, as it can be seen in Table 4.
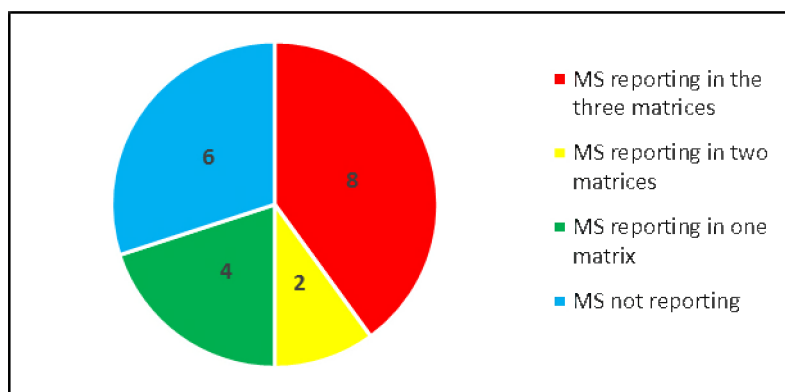
Figure 2. Number of MS reporting data on radionuclides in the key matrices.

Table 4. Number of MS per radionuclide and matrix.

Initial Assessment			
Radionuclides	Water	Sediment	Biota
137Cs	13	7	12
238-(239+240)Pu	3	2	4
90Sr	4	1	3
60Co	3	2	2
40K	3	2	2
54Mn	2	2	2
241Am	1	1	3
99Tc	3	-	2
65Zn	1	2	2
Tritium	4	-	1
210Pb	1	1	2
228Th	1	2	1
7Be	-	1	2
109Cd	1	1	1
226Ra	-	2	1
228Ra	1	1	1
110Ag	-	1	1
238U	1	1	-
131I	1	-	-

3.1.2 Hazardous substances and environmental matrices in the definitions of GES and the sets of environmental targets

Figure 3 summarizes the most relevant information with regard to the contaminants considered by MS in their definitions of GES on implementing Art. 9 of the MSFD.
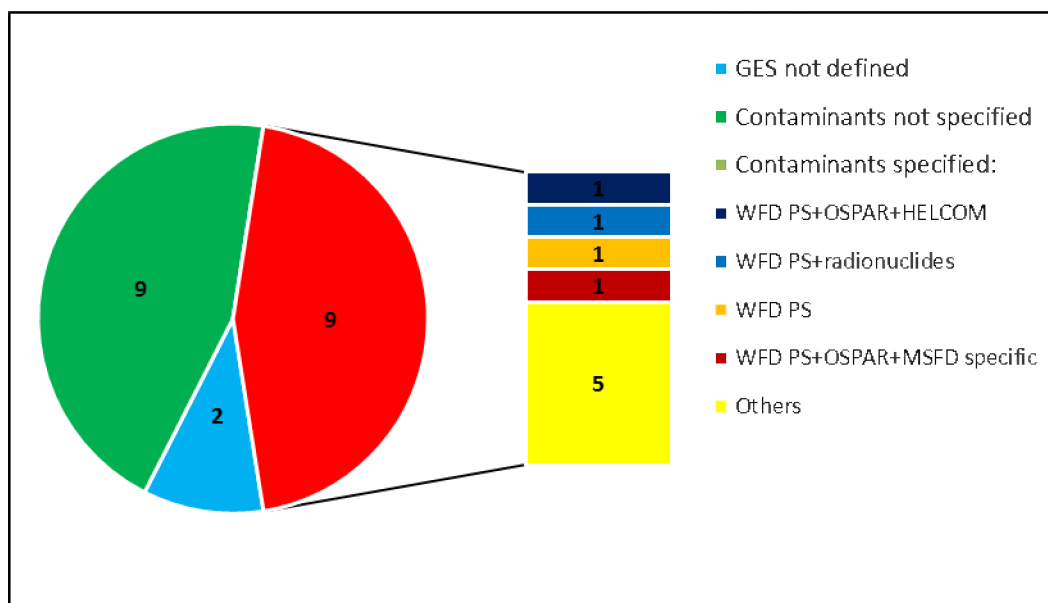
Figure 3. Number of MS specifying the contaminants in their definition of GES.

Less than half of the MS have specified the contaminants that need to be addressed for the definition of GES, and only four of them refer to all the priority substances (PS) listed in the WFD. Three of those four MS also mention other substances relevant for RSC, such as HELCOM or OSPAR, and only one includes some contaminants specifically for the purpose of the MSFD (BDE 209, methyl-Hg, HBCD, Tetrabromobisphenol A). The remaining five countries have considered a variety of compounds, principally heavy metals, PCBs, PAHs and organochlorine pesticides.

Most MS have mentioned the three key matrices (sediments, water and biota) in their GES definitions, although almost one third has not specified the matrix where measurements should be carried out, as it can be seen in Figure 6.
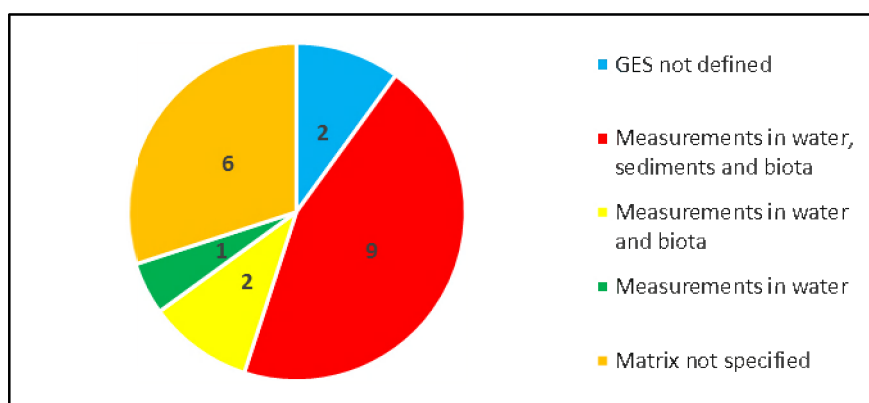
Figure 4. Number of MS specifying the matrix in their definition of GES.

Regarding the article 10 of the MSFD, half of the MS have identified the relevant substances when setting their environmental targets. Four of those ten countries refer to the WFD PS list, while the others focus on other compounds, namely heavy metals, PAHs, PCBs, dioxins, furans and petroleum hydrocarbons (Figure 5).
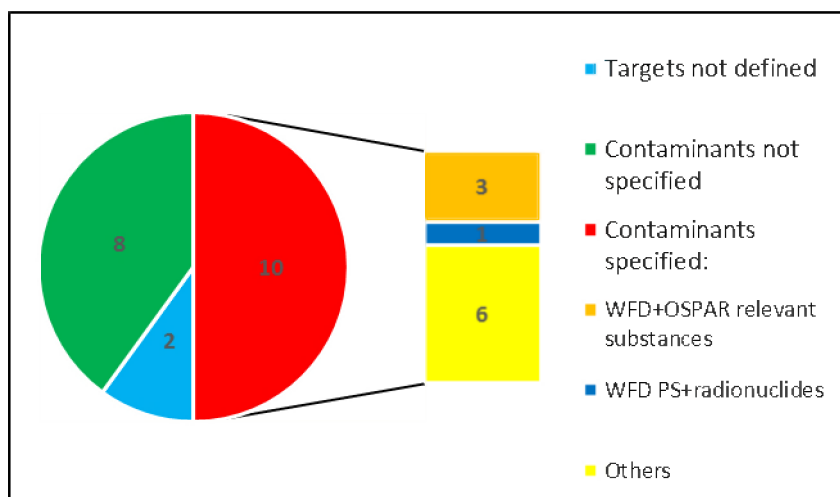
Figure 5. Number of MS specifying the contaminants in their environmental targets.

Although most MS refer to measurements in the three key matrices, some MS have also proposed the determination of contaminants at the pollution sources for their environmental targets (Figure 6).
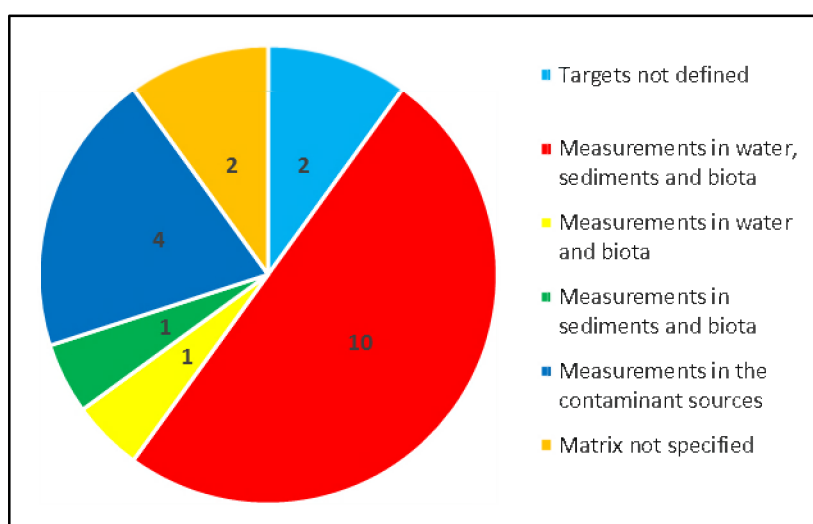
Figure 6. Number of MS specifying the matrix in their environmental targets.

3.2 Evaluation criteria

3.2.1 Evaluation criteria in the initial assessments

As seen for the substances and the matrices, there is also high variability in the criteria or benchmark standards that MS have utilized to evaluate the status of contamination of their marine environment and very often it is difficult to ascertain which standard has been considered for a particular substance or in a particular matrix. Here, the available information regarding the evaluation criteria to which MS have referred in their initial assessments of synthetic and non-synthetic compounds in the key three matrices is summarized.

Water is the matrix that presents the highest homogeneity across MS since most assessments have been conducted using the EQS of the WFD (Figure 7). Only one Member State has also referred to additional standards (the Water Quality Standards (WQS) of the US Environmental Protection Agency (US EPA), the OSPAR Background Assessment Criteria (BACs) and specific national standards) for the evaluation of some substances with no EQS available, such as Cu and Zn.
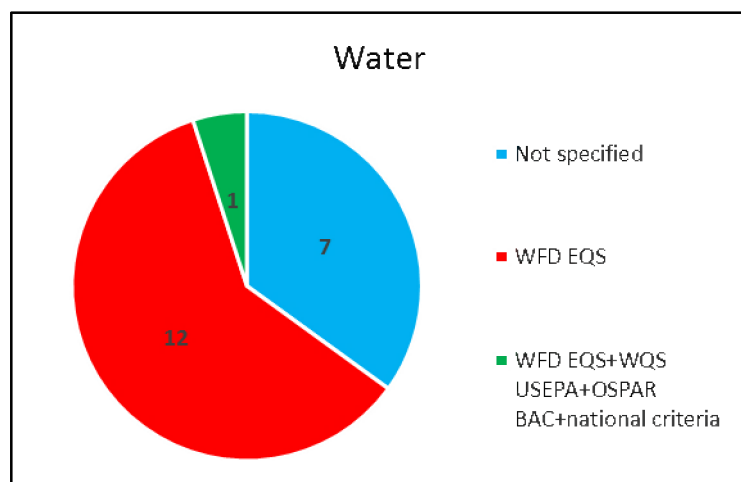
Figure 7. Number of MS using different evaluation criteria in water.

With regard to sediments, most MS have considered the BAC and EAC proposed by OSPAR, and also the Effect Range 10 Percentile (ERL) developed by US EPA (Figure 8). Two countries have also made reference to their specific national regulatory levels and another Member State has compared the levels of the insecticide endosulfan with the predicted no effect concentration (PNEC) for the benthic organisms used in the context of REACH (Registration, Evaluation, Authorization and Restriction of Chemicals (EC 1907/2006), though this standard is still to be refined.
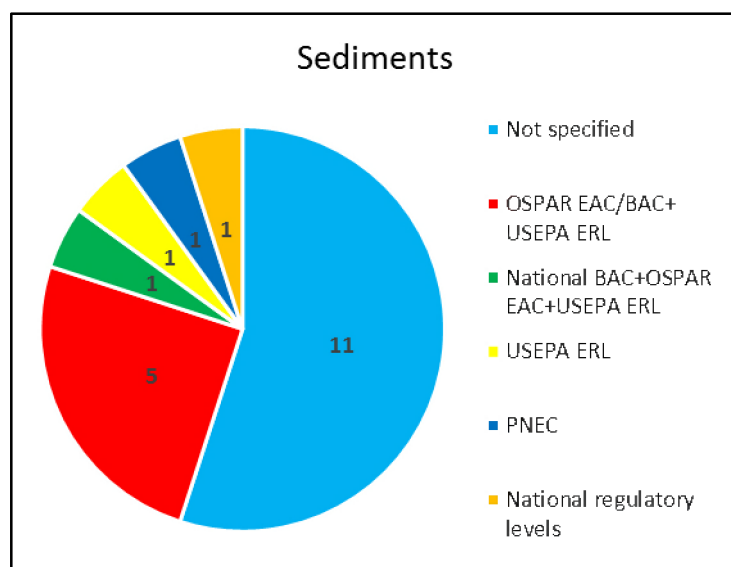
Figure 8. Number of MS using different evaluation criteria in sediments.

The variability in the use of target levels for the assessments of concentrations of contaminants is higher for the matrix biota, where MS have chosen a combination of OSPAR criteria, WFD EQS and maximum concentrations in foodstuffs to protect public health (EC) set out in Commission

Regulation no 1881/2006, and the provisional tolerable weekly intake (PTWI) of the World Health Organization (WHO) (Figure 9).
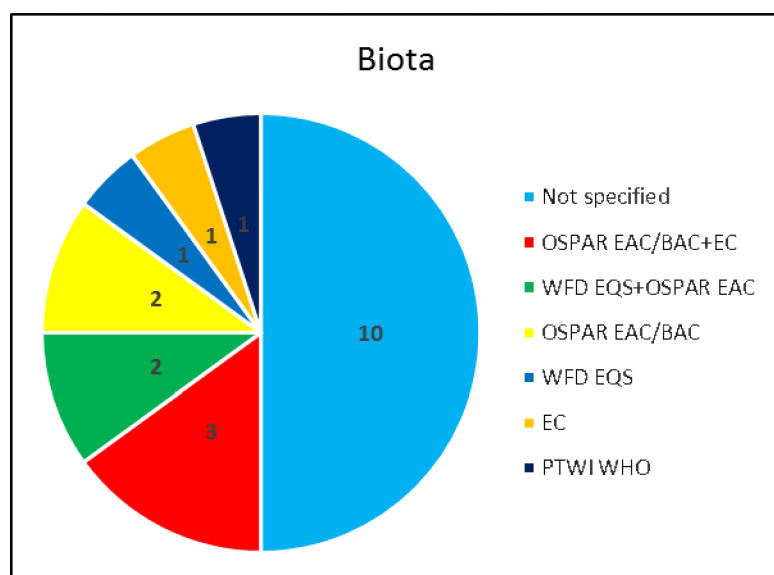
Figure 9. Number of MS using different evaluation criteria in biota.

It is important to note here, that none of those approaches is sufficient in itself to meet the requirements of the MSFD, so the assessment of contaminants in their relevant matrix implies the alternative use of different standards. In this regard, some MS have suggested the precautionary principle, without further specification, because of the uncertainties that result from the combined use of the WFD EQS and the OSPAR EAC. One such uncertainty arises in relation to the three substances for which WFD EQS can also be applied in biota, i.e. Hg, HCB, HCBD. Interestingly, almost all assessments of Hg in biota have been made in relation to descriptor 9, for which EC maximum levels have been utilized (see section 3.7), and not for environmental purposes. Only one Member State has compared concentrations with the WFD EQS set for this compound, and three MS have mentioned the use of OSPAR EAC, but without providing an assessment. As for HCB, three MS have utilized the OSPAR BAC and two MS, the WFD EQS. No assessments of HCBD have been provided in biota.

The uncertainties about the use and derivation of quality standards for offshore and deep waters have also been mentioned by some MS.

It is also important to note that there is no information on the standards utilized by a significant number of MS (7 in water, 11 in sediments and 10 in biota), in some cases because the detection limits are higher than the evaluation criteria and comparisons are therefore difficult. In absence of regulatory levels, some MS have provided data on temporal trends, and others have simply mentioned that concentrations are low or lower than the limit of quantification.

As regards radionuclides, only four MS have referred to the benchmarks identified in the EU ERICA project, and two MS to the pre-Chernobyl radionuclide levels. The other MS that evaluate the concentrations of this type of substances do so without specifying the evaluation criteria utilized. In fact, the importance of developing assessment criteria (thresholds values and baselines) for radionuclides has been indicated by several MS in their initial assessments.

3.3 Sources and inputs of contaminants

MS have provided a wealth of information about the main sources of contaminants in their marine environments, although many of them refer to general rather than specific problems. The Figure 10 shows the number of MS that have reported on sources of synthetic and non-synthetic hazardous substances in their initial assessments and the Figures 11, 12 and 13 indicate the percentage of those reporting countries for each relevant source.
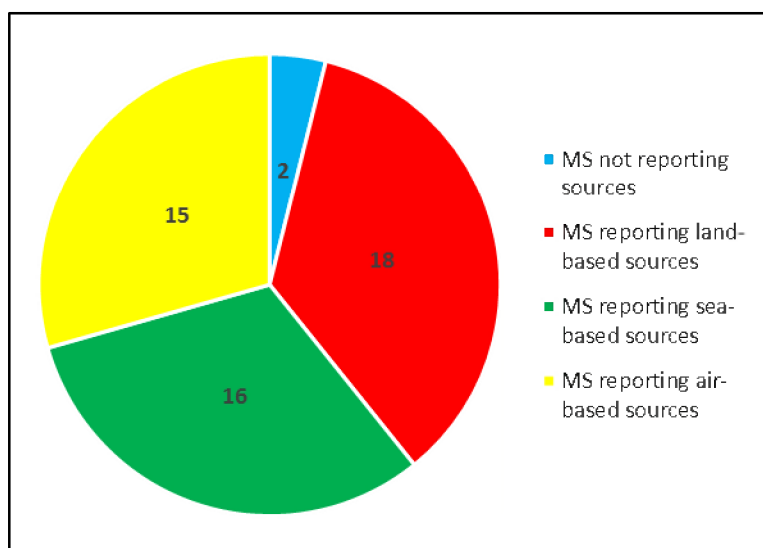
Figure 10. Number of MS reporting sources of synthetic and non-synthetic contaminants.
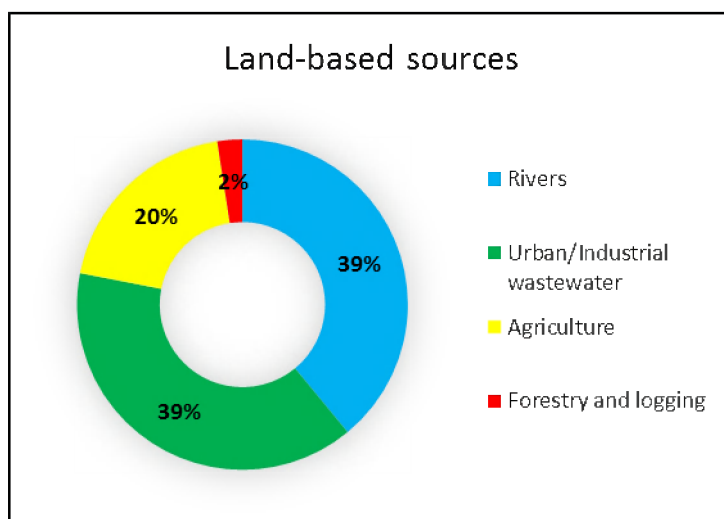
Figure 11. Percentage of MS reporting different land-based sources.
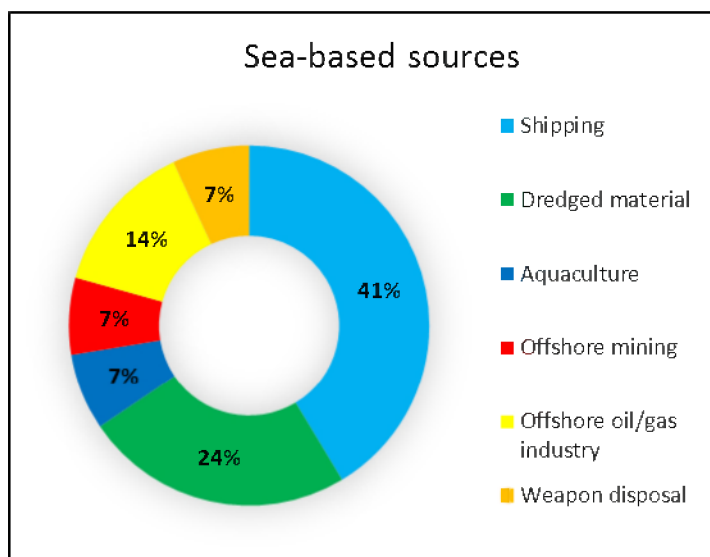
Figure 12. Percentage of MS reporting different sea-based sources.
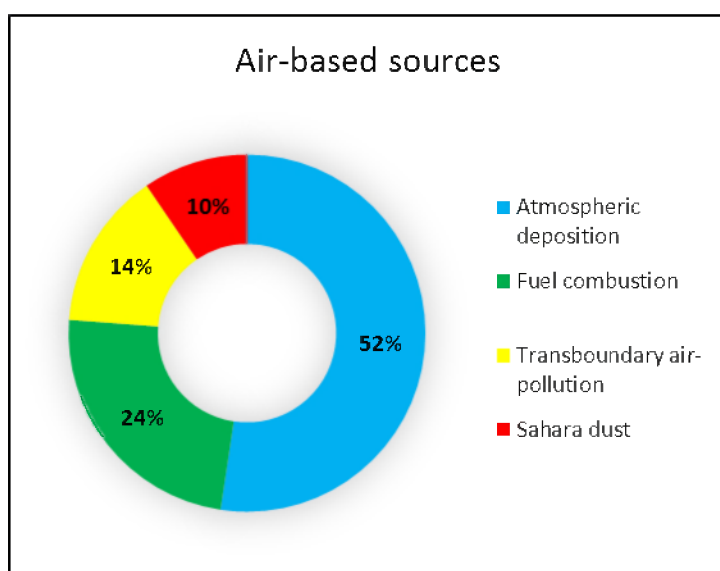
Figure 13. Percentage of MS reporting different air-based sources.

Figure 14 shows the main findings in relation to the sources of radionuclides described by MS in their initial assessments:
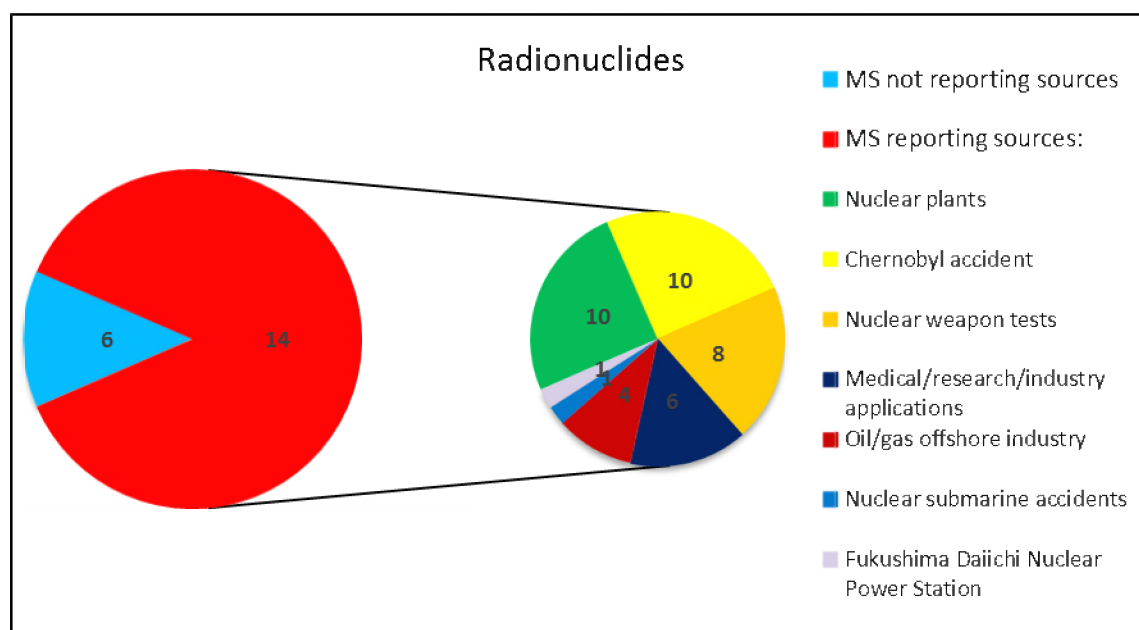
Figure 14. Number of MS reporting sources of radionuclides.

Data on inputs of contaminants have been provided by 15 MS, but then again there is a high variability both in relation to the substances considered and the source where they have been quantified, as it can be seen in Table 5:

Table 5. Number of MS providing data on inputs per substance and source of pollution.

Inputs / Substances	Rivers	Domestic/industrial wastewaters and controlled liquid spills	Atmospheric/ Sahara dust	Gas/oil offshore installations	Dredged material	Nuclear plants/ tests/ accidents
Heavy metals	10	8	10	2	3	
PAHs	2	4	2	1	1	
Phenols	1	4		1		
Dioxins		2	3			
Lindane	1		4			
PCBs	1		2		2	
Furans		2	2			
Oil				3	1	
TBT		2			2	
Detergents	1	1		1		
HCB	1		1		1	
Radionuclides				1		2
Toluene	1	2				
Pesticides	1	1				
Xylene	1	1				
α-HCH					1	
Phthalates		1				

3.4 Trends of contaminants

Essentially, two kinds of trends have been reported by MS: trends in concentrations of contaminants determined in the relevant matrix and trends in concentrations from land, sea and/or air-based

source inputs. Figure 15 shows the number of MS that have reported on trends in the initial assessments and Table 6 the substances considered and the source or matrix where trends have been determined.
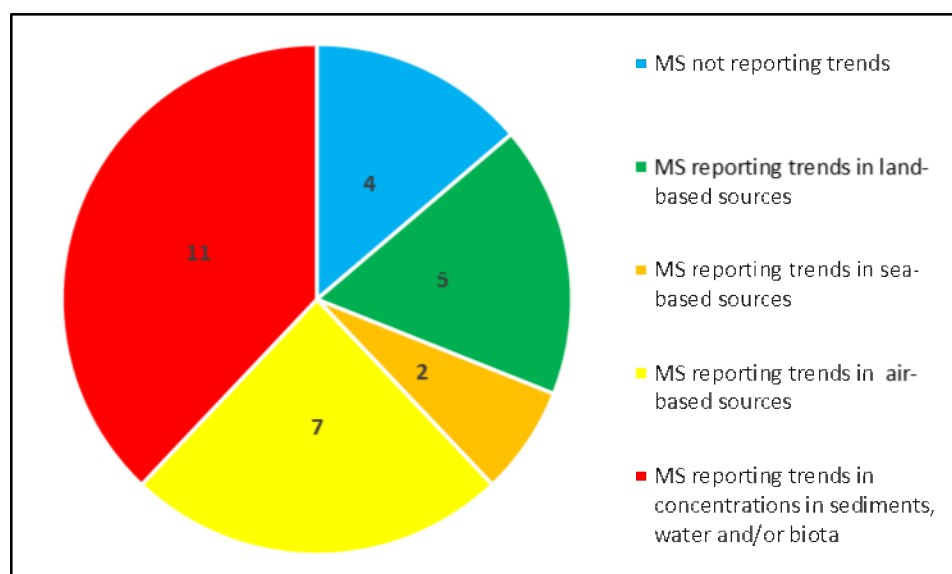
Figure 15. Number of MS reporting trends of contaminants.

Table 6. Number of MS providing contaminant trends per substance and source/matrix.

Substances	water	sediment	biota	Land-based sources	Sea-based sources	Air-based sources	Not specified
Heavy metals	2	8	8	4		6	
PCBs	2	6	8	1		3	
PAHs	1	5	4	1	2	1	
Lindane		2	4	2		3	1
DDT	1	1	3				1
HCB		2	4				
Radionuclides	2		1		1	1	
DDE		2	2				
TBT	1	2	1				
Dieldrin		1	2				
Dioxins			1			2	
Drins	1	1	1				
α-HCH		1	1				
Aldrin							1
Alkylphenols					1		
BDE-47			1				
DEHP		1					
Furans						1	
HBCDD			1				
PBDE			1				
Petroleum hydrocarbons	1						
PFO			1				

3.5 Biological effects

In this section, the information provided by MS regarding the impacts or biological effects from hazardous substances is evaluated. To this end, the MS that have considered this issue in their initial assessments, definitions of GES and sets of environmental targets have been first identified and then, the different biological methods used by them have been listed.
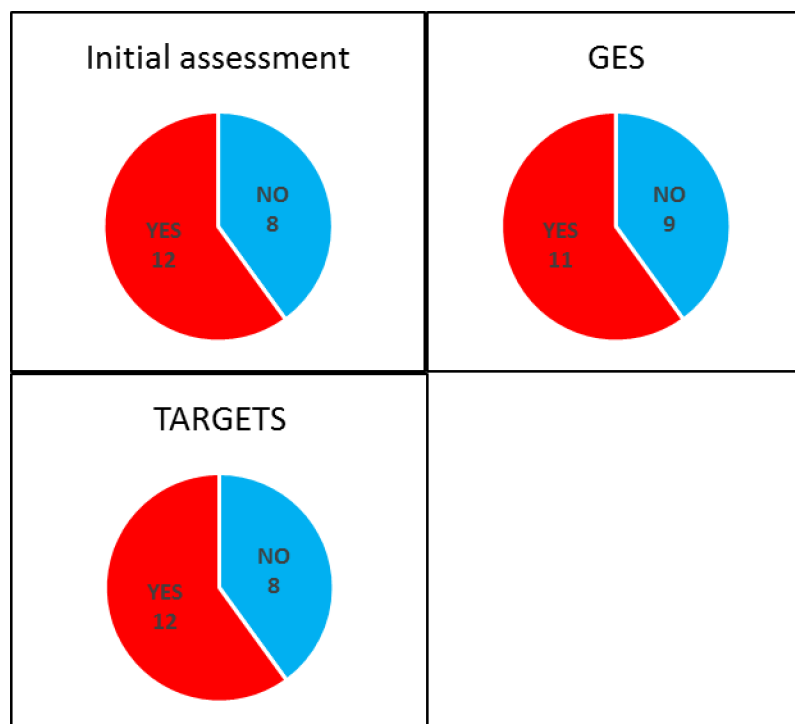
Figure 16. Number of MS considering biological effects when reporting on articles 8, 9 and 10 of the MSFD.

It can be seen than a significant number of MS has not considered the issue of biological effects when reporting on articles 8, 9 and 10 of the MSFD. Moreover, the particular biological effects that have been addressed are basically only specified in the initial assessments, as seen in Table 7. In this regard, there is also high variability, even though many MS have investigated the occurrence of imposex in gastropods. Furthermore, although a number of MS have made reference to biological effects in their GES definitions and environmental targets, very few of them have actually specified the kind of effect they are referring to.

Table 7. Number of MS considering the different biological effects methods.

Biological method	Initial assessment	GES definition	Environmental targets
Imposex in gastropods	10	3	4
Lysosomal stability (LMS) in mussels	2	1	2
Acetylcholinesterase (AchE) activity in mussels	3		
Contamination of coastal bird eggs	1	1	1
Embryos malformations in amphipods	2		1
Fish Disease Index (FDI)	2	1	
Metallothionein content (MT) in mussels	3		
Micronuclei formation (MN) in mussels	2	1	
Shell thickness of bird eggs	1	1	1
Cell damage in mussels	1		1
% Deformed fish larvae	1	1	
Ethoxyresorufin-O-deethylase (EROD) activity in fish	2		
Glutation-S-Transferasa (GST) activity in mussels	2		
Gonad index in fish	1	1	
Reproductive health of marine mammals		1	1
Activities of detoxification enzymes in fish	1		
Alteration of white blood cells in fish	1		
Bird breeding success	1		
Bird mass mortality	1		
Blood protein vitellogenin (VTG) in fish	1		
Catalasa (CAT) activity in mussels	1		
Chick mortality	1		
Fish liver pathologies	1		
Fish liver tumours	1		
Formation of DNA adducts in fish	1		
Glutation Peroxidasa (GPx) activity in mussels	1		
Intersex in fish	1		
Levels of bile metabolite 1-hydroxypyrene in fish	1		
Scope for Growth (SFG) in mussels	1		
Survival in air (SOS) in mussels			1

The available information with regard to the utilization of standards or criteria to evaluate these biological effects is also very limited, as seen in Table 8.

Table 8. Number of MS specifying the different criteria used for the assessment of biological effects.

Evaluation criteria / biological effect	Initial assessment	GES definition	Environmental targets
EcoQO / Imposex in dog whelks	6	4	4
EcoQO / Hg and organohalogens in seabird eggs	2	1	3
EcoQO / impacts on marine mammals and birds	1		
EcoQO / not specified		1	1
OSPAR BAC, EAC / bile metabolite 1-hydroxypyrene	1		
OSPAR BAC, EAC / AchE, MT, MN, LMS	1		
OSPAR BAC, EAC / Not specified		1	
Mediterranean BAC, EAC / AchE, MT, MN, EROD, SOS, LMS	1		1
Concentration levels in biota / Not specified		2	
Baseline data / eggshell thickness of seabird	1	1	1
Background data / productivity of white-tailed eagles		1	
Natural frequency / pregnancy in seal populations		1	

The Commission Decision of 1st September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU) comprises "levels of pollution effects on the ecosystem components concerned, having regard to the selected biological processes and taxonomic groups where a cause/effect relationship has been established and needs to be monitored". The variability and scarcity of data on this issue seem to denote that current knowledge of impacts on marine species is incomplete and needs further research and scientific discussion. MS have not clearly identified which biological effect quantification methods provide a cause/effect relationship. This has been specifically underlined by four MS when describing main gaps in their initial assessments.

3.6 Pollution events

The issue of acute pollution events has not been considered by all MS, as it can be seen in the following figure:
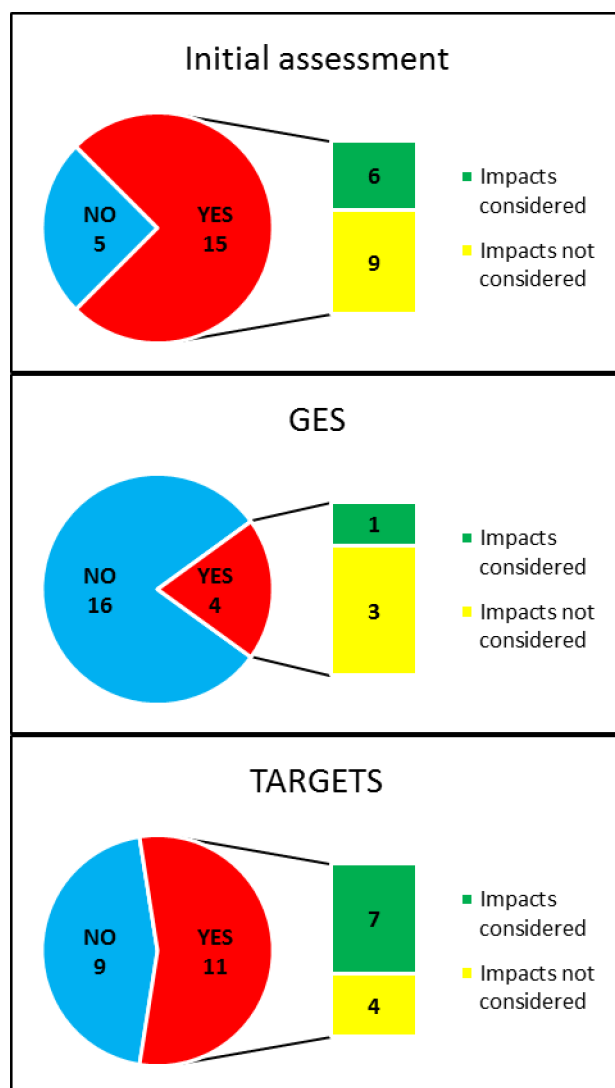
Figure 17. Number of MS considering acute pollution events when reporting on articles 8, 9 and 10 of the MSFD.

The MS reporting on pollution events in their initial assessments have basically focused on the quantification and trends of number of spills and illegal discharges and amount of substances released, and only six of them have made reference to potential impacts: one Member State has mentioned the reduction of species and community diversity, three MS have provided data on the number of oiled birds after the spills, and two MS have assessed impacts in relation to the OSPAR EcoQO for oiled guillemots.

The issue of acute pollution events has been almost totally neglected in the definitions of GES, since only four MS have addressed it, of which only one has referred to impacts.

Eleven MS have set specific environmental targets for the reduction of the occurrence and extent of acute pollution events, of which seven have also included the minimization of possible damaging

effects and impacts on biota resulting from such events. However, only for four MS, targets are potentially measurable as they include standards or thresholds: two MS have referred to the OSPAR EcoQO on oiled birds, one Member State has referred to the rate of oiled birds and another one, to the eggshell thickness of seabirds.

It is important to add here that the question of what "significant acute event" really denotes has been pointed out by some MS.

3.7 Contaminants in fish and other seafood for human consumption

MSFD descriptor 9 addresses contaminants in fish and other seafood for human consumption considering both the levels and number of contaminants which exceed regulatory levels and the frequency of such regulatory levels being exceeded. Figure 18 shows the number of MS considering this descriptor in their initial assessments, GES definitions and environmental targets.
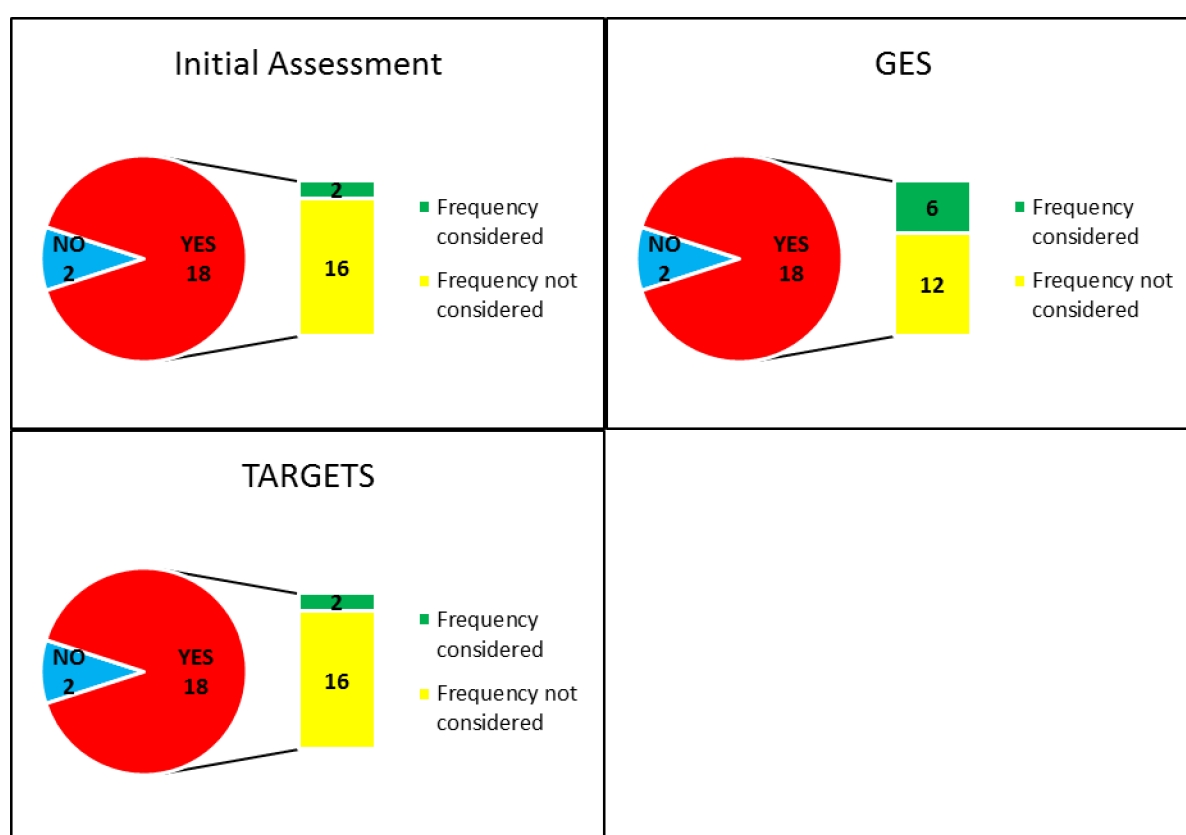
Figure 18. Number of MS considering descriptor 9 when reporting on articles 8, 9 and 10 of the MSFD, with indication of those addressing the frequency of regulatory levels being exceeded.

The analysis of the information provided by MS in relation to this descriptor 9 has also revealed a high heterogeneity, as much in the substances and the species analyzed as in the regulatory levels considered for the assessments, even though the limits established in the Regulation (EC) No. 1881/2006 have been the most commonly mentioned. Table 9 shows the different substances for which information is provided and the different regulatory levels that have been used in their evaluation. The references to the different regulations are listed in section 6. It is important to emphasize that sometimes the substances are mentioned but not the regulatory levels and vice versa, and even if the two parameters are mentioned, sometimes it is not easy to understand which

limits have been used in the assessment of a particular compound. Similarly, the species considered are not always mentioned in the reports, and if mentioned it is not always clear which compounds and regulatory levels have been assessed on them.

Table 9. Number of MS per contaminant and regulatory levels considered for the assessment of MSFD descriptor 9.

Substance	Regulatory levels														
	1881/ 2006	565/ 2008	629/ 2008	420/ 2011	1259/ 2011	2006/113 (shellfish waters)	2001/ 22/EC	835/ 2011	OSPAR BAC/ EAC	WFD EQS	PTWI WHO	MRL 396/ 2005	MAC	PNEC 1907/ 2006	CED
Hg	15	1	1	1	1	1	1	1	1	1					
Cd	13	1	1	1	1	1	1	1	1	1					
Pb	12	1	1	1	1	1	1	1	1						
Dioxin/furans+ dioxin-like PCBs	6				3						1				
Benzo(a)pyrene	4						1								
PCBs	2				2					1	1		1		
As	2	1	1	1	1										
DDT									1	1			1		
Biocides												1			
Cu											1				
137Cs															1
Endosulfan														1	
HCB										1					
Lindane										1					
Ni											1				
Octylphenol														1	
PAHs								1							
Pesticides												1			
PFOs														1	
TBT		1													
Zn											1				

PTWI (Provisional tolerable weekly intake); MRL (Maximal residual levels); MAC (Maximum allowable concentrations), regulation not specified; PNEC (Predicted no effect concentration); CED (Committed Effective Dose).

Moreover, it is also relevant to point out that five MS have highlighted the importance of the traceability of the samples in order to know where at sea the detected pollution has occurred. Hence, data coming from food safety authorities might not be appropriate if the geographical origin of the fish and seafood cannot be perfectly documented, but only the selling location. However, potential solutions or best practices to tackle this issue have not been identified by MS in the initial assessments. One Member State, however, has stressed the necessity of coordination with food authorities and neighbouring countries and the establishment of a specific monitoring program for this descriptor.

3.8 Integration of MSFD with other EU legislations

3.8.1 MSFD-WFD integration level among MS and marine regions
The following charts show the integration between MSFD and WFD on Pan-European and regional level with regard to the utilization of the WFD EQS per MSFD article, according to the methodology described in the section 2.2.
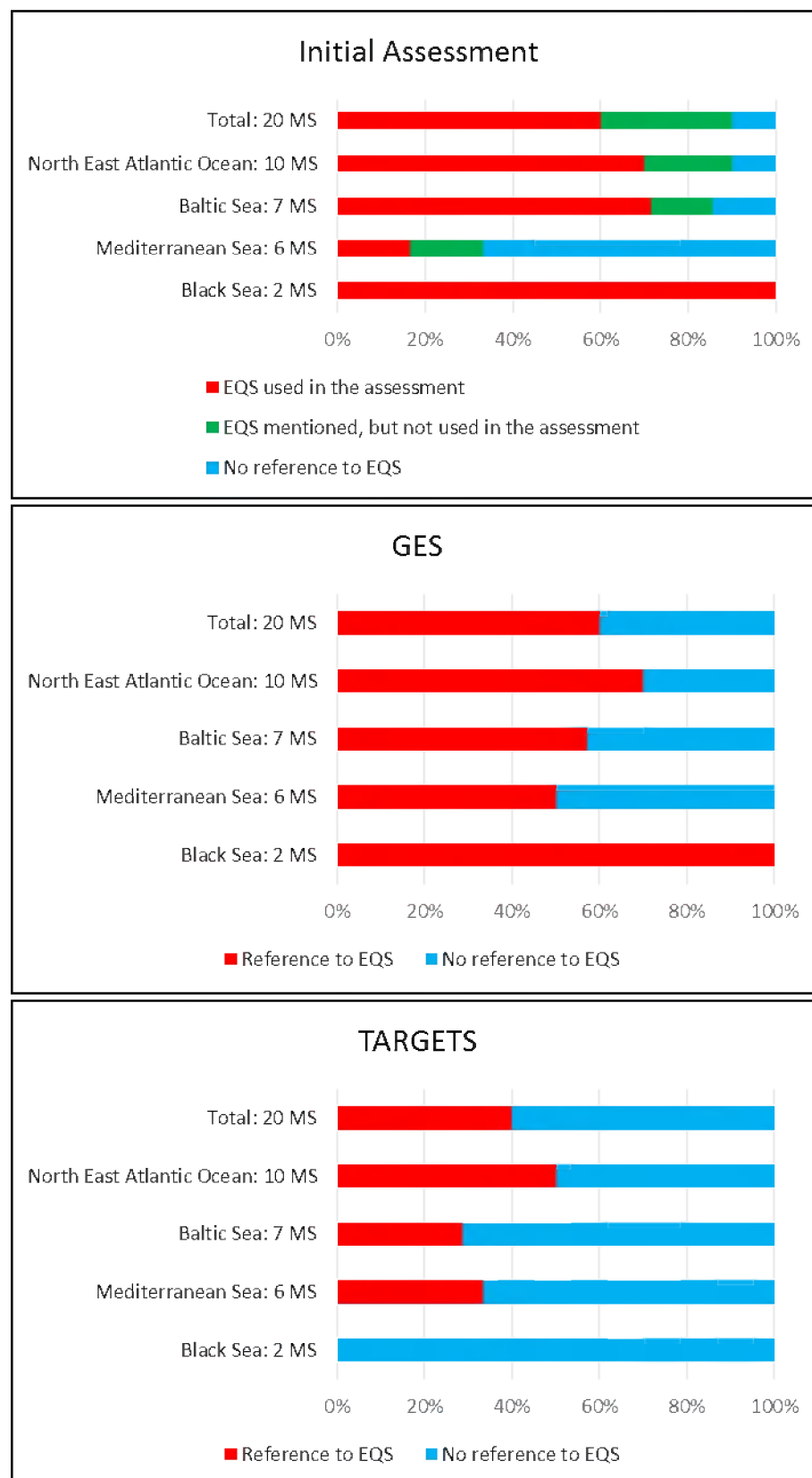
Figure 19. Pan-European and regional integration level between MSFD-WFD EQS for articles 8, 9 and 10.

3.8.2 MSFD-Regulation No. 1881/2006 integration level among MS and marine regions

The same methodology as before is here utilized to assess the utilization by MS of the maximum levels for certain contaminants in foodstuffs established in the Commission Regulation (EC) No 1881/2006 per MSFD article.
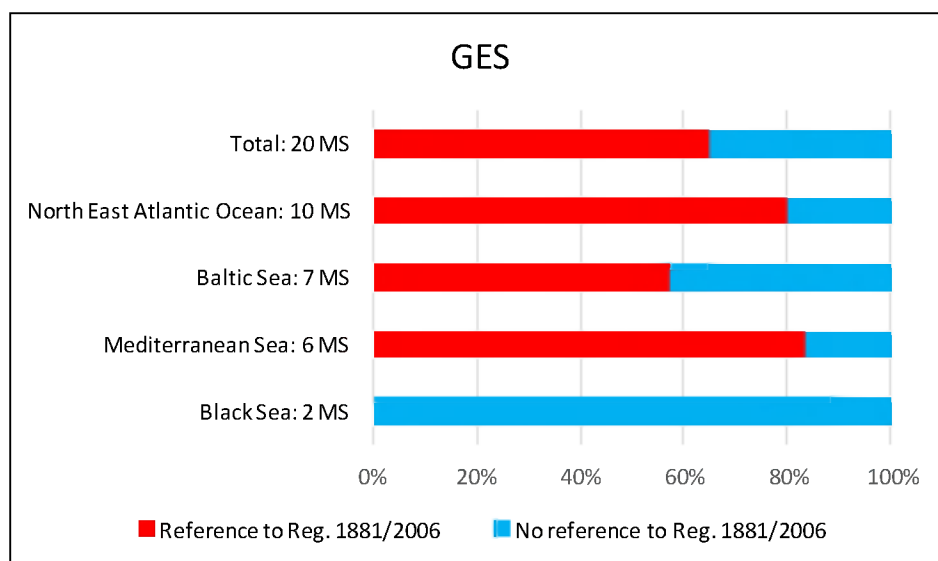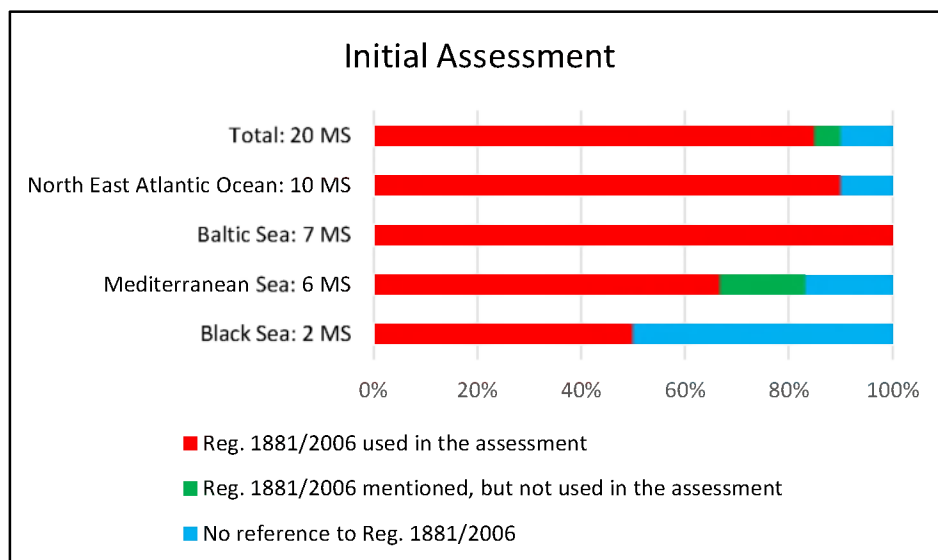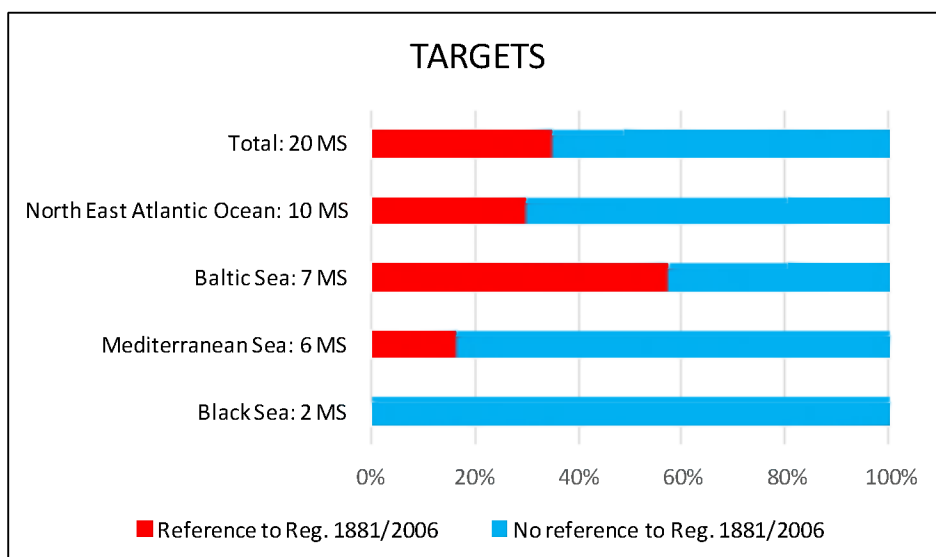
Figure 20. Pan-European and regional integration level between MSFD-Regulation 1881/2006 for articles 8, 9 and 10.

4. Discussion on findings

This assessment of the MSFD reports has been mainly focused on the identification and analysis of relevant technical issues relating to the implementation of MSFD Descriptors 8 and 9 by EU Member States. The obtained results allow to suggest potential actions to improvement in the next phase of implementation and support the eventual revision of the COM Decision (2010/477/EU) on criteria and methodological standards. The broad set of discussion points covers six distinct topics, namely one overarching issue related to the reporting process, and five specific issues related to the level of integration among MS in the use of criteria and indicators established for those descriptors.

4.1 Reporting issues

The analysis of the reporting process to MSFD is a complicated task, due to the different languages, multiple issues and the different areas covered. Information was provided by MS' paper reports in the original languages and in addition via a template (reporting sheets) in a reduced number of languages. Moreover, these two pathways of information within the same country often differ significantly from each other, by data, methodologies and goals, which limits the validity of the available information. Furthermore, the extraction of the relevant information is difficult in many cases, since many MS have included data related to chemical contamination in different sections through their original reports and also sometimes into improper worksheet cells (e.g. data of radionuclides included in cells corresponding to synthetic contaminants).

There is also a high variability in the kind and degree of detail of provided information (e.g. some MS have given quantitative data and others only qualitative; some MS have reported on all or many relevant issues for the descriptors under consideration while others have focused only on one or very few aspects; some MS have presented data for a large number of locations while others have focused on a limited area; sometimes it is easy to understand that there is no information for a particular subject while other times it is impossible to know whether information does not exist or it just has not been reported). This of course creates problems of comparability across reports, across countries, and across marine regions and might lead to biased conclusions.

Finally, there are also great inconsistencies in the definitions of GES and environmental targets, both in their level of ambition and coverage and the ways (if provided) in which they are to be measured or achieved. This can involve differences in the implementation of the MSFD across MS and, therefore, difficulties in the maintenance of the same level of protection for all European waters.

Recommendation: *The nature and type of required information should be clearly identified and indicated in order to ensure comparability and consistency within and among MS, and ensure the gathering of all crucial data. The information provided should be restricted to that specifically requested in order to facilitate the scrutiny and assessment process. MS must ensure that both electronic reporting and paper reports contain the same information. Collection of essential information in a single language could facilitate the assessment process, if feasible.*

4.2 Hazardous substances and environmental matrices

For the implementation of MSFD Descriptor 8, MS have to consider the substances that need to be assessed taking into account their impacts and threats to the marine environment and determine their concentration in the relevant matrix. This assessment has revealed a very high variability among MS with regard to the contaminants for which information has been provided, not only at Pan-European level, but also within the same marine region. Although no substance has been assessed by all MS, some contaminants could be considered as covered and monitored consistently (particularly the heavy metals Hg, Cd, and Pb). For other substances, there is not enough information, even for the priority substances listed in the WFD and the WFD river basin specific pollutants although most provided data referred to coastal areas. Many of those substances might not have been detected due to insufficient limits of detection, whereas other substances might be of particular concern in the marine environment and should be identified and considered. Under WFD, the non-consideration of PS in monitoring should be accompanied by an explanation and likewise reasons for non-monitoring should be reported in MSFD. Moreover, a significant proportion of MS have not mentioned the substances to be evaluated when defining GES and environmental targets, and this considerably increases the incoherency in the implementation and the reporting of the MSFD. On the other hand, there is also variability in the matrices chosen to perform the assessments and very often information on this regard is missing or difficult to ascertain. This is another factor of inconsistency among countries that should be resolved.

There is little information and understanding on the actual sources and inputs of relevant hazardous substances to the marine environment, which hinders the identification of contaminants that may entail significant risks and should also be addressed. Some MS have mentioned some confusion as to what constitutes a significant risk. Similarly, data on trends of levels of pollutants are very limited. Despite this, many MS have included in their definitions of GES and environmental targets that trends should be decreasing or maintained within acceptable limits.

> **Recommendation**: *The level of coherence and comparability in the MSFD implementation will be improved by selecting an appropriate core set of contaminants of concern and ensuring they are well covered and monitored by countries. Even if every country has a different situation, this core group of contaminants should provide an adequate base for comparable approaches among MS, at least, at regional level. This selection has to take into consideration the relevant provisions of the WFD for territorial and/or coastal waters as well as the special needs for the marine environment. At this point, it is relevant to note that data on deep and offshore waters are overall very scarce and efforts should be made to increase knowledge on this subject. For example, the appropriate sampling strategy for the deep and open sea should still be discussed and established.*
>
> *The most appropriate matrix for the determination of a particular compound needs also to be properly identified. For example, if measurements are decided to be carried out in biota, the species (alternatively the trophic level) to be considered should be indicated.*
>
> *Sources of contaminants should not be reported in a general manner, but in a way that allows obtaining a real comprehensive overview of the occurrence of substances that should be addressed by MS. The sentence "may entail significant risks to the marine environment from past and present pollution…" requires further explanation to make clear what "significant" denotes in this context and reflect a common understanding.*
>
> *Trends of contaminant concentrations have been considered by MS and appear to provide a means of protection against deterioration even if no environmental quality standards are available.*
>
> *MS should provide precise definitions of GES and targets. For example, if terms such as "decreasing or stable trends over time" or "concentrations close to baseline level" are used, details on the establishing of trends or baselines should also be provided.*

4.3 Evaluation criteria

MSFD indicator 8.1.1 provides that concentration of contaminants should be measured in the relevant matrix in a way that ensures comparability with the assessments under WFD. The MSFD-WFD integration has been assessed regarding to the use of the WFD EQS in the implementation of MSFD articles 8, 9 and 10. In the initial assessments, these standards have been taken into consideration for water by most MS and marine regions, with the exception of the Mediterranean region. However, it is particularly significant that the WFD EQS have not been included in the definitions of GES and environmental targets of a significant proportion of MS. Moreover, several MS have not specified their evaluation criteria and, if mentioned, in many cases it is not clear for which matrix and substance they are to be utilized, which adds difficulties in assessing consistency and measuring achievement of MSFD goals.

In biota and sediments, the IDA has shown a wide heterogeneity in the methodological approaches used and none of them is currently sufficient to meet the needs and requirements of the MSFD. This

involves the alternative use of one or another approach, which leads to incomparability and potential differences in the level of protection obtained.

The existence of different evaluation criteria for the same matrix and substance, the lack of standards for offshore and deep waters and also for sediments and/or organisms for substances of particular concern in the marine environment have also been highlighted as some of the major sources of uncertainty that can affect the implementation of the MSFD Descriptor 8.

Recommendation: The establishment of a common contaminant assessment approach is essential for the harmonious implementation of the MSFD Descriptor 8 within the EU. The WFD EQS should be used as a starting point and, despite potential differences in priorities and/or pressures, all MS should ensure they use coherent and comparable standards and harmonise their actions with that of neighbouring countries in order to facilitate the achievement of GES in their particular marine region. This harmonization can be considered to be at a quite advanced level in the North East Atlantic Ocean and the Baltic Sea, but it is still lacking for the Mediterranean and the Black Seas.

The obligatory application of international standards still requires building up consensus on which standard the countries will use. However, so far there is no a single approach suitable for all key matrices/substances, so a number of questions still need to be addressed and agreed, such as: Can existing assessment criteria be applied for marine open and deep water areas? What to do when different standards are available for the same substance and the same matrix? What to do if no criteria are available?

4.4 Biological effects

The criterion 8.2 refers to the evaluation of the effects of contaminants, and the indicator 8.1.1 specifically deals with the biological processes where a cause/effect relationship has been established and needs to be monitored. The information provided on this regard is very limited and even a number of MS have not provided any data when reporting on articles 8, 9 and 10 of the MSFD.

The scarce available information has shown high variability in the biological effects methods reported and the specific substances that have been determined by them. Furthermore, there is little consistency in the assessment criteria utilized for biological effects measurements.

The issues of biological-effects monitoring and of how to establish a cause/effect relationship have not been clearly addressed in the reports and should be discussed in order to adopt best practices and increase the level of integration among MS.

Recommendation: The scarcity of information reveals evidence of important needs that must be met to address the issue of biological effects. The aspects on which more research and scientific discussion are particularly needed seem to be the establishment of unequivocal links between concentrations and effects, the selection of proper and consistent biological effects methods and the criteria to assess them, furthermore the coordination with other biological effect monitoring programs, particularly those conducted under the WFD.

4.5 Acute pollution events

The indicator 8.2.2 refers to the significant acute pollution events and their impacts. The initial assessments provided by MS contain quite a lot of information on the occurrence and extent of spills and the kind of substances released but much less on their origin. Conversely, MS have given very little consideration to pollution events in their definitions of GES, although surprisingly they have considered this issue when establishing their environmental targets.

While oil spills are a well-known and investigated threat in marine waters, their potential impacts have received little attention through the reporting process for MSFD Articles 8, 9 and 10. There is very little information on the appropriate criteria to assess those impacts and it is almost reduced to the use of OSPAR EcoQO for oiled guillemots.

Some doubts have also arisen with regard to the real meaning of "significant acute pollution event".

> ***Recommendation***: *Reference points for assessing GES should be included to be consistent with the proposed targets.*
>
> *It should be checked if all MS have considered the information available through different initiatives, e.g. those dealing with emergency spill response or similar. The lack of data on the origin of the spills seems to point to difficulties in linking an acute pollution event with its source, so further research should be promoted on this subject.*
>
> *The proper indicators of impacts of acute pollution should be agreed, for example, the use of other biota apart from birds should be discussed.*
>
> *The specification of the meaning of "significant acute" in this context should be also be considered.*

4.6 Contaminants in food and seafood

Most MS have integrated their assessments of contaminants in food and other seafood for human consumption (descriptor 9) into the general assessment of hazardous substances. Information on this regard is very heterogeneous amongst MS, in terms of the substances and the species analyzed and the regulatory levels considered for the assessments.

Most assessments have been carried out for substances included in the Regulation (EC) No. 1881/2006 and consequently, the limits proposed there have been the most commonly utilized. However, a number of other standards have also been mentioned, sometimes without a clear specification of the regulation to which they relate. Many MS have specified the evaluation criteria in their definitions of GES, but not in their environmental targets, which causes uncertainty in the measurement of the achievement of goals.

MS have basically not provided any data on the number of contaminants which have exceeded maximum regulatory levels. Information on the frequency of regulatory levels being exceeded is also very limited, particularly in the initial assessments and the proposed environmental targets, although a few MS have included this parameter in their definitions of GES.

There is no consistency or coordination amongst MS in the selection of appropriate species for monitoring. Few MS have included aquaculture species in the evaluation of potential risks for human health. Moreover, few MS have also stressed that the knowledge of the origin of the samples is essential for a proper assessment of this descriptor.

Information on sampling methods is almost missing in the reports provided by MS.

Recommendation: *The fact that most MS have reported jointly on descriptors 8 and 9, could trigger the question of whether fish and seafood monitoring should be considered and integrated into a broad monitoring of contaminants in biota.*

Further discussions are needed about the contaminants of concern and the way they should be evaluated. The substances and limits established in the Regulation (EC) No. 1881/2006 seem to represent a good starting point. The relevant standards for other substances should still be agreed and their use harmonized. This also includes the establishment of thresholds for number and frequency of exceeding limits, for which there is not information.

The issue of the species that should be analyzed also needs further considerations. For example, should farmed species be used? Is it possible to use the same species to ensure comparability of data among marine regions? How to coordinate with neighbouring countries to help to reduce sampling efforts? How to deal with the issue of the geographic traceability of the samples and the coordination with seafood authorities? Should migratory fish be also considered?

Other parameters related to the design of sampling methods should be taken into account and discussed, including the seasonality of sampling and the appropriate number of samples.

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5. Conclusions

While the findings of the in-depth assessments will support a detailed analysis for the way forward, it has been possible to identify here generalized issues for which suggestions could be derived. The table 10 shows the key findings of the in-depth-assessment of the MS reports on Art. 8, 9, 10 on contaminants. Each addressed relevant issue is followed by a suggestion and potential actions and actors, where deemed appropriate.

Table 10. List of key issues derived from the in-depth assessment for D8 and D9, suggestions and potential actors.

Issues on reporting	*Suggestion*	*Potential actors*
Wide heterogeneity in the kind of information reported.	Common understanding on the kind of data needed and should be collected.	Expert network
High variability in the way of presenting the data.	Establishment of a harmonized, concise and well-organized report delivery process adapted to the identified requirements.	MSFD CIS
Significant differences in the information contained in the two pathways of information within the same country.	Report through one pathway in electronic format.	MSFD CIS

Difficulties to understand whether information is missing or it has not been reported.	Allow through reporting process a clear identification of lack of data.	MS, MSFD CIS
Issues on methodologies	***Suggestion***	***Potential actors***
Inconsistencies in methodological approaches, thresholds and limits.	Common agreed identification of appropriate and comparable approaches and parameters to ensure a minimum level of coherence. Ensure common understanding, providing rules and guidance.	MS, RSC, Expert network
Inconsistencies in technical issues among MS and marine regions, and also within the same country.	Agreement on details such as contaminant quantification, units of reporting, sampling strategy, and frequency. Alignment with WFD CIS.	MS, Expert network
Scarcity of data in sources of contaminants, biological effects and pollution events.	Development of common understanding, rules and guidance. Increase efforts to access these data. Alignment with WFD CIS.	MS, RSC, Expert network
Spatial inconsistency within and among MS regarding coastal-offshore data.	Assessment of both coastal and offshore water with clear boundaries and appropriate thresholds. Synergies in the definition of scales and possible common monitoring strategies. Alignment with WFD CIS	MS, Expert network
Issues on implementation	***Suggestion***	***Potential actors***
Inconsistencies with WFD	Improvement of alignment with WFD.	MS, MSFD CIS, WFD CIS
Low integration between marine regions and neighbouring countries.	Implementation of regionally coordinated strategies. Information exchange and efficient collaboration among regions.	MS, expert network, RSC exchange platform
Conceptual problems in the interpretation of criteria and indicators.	Development of concrete definitions and guidance to facilitate the interpretation of those issues and terms that have been found to be unclear.	Expert network
Definitions of GES and environmental targets often not consistent, specific and measurable.	Coherence in reporting GES and targets and establishment of measurable thresholds and goals to accurately assess their achievement.	MS, Expert network
Little consideration of link between MSFD and Food safety legislation.	Development of common understanding, establishing contacts.	Expert network, Food safety authorities in MS

6. References/sources

- Commission Decision 2010/477/EU of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters.
- Commission Directive 2001/22/EC of 8 March 2001 laying down the sampling methods and the methods of analysis for the official control of the levels of lead, cadmium, mercury and 3-MCPD in foodstuffs.
- Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs.
- Commission Regulation (EC) No 565/2008 of 18 June 2008 amending Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs as regards the establishment of a maximum level for dioxins and PCBs in fish liver.
- Commission Regulation (EC) No 629/2008 of 2 July 2008 amending Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs.
- Commission Regulation (EU) No 420/2011 of 29 April 2011 amending Regulation (EC) No 1881/2006 setting maximum levels for certain contaminants in foodstuffs.
- Commission Regulation (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non-dioxin-like PCBs in foodstuffs. Commission Regulation (EU) No 835/2011 of 19 August 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for polycyclic aromatic hydrocarbons in foodstuff.
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.
- Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006 on the quality required of shellfish waters.
- Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC.
- Directive 2013/39/EU of the European parliament and of the council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.
- JAMP Guidelines for Monitoring Contaminants in Biota (agreement 1999-2).
- JAMP Guidelines for Monitoring Contaminants in Sediments (agreement 2002-16).
- JAMP guidelines for the analysis of PFCs in water (agreement 2010-8).
- JAMP Guidelines for Contaminant-specific Biological Effects Monitoring (agreement 2008-9).
- Joint FAO/WHO Expert Committee on Food Additives (JECFA) publications.
- MSFD Task group 8 report. 2010. Contaminants and pollution effects. EUR 24335 EN.
- MSFD Task group 9 report. 2010. Contaminants in fish and other seafood. EUR 24339 EN.
- Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC.
- Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of

Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

I. ANNEX I Member States included in the analysis.

Member State	Abbreviation	RSC
Belgium	BE	OSPAR
Bulgaria	BG	Black Sea
Cyprus	CY	UNEP/MAP
Denmark	DK	OSPAR/HELCOM
Estonia	EE	HELCOM
Finland	FI	HELCOM
France	FR	OSPAR - UNEP/MAP
Germany	DE	OSPAR- HELCOM
Greece	EL	UNEP/MAP
Ireland	IE	OSPAR
Italy	IT	UNEP/MAP
Latvia	LV	HELCOM
Lithuania	LT	HELCOM
Netherlands	NL	OSPAR
Portugal	PT	OSPAR
Romania	RO	Black Sea
Slovenia	SI	UNEP/MAP
Spain	ES	OSPAR - UNEP/MAP
Sweden	SE	HELCOM- OSPAR
United Kingdom	UK	OSPAR

IN-DEPTH ASSESSMENT OF MEMBER STATES' SUBMISSIONS FOR MSFD ART. 8, 9 & 10 ON MARINE LITTER DESCRIPTOR D10

MARINE LITTER

Photo by Georg Hanke

Contents for D10

1. Introduction

While first indications of pollution through marine litter have been signalled decades ago, only recently, through the MSFD, a legislative framework for quantification and control of marine litter has been provided at EU level through MSFD Descriptor 10: "Properties and quantities of marine litter do not cause harm to the coastal and marine environment". Available information on marine litter has previously been collected through international efforts at UN level, Regional Sea Conventions and national efforts. Therefore available data is scarce, spotty in time and spatial coverage.

1.1 Scope of the in-depth assessment

On request from DG Environment to support the implementation of MSFD (Art. 12), JRC has performed the in-depth assessment (IDA) of D10 as reported by the Member States (MS) for Article 8, 9, and 10. Knowing the shortcomings on harmonized and comparable assessments of marine litter, within the MSFD common implementation strategy, on request of EU Marine Directors, a dedicated technical working group on Marine Litter has been established in 2011. This group has provided an overview about existing data and methodologies, analyzed needs for harmonization and, in a second step, provided guidance for the monitoring of marine litter. The aims of the IDA are therefore limited to provide an overview and eventually identify additional issues arising from the analysis on assessments made by MS within Art 8, 9, 10 reporting.

- o To evaluate comparability and coherence of methods and in particular their relation to the assessments under other policy frameworks and the latest scientific evidence.

- o To provide recommendations for improved implementation in the second MSFD cycle

- o To support the possible revision of the COM Decision (2010/477/EC) on criteria and methodological standards

The aim of this report is rather to present a holistic assessment of the implementation of MSFD per Member State than to judge or comment on particular Member States practices.

2. Assessment methodology

2.1 Input for D10 IDA

The JRC assessment for D10 was originally based on the consultant's reports provided by consultant Milieu and the information collected on the reporting sheets. Due to the difficulties to gather some technical information from the consultant's reports and the reporting sheets, original MS' paper reports have been also consulted to improve this document. From the total number of 23 MS involved in the MSFD implementation process, the available information considered in this report includes 20 MS, missing only Malta. On the other hand, no information was available for Poland, as they have not delivered yet their respective reports for Articles 8, 9 and 10. Croatia has not been considered because of its recent EU membership in 2013.

2.2 Methodological evaluation

A set of questions was developed to create a database for a total of 20 MS. Using this database, basic graphs have been produced and included in this document in order to show the proportion of countries that are considering certain elements for the assessment of Descriptor 10.

Results are presented in three sections considering separately the inputs for MSFD Article 8 (Section 3.2, Information on Initial Assessments), Article 9 (Section 3.1, Determination of GES) and Article 10 (Section 3.3, Environmental Targets).

3. Results

3.1 Determination of GES (Art. 9)

3.1.1 Definition of GES and MSFD requirements

A total of 15 MS out of 20 have delivered a definition of GES at descriptor level and according to MSFD Annex I. Further, 5 MS out of 20 have included the criteria in COM DEC 2010/477/EU. At indicator level, only 3 MS out of 20 have included details as specified in COM DEC 2010/477/EU.
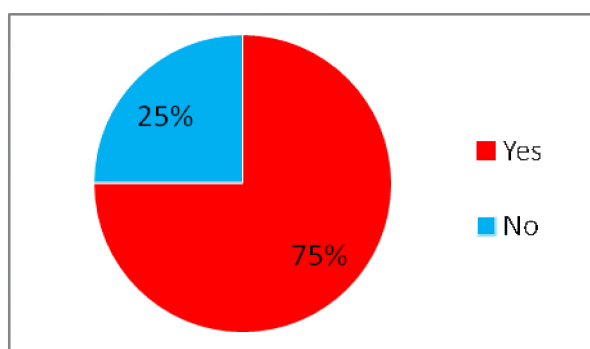
Figure 1. GES Definition at Descriptor level (according to MSFD ANNEX I).
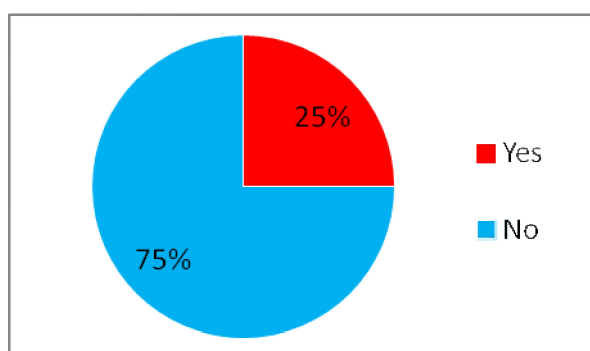
Figure 2. GES Definition at Criteria level (according to COM DEC).
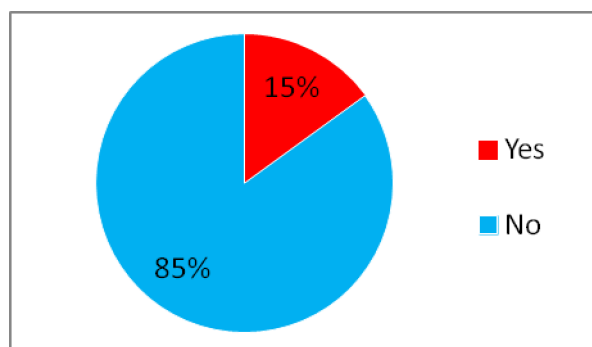
Figure 3. GES Definition at Indicator level (according to COM DEC).

Some countries have included additional elements in their definitions of GES that apparently goes beyond the MSFD Descriptor 10 scope. In fact, there are 5 MS out 20 that referred to the following aspects in their definitions: Non-indigenous species, related to Descriptor 2 (3 MS); socio-economic issues (4 MS); and human health (1 Member State).
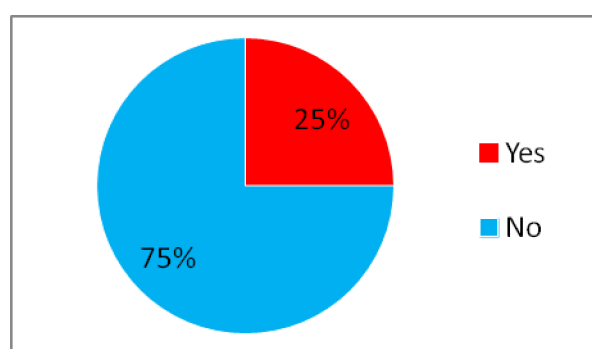
Figure 4. GES Definition includes additional elements beyond MSFD.

Only 2 MS out of 20 defined a baseline for determination of GES and none of them was able to included thresholds in their definitions.
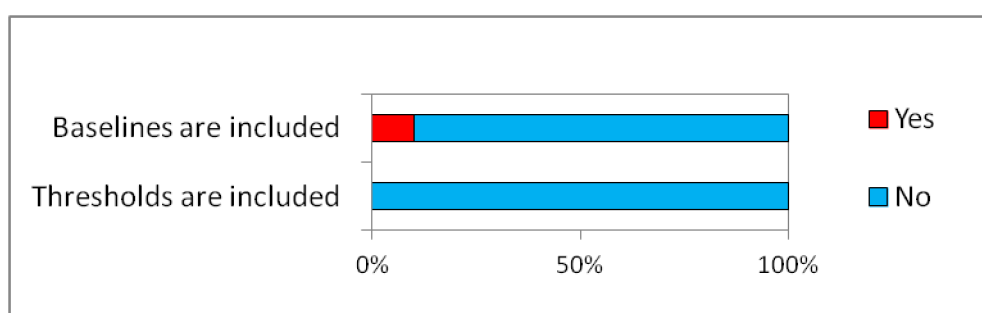
Figure 5. Baselines/Thresholds included in definition of GES.

3.1.2 References to RSC and other international frameworks

In this section, 8 MS out of 20 included references to Regional Sea Conventions (RSC). Having in mind that some of these countries can be involved in two different RSC because of geographical reasons, the balance showed that OSPAR was mentioned by 7 MS and HELCOM was mentioned by 2 MS. There were no mentions for UNEP/MAP or BSC. On the other hand, 3 MS out of 20 mentioned other international frameworks such as ICES (2 MS), MARPOL (1 Member State), UNEP (1 Member State) and the European Directive on port reception facilities (2000/59/EC).
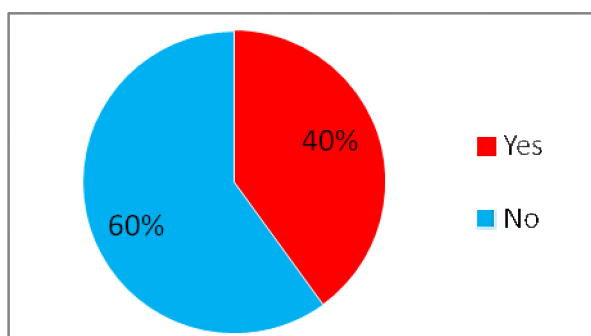
Figure 6. Reference to Regional Sea Conventions.
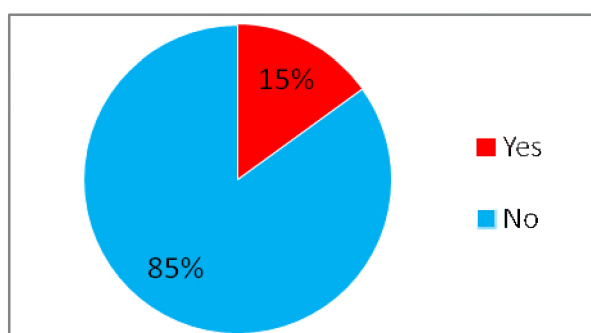
Figure 7. Reference to other international frameworks.

3.2 Information on Initial Assessment (Art. 8)

In general, 17 MS out of 20 have included information about their Initial Assessments. Unfortunately, this does not mean they were able to deliver an appropriate assessment, mainly because of the frequent lack of data and methodological knowledge. 10 MS out of 20 reported data availability in some of the compartments considered (e.g. coastline, water column), but as it will be further detailed in this section, there are many data gaps and, in most of the cases, availability is restricted (temporal and geographical limitations). On the other hand, only 2 MS were considered to have a total lack of data. Meanwhile, data availability from 4 MS can be considered as limited and for the remaining 4 MS as very limited. As an example, based on consultant's reports and reporting sheets information, only 6 MS out of 20 reported to have partial availability of trends in certain compartments (figure not included).
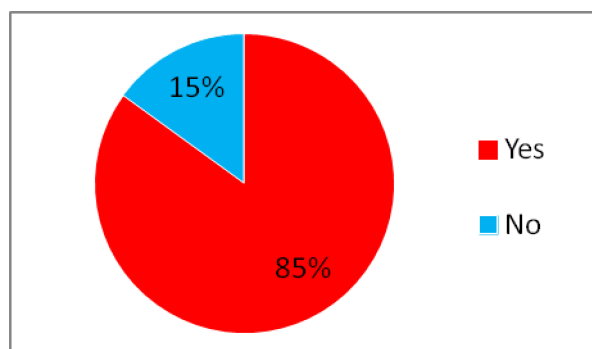
Figure 8. Information on Initial Assessment.
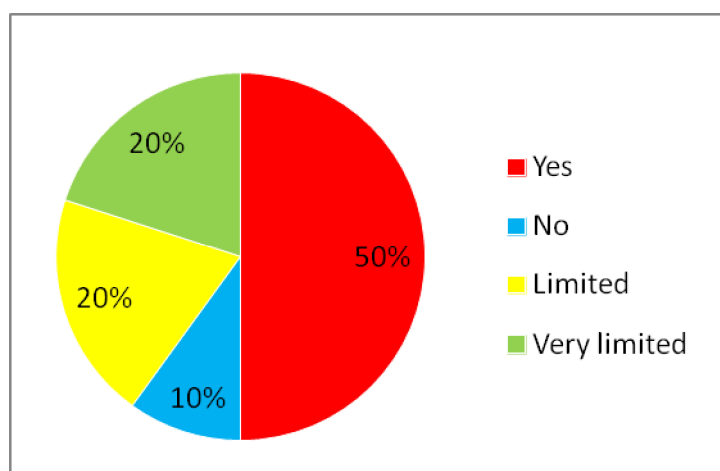
Figure 9. Data availability.

3.2.1 Levels of pressure on the coastline

A total of 15 MS out 20 considered pressure on the coastline in their assessments (i.e. level of marine litter). In this compartment, data availability was mentioned for 11 MS, while 5 MS had no data available. Besides, 3 MS reported to have limited data and 1 Member State to have very limited data.
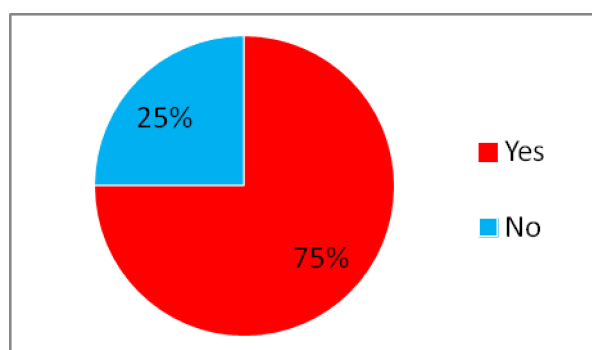
Figure 10. Levels of pressure on the coastline considered.
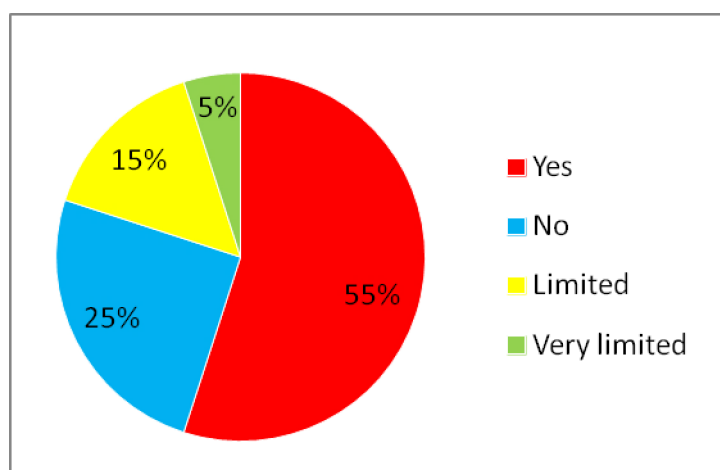
Figure 11. Data availability for pressures on the coastline.

17 MS out of 20 included information on the units used to report marine litter on the coastline. A total of 11 different units have been identified (table 1). The most common unit was items/100m and it was related to OSPAR methodologies. The use of more than one unit by a single country was observed quite often (8 MS out of 17).

Table 1. Units used by MS to report marine litter on the coastline.

10.1.1 (coastline)	UNITS										
	items/km	ton/year	pieces/m	items/100m	items/500m	kg/500m	kg/100m	kg/km	m3/day/100m	m3/year	m3/km/year
Number of countries	3	3	1	8	3	3	1	2	1	1	1

3.2.2 Levels of pressure in the water column

For pressure in the water column, 8 MS out 20 included this compartment in their assessments. Only 4 MS claimed to have data available for this compartment and 12 MS did not have data to develop an assessment. Data availability was classified as limited for 2 MS and as very limited for 2 MS.
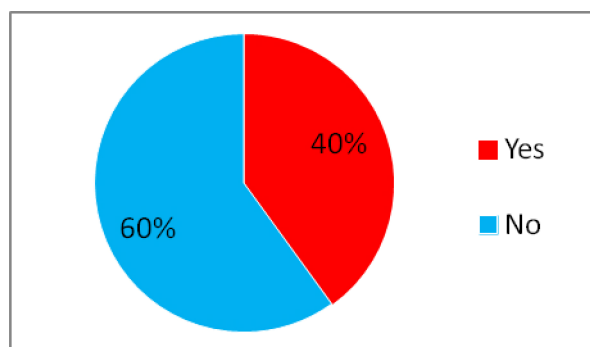
Figure 12. Levels of pressure in the water column considered.
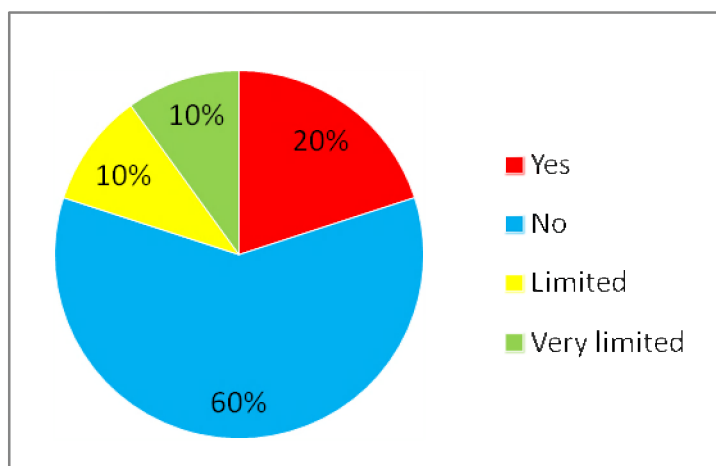
Figure 13. Data availability for pressure in the water column.

For the units used to report marine litter in the water column, only information related to 6 MS out of 20 was found. Countries included 7 different units that referred to several aspects of the water column (Table 2). Some measurements referred to the water column as litter per volume (e.g., items/m^3) and others to the water surface as litter per area (e.g., items/m^2). It is also noticeable that some units included or were even dedicated to fractions of micro-litter (or micro-plastics).

Table 2. Units used by MS to report marine litter in the water column.

10.1.2 (water column)	UNITS						
	m3/day	m3/km/year	items/m3 (200 μm mesh)	Fulmar EcoQO	a) Fibers ≥ 10 microns / l, b) Particles ≥ 300 μm/m3.	microplastic items/m2	Amount of litter captured from surface net trawls (units not specified)
Number of countries	1	1	1	2	1	1	1

3.2.3 Levels of pressure on the seabed

11 MS out of 20 included pressure on the seabed in their assessments. Regarding data availability, 8 MS had data while another 8 MS did not. Finally, 4 MS were considered to have limited data.
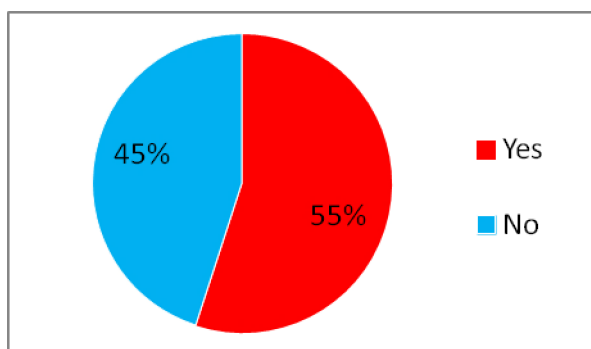
Figure 14. Levels of pressure on the seabed considered.
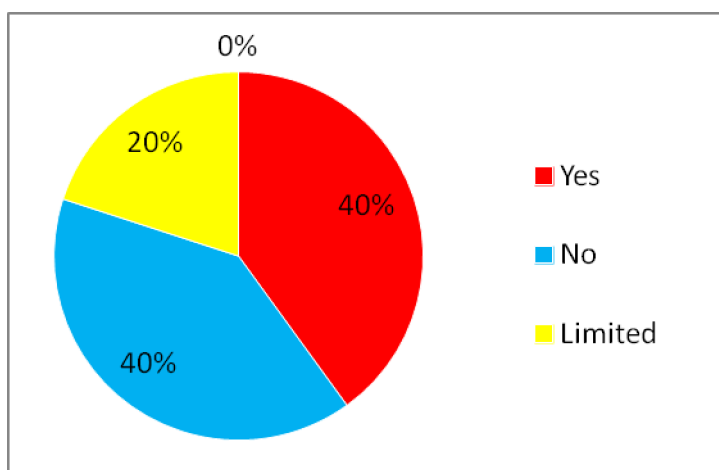
Figure 15. Data availability for pressure on the seabed.

Units used to report marine litter on the seabed were identified for 12 MS. Countries referred to 9 different units. Two main types of units were present: weight per area and items per area. The most common unit was kg/km^2.

Table 3. Units used by MS to report marine litter on the seabed.

10.1.2 (Bottom)	UNITS							
	ton	items/hectare	items/km2	items/1000m2	items/100m2	kg/hectare	kg/km2	kg/km trawl
Number of countries	1	3	3	1	1	1	5	1

3.2.4 Levels of pressure regarding micro-plastics

A total of 4 MS out of 20 managed to include micro-plastics in their assessments. Looking at the corresponding data availability, only 1 MS reported to have data, while 16 MS reported lack of data. Further, 2 MS presented limited data and 1 MS very limited data.
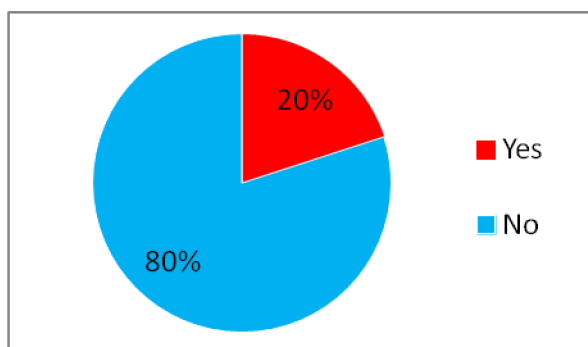
Figure 16. Levels of pressure regarding micro-plastics considered.
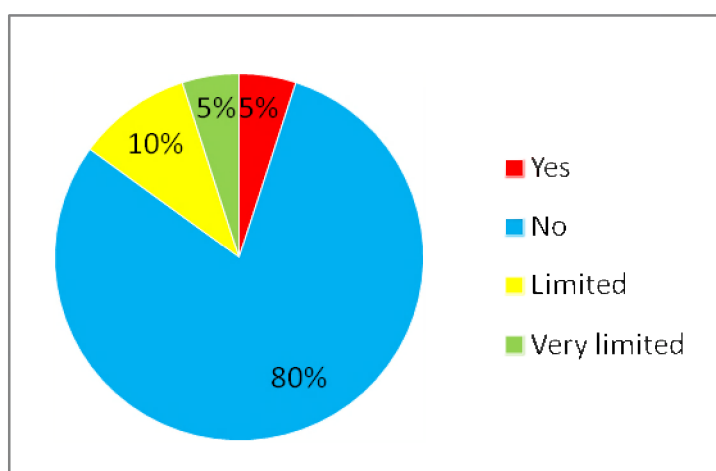
Figure 17. Data availability for pressure regarding micro-plastics.

Regarding units mentioned to report on micro-plastics, only information from 5 MS was identified, including 7 different units. In general, units were diverse with no predominant options and technicalities were not fully explained. Further, some units referred to the water column while others to the coastline. Harmonization efforts are needed for comparability purposes.

Table 4. Units used by MS to report marine litter regarding micro-plastics.

	UNITS						
10.1.3 (micro-plastics)	particles/km2	items/m3 (200 μm mesh)	average items/m2 upper 2 cm of beach sand	g/m2 upper 2 cm of beach sand	a) fibers ≥ 10 microns / l, b) Particles ≥ 300 μm/m3.	microplastic items/m2	items/1000m2
number of countries	1	1	1	1	1	1	1

3.2.5 Levels of impacts

Among the three different categories of impacts considered in the Initial Assessments (on marine animals, water column habitats and seabed habitats), basically only impacts on marine animals was

reported. For impacts on water column habitats, just one Member State included information about this compartment, while none of the countries reported impacts on seabed habitats.

9 MS out of 20 included impacts on marine animals. Data was considered available for 4 MS and not available for 11 MS. Additionally, data availability for 4 MS was identified as limited and for one Member State as very limited.
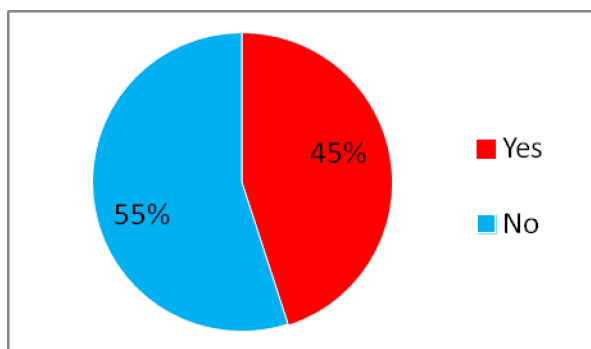
Figure 18. Levels of impacts on marine animals considered.
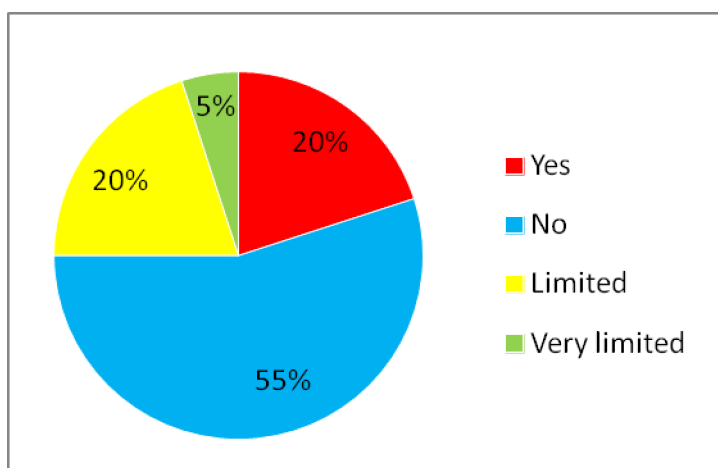
Figure 19. Data availability for impacts on marine animals.

Units or indicators used to assess levels of impacts on marine animals were tracked for a total of 9 MS. The predominant indicator was the OSPAR EcoQO (Ecological Quality Objective) on plastic particles in Fulmar stomachs, which refers to the North East Atlantic region. However, even some OSPAR countries did not fully agree in the adequacy of using Northern Fulmar (*Fulmarus glacialis*) as an indicator for certain subregions. Another indicator taken into account in the Mediterranean region was sea turtle (*Caretta caretta*). Some countries mentioned the use of seabirds, turtles and mammals, but did not specify species or methodologies.

Table 5. Units used by MS to report levels of impacts on marine animals.

	UNITS (indicators/species used for assessment)		
10.2.1 (Impacts on marine animals)	Fulmar EcoQO (OSPAR)	Caretta caretta	other seabirds, turtles and mammals
number countries	6	2	2

3.2.6 References to RSC and other international frameworks

A total of 11 MS out of 20 did references to the RSC frameworks. Particularly, 9 MSs included OSPAR activities in their reports and 4 MS included HELCOM. UNEP/MAP and BSC were not mentioned by any country.

Regarding technicalities and methodological approaches, some North East Atlantic countries included references to OSPAR methodologies such as: the Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area (OSPAR 2010) for pressure on the coastline; the OSPAR Recommendation 2010/19 (on the reduction of marine litter through the implementation of fishing for litter initiatives) for pressure on the water column; and the OSPAR EcoQO on plastic particles in Fulmar stomachs for impacts on marine animals. There were no technical documents from the rest of the RSC (HELCOM, UNEP/MAP and BSC). Furthermore, although not related to an specific Regional Sea Convention, there was one Member State that took into account technicalities from the document UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter (UNEP, 2009), particularly for pressure on the seacoast (used in combination with OSPAR Guidelines).

Other RSC relevant documents mentioned by MS for the assessment of Marine Litter included the OSPAR Quality Status Report (OSPAR QSR 2010) and the Assessment of the Marine Litter problem in the Baltic region and priorities for response (HELCOM Maritime, 6/2007).

In relation to additional international frameworks, occasional references were also made to: UNESCO Baltic Sea Coast Watch, WWF Naturewatch Baltic project, ICES International Bottom Trawl surveys (IBTS) and the previously mentioned UNEP/IOC Guidelines.
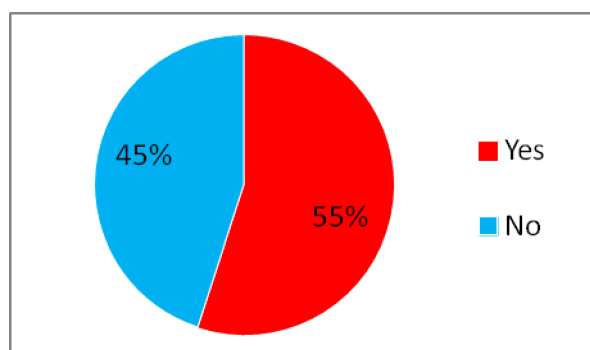
Figure 20. Reference to Regional Sea Conventions.

3.3 Environmental Targets (Art. 10)

Regarding establishment of environmental targets, 15 MS out of 20 delivered different targets and associated indicators. Targets related to the coastline compartment were set up by 15 MS out of 20, while for the water column compartment it was 8 MS out of 20 and for the seabed compartment 13 MS out of 20. Besides, targets regarding micro-plastics were included by 6 MS out of 20. Finally, targets for impacts on marine animals were set up by 12 MS out of 20.
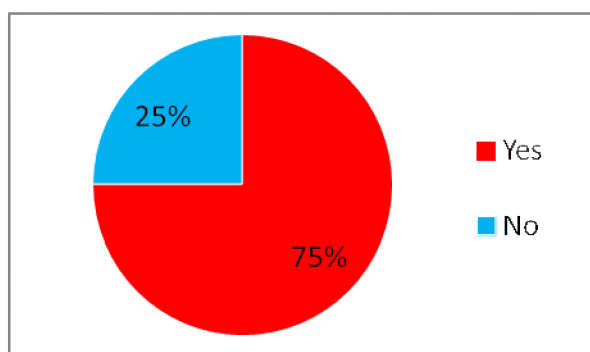
Figure 21. Environmental Targets.
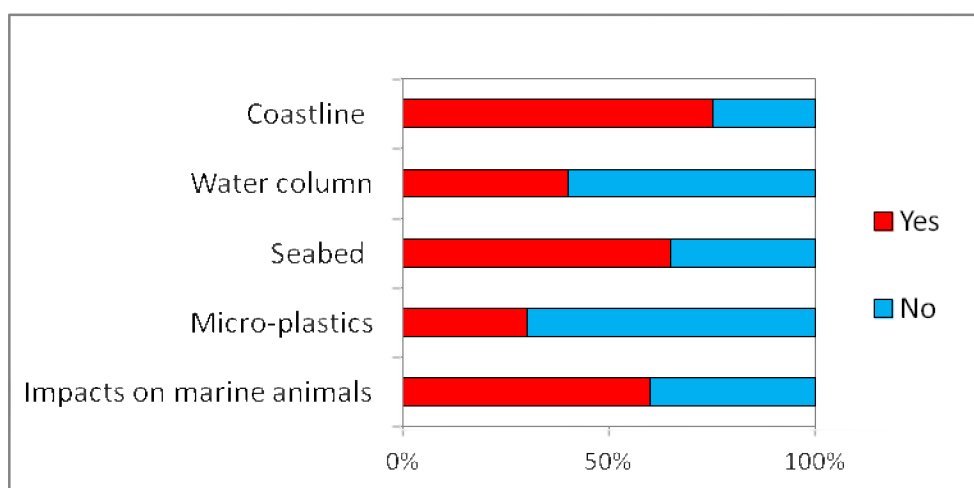
Figure 22. Environmental Targets in the different compartments.

Comparison of environmental targets among countries is not feasible due to the different nature and heterogeneity found in the reports. More importantly, only 3 MS out of 20 were able to define partially baselines and none of the countries was able to establish thresholds (expect one Member State that did partially).
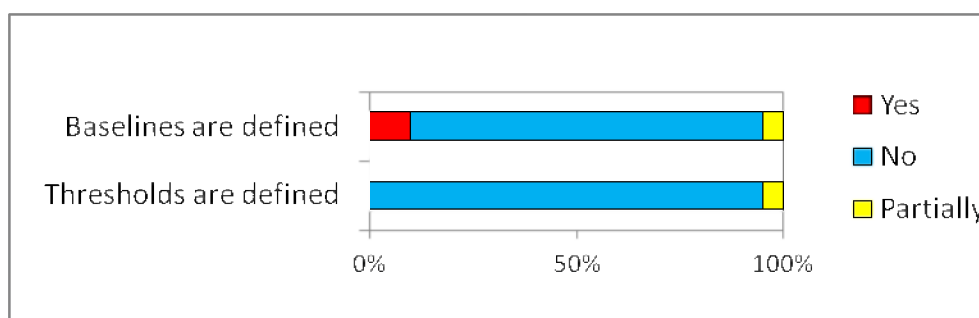
Figure 23. Baselines/Thresholds defined.

4. Discussion on findings

4.1 General discussion

Several MS have claimed lack of data and knowledge as main reasons preventing from delivering adequate reports to Articles 8, 9 and 10 requirements for D10, indicating basic needs for further development in terms of methodologies and monitoring programs to allow gathering consistent and coherent data sets for future assessment.

The existence of these needs is supported by the fact that a quarter of the MS considered in this IDA (5 out of 20) could not deliver a definition for GES under Article 9. Further, definition of baselines and establishment of thresholds were almost inexistent within these definitions for GES, caused mainly by the frequent lack of appropriate data sets and knowledge.

In relation to data availability, although most of the MS claimed to have some data (available, limited and very limited)) in their Initial Assessments reports (Art. 9), the information detailed in the results section of this report shows a high variability depending on the compartment considered. Often data was classified as limited, very limited and not available. Considering these three categories together, results ranged from 45% (9 MS out of 20) up to 95% (19 MS out of 20), which evidences the problems with data availability in most cases. Data availability among compartments could be ranked, from best case to worst case, as follows: pressure on seacoast > pressure on seabed > impacts on marine animals > pressure in the water column/water surface > pressure regarding micro-plastics.

Regarding units used to report marine litter, there was a great variability in the number of MS that included such information, but also in the number of units available. For marine litter on the coastline, most of the units were related to items/distance, implying feasibility to apply unit conversions to allow comparability in many cases. For the North East Atlantic countries, units were influenced by OSPAR methodologies. In relation to marine litter on the seabed, units were mainly related to weight/area or items/area, which could allow comparability only after applying item/weight conversions. On the other hand, for marine litter in the water column/water surface and micro-plastics, information was scarce with a low numbers of MS providing heterogenic and diverse units, indicating the need for further development and harmonization efforts. Finally, information on units used to assess impacts on marine animals was in general scarce and incomplete for most regions, with predominance of OSPAR methodologies in the North East Atlantic countries.

The establishment of Environmental Targets (Art. 10) was diverse and incomplete for many MS, depending on the compartment considered. Comparison of targets was not possible due to their different nature and heterogeneity among countries. Finally, similar to the situation found in the definition for GES reports (Art. 9), there was almost a general lack of baselines and thresholds in the establishment of Environmental Targets.

4.2 Level of integration with other EU legislation and RSC' agreements

In the case of Marine Litter, at the time of reporting, there was no integration between EU legislation and RSC' agreements. The attempt to establish common principles to deal with Marine Litter is quite recent at European level and most of the RSC do not even have a settled strategy to assess this issue yet. There is an important lack of standardized methodologies in most of the regions, except for OSPAR, where methodological aspects for some environmental compartments have been treated already, but not in coordination with MSFD. Meanwhile the MSFD Technical Group on Marine Litter has provided a platform for harmonization at EU level, with Regional Seas Conventions closely involved.

4.3 Methodological Approaches

While several methodological guidelines have been available at the time of initial assessments, as e.g. guidance from UNEP and OSPAR, there was no harmonized methodology at EU level. The MSFD Technical group on Marine Litter was installed for that reason and provided reports with the aim to harmonize and improve approaches in a collaborative approach with Member State experts. The work program of the group was based on the priorities identified by MS experts and does thus also respond to the shortcomings found in the MSFD Initial Assessments.

4.4 Reporting and assessing issues

The process of creating an overview and analyzing on Descriptor 10 could not provide many suggestions for improvements of the implementation process, as very little technical detail was provided. As for other descriptors it would be helpful if the reporting would follow a common format, so that technical information could easily be retrieved and eventual needs for further harmonization could be identified.

5. Conclusions

The conclusions include some general key findings of the in-depth-assessment of the MS' reports on Art. 8, 9, 10 on Marine Litter. With the available information it was not possible to derive many detailed suggestions, due to the few details provided in the summary reports. It needs to be mentioned that most of the identified issues had been flagged already by MS during the work of the MSFD Technical Group on Marine Litter. Accordingly, through the preparation of two guidance reports, most of the issues have been improved. Each addressed relevant issue is followed by a suggestion and potential actors, where deemed appropriate.

Table 6. List of key issues derived from the in-depth assessment for D10, suggestions and potential actors.

Issues on reporting	*Suggestion*	*Potential actors*
Wide heterogeneity in the kind of information reported.	Common understanding on the kind of data needed and to be collected.	TG Marine Litter
High variability in the way of presenting the data.	Establishing of a harmonized and concise report delivery process adapted to the identified requirements.	MSFD CIS
Significant differences in the information contained in the two pathways of information within the same country.	Report through one pathway in electronic format.	MSFD CIS
Difficulties to understand whether information is missing or it has just not been reported.	Allow through reporting process a clear identification of lack of data.	MS, MSFD CIS
Issues on methodologies	*Suggestion*	*Potential actors*
Inconsistencies in methodological approaches.	Common agreed identification of appropriate and comparable approaches and parameters to ensure a minimum level of coherence. Ensure common understanding, providing rules and guidance.	MS, RSC, TG Marine Litter
Inconsistencies in technical issues among MS and marine regions, and also within the same country.	Agreement on technical details at EU level.	MS, TG Marine Litter
Scarcity of data for some indicators.	Development of common understanding and guidance. Increase efforts to provide these data. Close link through TG ML with the development of Regional Action Plans.	MS, RSC, TG Marine Litter
Spatial inconsistency within and among MS regarding coastal-offshore data.	Assessment of both coastal and offshore water with clear boundaries and appropriate thresholds. Synergies in the definition of scales and possible common monitoring strategies.	MS, TG Marine Litter
No harmonized methodologies available for certain indicators	Trigger development of methodology through research efforts.	MS, TG Marine Litter
Issues on implementation	*Suggestion*	*Potential actors*
Inconsistencies between neighbouring countries	Development of common understanding	MS, RSC, TG Marine Litter
Low integration between marine regions.	Information exchange and efficient collaboration among Regions.	MS, TG Marine Litter
Difficulties in obtaining a data overview.	Development approaches for data accessibility, databases, etc.	TG Marine Litter
Definitions of GES and environmental targets are often not consistent, specific and measurable.	Coherence in reporting GES and targets and establishment of measurable thresholds and goals to accurately assessment their achievement.	MS, TG Marine Litter

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IN-DEPTH ASSESSMENT OF MEMBER STATES' SUBMISSIONS FOR MSFD ART. 8, 9 & 10 ON UNDERWATER NOISE DESCRIPTOR D11

INTRODUCTION OF ENERGY, INCLUDING UNDERWATER NOISE

Photo by Daniel Gonzalez

Contents for D11

1. Introduction

The introduction of energy, including as noise, into the marine environment is a direct consequence of human activities, such as construction, transport, recreation and energy production. Descriptor 11 of the MSFD introduces this component of GES as levels which do not adversely affect the marine environment.

1.1 Scope of the in-depth assessment

On request from DG Environment to support the implementation of MSFD (Art. 12), JRC has performed the in-depth assessment (IDA) of D11 as reported by the Member States for Article 8, 9, and 10. Knowing the shortcomings on harmonized and comparable assessments of marine noise, within the MSFD common implementation strategy, on request of EU Marine Directors, a dedicated technical working group on Underwater Noise has been established in 2011. This group has provided an overview about existing data and methodologies, analyzed needs for harmonization and, in a second step, provided guidance for the monitoring of Underwater Noise. The aims of the IDA are therefore limited to provide an overview and eventually identify additional issues arising from the analysis on assessments made by MS within Art 8,9,10 reporting.

- o To evaluate comparability and coherence of methods and in particular their relation to the assessments under other policy frameworks and the latest scientific evidence.

- o To provide recommendations for improved implementation in the second MSFD cycle

- o To support the possible revision of the COM Decision on criteria and methodological standards

The aim of this report is rather to present a holistic assessment of the implementation of MSFD per Member State than to judge or comment on particular Member States practices.

2. Assessment methodology

2.1 Input for D11 IDA

As for the D5 IDA, the JRC assessment is based on the reporting sheets, reported by the MS. The IDA for the introduction of energy, including underwater noise descriptors was performed on the updated reporting sheets that were uploaded on September 2013. By that time 19 MS had uploaded reporting sheets (XML files). The reports prepared for DG ENV by Milieu (consultant's reports; the versions that became available to JRC on August and September of 2013), including 19 MS and Portugal (only paper report), for the Art. 12 assessment were also consulted and were particularly useful as they identified cases where the reporting sheets were incomplete compared to the MS' paper reports. In such cases information missing from the reporting sheets was retrieved from the MS' paper reports. Chapter 6 includes the sources that JRC used or consulted for the D11.

The JRC assessment for D11 is based on the consultant's reports and the reporting sheets. From the total number of 23 MS involved in the MSFD implementation process, the available information considered in this report includes 20 MS, missing only Malta. On the other hand, no information was available for Poland, as they have not delivered yet their respective reports for Articles 8, 9 and 10. Croatia has not been considered because of its recent EU membership in 2013.

2.2 Methodological evaluation

A set of questions was developed to create a database for a total of 20 MS. Using this database, basic graphs have been produced and included in this document in order to show the proportion of countries that are considering certain elements for the assessment of Descriptor 11.

Results are presented in three sections considering separately the inputs for MSFD Article 8 (Section 3.2, Information on Initial Assessments), Article 9 (Section 3.1, Determination of GES) and Article 10 (Section 3.3, Environmental Targets).

3. Results

3.1 Determination of GES (Art. 9)

3.1.1 Definition of GES and MSFD requirements

A total of 15 MS out of 20 have delivered a definition of GES at descriptor level and according to MSFD Annex I. Further, 11 MS out of 20 have included the criteria settled down in COM DEC 2010/477/EU. At indicator level, only 2 MS out of 20 have included details as specified in COM DEC 2010/477/EU.
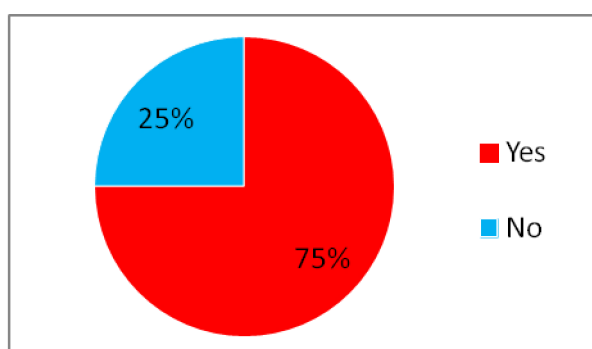
Figure 1. GES Definition at Descriptor level (according to MSFD ANNEX I).
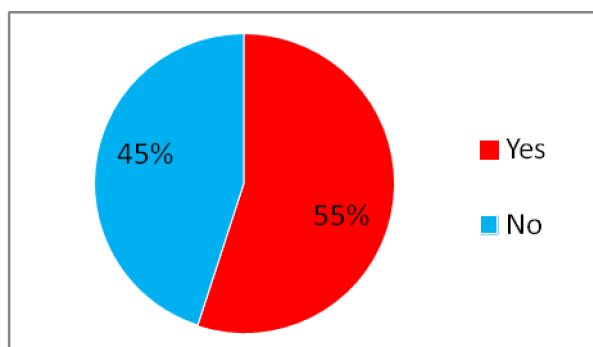
Figure 2. GES Definition at Criteria level (according to COM DEC).
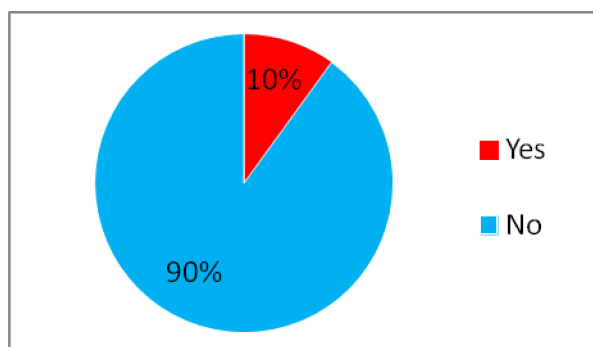
Figure 3. GES Definition at Indicator level (according to COM DEC).

In addition to underwater noise, there are 9 MS out 20 that included also other forms of energy in their definitions, but only 2 MSs detailed them as light, electromagnetism and changes in temperature.
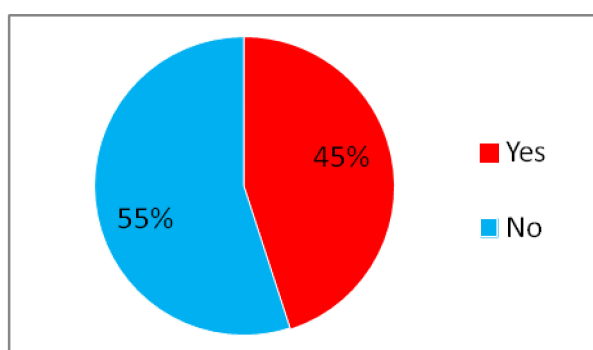
Figure 4. Other forms of energy included in definition of GES.
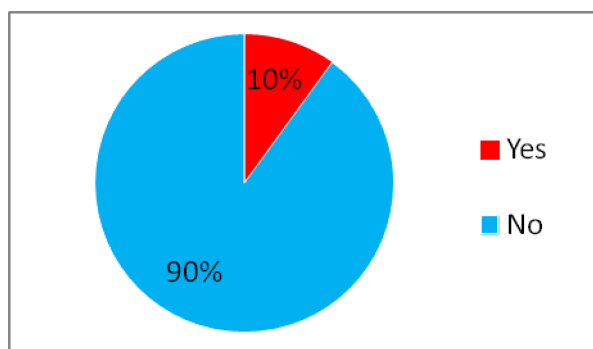
Figure 5. Other forms of energy detailed in definition of GES.

Only one Member State out of 20 defined baselines for determination of GES and none of them was able to included thresholds in their definitions except of one Member State that did partially.
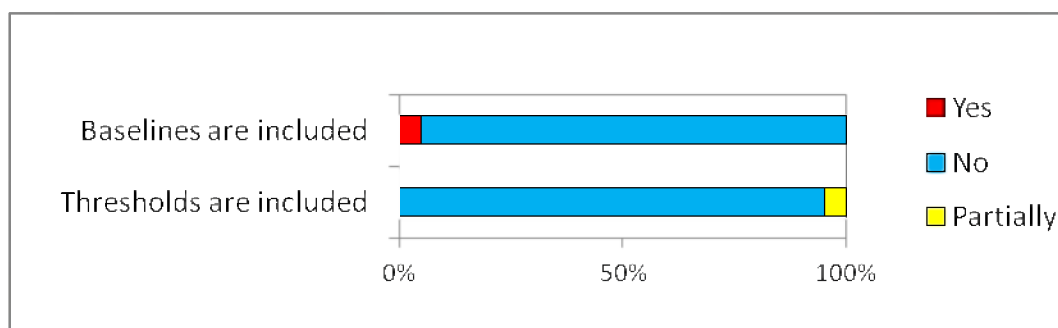
Figure 6. Baselines/Thresholds included in definition of GES.

3.1.2 References to RSC and other international frameworks

Regarding references to Regional Sea Conventions (RSC), only one Member State out 20 mentioned OSPAR. There were no references to UNEP/MAP, HELCOM or BSC. Furthermore, there were no references to any additional international framework.
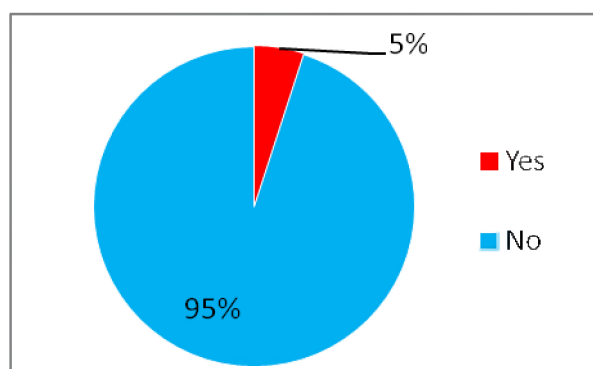
Figure 7. Reference to Regional Sea Conventions.

3.2 Information on Initial Assessment (Art. 8)

3.2.1 Information availability

Information on Initial Assessment for underwater noise was delivered by 18 MS out of 20. The distribution of available information in relation to known noise sources showed that 11 MS included information on this matter, while 4 MS did not. Besides, 5 MS had limited information. Further, 14 MS out of 20 were able to deliver lists of noise sources and 1 additional country had limited information.
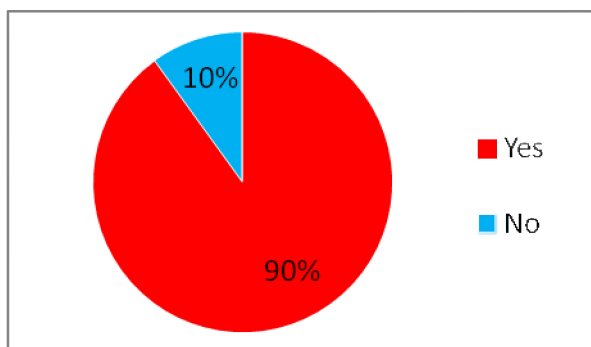
Figure 8. Information on Initial Assessment.
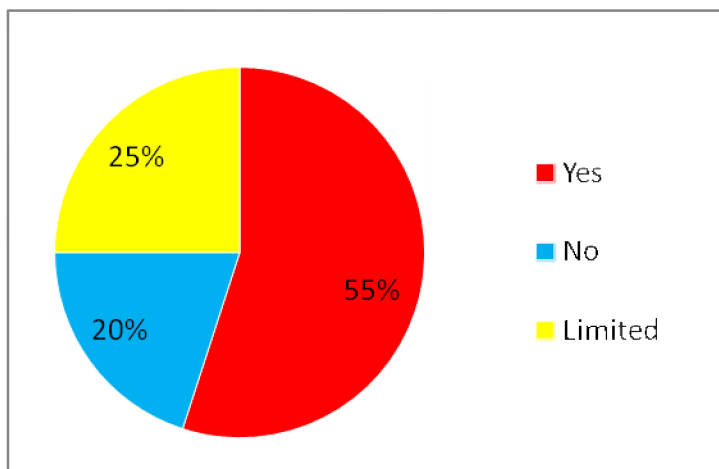
Figure 9. Information available on known noise sources.
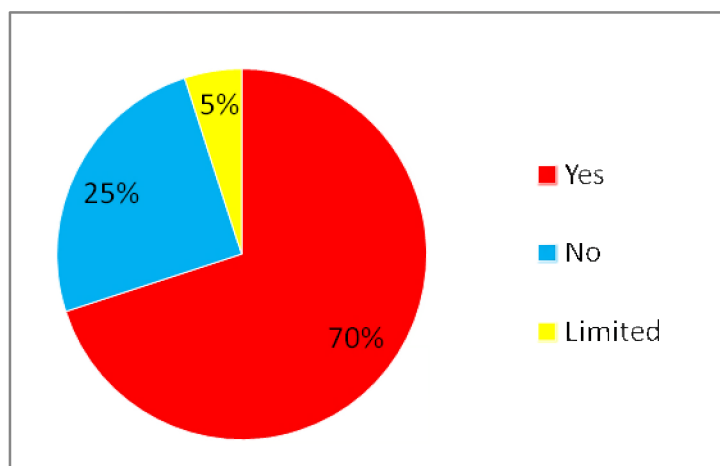
Figure 10. Lists of Noise sources.

In terms of data availability on underwater noise levels, only one Member State claimed to have data, while 5 MS were in the category of limited data. On the contrary, a total of 14 MS out of 20 did not have data available on underwater noise levels.
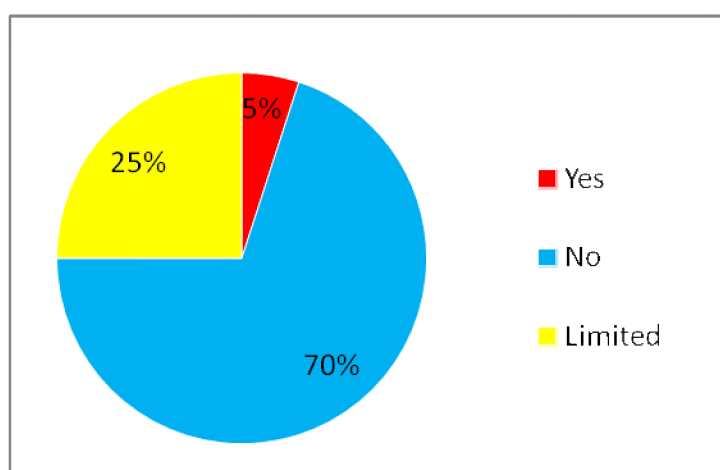
Figure 11. Data available on underwater noise levels.

3.2.2 References to RSC and other international frameworks

Only 2 MS out of 20 did references to RSC. One country mentioned OSPAR QSR 2010 document and another one mentioned HELCOM's assessment of noise sources and intensity and noise mapping across the Baltic Sea area. No mention was done for either UNEP/MAP or BSC.

Regarding other international frameworks, one country referred to the BIAS project that aims at measurements and modelling of a Baltic soundscape.
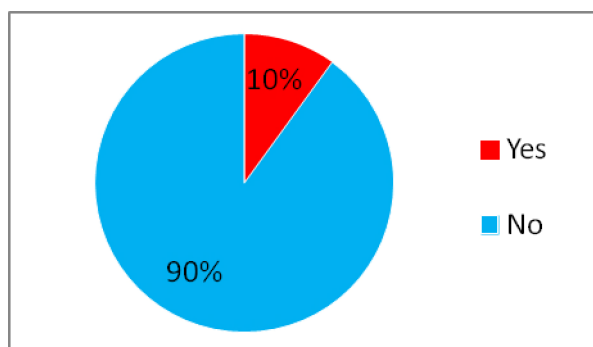
Figure 12. Reference to Regional Sea Conventions.
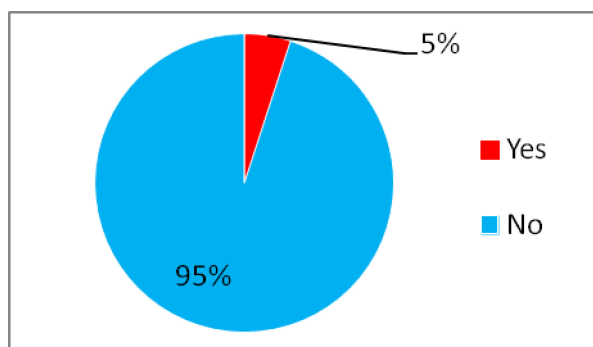
Figure 13. Reference to other international frameworks.

3.3 Environmental Targets (Art. 10)

A total of 13 MS out of 20 delivered targets and associated indicators. Comparison of environmental targets among countries is not feasible due to the different nature and heterogeneity found in the reports. The existing lack of data and knowledge is clear when only one Member State out of 20 was able to defined baselines. Besides, 3 MS out of 20 were able include thresholds but only partially.
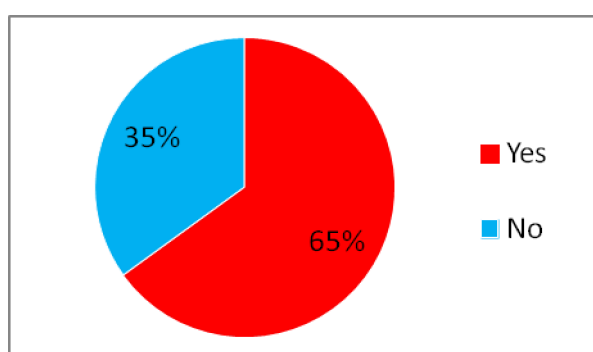
Figure 14. Environmental Targets.
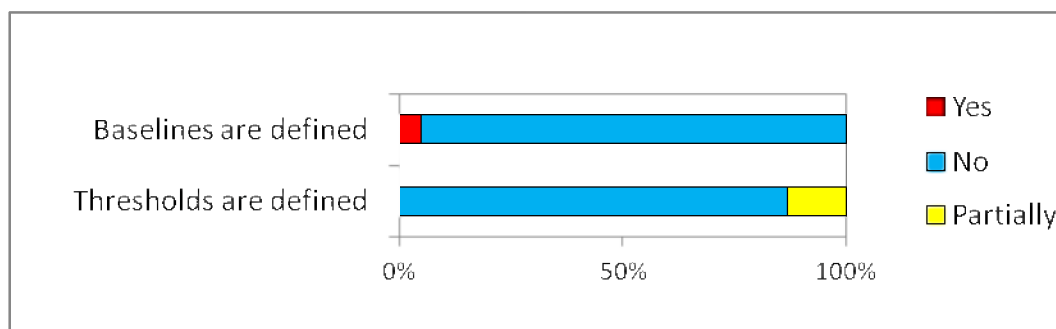
Figure 15. Baselines/Thresholds defined.

4. Discussion on findings

Overall the information supplied regarding marine energy and noise was very little as shown by the high percentage of non-reporting on different issues. It can be expected that this situation meanwhile has changed significantly due to the work performed in the Technical group on Noise and the published guidance documents.

A quarter of the considered MS did not deliver a GES definition (Art. 9) for Descriptor 11. Baselines or thresholds were almost inexistent. On the other hand, 9 MSs out 20 included other forms of energy in their definitions, but only 2 MS detailed them as light, electromagnetism and changes in temperature.

The available information on the Initial Assessment reports (Art. 8) was very limited and mostly focused on lists of potential noises sources. Regarding actual data on underwater noise levels, one Member State claimed to have availability, while 5 MS had some limited data. This fact remarks the non existence of previous methodological approaches or monitoring programs for the assessment of energy and noise introduction in the marine environment.

A total of 7 MS out of 20 did not included Environmental Targets in their reports (Art 10). Moreover, there was a general lack of baselines and thresholds for the associated indicators. It is clear the difficulty to establish Environmental Targets due to the lack of data and knowledge in the field, as it has been reflected by MS in the definition of GES and the Initial Assessment reports.

5. Conclusions

While the findings of the in-depth assessments will support a detailed analysis for the way forward, it was possible to identify here generalized issues for which suggestions could be derived. They include the key findings of the in-depth-assessment of the MS reports on Art. 8, 9, 10 on energy and noise. Each addressed relevant issue is followed by a suggestion and potential actions and actors, where deemed appropriate. It should be noted that most actions have meanwhile already been taken by the Technical Group on Noise, so that this table should serve only for a check against the so far provided outcome from the group.

Table 1. List of key issues derived from the in-depth assessment for D11, suggestions and potential actors

Issues on reporting	*Suggestion*	*Potential actors*
Wide heterogeneity in the kind of information reported.	Common understanding on the kind of data needed and how it should be collected.	TG Noise
High variability in the way of presenting the data.	Establishment of a harmonized, concise and well-organized report delivery process adapted to the identified requirements.	MSFD CIS
Significant differences in the information contained in the two pathways of information within the same country.	Report through one pathway in electronic format.	MSFD CIS
Difficulties to understand whether information is missing or it has not been reported.	Allow through reporting process a clear identification of lack of data.	MS, MSFD CIS
Issues on methodologies	*Suggestion*	*Potential actors*
Inconsistencies in methodological approaches, thresholds and limits.	Common agreed identification of appropriate and comparable approaches and parameters to ensure a minimum level of coherence. Ensure common understanding, providing rules and guidance.	MS, TG Noise
Spatial inconsistency within and among MS regarding coastal-offshore data.	Assessment of both coastal and offshore waters with clear boundaries and appropriate thresholds.	MS, TG Noise
Issues on implementation	*Suggestion*	*Potential actors*
Conceptual problems in the interpretation of criteria and indicators. Consideration of energy input.	Development of concrete definitions and guidance to facilitate the interpretation of those issues and terms that have been found to be unclear.	MSFD CIS, TG Noise
Definitions of GES and environmental targets often not existing.	Coherence in reporting GES and targets and through jointly developed guidance.	MS, MSFD CIS, TG Noise

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  https://circabc.europa.eu/sd/a/6b168331-711a-4ec5-9be3-26600c43808d/MSFD%20Monitoring%20Guidance%20Underwater%20Noise%20Part%20II%20Specifications%20IGR%200516.pdf

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Abstract: According to the Marine Strategy Framework Directive (MSFD), in 2012 Member States had to report on the initial assessment of their marine waters (art. 8), on the determination of good environmental status (art. 9) and on the establishment of environmental targets and associated indicators (art. 10). At the request of DG Environment, the Joint Research Centre of the European Commission has carried out an in-depth assessment (IDA) of the reporting done by Member States. This document presents the result of this IDA, carried out on the basis of reporting from the following Member States (MS): Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Netherlands, Portugal, Romania, Slovenia, Spain, Sweden, United Kingdom.
The aims of the IDA were: i) to evaluate comparability and coherence of methods and in particular their relation to the assessments under other European and international frames and the latest scientific evidence, ii) to provide recommendations for improved implementation of the MSFD in the second cycle (2018) and iii) to support the review and the possible revision of the Commission Decision (2010/477/EU). The IDA covers all MSFD descriptors expect D3 and D7 and is presented in six chapters (biodiversity: descriptors 1, 4 and 6; non indigenous species: descriptor 2; eutrophication: descriptor 5; contaminants: descriptor 8 and 9; marine litter: descriptor 10; underwater noise and other forms of energy: descriptor 11). This IDA presents a set of suggestions that can be pursued to strengthen the further implementation of the MSFD.

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