Amendments to Decision 2010/477/EU

Descriptor 6: Seafloor integrity

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Key conclusions:

- The Decision 2010/477/EU D6 criteria (6.1 *Physical damage, having regard to substrate characteristics* and 6.2 *Condition of benthic communities*) are insufficient and risk compromising our ability to assess seafloor integrity.
- The present criteria should be revised into new criteria 6.1 *Functionality* and 6.2 *Recoverability* that are more closely related to resilience and recovery potential of the seafloor. This would simplify the existing Decision and may not require any additional monitoring from Member States.
- To ensure resilience of the seafloor, the reference points of indicators that are selected should best reflect the possible tipping point, i.e. the level of perturbation at which the decline of the system functionality begins to accelerate.
- Recoverability needs to be considered in the spatial context within which a disturbed area is located (i.e. connectivity between impacted and non-impacted sites in the region).
- Both sensitivity and pressures need to be considered together to evaluate overall impact. Pressure indicators alone will result in an incomplete assessment.
- Natural disturbances occur on the seafloor, and this background needs to be considered in assessments, relative to sensitivity of the seafloor habitat(s) and anthropogenic pressures.

Issues to be further developed:

- Scientific guidance will be required in prioritizing functions to be assessed under each criteria, as well as choosing indicators and establishing GES boundaries for seafloor integrity (with reference points and targets). This will be required in any potential revisions of Decision 2010/477/EU and in its implementation by Regional Sea Conventions (RSCs) and Member States.
- A substantial body of scientific knowledge that can serve as the basis for this guidance has already been consolidated in the ICES WKMSFD Report 2014 and ICES/JRC 2010 Task Group 6 report. Appropriate experts building on this foundation can make rapid progress on finalizing the necessary guidance.

Annex I

Possible approach to amend Decision 2010/477/EU

Outline example for D 6

Title of Descriptor

Good environmental status (GES) for Descriptor 6, *"Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected"*

Approach

Definition relevant to the Descriptor

Seafloor is defined as a key compartment for marine life. It includes both the physical and chemical parameters of seabed (e.g. bathymetry, roughness (rugosity), substratum type, oxygen supply, etc.) as well as the biotic composition of the benthic community. Different kinds of habitats for sedentary and mobile marine species are formed inside and above the seabed.

Integrity is interpreted as including both (i) natural spatial connectivity (avoiding unnatural habitat fragmentation or connectivity), and natural ecosystem processes functioning in their characteristic ways.

Not adversely affected means that the cumulative effect of pressures associated with human activity are at a level that ensures the ecosystem maintains its respective components (structure) along with its natural levels of diversity, productivity, and dynamic ecological processes (functioning). Levels of disturbance (intensity, frequency, and spatial extent) must be at a level that ensures dynamic recovery potential is maintained.

Recovery means that the impacted seafloor attributes show a clear trend towards their pre-perturbation conditions, and the trend is expected to continue (if pressures continue to be managed) until the attributes lie within their range of historical natural variation. Benthic communities are not static entities, and thus recovery does not require that the ecosystem attributes return to their exact prior state.

Rapid must be interpreted in the context of the life histories of the species and natural rates of change in the community properties being perturbed. For some seafloor habitats and communities, recovery dynamics from perturbation would require multiple decades or more, and in such cases management should strive to prevent perturbations.

Impairment of an ecological component occurs if the negative ecological consequences of the direct or indirect perturbations extend widely through the ecosystem in space and/or time, or if the normal ecological linkages among species act to extend and amplify the effects of a perturbation rather than to dampen its effects.

Important considerations

The functions benthic organisms collectively provide across the seafloor maintain many goods and services upon which society depends. A key to defining whether or not overall "good environmental status" (GES) has been achieved for D6 is if habitat/environmental heterogeneity is maintained, allowing representative species to also maintain viable populations across a region. Habitat heterogeneity is necessary for representative community types to be maintained in a region (beta diversity) and with subsequent dispersal (larval, post-larval, and adults) over relatively shorter distances can promote rapid and secure recovery (source-sink dynamics) when natural or anthropogenic disturbances impact specific sub-populations in the region.

Community composition(s) and the importance of scale

As discussed in the 2010 ICES/JCR D6 Task Group report, delineating scales for assessing GES of the seafloor is particularly challenging because:

- Benthic ecosystem features are patchy on many scales.
- A wide range of human activities inducing pressures on the seafloor operate also at patchy spatial scales.
- Direct and indirect ecological consequences of human activities may be spread out considerably by physical and biotic processes although initial impacts are often local and patchy.
- Monitoring of the seafloor is also patchy and often local.

Moreover, the patchiness due to underlying ecological processes, environmental conditions, dispersal potential, and anthropogenic pressures varies among systems and can occur on multiple scales, further complicating the choice of appropriate scales for assessment of GES.

There are no points of significant disagreement among experts regarding key terms or what constitutes gradients of degradation in environmental status. When assessing GES for D6, however, the integration of results from local scales (where both natural benthic ecosystems and pressures may be very patchy) to broader (sub-)regional scales will be required. Although it might be possible to integrate indicators for individual attributes on a local scale, this is considerably more challenging across attributes and scales. No single scale will be the "right" one and logically indicators for D6 and their reference levels will also vary across the scale being considered. Expert assessments will be required for evaluating GES of seafloor integrity. Therefore, developing a single algorithm to combine indicator values will be inappropriate for an evaluation of GES or to provide a meaningful index of GES for seafloor integrity.

Linkages with existing relevant EU legal requirements, standards, and limit values

Seafloor integrity is a relatively new concept, as described in the Directive, but it encompasses aspects of the physical attributes and the functioning of seabed habitats and communities that have a long history of scientific study and environmental assessment, e.g. in the Water Framework Directive (WFD) and the Habitats Directive[1]. Indeed, an OSPAR group concluded that the overall concepts applied in the WFD and Habitats Directives of defining good environmental status as target values relative to defined baselines are suitable for the *Biodiversity* descriptor in the MSFD[2]. In general, as identified by JRC (In-Depth Assessment, 2014), the Habitats Directive, Birds Directive, and the Water Framework Directive do not explicitly define biodiversity and it is stressed here that Seafloor Integrity includes much more than just biodiversity. Finally, special habitats are covered by a range of protected area instruments, i.e. Natura 2000 sites, Sites of Special Scientific Interest, and Ramsar sites; however, seafloor integrity must

[1] Commission Staff Working Document on the first steps in the implementation of the MSFD - Assessment in accordance with Article 12, 2014.

[2] OSPAR's MSFD Advice Manual on Biodiversity, 2010.

be achieved for widespread or moderately resilient habitats, not just special (usually highly sensitive) ones.

Linkages with international and RSC norms and standards

In its In-depth Assessment (2014), JRC states that: "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".

In **HELCOM's** CORESET II project national experts are nominated as Task Managers to single indicators, for example relating to biodiversity and seabed habitats (including associated communities). Within this on-going process the project has developed a suite of indicators which will form the core of the commonly agreed indicators among the HELCOM Contracting Parties. CORESET II also allows for development of pre-core and candidate indicators relevant for D6. Both state- and pressure-indicators are under development, and the work will build on relevant previous HELCOM products such as the reports from the HELCOM Red List project where a biotope classification was developed and threatened biotopes were identified. In the HELCOM Red List projects, an attempt has also been made to create a hierarchical classification scheme with numeric split rules, to also provide the classification as a tool for mapping and modelling purposes.

The **OSPAR** Ecological Quality Objectives for threatened and/or declining habitats (EcoQOs) identifies a series of seabed habitats and associated communities which are threatened and/or declining and can contribute to the implementation of D6 of the MSFD. The OSPAR List of Threatened and/or Declining Species and Habitats was adopted in 2004, further updated in 2008 (OSPAR, 2008), and now includes 16 habitat types. Development of a set of common biodiversity indicators by OSPAR includes a number related to assessing seabed habitat quality and one assessing the spatial extent of damage from human activities. Six indicators pertaining to D6 are included in the OSPAR list of common indicators: BH1 Typical species composition, BH2 Multi-metric indices, BH3 Physical damage of predominant and special habitats, BH4 Area of habitat loss, BH5 Size-frequency distribution of bivalve or other sensitive/indicator species, and PH1 Changes of plankton functional types (life form) index ratio. They encompass several biodiversity components, from phytoplankton, zooplankton, angiosperms, and macroalgae to benthic invertebrates. However, not all of these indicators are operational yet.

The **Black Sea** and **Barcelona Conventions** have either not agreed or have just started a process to agree on indicators; the indicators are therefore not yet operational.

The **Barcelona Convention** Ecosystem Approach (EcAp), adopted by this RSC's Contracting parties, will gradually implement the ecosystem approach to the management of human activities in the Mediterranean, aiming to attain "A healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations" by May 2015. Indicators and monitoring programmes to support the 11 ecological objectives (EOs) of EcAp, including biodiversity objectives similar to those of MSFD, are currently being developed. A list of habitats and species has been proposed (not public yet) for priority monitoring and assessment in relation to EO 1 (equivalent to MSFD D1). These are likely to influence also monitoring priorities under D6, since this RSC is trying to establish some compromise between EU MS MSFD minimum obligations and the objectives of non-EU contracting parties. Biodiversity descriptors, EO 6 included, will also be discussed considering EO 3 (i.e., MSFD D3) in order to address links between fisheries and biodiversity monitoring needs.

To the extent that these international and RSC norms and standards focus on special, usually highly sensitive habitats, or solely on biodiversity rather than ecological functions provided by all aspects of the seafloor substrate and biota, they would be an incomplete basis for evaluating seafloor integrity.

Definition of GES

The Decision 2010/477/EU D6 criteria are insufficient and risk compromising our ability to assess seafloor integrity (6.1 *Physical damage, having regard to substrate characteristics* and 6.2 *Condition of benthic communities*). It is proposed that those two D6 criteria be revised into the two new criteria 6.1 *Functionality* and 6.2 *Recoverability* (see below) that can provide significant advantages in the form of a closer relation to the important aspects of resilience and recovery potential of the seafloor and as a simplification of the existing decision.

Criterion 6.1
Functionality

- **Definition at GES: The physical substrate and biotic community are in a condition where the various major ecosystem functions serv[illegible] the seafloor are within their historical range [illegible]tural variability.**
- *Example: a quantitative or trend-based indicator of abundance /biomass of a regional-specific bioengineer, important for functioning.*
- To ensure resilience of the seafloor, the reference points of indicators should be selected that best reflect the possible tipping point, i.e. the level of perturbation at which the loss of system functionality begins to accelerate.
- Many suitable indicators already exist and monitoring provides adequate information for defining the GES boundary (with reference points and targets).
- If links between functionality and an indicator are thought to exist but have not been measured, reference sites for the indicators can be used.
- In a situation when an area of the seafloor is so extensively perturbed that no reference sites exist, pressure should be reduced to see if functionality increases.
- Setting reference points should be done in parallel with on-going experimental approaches that can provide feedback in defining the GES boundary.

Criterion 6.2
Recoverability

- **Definition at GES: Where anthropogenic or natural pressures have altered the structure and processes of the seafloor substrate or biotic community, the return of these ecosystems to a less perturbed status is expected to be rapid and secure when the pressure is reduced, taking into account life history aspects of the key species providing the ecosystem functions.**
- *Example: a quantitative or trend-based indicator for the percentage of an area that has been unnaturally impacted and/or fragmented.*
- Recoverability needs to be considered in the spatial context within which a disturbed area is located, taking the life histories of species into account.
- The spatial landscape of the seafloor is natural patchiness across many spatial and time scales. Thus management measures will need to also ensure that regional scale processes and patterns are maintained (i.e. manage for hetero-, not homogeneity).
- With high levels of habitat/environmental heterogeneity per unit area representative community types (turnover in community types) are more likely to occur together with connectivity or dispersal (larval, post-larval, and adults) over relatively shorter distances.
- This will also increase the likelihood that recovery is rapid when natural or anthropogenic disturbances are reduced in an area.

The proposed changes may not require any additional monitoring from Contracting Parties. However, interpretation of existing monitoring data and indicators will require a better understanding of seafloor attributes that reflect the impact of pressures on the structure, functioning. and processes of the

seafloor. In doing so, scientifically sound GES boundaries (with reference points and targets) can be identified that better reflect non-linearity in reliance and recovery (i.e. seafloor integrity, see Figure 1 below). This guidance is essential for better management of human activities, so that goods and services provided by the seafloor can both be used and secured for the future, in line with the guiding principles of the MSFD.

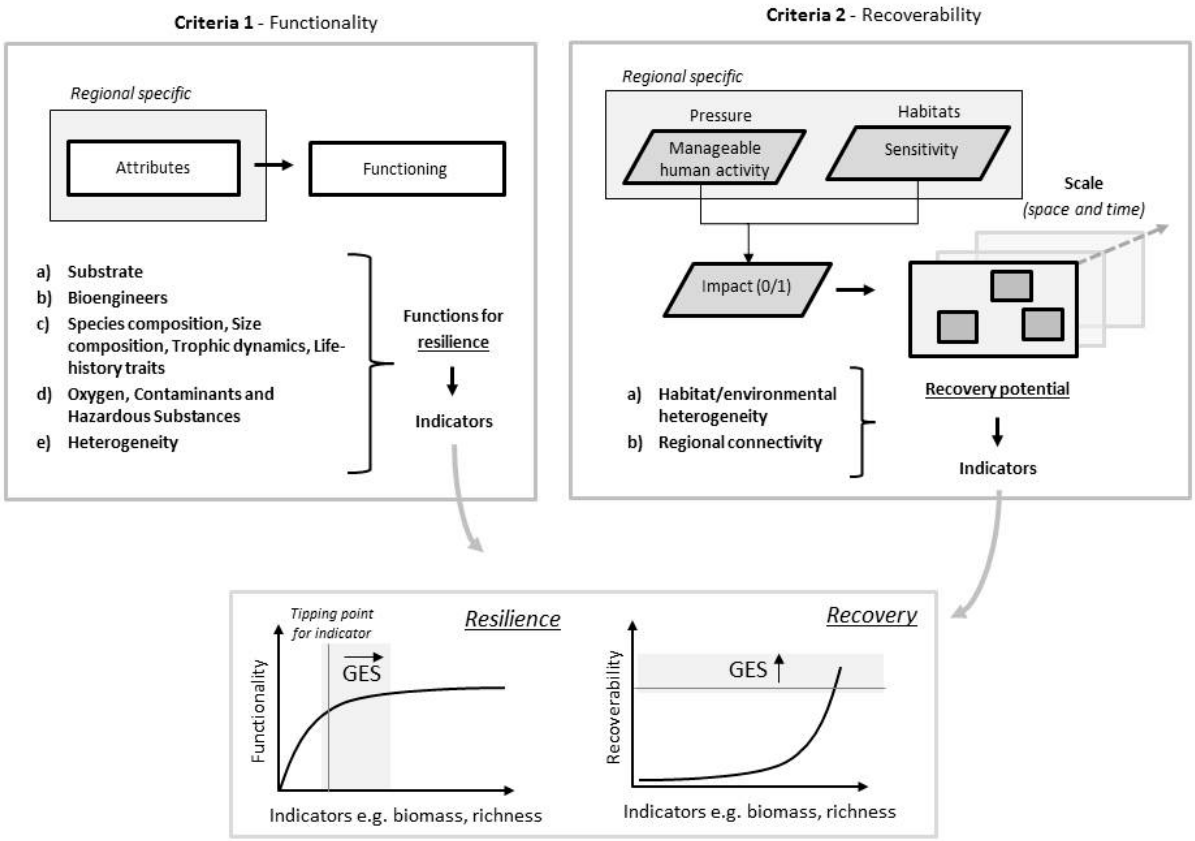

Figure 1. Conceptual diagram showing how the expert group viewed the revision of criteria to best address seafloor integrity.

The suggested new criteria *Functionality* and *Recoverability* would place the provision of ecosystem goods and services more centrally within D6. When selecting indicators and setting appropriate reference points and targets for functionality and recoverability that reflect GES for seafloor integrity D6 (Figure 1) the following seafloor attributes (see also ICES/JRC 2010 Task Group 6 report) need to be considered.

Substrate: By definition, the seafloor is at the core of the benthic ecosystem, encompassing both its abiotic and biotic components. This is particularly mentioned in the definition. In addition, substrate/substratum is linked to processes taking place in the water column, such as hydrodynamics, and may be expressed as spatial and possibly temporal variation in several components of the biological organization, from microbes to macrofauna. In addition, the natural disturbance regime must be considered as part of the process that shapes the benthic substrata and community composition.

Bioengineers: Bioengineers provide crucial functions that help ensure seafloor integrity. Bioengineers create habitat (both directly and indirectly) on which biotic communities depend. In addition, they will

influence physical processes such as deposition and re suspension rates of sediments. Bioengineering organisms should thus also be part of assessment of physical substrate.

Species composition, size composition, trophodynamics and life-history traits: There are many ways to measure species composition, size composition, and life-history traits, and the exact "taxonomy" used does not always matter that much. What does matter is our ability to interpret "integrity" so as to preserve the function and structure of the seafloor. Therefore, it is not possible to make a sound assessment of the seafloor integrity without measuring the status of the parts of the biotic component of the benthic ecosystem, or the functions served by the biota. The parts to measure are exactly those relating to the functions, and to the extent to which they may not be picked up in D1, D3, and D4 assessments. In that context, trophodynamic functions could be covered at least in part (and that part might be substantial) by D4. However, unless the indicators specifically track benthic as well as bentho-pelagic foodweb relationships, there is no assurance that benthic seafloor integrity (D6) will be assessed appropriately. Finally, recent progress in molecular biology will make it possible to develop indicators of the genetic structure of benthic species and their populations (e.g. for measuring connectivity), as well as the composition of the microbial communities in sediments.

Habitat/environmental heterogeneity and regional connectivity: An important consideration for the seafloor is habitat heterogeneity. Heterogeneity may exist at many scales and will, in combination with dispersal or connectivity, facilitate recovery following a disturbance. It should therefore be ensured that heterogeneity and connectivity are maintained in order to maintain viable populations which, in turn, facilitate the ecosystem's functions, including recovery from perturbations. However, heterogeneity-driven management may also serve to eliminate biogeographic barriers and establish unnatural connectivity in areas where it did not naturally exist. This can also facilitate range expansion of "unwanted" species (D2). "Heterogeneity and regional connectivity" is also addressed by D1 Criterion 1.4 *Habitat distribution*. However, when interpreting the criteria for assessing recoverability of the seafloor functionality the criteria become different and necessary for D6. In particular, the same proposed classes of indicators may be applied under different hypotheses in Descriptors 1 and 6 with their results being, accordingly, interpreted in a different way. As the sensitivity and specificity of any indicators of heterogeneity and connectedness are poorly known with regard to seafloor integrity, the issue can be tackled by risk assessment approaches. A description of this additional attribute is provided below:

- High habitat heterogeneity per unit area will increase the number of source locations of different species that are available within short dispersal distances from each other. This connectivity may promote higher local species richness and functional diversity. Hence heterogeneity and connectivity should be enhanced (where previously depleted) or, if already sufficient then maintained in order to keep populations viable. This will, in turn, facilitate community persistence (resilience) and recovery potential. This criterion is also key to effective Marine Spatial Planning (MSP), including the development of a coherent network of marine protected areas (MPAs); MSP and MPAs are both tools for achieving seafloor integrity.
- Several disturbances to the seafloor can either have a homogenizing (eutrophication) or heterogenizing (frequent small-scale physical damage) effect on the seafloor, directly or indirectly by changing underlying habitat/environmental conditions over large-scales. Habitat fragmentation can increase dispersal distances and thus impair source-sink dynamics and local population persistence, affecting overall recovery potential within the region and with less potential to export surplus individuals to other places that may require recruitment.

Impact: pressure and sensitivity

Natural disturbance (size, frequency, and intensity) occurs on the seafloor and the seafloor has inherent resilience. Therefore, when defining a GES boundary, impact of anthropogenic disturbances will need to be gauged. To do this pressure and state information will be required for more resilient Type 2 habitats (see below). Pressure indicators alone would give an incomplete assessment of the environmental status of these habitats. Exceptions are less resilient "special habitats" (e.g. vulnerable marine ecosystems, VMEs) for which pressure indicators can be sufficient due to their extreme/particular sensitivity (Type 1 habitats, see below).

Type 1 habitats are habitats with low resilience to human pressures and long recovery times, and which require a high level of protection. Some of the MSFD Annex III "special habitats" (defined as habitats protected under EU, regional, or national legislation) and vulnerable marine ecosystems (VMEs) are type 1 habitats, but any habitats characterized by their low resilience and long recovery times in relation to pressures are also candidates to be categorized as type 1 habitats. Once areal extent is established, either with existing *in situ* data or with habitat suitability modelling followed by targeted ground-truthing, appropriately selected pressure indicators can be used to monitor management measures and to track progress towards a GES reference point and target. For these habitats with low likelihood of rapid and secure recovery a benchmark of no impacts is implied, which is why pressure indicators alone can be used in assessing GES, particularly during the recovery phase.

Type 2 habitats are habitats with medium to high resilience and where recovery is more likely to be rapid and secure, taking into account the life histories of the dominant species. Pressure indicators alone would give incomplete assessment of environmental status of these habitats. State indicators, in particular ones that measure the natural range of variability and the possible tipping point at which the level of perturbation causes the loss of system functionality to accelerate, will add important information to the assessment of environmental status. This is because GES reference points can only be set through demonstrating non-linearities between pressures and metrics of ecosystem function (Figure 1). Consequently, pressure indicators can rarely be used without state indicators. A risk-based approach might be feasible to select type 2 habitats that are exposed to an elevated level of pressure. Meaningful and habitat-specific thresholds on level of impact (e.g. numbers of times trawled per year) would need to be set, taking resilience and recoverability into account. For risk-based models to be reliable, they will often need to be spatially resolved and appropriately stratified. This may include determining what the maximum amount of impact and/or fragmentation in an area can sustain before recoverability is compromised so that targets can be set above this boundary.

Habitats: links to other descriptors and frameworks

For habitats assessed under Functionality, some data or model-based rationale linking structure and function are needed for a conclusion on whether or not some ecosystem function(s) is (are) being degraded. This will also provide the context for how assessments of D6 may interact with assessments of other descriptors, such as D1. If no function can be identified as degrading when a species (or a group of species) abundance is declining, then the decline in abundance is a D1 issue – biodiversity is changing and D1 considerations will determine if this reduces GES. On the other hand, if the assessment concludes that a seafloor function is being degraded when a species (or species group) is declining, then this is a D6 issue even if the populations do not violate the D1 boundaries for GES.

This approach is likely to lead to GES boundaries that differ from reference points and targets for other policies, such as favourable conservation status (FCS) under the Habitats Directive. There is no inherent contradiction if the Habitats Directive sets higher standards than those set for *Recoverability* in D6, since most habitats represented in the Habitats Directive will be assessed more stringently.

Selecting indicators for *Functionality*

Once the relative risks to habitats are identified, indicators need to be selected to measure the level of their main functions that best reflect resilient communities. These can be specific to different habitat types or seafloor attributes (Table 1, below). It should be noted that many other functions exist that are not listed in Table 1, e.g. remineralization and benthic-pelagic coupling, but the primary functions for determining GES are addressed. Sets of relevant functions and associated indicators should be selected at a (sub-)regional scale. The relevant function should reflect the main functions of seafloor attributes at habitats occurring in the (sub-)region.

Table 1. Examples of functions of the seafloor, related attributes, and indicators to assess function level.

FUNCTION	SEAFLOOR ATTRIBUTE	EXAMPLE INDICATOR OF THE FUNCTION
Primary productivity	Species composition Size composition Trophodynamics Life-history traits	Remote sensing on benthic productivity (only in intertidal zone) *In situ* (subtidal)
Secondary production	Bioengineers Trophodynamics Life-history traits	Abundance/production of grazers, filter-feeders, deposit-feeders, detritivores, meiofauna Secondary production P/B ratios Growth rate
Provision of spawning area	Substrate Bioengineers Oxygen Habitat/environmental heterogeneity and regional connectivity	Occurrence/density of spawning (fish and other mobile organisms)
Provision of feeding ground	Substrate Bioengineers	Seasonal occurrence/abundance of mobile organisms
Production of food To infauna To epifauna To demersal/pelagic communities/species	Species composition Size composition Trophodynamics Life-history traits	
Energy flow Changes in functional traits	All	Abundance/biomass of dominant benthic feeding guilds Ratio of functional traits, e.g. filters/scavengers biomass ratio
Sediment reworking	Bioengineers	Bioturbation index (e.g. from video surveys) Bioengineer abundance/biomass
Sediment stabilization	Substrate Bioengineers	Abundance/ composition of bioengineer species

Provision of emergent three-dimensional structure		Area extent of three-dimensional structure
Permanent	Bioengineers	
Seasonal	Bioengineers (e.g. kelps)	Area extent of three-dimensional structure
Connectivity	Habitat/environmental heterogeneity and regional connectivity	Changes in turnover of community composition (beta-diversity) and average species richness (alpha-diversity)

Selecting indicators for *Recoverability*

Reference points and targets based on impact indicators may be used to measure the maximum amount of impact and/or fragmentation that an area can sustain before recoverability is compromised. High turnover in community composition in an area (beta diversity) can be expected if environmental conditions vary among different patches and different species are favored under different environments. Quantitative or trend-based indicators, together with average local species richness can be used to gauge changes in environmental/ habitat heterogeneity that are due to changes in disturbance regimes (frequency, spatial extent, and intensity) and that will affect the recovery potential of an area (i.e. recoverability).

The "climate sensitivity" for D6 (or criteria/indicators)

Climate change leads to changes in sea temperature and sea level as well as to ocean acidification, all of which can have an effect on seafloor integrity[3]. One potential impact is reduced pH and its effect on shell-forming organisms (calcium carbonate), such as bivalves that in turn perform important functions in the ecosystem. Furthermore, reduced exchange of nutrients between surface waters and deeper waters can reduce the growth of phytoplankton and eventually the amount of organic matter that sinks down to seafloor communities. This is expected to affect the composition, functioning, and biomass of deep-sea communities.[4] Changes in temperature / salinity regimes caused by climate change are also expected to change the distributional boundaries of individual species, and possibly thereby the ways that various ecosystem functions are delivered.

Results of the Article 12 assessment (including in-depth assessment)

Descriptor

All Member States but one who submitted a report have defined GES for Descriptor 6, with definitions applying to their entire marine waters. The definitions were formulated at descriptor level by most Member States.

Criteria

Most Member States provided additional detail at the criterion level, often with a close relationship to the Commission Decision 2010/477/EU criteria. In general, depending also on data availability, it seems that the contribution of each indicator into the implementation of MSFD differs; however, some

[3] Commission Staff Working Document on the first steps in the implementation of the MSFD - Assessment in accordance with Article 12, 2014.

[4] http://ec.europa.eu/environment/integration/research/newsalert/pdf/367na5.pdf.

Member States have not used both criteria mentioned in the Decision. Other Member States provided additional details at the indicator level, with a close relationship to the Commission Decision indicators although every Decision indicator was not always used. The definitions varied considerably in their content and level of detail; most were qualitative and many were rather vague, lacking definitions of key terms used or specificity of the seabed types to be addressed.

Decision 2010/477/EU Criterion 6.1 *Physical damage, having regard to substrate characteristics*

A majority of Member States refer to the reduction of physical pressures from human activities on the seabed, either directly or indirectly (through reference to impacts), but none provide information about which specific activities may cause pressure to the seafloor. Only four Member States included an indicator on the percentage of area occupied by biogenic substrate acted upon by human pressures but have not specified a threshold value with one exception. Three out of these four Member States also have quantified indicators for non-biogenic habitat impacted by human pressures but none of them have set a threshold yet.

Decision 2010/477/EU Criterion 6.2 *Extent of the seabed significantly affected by human activities for the different substrate types*

Across the Member States, the coverage of Criterion 6.2 on the condition of the benthic community is rather limited. In the Northeast Atlantic marine region, only one Member State has included a quantitative indicator in their GES definition, the benthic quality index (BQI), in relation to indicator 6.2.2. In the Baltic region, several Member States have used quantitative indicators in their GES definition, and in particular the BQI. In the Mediterranean, two Member States have indicated that the assessment of GES will be based on multi-metric indices, one of whom specifically refers to the WFD and good environmental status. The definitions for Criterion 6.2 from the other fourteen Member States are generally vague and only two of them make reference to the WFD good environmental status, despite the condition of the benthic community being one of the most studied and well documented aspects of biodiversity across most of Europe and one for which a number of WFD indicators could have been used.[5] None of the Member States include a discussion of how their indicators are linked to functionality in their consideration of the condition of the benthic community.

Regional coherence descriptor

The regional coherence for Decision 2010/477/EU Descriptor 6 is low in all regions except the Black Sea, where only one Member State has defined Decision 2010/477/EU Descriptor 6.

MS good practices

Four Member States (FR, IT, LT, SI) have included an indicator on the percentage of area occupied by biogenic substrate acted upon by human pressures. One (IT) has associated the indicator with a quantitative threshold value. Three Member States (LT, LV, SE) have included a quantitative indicator, the Benthic Quality Index, to serve as an indicator for 6.2.2. Three additional Member States (BE, CY, DE) refer to the WFD good environmental status. Two Member States (CY, IT) have specified the substrate types covered by the GES definition.

[5] Commission Staff Working Document on the first steps in the implementation of the MSFD - Assessment in accordance with Article 12, 2014.

Analysis of the current text of the Decision

- **To be kept in the Decision, in accordance with the mandate provided by the Directive**
- **To be taken out of the Decision and included in guidance**
- **Outdated**
- **N/A**

The present D6 criteria (6.1 *Physical damage, having regard to substrate characteristics* and 6.2 *Condition of benthic communities*) are insufficient and risk compromising our ability to assess seafloor integrity. The present criteria should be revised into new criteria 6.1 *Functionality* and 6.2 *Recoverability* that are more closely related to resilience and recovery potential of the seafloor (see earlier section). This would simplify the existing Decision and may not require any additional monitoring from Member States.

In revising other descriptors in the Decision 2010/477/EC, seafloor specific attributes should be taken into account so as not to jeopardize attempts to reach GES for D6. The following cross-cutting issues are presented as examples:

1. Although it is indirectly suggested by the Decision text that some attributes specific to seafloor integrity should be completely left to other descriptors, such as D1 and D4, it is their interpretation in assessing biodiversity and ecosystem functioning which makes them actually different and necessary for D6. In particular, the same proposed classes of indicators may be applied under different hypotheses in Descriptors 1 and 6 with their results being, accordingly, interpreted in a different way. For example, a species rarity indicator such as the level of curvillinearity of a species dominance curve can be used to (i) assess rare species presence (which is a biodiversity feature assessed under D1) and, at the same time, (ii) analyse the way species fill ecological space (which may be part of a D6 assessment by relating to the way ecosystem functions are served). However, the thresholds for ensuring the presence of a characteristic number of rare species may be quite different from the threshold for concluding that the ecological functions provided primarily by more common species are at typical levels.
2. Oxygen, contaminants, and hazardous substances, including litter: Though different components of these attributes are already measured under descriptors like D5, D7, and D8, oxygen availability in the pore water or variables in reduced sediments are still not measured in any of them. A comprehensive and credible environmental status assessment of seafloor integrity will always require the integration and interpretation of information on oxygen depletion and contaminant levels. Such information is instrumental in (i) interpreting, for instance, degraded biotic seafloor integrity indicators such as community composition, or (ii) providing pressure indicators under the Type 1 and Type 2 habitats.
3. Another key, and possibly specific, issue in assessing D6 is the inherent importance of the patchiness of both substrate and benthic biological communities. This mosaic nature of the seafloor can be degraded if the consequence of management is homogeneity of the environment. The assessments of D1, D4, and D5 might not take loss of heterogeneity into account as long as the pieces are still

present. However the heterogeneity itself may be important for seafloor integrity, as this habitat heterogeneity may be vital for certain biological populations to remain viable in a region. This, in turn, could be necessary for essential functions to be served and for a range of goods and services to be provided.

4. Spatial and time scales are crucial. Multiple anthropogenic pressures, acting in isolation or in concert on the seafloor have important impacts on its integrity.
5. Measurability and uncertainty: The nature of seafloor integrity needs to take into account several aspects such as: the scarcity of data, the occurrence of natural disturbance, and high natural variability. This should be incorporated as a strength, not a weakness, in identifying a GES boundary and when operationalizing indicators.

Conclusion

- Coherence between the Member States for Descriptor 6 is low, with many of the definitions being vague even though the condition of benthic communities is one of the most studied and best documented aspects of biodiversity across Europe.
- In the Baltic several Member States have used the benthic quality index (BQI).
- The Decision 2010/477/EU D6 criteria (6.1 *Physical damage, having regard to substrate characteristics* and 6.2 *Condition of benthic communities*) are insufficient and risk compromising our ability to assess seafloor integrity.
- The present criteria should be revised into new criteria 6.1 *Functionality* and 6.2 *Recoverability* that are more closely related to resilience and recovery potential of the seafloor. This would simplify the existing Decision and may not require any additional monitoring from Member States.
- To ensure resilience of the seafloor, the reference points of indicators that are selected should best reflect the possible tipping point, i.e. the level of perturbation at which the decline of the system functionality begins to accelerate.
- Recoverability needs to be considered in the spatial context within which a disturbed area is located (i.e. connectivity between impacted and non-impacted sites in the region).
- Both sensitivity and pressures need to be considered together to evaluate overall impact. Pressure indicators alone will result in an incomplete assessment.
- Natural disturbances occur on the seafloor, and this background needs to be considered in assessments, relative to sensitivity of the seafloor habitat(s) and anthropogenic pressures.
- Scientific guidance will be required in prioritizing functions to be assessed under each criteria, as well as choosing indicators and establishing GES boundaries for seafloor integrity (with reference points and targets). This will be required in any potential revisions of Decision 2010/477/EU and in its implementation by RSCs and Member States.
- A substantial body of scientific knowledge that can serve as the basis for this guidance has already been consolidated in the ICES/JRC 2010 report. Appropriate experts building on this foundation can make rapid progress in finalizing the necessary guidance.

Part II

GES criteria (in accordance with Art. 9.3)

ICES proposes two new criteria for Descriptor 6:

6.1 *Functionality*: The physical substrate and biotic community are in a condition where the various major ecosystem functions served by the seafloor are within their historical range of natural variability.

6.2 *Recoverability*: Where anthropogenic or natural pressures have altered the structure and processes of the seafloor substrate or biotic community, the return of these ecosystems to a less perturbed status is expected to be rapid and secure when the pressure is reduced, taking into account life history aspects of the key species providing the ecosystem functions.

GES methodological standards (in accordance with Art. 9.3)

Illustrative example: When estimating GES boundaries for assessment a decision-tree approach should be followed for change in a function (Figure 2, below).

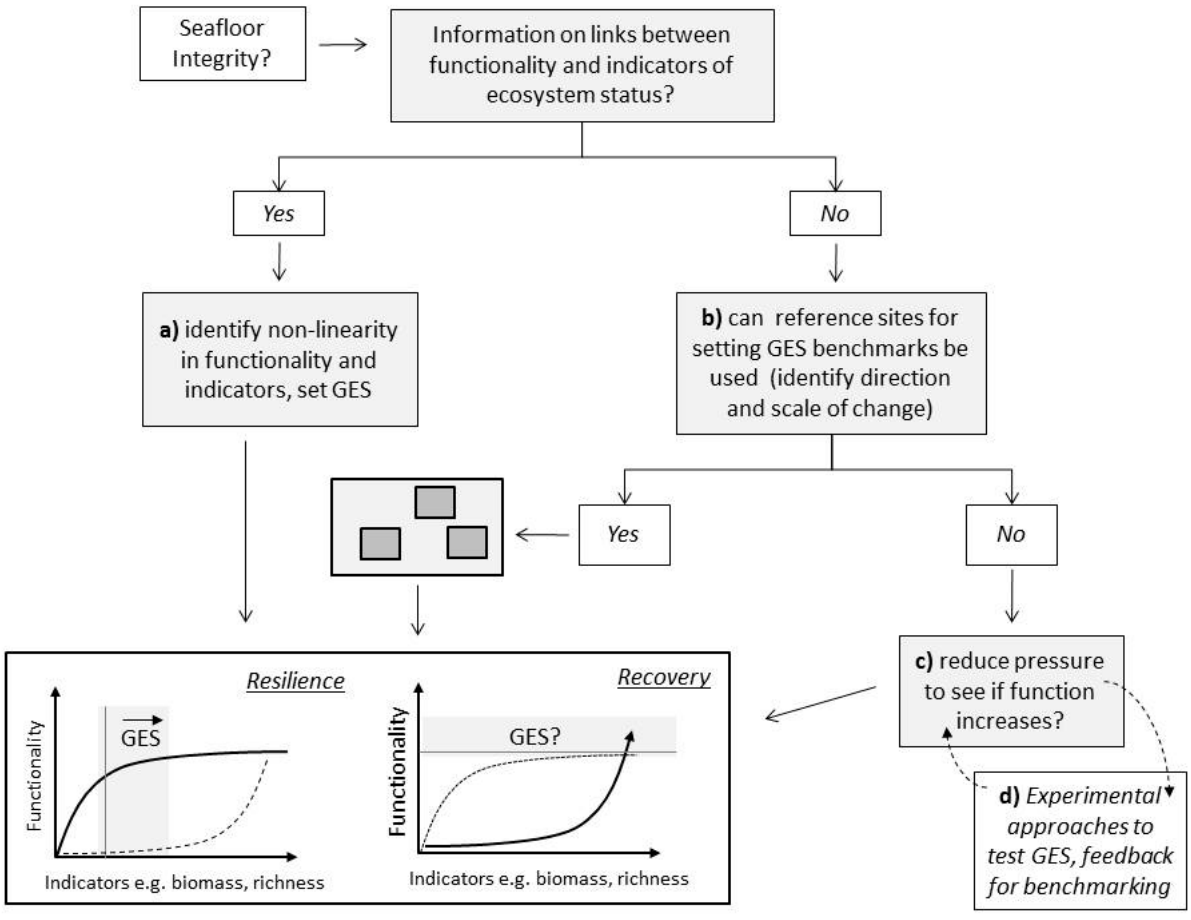

Figure 2. Decision-tree for GES assessment of seafloor integrity.

a) Where there is information on functionality and indicators of ecosystem status, analyses should look for tipping points (non-linearities) in ecosystem state–function relationship. Such non-linearities will provide a defensible estimate of a GES boundary reference point and target. Local studies, supported by models of the functional relationships can inform where the non-linearities may be on larger scales.
b) In cases where there is not sufficient information to even look for non-linearities in the relationship between function and indicators of ecosystem status, any loss of functionality will constitute a degradation of environmental status. However, absolute boundaries for GES of functions (or traits linked to functions) will be hard to identify biologically. It may be possible to locate areas in the region or subregion of the assessment that have been less perturbed than most other areas, or historically information on periods of less pertubation. Information from those areas, or from historical information, should be reviewed to see if they can provide information on at least levels of functions observed in the least perturbed areas available. Then if assessments of other areas provide estimates of functionality (or indicators linked to functions) lower than those of these less perturbed areas, at least the direction and scale of change in environmental status has been identified.
c) Data from most benthic systems come from systems that have already been altered beyond a reference point where un-impacted function levels can no longer be recognized. Modelling may be relevant to estimate such conditions, but for systems that have already been severely perturbed by past activities, maintaining current levels of functionality is a minimum management target, although insufficient to conclude that GES has *per se* been achieved. The more perturbed the system is known to be, the greater the rationale to at least reduce pressures to see if the functionality will increase.
d) If experimental or opportunistic reduction in pressures is possible and can be accompanied by appropriate monitoring, then information can be gained on whether or not GES may be higher than the current status. Feedback from such designed or natural experiments should be used to revise GES boundaries for future assessments.

Standardized methods for monitoring for comparability (in accordance with Art. 11.4)

- The main monitoring challenge for seafloor integrity is not the complete absence of monitoring of ecosystem components that would be of value to assessing GES of the benthos. Rather it is the impracticability of monitoring the European seas comprehensively on scales where the quality of seafloor integrity and pressures on the seafloor are highly patchy.
- Particularly for all but highly sensitive habitats the monitoring of the full extent of key functions provided by the seafloor is a practical alternative to monitoring the fine-scale seafloor physical and biotic structure, and this comprises the focus for assessing GES of seafloor integrity. Monitoring pressures is of particular value for highly sensitive habitats, but has some value in all assessments of seafloor integrity.
- The monitoring of functions needs to be stratified by both natural spatial heterogeneity of seafloor habitat types and by intensities of past and current pressures. Sound stratification regimes will differ around the European seas, but each nation's stratification should reflect expert input to monitoring design.

- Monitoring conducted for Descriptors 1 (*Biodiversity*), 4 (*Foodwebs*), 8 (*Contaminants*), and possibly other descriptors can contribute to monitoring for Descriptor 6 as well, but indicators from the monitoring are interpreted differently with regard to seafloor integrity for Descriptor 6 than for the other descriptors.

Standardized methods for assessment for comparability (in accordance with Art. 11.4 GES)

- Indirect indicators of functions are often more practical to use in assessing GES than indicators of substrate itself. The spatial scales of monitoring programmes are almost always much finer than the scales at which GES will be assessed, and the patchiness of seafloor substrates and biota mean that simple interpolation of monitoring results from monitored sites to other sites cannot be assumed to be valid.
- The standards for GES must reflect the different sensitivity and resilience of the indicators and their functions in ecosystem processes. Risk-based approaches to monitoring and assessment are proposed to deal with the local-scale patchiness of seafloor attributes, pressures, and impacts, considering the threats posed by the human activities occurring in the region.
- Assessments would start with the areas of highest risk, and if impacts of the highest risk areas do not exceed the threshold for good environmental status, then it can be assumed that the activities are overall sustainable. If the impacts in the highest risk areas do exceed the threshold for good environmental status, then assessments would be conducted for other risk strata, to determine how far along gradient impacts are considered not sustainable. Such an approach, with monitoring and assessment stratified by risk level, allows general statements to be made about environmental status at large scales.
- Extensive information on the details of how to conduct such assessments is given in the 2010 ICES/JRC Report for Descriptor 6 – Seafloor Integrity.

Rational and technical background for proposed revision

- See earlier section (Part I).

Other related products (e.g. technical guidance, reference in common understanding document)

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