

2012-09-28

# An environmental assessment of risk in achieving good environmental status to support regional prioritisation of management in Europe

Breen, P

<http://hdl.handle.net/10026.1/3406>

---

10.1016/j.marpol.2012.02.003

Marine Policy

Elsevier BV

---

*All content in PEARL is protected by copyright law. Author manuscripts are made available in accordance with publisher policies. Please cite only the published version using the details provided on the item record or document. In the absence of an open licence (e.g. Creative Commons), permissions for further reuse of content should be sought from the publisher or author.*

An environmental assessment of risk in achieving Good Environmental Status to support regional prioritisation of management in Europe.

Breen P.<sup>1</sup>, Robinson L.A.<sup>2</sup>, Rogers S.I.<sup>1</sup>, Knights A.M.<sup>2</sup>, Piet G.<sup>3</sup>, Churilova T.<sup>4</sup>, Margonski P.<sup>5</sup>, Papadopoulou N.<sup>6</sup>, Akoglu E.<sup>7</sup>, Eriksson A.<sup>8</sup>, Finenko Z.<sup>4</sup>, Fleming-Lehtinen V.<sup>8</sup>, Galil B.<sup>9</sup>, Goodsir F.<sup>1\*</sup>, Goren M.<sup>10</sup>, Kryvenko O.<sup>4</sup>, Leppanen J.M.<sup>8</sup>, Markantonatou V.<sup>6</sup>, Moncheva S.<sup>11</sup>, Oguz T.<sup>7</sup>, Paltriguera L.<sup>1</sup>, Stefanova K.<sup>11</sup>, Timofte F.<sup>12</sup>, and Thomsen F.<sup>1</sup>

*\*Corresponding author. Cefas, Pakefield Road, Lowestoft. NR33 0HT. Email: [freya.goodsir@cefass.co.uk](mailto:freya.goodsir@cefass.co.uk). Tel: 01502524420*

1. Centre for Environment, Fisheries and Aquaculture Science (Cefas). Pakefield Road, Lowestoft. NR33 0HT. UK.
2. School of Environmental Sciences, University of Liverpool, Nicholson Building, Liverpool. L69 7GP. UK.
3. Institute for Marine Resources and Ecosystem Studies (IMARES). Ijmuiden, Haringkade 1, 1976 CP Ijmuiden, The Netherlands.
4. A.O. Kovalevskiy Institute of Biology Of Southern Seas. National Academy of Sciences of Ukraine 2, Nakhimov av., Sevastopol, 99011, Crimea, Ukraine.
5. National Marine Fisheries Research Institute, Department of Fisheries Oceanography and Marine Ecology, ul. Kollataja 1,81-332 Gdynia, Poland.
6. Hellenic Centre for Marine Research, Institute of Marine Biological Resources, PO Box 2214, Heraklion 71003, Crete.
7. Institute of Marine Sciences, Middle East Technical University. P.O.Box 28, 33731, Erdemli-Mersin, Turkey.
8. Marine Research Centre, Finnish Environment Institute (SYKE), Po Box 140, FI-00251 Helsinki.
9. National Institute of Oceanography, Israel Oceanographic & Limnological Research (NIO-IOLR), Tel Shikmona, 31080 Haifa, Israel.
10. Department of Zoology, Tel Aviv University. Tel Aviv 69778, Israel.
11. Institute of Oceanology- BAS, 9000 Varna, P.O. Box 152, Bulgaria.
12. National Institute for Marine Research and Development "Grigore Antipa", 900581 Constanta, RO.

1 An environmental assessment of risk in achieving Good Environmental Status to support regional  
2 prioritisation of management in Europe.

3 **Abstract**

4 The Marine Strategy Framework Directive (MSFD) aims to achieve Good Environmental Status  
5 (GES) in Europe's Seas. The requirement for regional sea authorities to identify and prioritize issues  
6 for management has meant that standardized methods to assess the current level of departure from  
7 GES are needed. The methodology presented here provides a means by which existing information  
8 describing the status of ecosystem components of a regional sea can be used to determine the effort  
9 required to achieve GES. A risk assessment framework was developed to score departure from GES  
10 for 10 out of the 11 GES descriptors, based on proposed definitions of 'good' status, and current  
11 knowledge of environmental status in each of the four regional seas (North-East Atlantic,  
12 Mediterranean Sea, Baltic Sea and Black Sea). This provides an approach for regional evaluation of  
13 environmental issues and national prioritization of conservation objectives. Departure from GES  
14 definitions is described as 'high', 'moderate' or 'low' and the implications for management options and  
15 national policy decisions are discussed. While the criteria used in this study were developed  
16 specifically for application toward MSFD objectives, with modification the approach could be applied  
17 to evaluate other high-level social, economic or environmental objectives.

18 **Key-words:** risk assessment; status; Marine Strategy Framework Directive; management; GES

27        **1. Introduction**

28        Ecosystem-based management (EBM) considers both ecological and human objectives in the  
29        exploitation of resources [1]. It aims to maintain ecosystems in a healthy, productive, resilient  
30        condition whilst still providing key marine resources for human consumption [2]. As such there are  
31        numerous policies and directives which aim to support EBM. In many cases, initiatives have been  
32        focused on single species or sectors at a relatively small-scale [3], although larger-scale initiatives  
33        have recently been proposed which require an array of different sectors, habitats and species to be  
34        considered. Within Europe, the Marine Strategy Framework Directive (MSFD) (2008/56/EC) [4] is  
35        one such policy; its key objective is the achievement of Good Environmental Status (GES) in each of  
36        the four European regional seas: The North-East Atlantic, The Mediterranean Sea, The Baltic Sea and  
37        The Black Sea (Fig. 1) by 2020.

38        The MSFD has used 11 descriptors of GES to broadly describe the natural environment and the  
39        pressures related to it. It has placed obligations on Member States to promote GES. There are four  
40        main steps in this process; the outcome of which is to support the identification of current aspects of  
41        the marine ecosystem under threat and lead to the implementation of management options to mitigate  
42        impacts and support sustainable use of marine ecosystems. The steps include: (1) completing an initial  
43        assessment of the current state of marine waters (by 2012); developing targets and indicators to  
44        demonstrate GES (by 2012); (3) setting up monitoring programmes to assess progress against GES  
45        (by 2014); and (4) implementing a programme of measures to help achieve GES (by 2016). The need  
46        for cooperation between member states bordering the regional seas, to take forward implementation of  
47        the MSFD, is emphasized strongly in the documentation [4]; see summary in [5].

48        Achieving GES may not be possible for all ecosystem components by 2020 (Article 29[4]) and  
49        Member States are not required to take steps to mitigate threats when there is no significant risk to the  
50        marine environment (Article 11[4]). ‘Failure’ to meet the Directive’s requirements only occurs when  
51        management measures are not implemented to address an identified threat (Article 11[4]). The need to

1  
2 52 rationalise resource use may lead to the prioritisation of issues by Member States of management  
3 53 measures most likely to have a beneficial effect.  
4

5 54 Whilst existing ecosystem status assessments are useful in the context for which they were developed,  
6  
7 55 the specific criteria and methodology used to determine status and trends do not allow for easy inter-  
8  
9 56 comparison across regional seas. The motivation for existing assessments can be wide-ranging and  
10  
11 57 cover topics as diverse as sustainability of fish stocks, coastal, estuarine and whole marine ecosystem  
12  
13 58 condition assessments to predicting potential impacts of future projects, programmes and policies [6].  
14

15  
16 59 In addition the assessments may have been undertaken at very different spatial scales adding  
17  
18 60 complexity. For example, national ecosystem assessments may not account for transboundary  
19  
20 61 pressure (e.g. exploitation of fish stocks straddling territorial boundaries) and hence, may  
21  
22 62 underestimate the level of threat at a regional scale. Large-scale ecosystem assessments such as the  
23  
24 63 OSPAR Quality Status Report 2010 [7] by comparison, go some way toward providing a regional  
25  
26 64 overview of potential problem areas. However, differing regional interests and the wide range of goals  
27  
28 65 and objectives of each assessment means that the information available, even if at a similar spatial  
29  
30 66 scale, may not cover all of the issues highlighted by the MSFD's descriptors of GES. Furthermore  
31  
32 67 where the same issues are covered, the objectives and baselines of the assessments may differ.  
33  
34

35  
36  
37 68 To fulfil the first step of implementing the MSFD and help prioritise monitoring and management, a  
38  
39 69 regional overview of ecosystem status is required which is set around the 11 GES descriptors. To  
40  
41 70 achieve this, existing national and regional assessments must be collated and their outcomes  
42  
43 71 interpreted to form a coherent assessment that can cover all aspects of GES [5, 8]. Here, we present a  
44  
45 72 methodology that can assess the wide range of existing assessments relevant to the different aspects of  
46  
47 73 good environmental status. A risk assessment framework was used to assess the degree of departure  
48  
49 74 of current ecosystem status from proposed definitions of GES, and indicated the likely level of effort  
50  
51 75 required by Member States to achieve GES for each descriptor. Using a combination of existing  
52  
53 76 assessments and/or expert judgement, the major challenges to the GES objectives are identified for  
54  
55 77 each of Europe's four regional seas. The outcomes allow Members States to identify national and  
56  
57 78 regional management priorities to support achievement of GES by 2020.  
58  
59  
60  
61

79

1  
2  
3 **80 2. Methods**

4  
5 **81 2.1 Definition of objectives**

6  
7  
8 **82** Each MSFD Descriptor of GES was defined in the Directive (Annex I, EC, 2008; listed here in  
9  
10 **83** Appendix A), but in many cases the definitions failed to provide sufficient detail to determine if GES  
11  
12 **84** is likely to be achieved. For example, Descriptor 2 (D2) is defined as “NIS (NIS) introduced by  
13  
14 **85** human activities are at levels that do not adversely alter the ecosystems” but it is not clear what would  
15  
16 **86** constitute adverse effects on the ecosystem, nor how these might be linked to the distribution or  
17  
18 **87** number of NIS.

19  
20  
21  
22 **88** For each of the descriptors assessed (here 10 of the 11 MSFD Descriptors<sup>1</sup>) a more detailed definition  
23  
24 **89** was developed against which to assess the extent of departure from the current ecosystem status, and  
25  
26 **90** thus the risk of failing to achieve the objective.

27  
28  
29  
30 **91** To define GES for each descriptor a number of key documents were consulted. These were: EC  
31  
32 **92** Commission Decision Document [9] which lists the indicators required to assess each Descriptor, and  
33  
34 **93** Cardoso et al. [10] which informed the Commission Decision Document [9] and draws together  
35  
36 **94** advice given by expert task groups set up to review knowledge and understanding of the GES  
37  
38 **95** descriptors. These more detailed definitions incorporated specific characteristics associated with  
39  
40 **96** achievement of GES to enable interpretation at a regional sea scale (Appendix B).

41  
42  
43  
44 **97**

45  
46  
47 **98 2.2 Definition of risk criteria**

48  
49  
50 **99** Having clarified the characteristics associated with achievement of each descriptor, criteria describing  
51  
52 **100** high, moderate and low levels of departure from GES were then defined, corresponding with different  
53  
54 **101** levels of risk of failing to achieve them (Appendix B). In order to apply the assessments across the

55  
56  
57  
58  
59 

---

<sup>1</sup> Descriptor 7 (Hydrographical conditions) was not assessed since there has been little clarity on how this aspect  
60 of GES should be interpreted.  
61

102 four European regional seas it was often necessary to define several different criteria for each level of  
103 risk corresponding with the indicators outlined in the Commission Decision document [9]. Criteria for  
104 assessing confidence in the application of the risk score were also developed. Confidence indicates the  
105 degree of certainty in our assessment of effort required to achieve GES in each of the four regional  
106 seas. These criteria were also of a qualitative nature (e.g. high, medium and low) and were based on  
107 the quality of information, the ease of interpreting the information with regards to the assessment  
108 criteria and the agreement within the expert group carrying out the assessment (Appendix B).

109 Cardoso et al. [10] also provided information about integrating several different pieces of evidence i.e.  
110 whether this should use an integrated or worst case scenario approach. An integrated approach meant  
111 that information should be combined before a final assessment was given whilst a worst case  
112 approach followed a ‘one-out all-out’ principle whereby if one set of evidence suggested that the risk  
113 was ‘high’ then ‘high’ was automatically assessed for the entire descriptor. Descriptors which applied  
114 an integrated approach were Biodiversity, NIS, Eutrophication and Seafloor Integrity. All other  
115 descriptors used a worst case approach.

116

### 117 **2.3 Status and pressure assessments**

118 Information required to evaluate GES include descriptions of the status and trends of ecological  
119 characteristics in the regional sea, and/or an assessment of the extent and frequency of human  
120 pressures and their impacts. The relationship between this evidence and each of the GES descriptors  
121 was initially described by Cardoso et al. [10] and here refined to only include direct linkages. These  
122 linkages were used to sort available evidence by descriptor therefore specifying which information  
123 should be used to assess each descriptor.

124

#### 125 *Status and Trend information*

126 Many of the ecological characteristics described in the MSFD are already evaluated in accordance  
127 with various Directives, and other national or regional initiatives (e.g. OSPAR). However, these tend

128 to have different criteria, objectives and baselines, because they fulfil different purposes. Existing  
129 status and trend assessments from more than 100 reports, journal articles and grey literature were  
130 collated and linked to each ecological characteristic. Where status information was unavailable, trend  
131 information was used which describes a change in an indicator over time.

132

### 133 *Pressures*

134 Pressure is the mechanism through which an activity has an effect on any part of the ecosystem, and  
135 pressure has been explicitly recognised in some GES descriptors of the MSFD (e.g. Descriptor 10 on  
136 Marine Litter and Descriptor 5 on Eutrophication).

137 For those descriptors that require information on pressures, a pressure assessment was used to identify  
138 the potential pressure pathways or 'linkages' between activities and ecosystem characteristics followed  
139 by evaluation of those linkages in terms of their severity and persistence [11]. Coupled with estimates  
140 of human activity footprint (extent) and frequency of occurrence, the relative threat of each activity  
141 and pressure to the status of the relevant components of the ecosystem was evaluated. This method  
142 uses expert judgment evaluations of five criteria: (1) overlap between the pressure and ecological  
143 characteristic (extent), (2) frequency of occurrence of the pressure, (3) degree of impact of the  
144 pressure on the ecological characteristic, (4) ecological characteristic resilience (recovery time), and  
145 (5) pressure persistence beyond activity cessation. The interaction of each pressure combination was  
146 ranked using predefined categories each indicating a different level of threat to the ecological  
147 characteristic being evaluated. Information from the results of the pressure assessment undertaken in  
148 each regional sea were then used to inform the risk assessment for relevant descriptors.

149

## 150 **2.4 The assessment**

151 The assessment was carried out by 30 marine experts from 16 European countries assembled at a  
152 workshop in February 2011. Experts were divided into regional groups and assessments were carried  
153 out as a team. Biodiversity was disaggregated into five component parts: (1) Phyto-zooplankton, (2)  
154 Fish, (3) Seabirds, (4) Marine mammals and reptiles, and (5) Predominant habitat types, due to the



155 difficulties associated with an integrated assessment of all those characteristics. Experts used the GES  
156 descriptor definitions (Appendix B) and scored the effort required to achieve GES as high, moderate  
157 or low using the compiled status and trends database and information from the pressure assessment on  
158 their region. For each descriptor, a confidence score was also applied. Where it was not possible to  
159 distinguish between 2 risk categories (e.g. low or moderate), an intermediate score was applied e.g.  
160 low-moderate. A commentary sheet was also completed during the assessment; this provided a self-  
161 assessment framework to ensure consistency of methodology application and interpretation, as well as  
162 providing an audit trail for the assessment.

163

### 164 **3 Results**

165 The level of risk in the achievement of GES varied across descriptors and between regions, however  
166 when summarized across descriptors, there was little difference in the overall level of risk between  
167 regions (Table 1). For the North East Atlantic, six of the 14 descriptor categories were assessed to be  
168 at high risk, whilst seven were assessed as high for the other three regions combined. In general  
169 pressure based objectives (i.e. underwater noise, marine litter) or those directly related to impacts  
170 from pressures (e.g. commercial fish and shellfish and seafloor integrity) exhibited higher risk than  
171 state objectives (e.g. biodiversity).

172 Five descriptors were assessed as having a high risk in all four regions (NIS, fish and shellfish, food  
173 webs, seafloor integrity and marine litter) (Table 1). Underwater noise was scored as high risk in the  
174 NE Atlantic, Mediterranean Sea and Black Sea and moderate-high risk in the Baltic Sea. Only  
175 contaminants in fish and shellfish in the Mediterranean Sea was considered at low risk (Table 1).

176 Of the descriptors classified as high risk in all four regions, risk for Commercial Fish and Shellfish  
177 was associated with the number of over-exploited species. The Food Web descriptor was at high risk  
178 due to declining populations of many of the biodiversity components that form essential parts of the  
179 food web (e.g. top predators such as some of the marine mammals) and the poor status of several  
180 commercial fish stocks, which both act as a proxy for food web functioning. Seafloor Integrity was

181 assessed using the results of the pressure assessment and indicated several sectoral activities result in  
182 widespread detrimental effects to seafloor habitats and species. In general, increases in the abundance  
183 and number of NIS were reported in all regions, and in many cases, evidence of adverse effects  
184 shown. The availability of data describing trends in the quantity of Marine Litter was limited, but  
185 reports of litter on beaches, the concentration of microplastics in the environment and plastic ingested  
186 by seabirds indicated a high risk of failure to achieve our potential GES definitions. Underwater Noise  
187 was classified as high risk in three of the four regions; an assessment largely driven by high levels of  
188 shipping activity in all regions (see also QSR 2010).

189 The analyses also highlighted some issues specific to each region. For example, Eutrophication was  
190 scored as high risk in the Baltic Sea, but classified as moderate risk in all other regions. Both  
191 Contaminant descriptors were at higher risk of failing to achieve GES in the Baltic Sea and the Black  
192 Sea. There was high risk to Biodiversity in three of the four regional seas. High risk categorisation  
193 was achieved when a species/habitat was thought to be of high likelihood to be lost within the next 10  
194 years (Table 1) e.g. the critically endangered Monk seal in the Mediterranean Sea[12]. Based on this  
195 criterion, high risk Biodiversity sub-groups included marine mammal and reptiles in the  
196 Mediterranean, predominant habitats in the Baltic Sea, and seabird diversity in the Black Sea (Table  
197 1).

198

#### 199 *Confidence in assessments*

200 A high degree of confidence was reported for ~40% of assessments, and 89% of assessments scored  
201 as moderate confidence or better (see confidence criteria in Appendix B). In general, low confidence  
202 in assessment was rare in the majority of regions, for example no descriptors in the Baltic and  
203 Mediterranean Sea and only Contaminants in Fish and Shellfish in the Black Sea was classified as a  
204 low confidence assessment. In contrast, uncertainty in assessments was reported in Biodiversity-  
205 plankton (L-M); Biodiversity-Marine mammals and reptiles (L); Biodiversity-Predominant habitat  
206 types; and Contaminants in Fish and Shellfish (L) in the NE Atlantic.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

207 There was more variation in the assessment of confidence between regions than in the assessment of  
208 risk itself. For example, the Baltic Sea recorded highest levels of confidence in their assessment (eight  
209 out of 14 descriptor categories were recorded as high confidence whilst the other regions only  
210 allocated high confidence to five out of 14 descriptor categories). In general, the confidence in  
211 assessment of descriptors Eutrophication, Seafloor Integrity and Contaminants was high. However,  
212 there were only three descriptors (Marine litter, Biodiversity-predominant habitat types and  
213 Biodiversity- marine mammals) which differed by more than one whole confidence score between  
214 regions (i.e. low in one region and high in another). Less than half of assessments (41%) were given  
215 both a high risk and a high confidence score (i.e. 11 assessments out of 27 total assessments scored as  
216 high risk and high confidence). Only three assessments in total were considered to have a low  
217 confidence and none of these was considered to have high risk of failure.

218

#### 219 **4 Discussion**

220 The Marine Strategy Framework Directive (MSFD) is the first piece of legislation applied across  
221 Europe's regional seas that requires assessment of the range of issues that should encompass overall  
222 marine environmental sustainability [13]. Prior to this coming into place, legislation tended to focus  
223 primarily on a single activity or issue. As such, most status, trend and impact assessments also  
224 focused on these specific issues. Broader assessments of the status of marine ecosystems do exist for  
225 particular sea areas (e.g. under the regional sea conventions), but although their focus may in some  
226 cases align with the MSFD's overall objective of healthy, productive, safe and biologically diverse  
227 seas, the reporting does not tend to cover all aspects of GES (the 11 GES descriptors) (Appendix A).

228 We have presented a methodology that combines information on status and human impacts within a  
229 regionally consistent framework to assess the level of risk to GES. Over 100 sources were included in  
230 the risk analysis and included broad-scale assessments of status (e.g. [14]), pressure distribution (e.g.  
231 [15]), impacts (e.g.[16]) and trends in ecosystem characteristics (e.g. [17]). Sources covered a range

232 of assessment timelines, reference conditions and were of varying spatial coverage. However, in the  
233 majority of cases, the regional expert groups felt confident and could agree on a suitable risk category.  
234 The need for such a methodology was highlighted in the process of conducting the assessments, when  
235 specific national or sub-regional status reports were inconsistent with overall regional views. For  
236 example, UK predominant habitats [14] are reported as being in poor status, but when assessing risk  
237 to GES based on Biodiversity of predominant habitats for the whole regional sea (in this case the NE  
238 Atlantic), the level of risk was classified as ‘moderate’ (see Figure 1) indicating the importance of  
239 considering spatial scale of assessments when evaluating status at a regional sea level.  
240 The assessment of risk of failing to achieve these GES definitions identified issues for regional  
241 prioritization in addition to those identified in existing status reports. For example, the Baltic Sea and  
242 Black Sea Action Plans [18] [19] focus on issues relating to the descriptors (1) Biodiversity, (5)  
243 Eutrophication, (6) Seafloor Integrity and (8&9) Contaminants and Contaminants in Fish and  
244 Shellfish. However, the risk assessment undertaken here suggests that NIS, Food Webs, Marine Litter  
245 and Underwater Noise are also potential areas of concern. This shows that translation of the outcomes  
246 of even spatially comparable assessments and their placement in the context of the MSFD may be  
247 precluded by differences in assessment objectives.

248

#### 249 *Levels of risk to achieving GES*

250 Application of the risk methodology to Europe’s four regional seas identified GES descriptors at high  
251 risk that were common to all regional seas, suggesting a similar level of effort required within all  
252 regions to achieve the MSFD objectives. In most cases, the contributing threats to the high risk  
253 classification were logical and fit well with documented areas of concern e.g. commercial fish  
254 sustainability, the establishment and spread of NIS, amount of marine litter, the state of food webs and  
255 the extent of human activities. Similarly, descriptors classified as at moderate or low risk, such as  
256 Contaminants and Eutrophication, are already focus issues of regional sea conventions and in some  
257 cases, have been regulated for many years.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

258 Surprisingly, there were few high risk Biodiversity components, despite some other descriptors that  
259 we might expect to have consequences for Biodiversity such as NIS classified as at high risk. Risk  
260 outcomes are closely linked to the level of ambition of the descriptor and these differed between the  
261 descriptors. Using the example of NIS and Biodiversity, the crucial difference in GES ambition is in  
262 the definition of acceptable ‘loss’. High risk under Biodiversity requires the likelihood of “loss of  
263 biodiversity or maintained change in dominance/assemblage structure” (Appendix B) (both of which  
264 are major changes at a regional sea scale), whereas for NIS, significant adverse effects of an invasive  
265 species do not have to be as severe as elimination of a population and can include effects such as  
266 increased seasonal dominance of algal blooms in the region.

267 Disparities may also be the result of the level of precaution adopted. The timeline for biodiversity loss  
268 was defined as <10 years (i.e. within the 2020 reporting timescale of the MSFD). However, this  
269 timeline is perhaps not precautionary enough to help prioritise management. For example, a species or  
270 habitat faced with loss from an area as large as one of Europe’s regional seas within the next 10 years  
271 may be beyond recovery [20] and therefore, high risk criteria should reflect a period before the  
272 condition/status of the habitats/species becomes irrecoverable. Doing so would potentially result in a  
273 high risk score for a greater number of biodiversity components.

274 Difficulties in assessing risk criteria may also account for differences in risk score. The availability of  
275 reliable information on threatened and declining species or changes in dominance of assemblages (the  
276 two types of criteria for biodiversity) can vary widely and thus, affect the outcome of the assessment.  
277 Confidence in assessment can be interpreted in terms of prioritization of action to help achieve GES  
278 for particular descriptors where there are data or an understanding of the limitations of the data. As  
279 such, when confidence is low or low-moderate, recommended actions might include: (i) implementing  
280 monitoring programmes to improve data knowledge, (ii) re-analysing data to make our current data  
281 more useful for the MSFD, (iii) further development and research to improve understanding and use  
282 of the descriptors.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

283 Where improving data provision is not possible, it may be more sensible to use a precautionary  
284 approach whereby high risk in one descriptor (e.g. Seafloor Integrity) automatically triggers high risk  
285 categorisation of a related descriptor i.e. Biodiversity of predominant habitats. This would ensure that  
286 at a minimum, monitoring and evaluation of biodiversity aspects would occur. There are clear inter-  
287 relationships between some of the descriptors of Europe's MSFD [5] and our results suggest that it  
288 will be important to recognise the links between descriptors such that high risk issues identified for  
289 one descriptor can trigger a similarly high level of priority in others.

290

### 291 *Implications for prioritisation of management and monitoring*

292 Given the high number of high risk issues for GES in each of Europe's regional seas as illustrated  
293 here, it is clear that member states (MSs) will need to implement management measures for many of  
294 the descriptors by 2016. A number of MSs are reviewing the types and performance of existing  
295 management measures and mapping the suitability of these in tackling areas of concern. For some  
296 descriptors, existing measures may already be helping to reduce the likelihood of status deteriorating  
297 beyond GES thresholds. Depending on the spatial scale of those measures e.g. national vs. regional  
298 programmes, dialogue between MSs could support the objectives of existing management options and  
299 also address the collaborative requirement of the MSFD (Article 13). However, the complexity in  
300 achieving GES at a regional sea scale should not be underestimated and may limit potential  
301 collaboration [21]. For example, for some regional seas the proportion of countries bordering the sea  
302 that are MSs (and obligated under the MSFD) is low and/or in other cases, the natural conditions  
303 within a region may require targets for GES that are less ambitious.

304 For other descriptors (e.g. NIS, Commercial Fish and Shellfish, Marine Litter) existing measures are  
305 clearly not sufficient in any of Europe's regional seas. The recent consultation on the Common  
306 Fisheries Policy [22] (CFP) reflects the widespread understanding that fisheries management in  
307 Europe must change if we are to support sustainable fisheries. Irrespective of the level of  
308 implementation, it is likely that MSs will still be required to assess their own stocks and need to

309 reduce the number of species that are overexploited. Measures required to improve status will  
310 certainly require international coordination and agreements to be effective. For example, the  
311 Convention on Biological Diversity (CBD) has recently provided guidance for some descriptors, such  
312 as NIS by the major sources and pathways of introduction and suggesting that stricter reduction  
313 measures should be introduced [23].

314

### 315 *Conclusions*

316 Key elements of the MSFD include the need for a knowledge-based approach driven initially by what  
317 we already know [24] and the need for co-ordinated efforts within and between regional seas [4, 5, 8,  
318 9]. Given the current global economic downturn it is likely that MSs will first look to existing data  
319 gathering exercises to support the MSFD. This is reflected in the approach taken by several member  
320 states (e.g. UK, Germany, Netherlands) who have begun to develop targets and indicators based on  
321 outcomes of existing monitoring programmes and regional assessments [25]. The results presented  
322 here are a first attempt to take the existing status and trends assessments to assess risk to GES using a  
323 transparent and consistent risk based approach. Our experience of applying this approach across  
324 Europe's regional seas supports the need for a common tool if the results from the initial assessments  
325 are to be in any way comparable.

326 This first look at regional priorities identified five high risk issues common across regional seas, and  
327 several other areas where there is high risk in particular regional seas. This supports existing  
328 suggestions that joined up, cross regional work on the development of objectives, targets, monitoring  
329 programmes and management should be undertaken [5]. High risk outcomes also provide an initial  
330 prioritization of management measures and in association with tools such as Management Strategy  
331 Evaluation (MSE; e.g. [26]) and Cost Benefit Analysis (CBA; e.g. [27]), measures that confer the  
332 greatest benefits in terms of environmental, socio-cultural and economic status can be identified. Our  
333 analyses suggest the need for a pragmatic approach which links descriptors so that the introduction of

334 management measures could lead to multiple gains in terms of the environmental, social and  
1  
2 335 economic benefits while increasing the likelihood of GES being achieved in Europe's regional seas.  
3  
4

5 336  
6  
7

### 8 337 **Acknowledgements** 9

10  
11 338 This work is funded by and is part of the ongoing research within the EU FP7 programme 'Options  
12  
13 339 for Delivering Ecosystem Based Marine Management' (ODEMM; grant number: 244273;  
14  
15 340 [www.liv.ac.uk/odemmm](http://www.liv.ac.uk/odemmm)). Matched funds are provided to Cefas by DEFRA project number E5405.  
16  
17  
18

19 341  
20  
21

### 22 342 **References** 23 24

- 25 343 [1] Curtin R, Prellezo R. Understanding marine ecosystem based management: A literature review.  
26 344 Marine Policy. 2010;34:821-30.  
27 345 [2] Rosenberg A, Sandifer P. What do Managers Need? Ecosystem-Based Management for the  
28 346 Oceans. Washington DC: Island Press; 2009.  
29 347 [3] Ruckelshaus M, Klinger T, Knowlton N, DeMaster DP. Marine Ecosystem-based Management in  
30 348 Practice: Scientific and Governance Challenges. BioScience. 2008;58:53-63.  
31 349 [4] EC. DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL  
32 350 of 17 June 2008 establishing a framework for community action in the field of marine environmental  
33 351 policy (Marine Strategy Framework Directive). 2008.  
34 352 [5] Borja A, Elliott M, Carstensen J, Heiskanen AS, van de Bund W. Marine management - Towards  
35 353 an integrated implementation of the European Marine Strategy Framework and the Water Framework  
36 354 Directives. Marine Pollution Bulletin. 2010;60:2175-86.  
37 355 [6] Foden J, Rogers SI, Jones AP. A critical review of approaches to aquatic environmental  
38 356 assessment. Marine Pollution Bulletin. 2008;56:1825-33.  
39 357 [7] OSPAR. Quality Status Report 2010. London OSPAR Commission; 2010.  
40 358 [8] Piha H, Zampoukas N. Review of Methodological Standards Related to the Marine Strategy  
41 359 Framework Directive Criteria on Good Environmental Status. European Commission Joint Research  
42 360 Centre. Institute for Environment and Sustainability; 2010.  
43 361 [9] EC. Commission Decision of 1 September 2010 on criteria and methodological standards on good  
44 362 environmental status of marine waters. Brussels: European Commission 2010/477/EU; 2010.  
45 363 [10] Cardoso AC, Cochrane S, Doerner H, Ferreira JG, Galgani F, Hagebro C, et al. SCIENTIFIC  
46 364 SUPPORT TO THE EUROPEAN COMMISSION ON THE MARINE STRATEGY FRAMEWORK  
47 365 DIRECTIVE Management Group Report. 2010.  
48 366 [11] Robinson LA, Rogers SI, Frid CLJ. A marine assessment and monitoring framework for  
49 367 application by UKMMAS and OSPAR - Assessment of Pressures. Contract No: F90-01-1075 for the  
50 368 Joint Nature Conservation Committee: University of Liverpool, Liverpool and Centre for the  
51 369 Environment, Fisheries and Aquaculture Science, Lowestoft; 2008. p. 108.  
52 370 [12] IUCN. The IUCN Red List of Threatened Species. 2011.  
53 371 [13] EC. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008  
54 372 establishing a framework for community action in the field of marine environmental policy (Marine  
55 373 Strategy Framework Directive). Official Journal of the European Union 2008. p. 19-40.  
56 374 [14] DEFRA. Charting Progress 2: The state of UK Seas. London DEFRA; 2010. p. pp. 194.  
57  
58  
59  
60  
61  
62  
63  
64  
65



375 [15] BSC. Marine Litter in the Black Sea Region. Istanbul: Black Sea Commission; 2009.

1 376 [16] DAISIE. Handbook of Alien Species in Europe 2009.

2 377 [17] Greenstreet SPR, Rogers SI. Indicators of the health of the North Sea fish community:

3 378 identifying reference levels for an ecosystem approach to management. ICES Journal of Marine

4 379 Science: Journal du Conseil. 2006;63:573-93.

5 380 [18] BSC. Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea.

6 381 Sofia: Black Sea Commission; 2009.

7 382 [19] HELCOM. HELCOM Baltic Sea Action Plan. Krakow: HELCOM; 2007.

8 383 [20] IUCN. IUCN Red List Categories and Criteria version 3.1. IUCN; 2001. p. ii +30 pp.

9 384 [21] Koss R. in prep.

10 385 [22] EC. European Commission: a fisheries policy for the future In: Commission E, editor. 2011.

11 386 [23] CBD. Aichi Biodiversity Targets. 2011.

12 387 [24] Borja A. The new European Marine Strategy Directive: Difficulties, opportunities, and

13 388 challenges. Marine Pollution Bulletin. 2006;52:239-42.

14 389 [25] ICES.WGECO. Unpublished report. 2011.

15 390 [26] Punt A, #233, E., Smith ADM, Cui G. Evaluation of management tools for Australia's

16 391 South East Fishery. 3. Towards selecting appropriate harvest strategies. Marine and Freshwater

17 392 Research. 2002;53:645-60.

18 393 [27] Pearce D. Cost-benefit analysis and environmental policy. Oxford review of economic policy.

19 394 1998;14:84-100.

20

21

22

23 395

24

25 396

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65

397 **Tables**

398 Table 1. Results of the risk assessment for each descriptor per regional sea. Darker grey colour  
 399 indicates high risk whilst a lighter grey indicates a lower risk. High risk/confidence was scored 3,  
 400 moderate risk 2 and low risk 1. Total indicated the overall risk in assessments per region across  
 401 descriptors and per descriptor across all regions.

	NEA	MED	Baltic	Black	Total across regions
Biodiversity-Phyto-zooplankton	LM	M	M	M	7.5
Biodiversity-Fish	M	M	M	M	8
Biodiversity-Marine mammals and reptiles	LM	H	M	MH	9
Biodiversity-Seabirds	M	M	M	H	9
Biodiversity-Predominant habitat types	M	M	H	MH	9.5
Non-indigenous species	H	H	H	H	12
Fish and shellfish	H	H	H	H	12
Food webs	H	H	H	H	12
Eutrophication	M	M	H	M	9
Sea floor integrity	H	H	H	H	12
Contaminants	M	M	MH	MH	9
Contaminants in fish and shellfish	LM	L	M	M	6.5
Marine litter	H	H	H	H	12
Underwater noise	H	H	MH	H	11.5
<b>Total score</b>	<b>32.5</b>	<b>34</b>	<b>36</b>	<b>36.5</b>	

402 **Risk**

High H  
 Moderate-high MH  
 Moderate M  
 Low-moderate LM  
 Low L

403 Table 2. Results of the confidence assessment for each descriptor per regional sea. Darker grey colour  
 1  
 2 404 indicates higher confidence in the risk assessment whilst a lighter grey colour indicates a lower  
 3  
 4 405 confidence in the risk assessment.  
 5  
 6

	NEA	MED	Baltic	Black
Biodiversity-Phyto-zooplankton	LM	M	M	M
Biodiversity-Fish	MH	M	H	M
Biodiversity-Marine mammals and reptiles	L	H	H	H
Biodiversity-Seabirds	M	M	H	H
Biodiversity-Predominant habitat types	L	M	H	M
Non-indigenous species	MH	H	H	H
Fish and shellfish	H	M	MH	M
Food webs	M	M	H	M
Eutrophication	H	H	H	H
Sea floor integrity	M	M	M	M
Contaminants	H	H	H	H
Contaminants in fish and shellfish	L	M	MH	LM
Marine litter	LM	H	M	M
Underwater noise	H	M	M	M

29 406

31  
 32 **Confidence**

33 High H  
 34 Moderate-high MH  
 35 Moderate M  
 36 Low-moderate LM  
 37 Low L  
 38  
 39  
 40  
 41  
 42  
 43  
 44  
 45  
 46  
 47  
 48  
 49  
 50  
 51  
 52  
 53  
 54  
 55  
 56  
 57  
 58  
 59  
 60  
 61  
 62  
 63  
 64  
 65

407 Figure 1

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

408 Figure 1. The four European regional seas included in the Marine Strategy Framework Directive.

409 **Appendix A**

1  
2  
3 410 Descriptor 1. Biological diversity is maintained. The quality and occurrence of habitats and the  
4  
5 411 distribution and abundance of species are in line with prevailing physiographic, geographic and  
6  
7 412 climatic conditions. (Biodiversity)  
8

9  
10 413 Descriptor 2. Non-indigenous species introduced by human activities are at levels that do not  
11  
12 414 adversely alter the ecosystems. (Non-Indigenous Species)  
13

14 415 Descriptor 3. Populations of all commercially exploited fish and shellfish are within safe  
15  
16 416 biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.  
17  
18 417 (Fish and Shellfish)  
19

20  
21 418 Descriptor 4. All elements of the marine food webs, to the extent that they are known, occur at  
22  
23 419 normal abundance and diversity and levels capable of ensuring the long-term abundance of the  
24  
25 420 species and the retention of their full reproductive capacity. (Food Webs)  
26

27 421 Descriptor 5. Human-induced eutrophication is minimised, especially adverse effects thereof, such  
28  
29 422 as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in  
30  
31 423 bottom waters. (Eutrophication)  
32  
33

34 424 Descriptor 6. Sea-floor integrity is at a level that ensures that the structure and functions of the  
35  
36 425 ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. (Sea-  
37  
38 426 floor integrity)  
39

40  
41 427 Descriptor 7. Permanent alteration of hydrographical conditions does not adversely affect marine  
42  
43 428 ecosystems. (Hydrographical Conditions)  
44

45 429 Descriptor 8. Concentrations of contaminants are at levels not giving rise to pollution effects.  
46  
47 430 (Contaminants)  
48

49  
50 431 Descriptor 9. Contaminants in fish and other seafood for human consumption do not exceed levels  
51  
52 432 established by Community legislation or other relevant standards. (Contaminants in Fish and  
53  
54 433 Shellfish)  
55

56 434 Descriptor 10. Properties and quantities of marine litter do not cause harm to the coastal and marine  
57  
58 435 environment. (Marine Litter)  
59  
60  
61

436 Descriptor 11. Introduction of energy, including underwater noise, is at levels that do not adversely  
1  
2 437 affect the marine environment. (Underwater Noise)  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

438 **Appendix B**

439 Descriptor 1: Biodiversity

440 Good status is achieved when biodiversity is maintained in the regional sea such that the quality and  
 441 occurrence of habitats and the distribution and abundance of species are in line with prevailing  
 442 physiographic, geographic and climatic conditions. Failure of GES is defined to occur where there is  
 443 loss of biodiversity beyond that expected under prevailing conditions before 2020. Loss of  
 444 biodiversity can be described as occurring where there is a reduction in genetic, species, habitat or  
 445 ecosystem diversity within the regional sea over this time scale. More specifically loss of particular  
 446 meta-populations, species, habitat types or ecosystem properties within the region (e.g. extirpations)  
 447 would certainly count as a loss of biodiversity, but so could a noticeable change in diversity based on  
 448 changes in evenness (e.g. shifts in dominance). However, both of these cases would need to be a  
 449 loss/change beyond that expected under prevailing conditions. GES under Biodiversity should be  
 450 assessed individually for each of the major ecosystem characteristics listed in Annex iii of the MSFD  
 451 as recommended in the Commission decision. Consideration should be given separately to listed  
 452 species and habitats under the Habitats Directive. Consistency should be checked against the level of  
 453 risk identified for other relevant Descriptors (e.g. seafloor integrity for the aspects of habitats-  
 454 ecosystem level diversity).

455 Table B.1 Risk categories for Biodiversity

High (3)	Continued decline in a genotype, species, habitat or ecosystem type at the regional scale (decline in biodiversity) to the extent that there is a high likelihood of its loss from the region (= extirpation) within the next 10 years <i>and/or</i>
	Maintained change in the dominance of genotypes, species, habitat types or ecosystem types (change in evenness) where this change is likely to last for at least the next 10 years
Moderate (2)	New or further decline in extent and/or condition of genotypes, species, habitat types or ecosystem types at the regional scale within the next 10 years <i>and/or</i>

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

---

	Alterations in the dominance of genotypes, species, habitat types or ecosystem types (change in evenness) within the next 10 years, not necessarily having led to a maintained change
Low (1)	No notable changes in extent and condition of genotypes, species, habitat types or ecosystems at the scale of the region beyond that expected given prevailing conditions within the next 10 years  <i>and</i>  No clear change in dominance of genotypes, species, habitat types or ecosystem types (change in evenness) given prevailing conditions within the next 10 years

---

456

457 Descriptor 2: Non-indigenous species introduced by man

458 GES for Non-indigenous species (NIS) is a function of their relative abundances and distribution

459 ranges, and environmental impact. These may vary from low abundances in one locality with no

460 measurable adverse effects, up to occurrence in high numbers in many localities resulting in

461 significant impacts. Good status will be maintained when significant adverse effects on

462 environmental quality from NIS are avoided, including no elimination or extinction of sensitive

463 and/or rare populations, alteration of native communities, seasonal dominance of algal blooms,

464 alteration of water chemistry (oxygen, nutrient content, pH and transparency) or accumulation of

465 synthetic pollutants. Invasive NIS are a subset of established NIS which have spread, are spreading or

466 have demonstrated their potential to spread elsewhere and have an adverse effect on environmental

467 quality. Therefore it is invasive NIS that are of most concern in terms of posing a risk to GES.

468 Table B.2 Risk categories for NIS

---

High (3)	High abundance and increasing trends in abundance of established invasive NIS in many sub-regions  <i>and/or</i>  High numbers of invasive NIS in many sub-regions.  <i>and</i>  Clear evidence of significant adverse effects on environmental quality in those sub-regions
----------	--

---



---

Moderate (2)      High abundance of some established invasive NIS in some sub-regions  
or generally increasing trends in abundance in some areas.

*and/or*

High numbers of invasive NIS in some sub-regions

*and*

Evidence of adverse effects at species, habitat or ecosystem level but  
only in some sub regions

---

Low (1)      Low abundance of established invasive NIS in the region with no  
apparent increasing trends.

*and/or*

Low numbers of invasive NIS

*and*

No evidence of adverse effects at species, habitat or ecosystem level

---

469

470      Descriptor 3: Commercial Fish and shellfish

471      GES for commercially exploited fish and shellfish will be achieved when stocks are sustainably  
472      exploited consistently with high long-term yields and have full reproductive capacity. To achieve  
473      GES it will also be necessary, in addition to sustainably exploited stocks at full reproductive capacity,  
474      for the age and size distribution of fish and shellfish populations to be representative of a healthy  
475      stock, assessed by reference to the proportion of older and larger fish in the population. GES is  
476      achieved for a particular stock only if criteria for all attributes are fulfilled.

477      Table B.3 Risk categories for commercially exploited fish and shellfish

---

High (3)      SSB < SSBpa for some stocks

*and/or*

exploitation rate F exceeds precautionary levels for some (>25%) stocks

*and/or*

the age and size distribution of fish and shellfish stocks shows  
consistent long-term degradation. i.e. smaller, younger fish.

---

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

---

Moderate (2)      25% stocks are exploited sustainably ( $F < F_{MSY}$ )  
*and/or*  
all stocks  $SSB > SSB_{pa}$

---

Low (1)

All stocks are exploited sustainably ( $F < F_{MSY}$ )  
*and/or*  
 $SSB > SSB_{MSY}$  for >50% of stocks  
*and/or*  
all stocks  $SSB > SSB_{pa}$   
*and/or*  
the age and size distribution of fish and shellfish stocks show no degradation. i.e. smaller, younger fish.

---

478

479 Descriptor 4: Food webs

480 The interactions between species in a food web are complex and constantly changing, making it  
481 difficult to identify one condition that represents ‘good’ status. However, some changes in species’  
482 relative abundance in an ecosystem can have significant adverse effects on food web status. Good  
483 Environmental Status of Food Webs will be achieved when energy flows through the food web, and  
484 the size, abundance and distribution of key trophic groups/species, are all within acceptable ranges  
485 that will secure the long-term viability of all food web components in line with prevailing natural  
486 conditions.

487 Table B.4 Risk categories for food webs

---

High (3)      Spatially extensive and long-term changes have occurred in energy flows

---

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

---

	through the food web, as recorded by changes in the productivity (production per unit biomass) of several key species or trophic groups, which have both direct and indirect effects on different trophic levels.
	<i>and/or</i>
	Trends in the abundance and distribution of carefully selected indicator populations, and in the proportion of species at the top of food webs, show continuous decline across the Region and provide evidence of adverse impacts on food web integrity.
	<hr/>
Moderate (2)	Recent changes in the productivity (production per unit biomass) of some key species or trophic groups suggest that direct and indirect effects have occurred on different trophic levels.
	<i>and/or</i>
	Trends in the abundance and distribution of local indicator populations, and in the proportion of species at the top of food webs, suggest that adverse impacts to food web structure have occurred in some sub-regions.
	<hr/>
Low (1)	Recorded changes in energy flows through the food web, as recorded by changes in the productivity (production per unit biomass) of key species or trophic groups, have no significant direct and indirect effects on different trophic levels.
	<i>and/or</i>
	Trends in the abundance and distribution of carefully selected indicator populations, and in the proportion of species at the top of food webs, vary in accordance with natural cycles and show no cause for concern in relation to food web structure.
	<hr/>

488

489 Descriptor 5: Eutrophication

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

495

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

496 Table B.5 Risk categories for Eutrophication

High (3)	Undesirable disturbance* caused by eutrophication is widespread (even or patchy) and frequent in the region (> once a year)
Moderate (2)	Undesirable disturbance* caused by eutrophication is widespread but rare in the region (< once a year)
	<i>And/or</i>
	Undesirable disturbance* caused by eutrophication only occurs at a site or local scale in the region, but it occurs at least once a year
Low (1)	Undesirable disturbance* caused by eutrophication does not occur in the region, or where it does occur it only occurs rarely (<once a year) and on a very local scale (site or local patchy)

497

498 \*Undesirable disturbance includes one or more of the following: harmful algal blooms, low dissolved  
499 oxygen, associated declines in perennial seaweeds or seagrasses, kills of benthos and fish, dominance  
500 by opportunistic macroalgae

501

502 Descriptor 6: Sea-floor integrity

503 GES is achieved where seafloor integrity is at a level that ensures that the structures and functions of  
504 the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. “Sea  
505 Floor” includes both the physical structure and biotic composition of the benthic community.  
506 “Integrity” includes the characteristic functioning of natural ecosystem processes and spatial  
507 connectedness. “Not adversely affected” is interpreted as meaning that impacts may be occurring, but  
508 at a level where natural levels of diversity, productivity, and dynamic ecosystem processes are not  
509 degraded

510 Seafloor integrity will be assessed here for the broad predominant habitat types only where the

511 assessment will be based on the outcomes of the pressure assessment undertaken in ODEMM and any

512 other useful information on status/trends at the broad habitat level. Thus the integrity of the seafloor is

513 assessed in terms of the extent of damage caused by the various human activities that interact with it.

514 This is done indirectly through a pressure assessment.

515 The habitats listed under the Habitats Directive will be assessed against the FCS criteria of the

516 Habitats Directive (listed after the MSFD descriptors). If they are achieving FCS they will also be

517 meeting the criteria for GES for seafloor integrity. If they are failing against the FCS criteria that in

518 itself identifies a regional mismatch to the relevant HLO.

519 Table B.6 Risk categories for Sea-floor integrity

---

High (3) Where the pressures and habitats overlap:

1. Extent is widespread (even or patchy), severity is acute or chronic and the persistence of the pressure is high or continuous, irrespective of frequency of occurrence

*and/or*

2. Extent is widespread (even or patchy), severity is acute and the frequency of occurrence is occasional or higher, irrespective of Persistence category

*and/or*

3. Extent is widespread (even or patchy), severity is chronic and the frequency is persistent or common, irrespective of Persistence category

*and/or*

4. A combination of multiple local pressures which result in a widespread extent with a severity, frequency and persistence combination equivalent to one of the above

*and/or*

5. The overlap of multiple low severity pressures which combine to form a severe (acute or chronic) impact combination equivalent to one of the above

---

Moderate (2) Any combination other than high or low

---

Low (1) Where severity is classified as 'low' for all interactions with pressures in the region even when they are combined

*and/or*

---

---

Where any severe effects (chronic or acute) occur and frequency of occurrence is rare, persistence of the pressure is low, and resilience of the habitat is high

---

1  
2  
3  
4  
5 520

6  
7 521 Descriptor 8: Contaminants in the environment

8  
9 522 Assessment of whether concentrations of contaminants are at levels not giving rise to pollution effects

10  
11 523 should be based on monitoring programmes for chemical contaminants, and on biological

12  
13 524 measurements relating to the effects of pollutants on marine organisms in each of the assessment

14  
15 525 regions. GES will therefore be achieved when concentrations of contaminants in water, sediment and

16  
17 526 biota are below assessment thresholds identified on the basis of toxicological data; pollution levels are

18  
19 527 below assessment thresholds representing harm at organism, population, community and ecosystem

20  
21 528 levels; and trends in concentrations of contaminants in water, sediment and biota, and the occurrence

22  
23 529 and severity of pollution effects, are within acceptable limits and declining.

24  
25 530

26  
27 531 Table B.7 Risk categories for contaminants in the environment

---

33 34 35 36 37 38 39 40 41 42 43 44	High (3)	Concentrations of all contaminants in biota, sediments and water exceed the relevant Environmental Quality Standards over extensive areas of the Region.
--	----------	--

*and/or*

Significant impacts on and risk to the marine environment have recently been shown by the occurrence and extent of pollution effects throughout the Region.

---

45 46 47 48 49 50 51 52 53 54 55 56	Moderate (2)	Concentrations of some contaminants in biota, sediments and water exceed the relevant Environmental Quality Standards in some sub-regions of the Region.
--	--------------	--

*and/or*

Impacts on and risk to the marine environment have recently been shown by the occurrence and extent of pollution effects in sub-regions.

---

57 58 59 60 61	Low (1)	Concentrations of contaminants in biota, sediments and water do not exceed the relevant Environmental Quality Standards established for the
----------------------------	---------	---

---

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

---

Region.

*and/or*

The occurrence and extent of pollution effects throughout the Region indicate no significant impacts on or risk to the marine environment

---

532

533 Descriptor 9: Contaminants in fish and shellfish

534 A number of contaminants in the marine environment giving rise to concern both from an  
535 environmental and public health point of view have been selected. Regulatory levels have been laid  
536 down for lead, cadmium, mercury, polycyclic aromatic hydrocarbons, dioxins & dioxin-like PCBs  
537 and radionuclides. Other substances of concern are arsenic, non-dioxin like PCBs, phthalates,  
538 organochlorine pesticides, organotin compounds, brominated flame retardants and polyfluorinated  
539 compounds. Good Environmental Status (GES) would be achieved if all contaminants are at levels  
540 below the levels established for human consumption or showing a downward trend (for the substances  
541 for which monitoring is ongoing but for which levels have not yet been set). However, it is generally  
542 felt that GES for descriptor 9 must be judged in view of the monitoring of descriptor 8, also dealing  
543 with contaminants in the marine environment.

544 Table B.8 Risk categories for contaminants in fish and shellfish

---

High (3)	Many contaminants in edible tissues are currently exceeding regulatory limits in some areas of the Region
	<i>and/or</i>
	Regulatory levels of one or more contaminants in edible tissues are being exceeded on a regular basis in large areas of the Region.
Moderate (2)	Some contaminants in edible tissues are currently exceeding regulatory limits in some areas of the Region.
	<i>and/or</i>
	Regulatory levels of one or more contaminants in edible tissues are being exceeded occasionally in large areas of the Region.
Low (1)	Levels of contaminants in edible tissues do not currently exceed regulatory limits anywhere in the Region.

---

---

*or*

Regulatory levels are rarely exceeded in large areas of the Region.

---

1  
2  
3  
4  
5 545

6  
7 546 Descriptor 10: Marine litter

8  
9  
10 547 GES occurs when the properties and quantities of marine litter do not cause harm to the coastal and

11  
12 548 marine environment. This can be achieved through a measurable and significant decrease in

13  
14 549 comparison with the baseline (i.e. the situation up until 2012) in the total amount of marine litter by

15  
16 550 2020 using as attributes the characteristics of litter in the marine and coastal environment and the

17  
18 551 impacts of litter on marine life. In addition, it is possible to use information from the ODEMM

19  
20  
21 552 pressure assessments on the the intertidal habitats for criterion 1 and the pelagic water column habitat

22  
23 553 for criterion 2 in all risk categories below. The information in the pressure assessment can be used to

24  
25 554 summarise the spatial extent and frequency of any activities adding marine litter to the environment,

26  
27 555 since marine litter is one of the pressure categories used. Any additional information on the future

28  
29 556 trends in activity for the major sectors contributing litter can also be used to ascertain whether the

30  
31  
32 557 extent of marine litter currently recorded in the pressure assessment is likely to change in the future.

33  
34  
35 558 Table B.9 Risk categories from Marine Litter

---

High (3)	Unchanged or increasing trend in the amount of litter washed ashore and / or deposited on coastlines over widespread areas (patchy distribution within this fine) of the region.
----------	--

37  
38  
39  
40  
41  
42  
43  
44  
45 *and/or*

46  
47 Unchanged or increasing trend in the amount of litter in the water column  
48 over widespread areas of the region.

49  
50  
51 *and/or*

52  
53 Unchanged or increasing trend of micro particles over widespread areas of  
54 the region

55  
56  
57 *and/or*

58  
59 Unchanged or increasing trend in litter ingested by large numbers of marine

---



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

---

	animals in the region
Moderate (2)	Unchanged or increasing trend in the amount of litter washed ashore and / or deposited at coastlines in some sub-regions
	<i>and/or</i>
	Unchanged or increasing trend in the amount of litter in the water column in some sub regions
	<i>and/or</i>
	Unchanged or increasing trend of micro particles in some sub regions
	<i>and/or</i>
	Unchanged or increasing trend in litter ingested by marine animals in some sub regions
Low (1)	Decreasing trend in the amount of litter washed ashore and / or deposited at coastlines over extensive areas of the region
	<i>and/or</i>
	Decreasing trend in the amount of litter in the water column over extensive areas of the region.
	<i>and/or</i>
	Decreasing trend of micro particles over extensive area of the region.
	<i>and/or</i>
	Decreasing trend in litter ingested by marine animals over extensive areas of the region.

---

559

560 Descriptor 11: Underwater noise  
561 In relation to underwater noise, GES would occur when there is no adverse effect of noise inputs on  
562 any component of the environment. However such an objective is probably not achievable or  
563 measurable. Therefore indicators for environmental status have been developed that are based on  
564 pressures addressing two main issues with regards to underwater noise. One is the distribution in time  
565 and place of loud, low and mid frequency impulsive sound that is mainly introduced by offshore

566 construction using pile driving (e.g. for offshore wind farms) and seismic surveys. The other is the  
 1  
 2 567 trend of continuous low frequency sound indicated mainly by shipping activity.  
 3  
 4

5 568 Table B.10 Risk categories for underwater noise  
 6  
 7

High (3)	High activity and increasing trend of offshore construction using pile driving (e.g. oil and gas platforms, offshore wind farms), seismic surveys and sonar systems, which is widespread in the region.
	<i>and/or</i>
	High activity and increasing trend of shipping (commercial and recreational) indicated by the number of tourist vessels and commercial shipping activity (number and intensity of shipping lanes) over widespread areas of the region.
Moderate (2)	High activity of offshore construction using pile driving (e.g. oil and gas platforms, offshore wind farms), seismic surveys and sonar systems in some sub regions, or an increasing trend in some areas.
	<i>and/or</i>
	High activity of shipping (commercial and recreational) indicated by the number of tourist vessels and commercial shipping activity (number and intensity of shipping lanes) in some sub regions or an increasing trend in some areas.
Low (1)	Little offshore construction works using pile driving throughout or moderate activity only in a few places (local or site under the pressure assessment) in the region.
	<i>or</i>
	Little shipping activity throughout or moderate activity only in a few places in the region (local or site).

44 569

47 570 Confidence assessment criteria:

50 571 Confidence should be assessed based only on the criteria that is listed to be used for the assessment.

51 572 Any further sources of ambiguity with regards the risk score for that descriptor should be listed in the

52 573 commentary sheet under the question about confidence. E.g. impacts of noise on the marine

53 574 environment.  
 54  
 55

56 575 Table B.11 Confidence categories  
 57

High	Good quality information is available for the majority of the criteria used for the assessment
------	--

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

---

	<i>and</i>
	Information available for that descriptor is easy to interpret in terms of the criteria
	<i>and</i>
	There is complete agreement amongst experts in the group
Moderate	Good quality information is available for some criteria used for the assessment
	<i>and/or</i>
	There is some information available for all criteria
	<i>and/or</i>
	Information that is available for that descriptor can be interpreted in terms of the criteria with expert judgement
	<i>and</i>
	There is majority agreement amongst experts within the group
Low	Information is available for few criteria used in the assessment
	<i>and/or</i>
	There were difficulties with interpretation of available information in terms of the criteria used for the assessment
	<i>and/or</i>
	The group could not reach a common agreement about the risk score

---

576

Figure 1  
[Click here to download high resolution image](#)

