Indicators for Sea-floor Integrity under the European Marine Strategy Framework Directive

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ARTICLE INFO

ABSTRACT

The European Marine Strategy Framework Directive (MSFD) requires European states to maintain their marine waters in 'Good Environmental Status'. The MSFD includes 11 descriptors of "Good Environmental Status" (GES), including "Sea-floor Integrity". This descriptor is defined as: *"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."*

This contribution briefly summarizes the main conclusions of an international expert group established to review the scientific basis for making this concept operational. The experts concluded that consideration of 8 attributes of the seabed system would provide adequate information to meet requirements of the MSFD: (i) substratum, (ii) bioengineers, (iii) oxygen concentration, (iv) contaminants and hazardous substances, (v) species composition, (vi) size distribution, (vii) trophodynamics and (viii) energy flow and life history traits. The experts further concluded that "*Good* Environmental Status" cannot be defined exclusively as "*pristine* Environmental Status", but rather status when impacts of all uses were sustainable. Uses are sustainable if two conditions are met:

- the pressures associated with those uses do not hinder the ecosystem components to retain their natural diversity, productivity and dynamic ecological processes
- recovery from perturbations such that the attributes lie within their range of historical natural variation must be rapid and secure.

No single specific suite of indicators is proposed, both because no single set of indicators will meet the needs of all EU countries in all regional seas, and because according to the MSFD indicator selection is the prerogative of individual states. However, the need for conceptual consistency in assessing GES throughout European seas should be served if the selection of indicators and the integration of their information content in assessing GES follow the guidance in the report of the TG on Seafloor Integrity. This guidance is presented here in summary form.

Informed by this report European Commission selected as indicators for the Sea-floor Integrity: (i) type, abundance, biomass and areal extent of relevant biogenic substrate; (ii) extent of the seabed significantly affected by human activities for the different substrate types; (iii) presence of particularly sensitive and/or tolerant species; (iv) multi-metric indices assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species; (v) proportion of biomass or number of individuals in the macrobenthos above some specified length/size; and (vi) parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community.

1. Introduction

Since the early 1990s many jurisdiction have adopted framework legislation to guide sustainable use of marine environments while protecting and where necessary restoring good environmental quality (Australia, Canada; the European Union [EU]; South Africa) (Ratza et al., 2010; Borja et al., 2010a). One of the most recent is the European Marine Strategy Framework Directive (MSFD; 2008/56/EC), with an Annex listing 11 descriptors that constitute the basis for the evaluation of "Good Environmental Status" (GES): (1) biodiversity; (2) non-indigenous species; (3) exploited fish and shellfish; (4) food webs; (5) human-induced eutrophication; (6) Sea-floor Integrity; (7) hydrographical conditions; (8) contaminants in water and sediment; (9) contaminants in fish and shellfish; (10) marine litter; and (11) introduction of energy/noise. Assessing GES involves indicator-based assessments of status of each of these descriptors, with an integration of indicators both within and across descriptors to produce the assessment of GES (Gammeltoft, 2009; Lyons et al., 2010; DEFRA, 2010).

For descriptor 6, which is "Sea-floor Integrity", GES is defined as "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". This policy recognition of benthic ecosystem quality poses several challenges for implementation (Van Hoey et al., 2010). However, the implementation challenges were not unique to this descriptor, and the European Commission asked the International Council for Exploration of the Sea (ICES) and the Joint Research Centre of the European Commission (JRC) to oversee expert Task Groups (TGs) for ten of these descriptors (see reports in Cardoso et al., 2010). These TGs were tasked to review scientific information on each descriptor, and provide consensus expert guidance on: (i) a scientific interpretation of the terms in the descriptor; (ii) what constitutes GES according to the descriptor, including what are "axes of degradation"; (iii) how to deal with issues of ecological scale; (iv) what are the ecological attributes of Sea-floor Integrity; (v) what indicators or classes of indicators for assessing status on the attributes (how would reference levels be set on the indicators and what pressures are linked to the indicators); (vi) how would information on the indicators be rolled up to an overall evaluation of GES for Sea-floor Integrity; and (vii) research and monitoring needs.

Hence, this contribution summarizes the main conclusions of the Sea-floor Integrity TG (for details see Rice et al., 2010), focusing on the conclusions regarding: (i) selection of indicators for the six identified attributes of "Sea-floor Integrity"; (ii) properties of reference points (management benchmarks) on the indicators; and (iii) how information from the individual indicators should be combined in the assessment of GES.

2. Materials and methods

2.1. Process for producing the TG report

From nominees proposed by European member states, ten experts and two additional observers from OSPAR and HELCOM Conventions were selected. The observers ensured that the dialogue among TG members was accurately informed about current practices, capacities, etc., of the Regional Seas Organisations which, along with their member states, would be engaged in delivering the programmes under the MSFD. All experts and observers were engaged in all aspects of the work of TG, and the report was a consensus report of all participants. Subgroups worked on specific attributes of Sea-floor Integrity, coordinated by several conference calls and two meetings, with extensive sharing of drafts of text as the report sections developed. A management committee (MC) comprising all TG chairs and coordinators from ICES and JRC provided liaison between the TG and consultation meetings with EU states and stakeholders. The MC also coordinated the final round of seeking quality assurance and external feedback on each TG report, and prepared an integrative overview of the full set of reports (Cardoso et al., 2010).

2.2. Extraction of content of this report

From the full TG report, only the final conclusions for the sections on interpretation of the descriptor, description of GES, and which attributes comprise "Sea-floor Integrity" are extracted in this contribution. These are necessary as context for the information on selection and use of indicators. The MSFD explicitly allows individual EU states substantial leeway in adapting the advised GES assessment frameworks to national or regional conditions. Hence, no single list of recommended indicators could be provided by the TG. Rather, the TG developed rationales as well as conclusions regarding types of indicators appropriate for each attribute. These conclusions and the rationales that underpin them are reported in more depth, as well as the TG guidance for assessing GES based on the results on the suites of indicators (Rice et al., 2010). In all cases the rationales and conclusions reported here adhere closely to the contents of the TG report, where the full documentation and citations to the scientific literature behind each conclusion can be found (Rice et al., 2010).

3. Results

3.1. Major conclusions on context for selection of indicators for Sea-floor Integrity

3.1.1. Scientific interpretation of the definitions of the descriptor and GES

According to the MSFD, "*Sea-floor*" includes the physical and chemical parameters of the seabed and the biotic composition of the benthic community. "*Integrity*" covers spatial connectedness so that the habitats are not artificially fragmented, and having the natural ecosystem processes functioning in characteristic ways. Areas of high integrity on both of these properties are resilient, so human uses may cause some perturbation without lasting or spreading harm to the ecosystems. "*Structure and functions of ecosystems*" is used in its conventional sense in ecological studies. "*Not adversely affected*" is interpreted as meaning that impacts