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Developing the concepts of good environmental  
status and marine ecosystem objectives: some  
important considerations

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**Developing the concepts of good environmental status and marine ecosystem objectives: some important considerations**

Laffoley, D'd'A, Brockington, S., Gilliland, P.M.

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## Summary

In 2005 the European Commission published their proposal for a Marine Strategy Directive. This has at its core the need to meet Good Environmental Status (GENS). Similarly, a key approach being developed in the UK to underpin the proposed Marine Bill is Marine Ecosystem Objectives (MEOs). Whilst MEOs will most likely need to be more detailed, in general both concepts are objective-led processes that seek to define a minimum suite of regionally-relevant headline indicators that allow reporting on state. These holistic approaches will accordingly provide advice on management and policy to sea users, regulators and decision makers.

The difficulty in developing new policy approaches such as GENS and MEOs, is that they tend to look to the traditional science base or existing regulatory requirements to service the needs of the new policy. Whilst using existing scientific information is essential, new approaches are required that draw in the best existing science and advice that is available, but that are also more holistic in their efforts to encourage sustainable development.

This report sets out some important considerations to create information resources that meet these policy needs. In this report we conclude that:

1. Due to the plethora of existing monitoring and assessment ‘activities’, guiding principles and a conceptualisation model are needed to ensure that any proposals for GENS and MEOs are fit-for-purpose – we offer six principles and a simple model to do this.
2. The overall approach to GENS and MEOs should predominantly be threat-orientated (‘activity/pressures’), drawing both from our existing experience of the impacts of human activities, but also ensuring that future regional sea-scale threats to ecosystem quality, structures, functions and processes from climate change and surface ocean acidification are also encompassed.
3. Objectives for GENS and MEOs should be simple, few in number, established for the regional sea as a whole, and assessed via headline indicators established for various component elements of the regional seas ecosystems. GENS and MEOs are therefore different to ‘quality objectives’ (Water Framework Directive) and condition assessments (Habitats Directive), which are site measures and usually based on local water quality, and physical and biological characteristics.
4. Objectives for GENS and MEOs should be assessed through a balanced set of headline indicators focussed on activity/pressures and the quality, structure, function and processes of the regional sea ecosystem – the inclusion of some indicators of function and process being particularly fundamental to future-proofing these concepts for climate change and surface ocean acidification.
5. The use of ‘headline indicators’ will streamline application and end assessment processes across regional seas. The term provides a clear message about selectivity, but does not preclude other relevant work being offered by national and supranational bodies to support assessments for any given regional sea.
6. A focus on regional sea ecosystem quality, structure, function and processes alongside impact indicators will need to draw in existing work, but will need to extend beyond

the well established initiatives (eg from OSPAR) into other areas of relevant work distributed across marine science institutes that can support such holistic approaches.

7. Target reference points will need to be set for the headline indicators, and a mixture of 'limits' and 'trend' approaches will need to be used to assess progress. 'Trend' information may be particularly helpful where there is insufficient knowledge to establish meaningful 'limits' around a target, and for aspects of ecosystems where climate change and surface ocean acidification may make the 'limit' approach redundant in the coming decades.
8. It is difficult to measure 'ecosystem health', so any headline indicator set will need to encompass some measure of the diversity of communities and the health of individuals in populations.
9. It is possible to develop a generic set of headline indicators that is relevant across all regional seas – target reference points, limits and trends for indicators will vary though, depending on the status of each regional sea. For efficiency, for most headline indicators, it would be feasible to develop generic methodologies and, for some, provide central measurements across all regional seas.
10. The future significant impacts predicted from climate change and surface ocean acidification make it challenging to set meaningful target reference points, limits and trends, and a development of the current philosophy to also address future climate impacts and what will characterise eventual 'success' is likely to be necessary.
11. Given the fact that headline indicators need to span ecosystem quality, structure, function and processes, the assessment of status will need to take the form of an integrated assessment where a judgement is made on progress towards meeting the target reference point set for each headline indicator – in our view it will not be possible to arrive at a single numerical answer at the regional seas scale due to the inability of current statistical packages to sensibly compare across such varied parameters.
12. Given the fact that different elements of ecosystems respond on different timescales to management intervention, and that considerable inertia may occur, a mixture of activity/pressure, and structure, function and process headline indicators is considered essential. It is suggested that 'success' for GEnS and MEOs should be when 'targets' for headline indicators have been met, where 'limits' have not been exceeded, and where 'trends' are progressing in the correct direction year-on-year.
13. Assessment of 'success' may be aided by the use of a simple traffic light approach, where red demonstrates GEnS and MEO are not being met and new management/policy intervention is needed, where amber shows a need for more limited intervention, and where green reflects targets being met, limits not being exceeded, and trends in a positive and progressive direction.

It is hoped that this advice will be seen as an important contribution towards the current debate and that it will prove valuable to those charged with developing both approaches.



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Research Information Note



# 1 Aim of the report

- 1.1 The purpose of this report is to provide advice on some important considerations that are fundamental to the development and implementation of the ‘environmental’ and ‘ecosystem’ concepts underlying the proposed European Marine Strategy Directive in Europe, and the proposed Marine Bill within the UK.
- 1.2 The report focuses on the shape and nature of the high-level interaction between these two initiatives. Further detail will be required in both instances to make these concepts fully operational, but such detail falls outside the scope of this current report.

# 2 Introduction

- 2.1 In the winter of 2005, the European Commission published a proposal for a Directive to underpin its Marine Thematic Strategy. In response to the continued deterioration in environmental status and loss of biodiversity, the draft Directive has as its central aim to achieve “Good Environmental Status” (GEnS) for European seas by a proposed date of 2021, at the latest. It would also require Member States to develop Marine Strategies for their waters, undertake an initial assessment of their status, determine what constitutes GEnS (based on generic qualitative descriptors due to be produced by the Commission within two years of the Directive coming into force at the latest) and develop programmes of measures needed to achieve GEnS.
- 2.2 At the present time there is uncertainty over what aspects of marine ecosystems will be used to measure and assess GEnS because these have yet to be defined. This report intends to make a contribution by identifying some important considerations that should help this identification process, as this work is undertaken by the European Commission and Member States.
- 2.3 Within the UK, and alongside the emerging European debate on GEnS, is an important strand of work being developed to support the proposed Marine Bill. This is centred on the development and implementation of Marine Ecosystem Objectives (MEOs). MEOs are intended to provide a framework of objectives for an Ecosystem Approach to management in the marine environment. Whilst work has begun on MEOs, it is not clear what shape these will take, but it is critical that this is now done. In this report we focus on ecological aspects of MEOs and not the broader socio-economic considerations within which MEOs should be applied.
- 2.4 The authors consider that concepts of GEnS and MEOs should be considered as intimately related. Whilst it may be that MEOs will need to go into greater detail on management issues, there is clearly a need to ensure that the overall frameworks for both fit together generically and at the scale of regional seas<sup>1</sup>. It is therefore not only helpful to take both initiatives forward together, but this would be the most efficient approach.
- 2.5 This report accordingly recommends some solutions to important strategic considerations that should be addressed in developing both concepts. These include:

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<sup>1</sup> Here “regional” is used in the sense of what are now called “sub-regions” in the Marine Strategy, eg the Greater North Sea.

- the challenges of developing a forward looking framework for assessing ecosystem ‘health’, with recommendations on a common set of guiding principles to help devise such an approach;
- providing a simple conceptualisation model to help develop thinking and progress on both initiatives, and illustrating this with some example objectives and headline indicators for assessing GEnS/MEOs; and
- offering some recommendations on reporting and assessment processes. This includes the need for a thematic reporting to underlie the implementation of both concepts, alongside the need to make strong linkages to marine climate change impacts assessments.

2.6 It is hoped that addressing these considerations will result in a fit-for-purpose approach to both concepts, which do not become overly driven by current monitoring and reporting practices. In this way the need and overall approach can be set out, and then an assessment made of where current practice and programmes contribute, where there is redundancy and duplication, and where there are key gaps. This would be a more strategic and therefore efficient and cost-effective process than building up an overall approach based just on experience with current monitoring and reporting.

2.7 Whilst this report suggests some key elements that may form the core of the GEnS and MEO concepts, it does not go so far as to provide comprehensive detail at the regional sea scale – this level of detail falls outside the scope of this report.

## **3 The developmental challenge**

### **3.1 Identifying the challenges**

3.1.1 The concept behind both GEnS and MEOs appears at first sight deceptively simple – to establish a few objectives, which inform management and policy decisions and which, when monitored and reported upon using indicators, will enable assessments to be made on ‘environmental’/‘ecosystem’ health. From the GEnS perspective, this is different to existing European processes (eg under the Water Framework Directive) which use the term *Good Ecological Status* (GES), and where a more detailed assessment requirement is meant and is being taken, and is most meaningful for the protection of biodiversity.

3.1.2 Despite previous initiatives to take a more ‘holistic’ view of the state of the marine environment, up to now current science in this area in the UK and Europe has been mostly driven by specific and quite narrow, sectoral and legally-based monitoring requirements. Less accessible knowledge and experience held more widely within the science, conservation and management communities is not so often drawn upon. The highly sectoral management and research infrastructure does not help this situation. This has made it challenging to gain an overall perspective at the regional sea scale and develop new approaches that are more holistic in their efforts to encourage sustainable development.

3.1.3 Defining objectives and indicators is not new and there have been numerous initiatives which have considered how best to go about it and how to adapt existing practices to fit new requirements. What is new is the challenge posed by the concepts of GEnS and MEOs. The intent of these concepts is to give tangible expression to the Ecosystem Approach by assessing the overall health of the environment at the regional seas scale. Managers, decision makers and policy advisors find it difficult to address the Ecosystem Approach<sup>2</sup>. This is reflected in current management objectives and targets that tend to be very short term, focussed on discrete aspects, such as water quality or the presence and distribution of habitats and species. The longer-term and broader processes upon which more recognisable elements of ecosystem depend (eg oceanographic processes and nutrient cycling) often don't feature as they are less easy to define in policy and management terms. Thus resultant management has been generally poor at maintaining the overall health of the marine environment.

3.1.4 The development of concepts for GEnS and MEOs provide an opportunity to take a fresh look at the holistic approach needed to report on the overall health of the marine environment. This opportunity should not be missed. If it is to be taken there are at least six significant inter-related issues that would need to be overcome:

- **The current approach versus the GEnS and MEO approach:** The current approach to assessing the state of the sea is a result of specific regulatory requirements arising from multiple sources. Despite some efforts to take a more holistic view, in practice the focus is skewed towards certain headline indicators (eg birds, individual assessments of some species of commercially exploited species of fish etc.). A more balanced approach needs to be taken. This is one that includes headline indicators reflecting more complex ecosystem processes that are under threat from climate change and surface ocean acidification – impacts that are predicted to become increasingly significant in the coming years. If this skew is addressed at the outset it will result in development of approaches that are more fit-for-purpose.
- **The focus of our current approach versus the focus for GEnS and MEOs:** The current approach has a strong emphasis on certainty and being able to relate the monitoring and assessment to the consequences of (usually) single impacting human activities. Whilst this has resulted in workable solutions it has also resulted in a narrow fragmented approach to management. A narrow approach provides important information relevant to management of those particular human impacts, but it does not enable reporting on broader function and processes that are fundamental to the GEnS and MEO concepts. Relevant data and research on broader functions and processes does exist but has not yet been utilised effectively as it could be.
- **The lack of a broader perspective within which to develop GEnS and MEOs:** Current objectives are driven from regulatory requirements. Whilst there have been initiatives that considered moving beyond this approach, up to now there has been no policy or legal requirement to actually devise or implement an all encompassing 'environmental'/ 'ecosystem' approach. We

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<sup>2</sup> The Ecosystem Approach referred to in this report is the approach agreed by the Convention on Biological Diversity in May 2000, subsequently elaborated upon with 12 principles and five points of operational guidance.

therefore lack the broader-scale overarching framework and conceptualisations within which to devise GEnS and MEOs. This needs to be developed through new creative thinking rather than by adding up the sum of the existing regulatory drivers, objectives and indicators – scaling effects and the holistic nature of GEnS and MEOs dictate against the latter approach from the outset.

- **The challenge of looking beyond the current focus of effort in order to devise GEnS and MEOs:** Without a new strategic approach there is the significant risk that too much of the existing process will be seen as being required, when in reality only some elements are likely to be needed to provide a strategic overview at the regional seas scale. This is as hopefully a more appropriate balance is obtained between activity/pressure indicators and those that reflect broader-scale processes ('pick and mix', as opposed to 'bussing it all in').
- **The challenge of how to devise a common approach to GEnS and MEOs that can be implemented at a regional seas scale:** A common characteristic of GEnS and MEOs is that whilst the concept applies at European and UK scales respectively, both will be implemented at the scale of regional seas (or finer scales). There is therefore the need to provide generic advice that can be elaborated on at the regional scale. This is so that GEnS and MEOs can be applicable to the varying 'environmental' / 'ecosystem' conditions that are present in regional seas. A key consequence of this is that overall definition of GEnS and MEOs should relate to generic objectives and a common suite of headline indicators. For GEnS, this would be consistent with the framework principles behind the proposed Directive, whilst MEOs will ultimately need to be defined in greater detail at the regional sea scale. However, for both GEnS and MEOs this approach would provide a level of consistency across all regional seas, which can then be amplified at the regional level to provide the appropriate level of detail. With clear linkages between the two concepts, duplication of effort and unnecessary expenditure of resources can be avoided.
- **The challenge of assessing actual ecosystem 'health':** many of the ecosystem processes that maintain the health of the marine environment are complex and not well understood. They are often 'non-linear' - demonstrating thresholds for system collapse and also for recovery. By definition 'health' is an imprecise science, related to the quality and condition of a given 'unit'. When applied to the marine environment it is evident that assessing the health of such a large-scale marine 'unit' will entail measurements and assessment to be made across the constituent components. These need to range from the chemical and physiological health of individual species, the quality status of habitats and communities of species, through to perceived condition of broad-scale ecological processes. It is easier and certainly more meaningful to focus what we mean by 'health' on the measuring the quality of communities of species, and the health of individual species, rather than the health of the overall sea.

## 4 Moving forward with the GEnS and MEO concepts

- 4.1 From this analysis it is evident that addressing the GEnS and MEOs concepts and translating them into a workable framework will be a challenging process. To make this easier, thinking on the development of GEnS and the high-level aspects of MEO could be assisted by consideration of:
- a set of guiding principles to help shape these approaches;
  - an overall conceptualisation of what is required, within which current approaches can be set, progress assessed and decisions taken on where further actions are needed; and
  - an understanding of how GEnS and MEOs may work in practice and how they should therefore be assessed and reported on.
- 4.2 Each of these elements is considered in detail in the following sections. In addition, this report also illustrates the consequences of applying these elements by identifying illustrative objectives and a possible suite of headline indicators.

## 5 A ‘systems’ approach – addressing ecosystem complexity

- 5.1 By definition ‘environmental’ and ‘ecosystem’ lie at the core of both these concepts. An *ecosystem* is a dynamic complex of plant, animal and micro-organism communities and their non-living environment, which interact as a functional unit. *Environment* relates to the physical and chemical conditions, together with structural species that ‘shape’ the environment and from which we derive ecosystem goods and services. The presence of these terms means that these concepts relate not just to the mix of species in the sea, but also to their functional interaction with the habitats and processes that shape the living world around us.
- 5.2 The complexity of ecosystems or the environment is frequently broken down into a number of different aspects for practical descriptive purposes – often from a science perspective into ‘structure’, ‘functions’ and broader ‘processes’, where:
- ‘structure’ is the presence of individuals, species, populations and habitat types, and the physical complexity they provide to ecosystems eg kelp forests;
  - ‘functions’ are used to reflect the activities, processes or properties of ecosystems that are influenced by the presence of species in association with their habitats eg the burrowing ‘function’ of animals in the seabed (bioturbation), which results in the ecosystem ‘process’ of nutrient recycling; and
  - ‘processes’ represents the four basic processes within an ecosystem: water cycle, mineral cycle, energy flow and community dynamics. Examples include specific interactions between individuals, species or habitat types, as well as processes such as photosynthesis, predation and nutrient cycling.

- 5.3 Ecosystem structure, function and processes provide the benefits that we value and need. Sometimes we explicitly recognise them, but often we don't. They are often difficult to translate into pounds and pence, and yet are critical to support sustainable development, critical for our overall well-being, and essential to life on earth. Explicit benefits may range from a potentially renewable source of protein (eg fish) through to a quality environment for recreation and enjoyment (eg holidays at the seaside). Critical benefits we are usually unaware of range from maintaining water quality and the recycling of nutrients to support the food chain, through to regulating climate and shaping the weather. Implementation of GEnS and MEOs must therefore embrace such concepts if they are to act as the tools to support the delivery of sustainable development.
- 5.4 Not only do we need to recognise the ecosystem structures, functions and processes that shape our seas, but we also need to understand how our uses impact in different ways on these differing levels of complexity (**Table 1**). This relationship is important as it underpins the threat-orientated approach advocated in this report, and accordingly what aspects of ecosystems we may therefore need to assess in order to form a view as to whether ecosystems are 'healthy' and sustainable development is being achieved. Using this artificial division therefore makes it possible to develop recommendations to help ensure that any approaches to GEnS and MEOs, which need to assess overall health, address more than just the presence of species and habitats, or the concentrations of pollutants, but also broader scale processes. By creating an approach that recognises these different aspects of ecosystems a more holistic 'systems' approach can be developed.
- 5.5 Not only does this reinforce the need for inclusion of the words 'environmental' and 'ecosystem'<sup>3</sup>, but it also demonstrates that the selection of objectives and headline indicators to underpin these concepts needs to be given particularly careful consideration. This is to create the right 'shape' to the GEnS and MEO approaches: a 'shape' that will be critical in assessing health and determining if sustainable development is being achieved, and a 'shape' that would need to be applied across all regional seas, but that can be adapted to the differing conditions found in each individual regional sea.

## 6 Guiding principles to shape a structured approach to GEnS and MEOs

- 6.1 To help develop GEnS and MEOs using such a 'systems' approach the following principles are therefore recommended. These principles are defined below in no particular order and have been devised to capture experience on applying holistic approaches to environmental management. The principles are that the objectives and headline indicators used to support GEnS and MEOs should be:
- **Comprehensive:** The focus should be on the selection of headline indicators that span the full range of ecosystems components. Thus they should include headline indicators for individual species and habitats, through to species

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<sup>3</sup> There has been some debate in the UK on re-titling MEOs as 'marine objectives' or 'ecological objectives', but this misses the point about the fundamental role of these concepts to underpin the delivery of sustainable development.



groups, habitat complexes, populations and communities. They should address the complexity of the ecosystem and span ecosystem structures, functions and processes in the most economically efficient manner. Composite surveillance indexes should be employed alongside headline indicators that draw on more traditional monitoring approaches.

- **Representative:** The selection of headline indicators should address the character of the ecosystems they have been selected to represent. Thus they should have sufficient flexibility to be adapted at the regional seas scale to be regional seas-relevant to include characteristic habitats, species and processes that are of interest.
- **Threat orientated:** The selection of headline indicators should focus on aspects of ecosystems where impacts from human activities may foreclose future options for the conservation of biodiversity, the maintenance of ecosystem structures, functions and processes, and the delivery of sustainability. Thus they should relate both to individual damaging activities and to overall human pressures, and embrace existing impacts and the future scope and nature of impacts arising from human uses, climate change and surface ocean acidification. They should include headline indicators that relate to the health of the ‘system’ as well as the health of individual species within it.
- **Precautionary:** The selection of headline indicators should not allow the absence of scientific certainty as a reason for precluding some important aspects that contribute to a comprehensive and representative perspective. There should not just be a focus on well known headline indicators where detailed datasets allow for the identification of limits around targets. A ‘systems’ approach will also need to include other aspects, usually focused on assessing function or processes, where development work may be needed, where less precision may be possible, and where the direction of longer-term trends may be most informative.
- **Temporally relevant:** Ecosystems operate at a variety of temporal scales – in other words they show short-term responses that can be measured in hours, days, months and years, through to long-term changes that can only be seen and assessed over many years and decades. The selection of headline indicators should therefore be undertaken to effectively integrate both long-term, medium-term and short-term changes, to ensure that reporting can assess overall health of the ecosystem, and is not skewed towards short-term perturbations.
- **User orientated:** Whilst the assessment of overall health of the ecosystem will require some technical headline indicators, the process should ensure that some of the headline indicators chosen are easy to explain to sea users and managers, and accordingly have resonance with them. This will usually be in the form of headline indicators using familiar species or species groups.

6.2 Applying these guiding principles in the development of approaches for GEnS and MEOs should support the identification of fit-for-purpose headline indicators. This should have the consequence of enabling reporting on ‘environmental’ and ‘ecosystem’ status. It should also provide the basis of a feedback through assessment

processes to decide if subsequent management and policy measures recommended at the regional sea scale are appropriate for achieving GEnS and MEOs.

## 7 Conceptualising the ‘systems’ approach

- 7.1 A conceptualisation model is a helpful way to see and therefore understand the application of these guiding principles and the associated ‘shape’ and ‘nature’ of the ‘systems’ approach which will be needed to assess ‘environmental’/‘ecosystem’ state.
- 7.2 GEnS and MEOs will need to find a way to address the complete continuum of ecosystem organisation (structures, functions and broader processes). In terms of how we use the seas this will need to be set in the context of the changes that our human usage may cause (ranging from small scale impacts to broader scale, often cumulative effects, over longer (decadal) time periods). These elements form the basis of the model provided in this section of the report. The model provides a framework that can be used to test proposals for GEnS and MEOs to ensure that they are fit-for-purpose.
- 7.3 The key elements of the model are set out in **Figure 1**. Thus the graph in **Figure 1 (a)** shows the main elements of the simple conceptual model, where increasing complexity of ecosystem organisation is given on the vertical axis, and increasing complexity of human pressures on the horizontal one. The arrows and associated text are there to illustrate how ecosystem complexity increases vertically.
- 7.4 This type of conceptualisation can be used to show (**Figure 1 (b)**) that the majority of current sectorally-based regulatory initiatives relate to the area shaded A – single instruments looking at single effects. This is because the framework has been driven from the regulatory perspective focussed usually on discreet issues – indeed ICES advice has tended to focus on identifying and using indicators that are responsive in short order to single manageable activities, where good data exists. In the overall context of the full range of ecosystem complexity and human impact complexity this has led to a skewed focus on such aspects to the detriment of any broader view.
- 7.5 **Figure 1** shows that in order to define an objective/headline indicator-led process under GEnS and MEOs it will be essential to cover broader scale issues of ecosystem function and process, where generally less precision is possible and where trend information becomes increasingly important. This is alongside the more discreet aspects that are more easily identified in the shaded area A.
- 7.6 This report accordingly advocates (**Figure 1 (b)**) that for effective reporting on the health of regional seas, alongside current regulatory monitoring, there is the need to make operational existing research on:
- **Key ecosystem functions and processes.** This area is shaded D and includes functional and process related indicators that give medium- to longer-term trends on important indicators of environmental/ecosystem health. This should include indexes covering trophic structure, productivity, stratification, nutrient cycling, nitrification and surface ocean acidification;
  - **Long-term monitoring of species and groups which are expressly designed to capture changes in functional relationships.** Such studies would relate to

the area shaded C. Longer-term indicators at the ‘structural’ species or species group level that reflect broader in-combination effects, such as intertidal studies on barnacles and molluscs by MarClim or plankton by SAHFOS; and

- **Medium-term composite headline indicators for species groups designed to report on status.** By way of illustration this is the shaded area B and could take the form of composite indexes for coastal birds, for commercial fish species, and for sharks, skates and rays (see **Table 3**). Such indexes give an overall trend on status across such groups, using the Red List processes of IUCN’s Species Survival Commission and provide standard globally-adopted reference points against which to judge an element of health.

7.7 Other important characteristics that are illustrated in **Figure 1** relate to recognition of the fact that as the focus moves diagonally away from the origin of the graph, the nature of the structure of indicators and management responses changes. It is important to recognise this when developing approaches to GEnS and MEOs. Thus as the focus moves diagonally towards the top right of the graph the focus *generally* changes:

- from one where setting limits around target reference points for indicators may be more appropriate, to one where may be more appropriate to use medium- to longer-term trend information to assess progress against targets (**Figure 1 (c)**); and
- from one where more direct management responses will be needed and can be taken, to one where policy changes become more relevant (**Figure 1 (d)**).

## 8 Moving from concepts to reality

8.1 In this section the guiding principles and concept model given above have been applied to our seas, within the context of current research, knowledge and statutory requirements. The results of this exercise are an illustration of the value of taking a ‘systems’ approach and an example of what regional sea scale objectives and the suite of headline indicators for GEnS/MEOs might look like. This is summarised in **Table 2** and set out in more detail in **Table 3**. **Table 3** provides an illustrative worked example. It should not be taken as a definitive high-level definition of GEnS/MEOs, although it can be anticipated that a thorough consideration of such issues may result in the selection of a similar spread of headline indicators.

8.2 It is evident from **Table 2** that the generation of objectives and a supporting suite of headline indicators for GEnS/MEOs is a practical proposition. It primarily relies on being highly selective, economical, and using the hierarchy of scales to build synergies between the different elements that are selected. In doing so it is also important to recognise where commitments have already been made to implement various approaches, and to build them into the suite of headline indicators that are selected. For example, on aspects such as trophic structure there are already obligations to implement such a measure from the Convention on Biological Diversity. This is already recognised in the development of the England Biodiversity Strategy, so it is important to achieve coherence between these initiatives and GEnS/MEOs to ensure single measures serve multiple purposes.

- 8.3 What becomes evident from the examination of **Table 3** is that some of these headline indicators are at different levels of development; some are readily measurable subject to agreement on methodology and protocols, whilst others would need some further thought and development. But even in the latter areas, research is conducted at UK and European levels and needs to be drawn upon more effectively. It is difficult to see how any assessment of ‘environmental’/‘ecosystem’ state can be achieved without the inclusion of medium to longer-term trend information for some key aspects of marine ecosystems. These considerations have important implications for the eventual suite of generic objectives and headline indicators that will be used to define GEnS and MEOs.
- 8.4 Thus from **Figure 1**, and **Tables 1, 2** and **3**, it can be seen that the provision of such a simple conceptualisation framework can help provide some clarity on current progress. It would be possible to use it to support the identification of objectives and headline indicators that may be used. It is intended that **Table 3** could also help focus future actions on areas that are fundamental to both GEnS and MEOs, and where development is needed to support effective assessments and reporting. The model provided in **Figure 1**, taken together with **Table 3**, can also serve to identify the new linkages that are required between different elements of the science community and those decision makers and policy advisors that are charged with taking these initiatives forward.

## **9 Implementation and reporting considerations**

- 9.1 **Figure 2** provides a representation of a possible process for implementing GEnS and MEOs, drawing from the analysis in this report. It shows a possible common approach for generic objectives and headline indicators, but also that some would need to be further developed at the regional scale to address characteristics relevant to each regional sea. This ‘regionalisation’ aspect will need addressing in any implementation processes and will be a particularly important element to develop alongside more generic processes.
- 9.2 **Figure 2** illustrates the thematic reporting requirements and that any corrective measures that emerge as a result of such report will need to take the form of a mix of policy changes and more direct management interventions at European, national and regional scales depending on the issue (and initiative – GEnS or MEOs) concerned.

## **10 Assessing overall ecosystem ‘health’ – thematic reporting versus integrated assessments**

- 10.1 A key challenge in assessing ecosystem health using GEnS and MEOs relates to whether it is possible to move from thematic reporting to a true integrated assessment process.
- 10.2 The most practical and, perhaps from the regional seas management perspective, the most informative solution will be to undertake the assessment as an integrated analysis, but where a view is reached on each headline indicator that make up the generic set. This will enable rapid assessments to be given on where remedial action will be necessary through management and/or policy intervention. This also allows

for the fact that confidence and certainty on reporting will be higher for some headline indicators than for others.

- 10.3 This assessment process could be operated on a simple traffic light approach, where red demonstrates GEnS and MEO are not being met and new management/policy intervention is needed, where amber shows a need for some intervention, and where green reflects targets being met or trends moving in a positive direction.
- 10.4 There is, however, an interest in whether greater integration can be achieved than this in order to provide a single view on ecosystem health – ‘can we have a single figure answer’. In addition to the points made above, this integration is particularly challenging in its own right. This is because any headline indicators selected to underpin GEnS and MEOs would invariably operate at different temporal and spatial scales, and cannot therefore be considered to be equivalent. Bring into play the differing levels of confidence and certainty, and the true nature of such a challenge becomes clear.
- 10.5 Statistical analysis packages currently find such issues difficult to handle in a meaningful way. It is possible to weight measures in analyses, but it is unlikely without further development of such analytical tools that it would be possible to operate such an approach at this time. Indeed it is questionable about whether any greater integration would be meaningful or helpful for management and policy purposes. ‘Single figure answers’ will mask where follow-up action for the regional sea will be needed. Despite these limitations, statistical tools can be helpful and should be used alongside integrated analysis. This is to provide valuable insight into possible causal relationships within marine ecosystems that can amplify and explain the results observed from reporting on the headline indicator set.

## **11 The next steps**

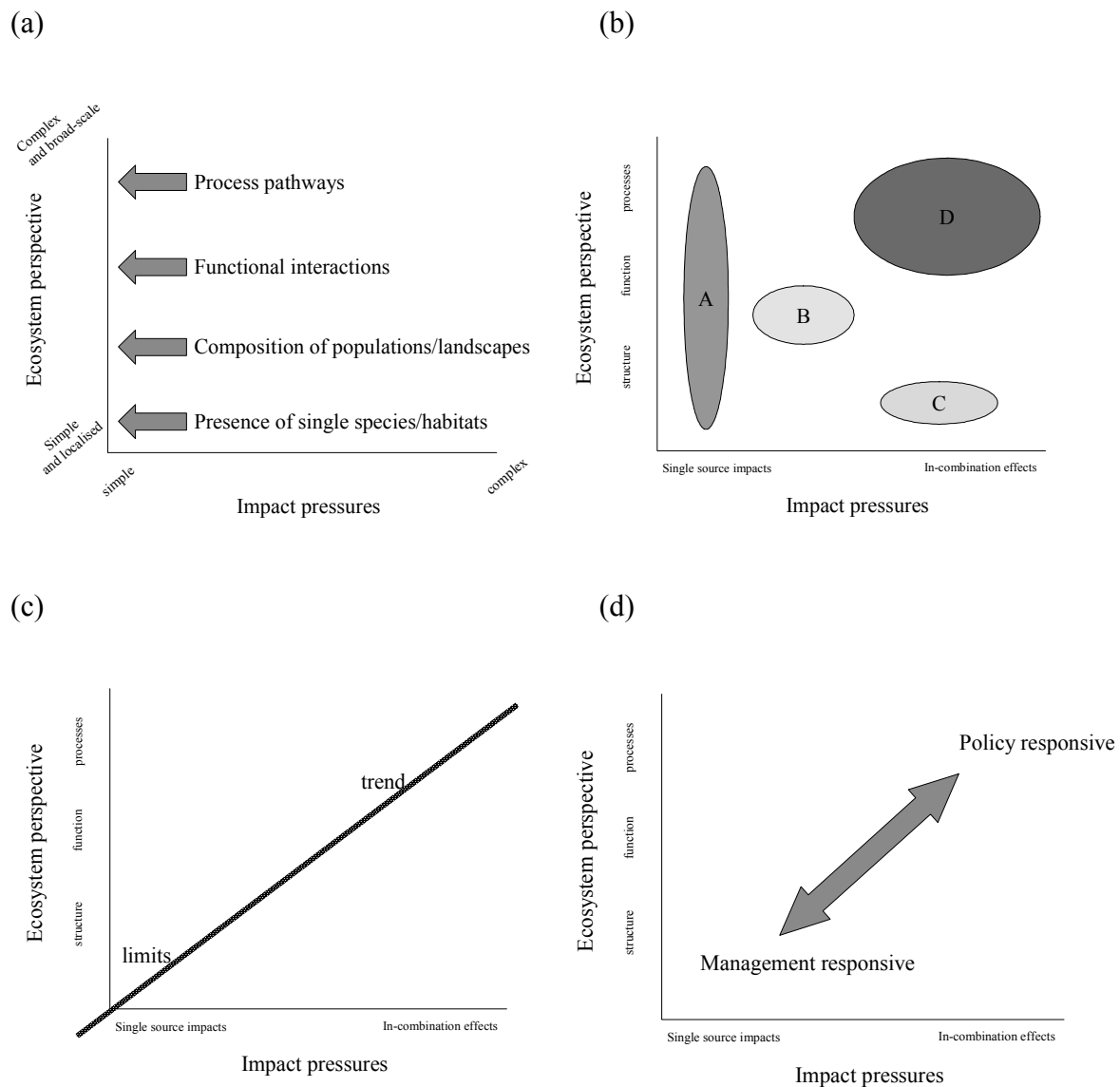
- 11.1 GEnS and MEOs can be made operational now. For the future there is a need to increase our understanding in a number of ‘environmental’/ ‘ecosystem’ areas. Alongside implementing GEnS and MEOs, it is recommended that early attention should be focused on undertaking research, improving knowledge, or making existing knowledge more ‘visible’ on key functional issues. This may include:
  - promoting better join-up across all areas of relevant marine science with policy advisors and managers involved with GEnS and MEOs;
  - invigorating research in key areas of ecosystems where understanding is limited but which are fundamental to ecosystem functioning, for example the role and significance of viruses in marine ecosystems;
  - improving our understanding of ecosystem science, for example the notion of species redundancy, trophic cascades and the associated ‘ripple’ effects through ecosystems; and
  - improving the knowledge base and methodology for some of the less well developed indexes cited in this report.

- 11.2 Alongside this, as indicated above, is the need to consider the statistical approaches and tools that are needed in reporting and assessment processes to interpret results, and what developments are needed in this area.
- 11.3 A key element of improving the information base will be the need to view any attempts at assessing GEnS and MEOs alongside information on impacts of climate change on the marine environment. Whilst careful selection of generic headline indicators may build some of this information into the GEnS and MEO processes, there will be a clear need to consider the assessment of ecosystem health alongside up-to-date knowledge on climate change and surface ocean acidification. This is especially true given the scale of impacts predicted to occur in the next few decades. These impacts are likely to make it necessary for us to develop our ideas on how to set meaningful targets, limits and trends and, ultimately, what ‘success’ may look like in the future. Drawing information together on marine climate change impacts, quality assuring it and presenting it in a easy-to-understand and use format will be critical. The UK’s Marine Climate Change Impacts Partnership and its ‘Annual Report Cards’ will be an essential component to make MEOs operational and a useful model to examine in Europe in relation to applying GEnS.
- 11.4 Within the UK, work could also be taken forward on MEOs to enhance their potential effectiveness by providing a comprehensive user interface to underpin the broad generic objectives provided in this report. This could specifically focus on ecosystem management advice based on the individual marine landscapes mapped at the regional seas scale. This would provide an ideal interface to relate MEOs to marine spatial planning and therefore to enable effective linkages to be made with social and economic considerations.

**Table 1** Examples of the relationship between marine ecosystem organisation and the consequences of human influences.

MEOs and GEnS will need to take a threat-orientated approach, based on human influences to ecosystem structure, function and processes. The predicted broad-scale consequences to regional seas from climate change and surface ocean acidification will necessitate greater emphasis being placed on functional and process aspects of marine ecosystem than may have been the case up to now.

<b>Examples of ecosystem organisation</b>	<b>Examples of human influences</b>
<p><b>Process:</b></p> <ul style="list-style-type: none"> <li>• Energy (carbon)</li> <li>• Nutrients (nitrogen)</li> <li>• Reproductive (genetic)</li> <li>• Physical (water / sediment)</li> </ul>	<p><b>Failure of Key Services:</b></p> <ul style="list-style-type: none"> <li>• Marine climate regulation</li> <li>• Marine food supply</li> <li>• Marine recreation</li> </ul>
<p><b>Functional:</b></p> <ul style="list-style-type: none"> <li>• Competition</li> <li>• Predation</li> <li>• Disease</li> <li>• Recruitment</li> </ul>	<p><b>Impairment of function:</b></p> <ul style="list-style-type: none"> <li>• Trophic shift</li> <li>• Reduction of bioturbation potential</li> <li>• Species recruitment failure</li> </ul>
<p><b>Landscape:</b></p> <ul style="list-style-type: none"> <li>• Landscapes</li> <li>• Communities</li> <li>• Biotopes</li> </ul>	<p><b>Diffuse &amp; in-combination</b></p> <ul style="list-style-type: none"> <li>• Eutrophication</li> <li>• Synergistic effects</li> </ul>
<p><b>Species &amp; Habitat:</b></p> <ul style="list-style-type: none"> <li>• Biodiversity</li> <li>• Single species</li> <li>• Single habitats</li> </ul>	<p><b>Point Source Impacts:</b></p> <ul style="list-style-type: none"> <li>• Single Outfalls</li> <li>• Oilspills</li> <li>• Overexploitation</li> </ul>



**Figure 1** A conceptualisation framework to support the development of GEnS and MEOs.

(a) the main elements of the conceptualisation framework which set ‘ecosystem perspective’ against the complexity of pressures (impacts); (b) the broad conceptualisation of the general focus of current regulatory-based efforts (A), set against some key elements that are also required to assess status/health - (B) species indexes, (C) long-term monitoring of species and species groups (MarClim and SAHFOS studies), and (D) indexes of ecosystem functional and process issues; (c) the relationship between limits and trend information and why the inclusion of trend information is critical to assessing targets for environmental/ecosystem health; (d) the relationship between management actions and broader policy responses, and how both are needed to address any subsequent actions that may be needed as a result of thematic reporting.



**Table 2** An illustration of a possible suite of objectives and headline indicators for MEOs and GEnS to enable reporting on ‘clean, safe, healthy, productive and biologically diverse oceans and seas’ – where safe is interpreted in the ‘environmental’/ecosystem’ quality sense.

GEnS/MEO regional sea objective	Indicator group	Headline indicator sets
<p>Maintain the function and processes of the regional sea at a favourable status</p> <p>‘Status’ is determined through resource assessment at the regional sea scale and is generally taken to be ‘favourable’ when function and processes are stable over the medium to long-term, or are recovering where known to be depressed.</p>	<p>Functions and processes</p>	Trophic index
		Productivity index
		Stratification index
		Bioturbation index
		Acidification index
		Nitrification index
		Water quality index
<p>Maintain the marine habitats and species characteristic of the regional sea in favourable status</p> <p>‘Characteristic’ is taken to be those habitats and species that traditionally occur in the regional sea. ‘Favourable’ is when decline in habitat quality is halted and is being recovered, and where the status of species is viable and stable, or recovering where declines have occurred, so status is within safe limits as defined by best international practice and criteria.</p>	<p>Habitats and species</p>	Small cetacean index
		Seal index
		Coastal bird index
		Fish index
		Sharks, Skates and Rays index
		Plankton index
		Oil pollution indicator
		Seabed disturbance index
		Non-native species index
		Climate change indicator
		Species health index
		Habitats condition Index

**Table 3** An illustration of the headline indicator set addressing structures, functions and processes at the regional sea scale, taking into account significant physiographic, geographic and climatic factors as well as physical and chemical conditions.

If more objectives are required than the two set out below, then it might be possible to assign objectives to the level of headline indicators as given in this table, although this makes subsequent end assessment processes more complex. Objectives and headline indicators can be defined generically but as indicated in the ‘regionalisation needed?’ column, work will be required for practical implementation at the regional seas scale. Inclusion of headline results from the Water Framework Directive and the Habitats Directive reporting illustrate how assessment of GEnS could take into account existing measures required by the Community. It is recognised in providing this table that further detail will be needed to make MEOs fully operational at the regional seas scale in the UK, particularly in linking objectives and indicators to spatially-based management advice, and potentially marine spatial planning.

<b>GEnS/MEO regional sea objective</b>	<b>Headline indicator group</b>	<b>Headline indicator sets</b>	<b>Focus</b>	<b>Regionalisation needed?</b>	<b>Assessment of headline indicator target</b>	<b>Comments</b>
Maintain the function and processes of the regional sea at a favourable status  ‘Status’ is determined through resource assessment at the regional sea scale and is generally taken to be ‘favourable’ when function and processes are stable over the medium to long-term, or are recovering where known to be depressed.	Function and process indexes	Trophic index	Exploited fish species in each regional sea	Yes - species defined by regional sea	Medium to long-term <u>trend</u> – policy and management measures to halt decline and deliver recovery	A ‘Marine Trophic Index’ has been agreed at CBD and with the England Biodiversity Strategy. Technique already defined but standard methodology would need to be developed for adaptation at regional sea level.
		Productivity index	Ocean colour as measured by satellite, ground-truthed with in situ readings	No - can be provided centrally	Deviation from medium to long-term <u>trend</u> – policy measures in relation to agricultural policy and climate (CO <sub>2</sub> emissions)	Remote sensing already provides the basis for this index (eg SeaWifs) but standard methodology would need to be developed to overcome seasonality issues. Latest analysis indicates the ability to link SeaWifs data with SAHFOS long-term data, and so hind cast a long-term trend framework

GEnS/MEO regional sea objective	Headline indicator group	Headline indicator sets	Focus	Regionalisation needed?	Assessment of headline indicator target	Comments
		Stratification index	Numerical index	No – can be provided centrally	<u>Limit</u> via quartile classification based on stability – policy measures in relation to climate (CO <sub>2</sub> emissions)	Stratification of regional seas will be affected by climate change. Index is operable but would need a standard methodology
		Bioturbation index	Index from seabed sampling/observations	Yes – sampling needed	<u>Limit</u> via quartile classification set against reference levels <b>or</b> medium to long-term <u>trend</u> – policy and management measures in relation to fishing impacts and other relevant human activities	Nutrient cycling is critical to the health of regional seas – index would need development but would be based around some measure of large bioturbators in the seabed
		Acidification index	Ocean pH or new ‘calcium’ index	No but would be measured regionally	medium to long-term <u>trend</u> based on pH scale – policy measures in relation to climate (CO <sub>2</sub> emissions)	Just starting to be implemented. Surface Ocean Acidification is a particular threat to the well-being of regional seas. In situ measurements of surface pH are starting to be made through ‘ferrybox’ but the more complex biological ‘calcium’ index would require development.

<b>GEnS/MEO regional sea objective</b>	<b>Headline indicator group</b>	<b>Headline indicator sets</b>	<b>Focus</b>	<b>Regionalisation needed?</b>	<b>Assessment of headline indicator target</b>	<b>Comments</b>
		Nitrification index	Chemical analysis	Yes- regional sampling needed	<u>Limit</u> via quartile classification <b>and/or</b> medium to long-term <u>trend</u>	Nitrification is critical to the health of regional seas. Technique are used that would need a standard methodology to be applied.
		Water quality index	Can be obtained from Water Framework Directive	Yes – regional sampling needed but via Water Framework Directive	Classification of status against <u>limits</u> (reference conditions) – policy measures in relation to agriculture and point-source discharges	Already being implemented – would need headline reporting through from WFD – no additional offshore application considered needed as major issues are near-shore waters or are picked up by other indexes above.
Maintain the habitats and species characteristic of the regional sea in favourable status		Small cetacean index	By-catch of small cetaceans in fishing nets	No – measured in regional seas against generic standard	Avoidance of bycatch threshold – numerical <u>limit</u> – management measures in relation to fishing	Already operated
		Seal index	Seal population trends	No – but data relevant at regional seas scale	Status against medium to long-term <u>trend</u> – pup production ratio	Already operated

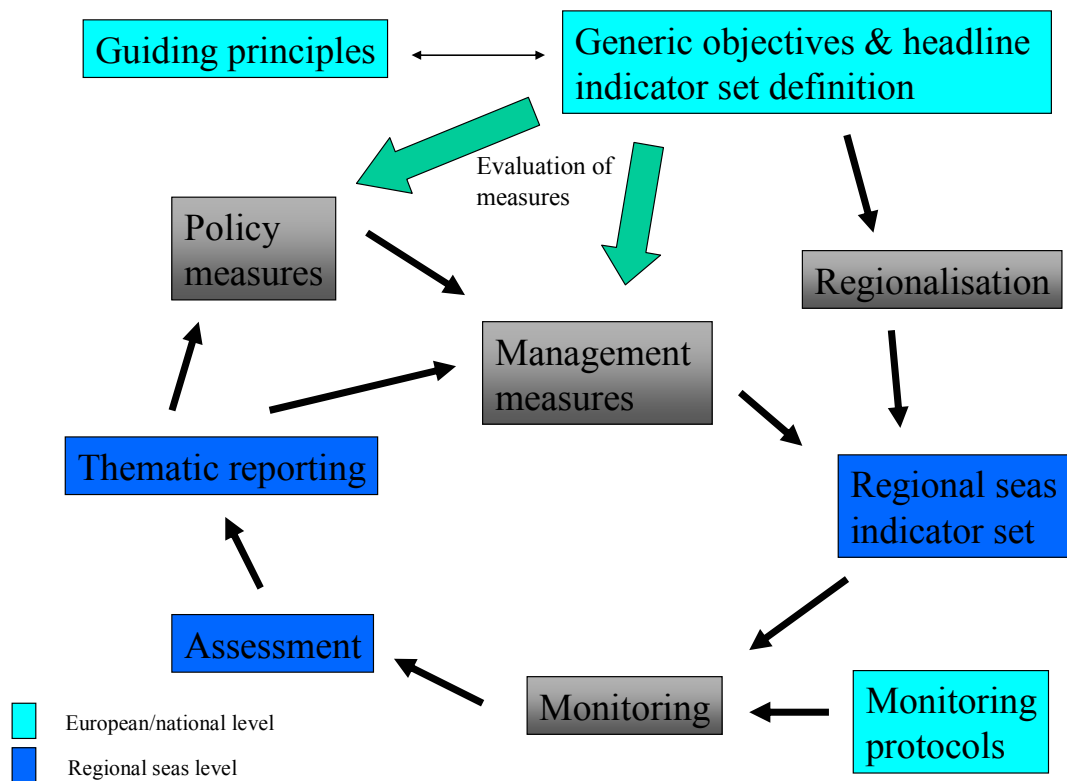
<b>GEnS/MEO regional sea objective</b>	<b>Headline indicator group</b>	<b>Headline indicator sets</b>	<b>Focus</b>	<b>Regionalisation needed?</b>	<b>Assessment of headline indicator target</b>	<b>Comments</b>
<p>‘Characteristic’ is taken to be those habitats and species that traditionally occur in the regional sea. ‘Favourable’ is when decline in habitat quality is halted and is being recovered, and where the status of species is viable and stable, or recovering where declines have occurred, so status is within safe limits as defined by best international practice and criteria.</p>	Habitat and species indicators	Coastal bird index	Status of coastal birds	Yes – species defined by regional sea?	Status against medium to long-term <u>trend</u> – policy and management measures in relation to fishing and climate (CO <sub>2</sub> emissions)	Index already exists? But would need further development
		Fish index	Status of top 10 commercially exploited fish species	Yes – species defined by regional sea	Numerical value as reflection of status set against medium to long-term <u>trends</u> – policy and management measures in relation to fishing and climate (CO <sub>2</sub> emissions)	Index already tested by Cefas. Red List status for all fish species in European seas to be available by 2008/09 through the Global Marine Species Assessment Programme of IUNC/CI

GEnS/MEO regional sea objective	Headline indicator group	Headline indicator sets	Focus	Regionalisation needed?	Assessment of headline indicator target	Comments
		Sharks, Skates and Rays index	Status of species	Yes – species defined by regional sea	Numerical value as reflection of status against medium to long-term <u>trends</u> – policy and management measures in relation to fishing	Index can be easily made operational. Status of all species in these groups completed in February 2006 to IUCN Red List standards
		Plankton index	Status of species	No – centrally gathered by SAHFOS	Status against medium to long-term <u>trends</u> – policy measures in relation to climate (CO <sub>2</sub> emissions).	Already operated detecting climate and regime shifts. Extent of programme may require some expansion to cover all regional seas in a comprehensive manner
		Oil pollution indicator	Quantity of oiled seabirds	Methodology is generic but species used may vary by regional sea	Status against medium to long-term <u>trend</u> – policy and management measures in relation to shipping and other relevant human activities.	Already operated through OSPAR

GEnS/MEO regional sea objective	Headline indicator group	Headline indicator sets	Focus	Regionalisation needed?	Assessment of headline indicator target	Comments
		Seabed disturbance index	Intensity of fishing that impacts the seabed – areas subject to bottom trawling	Can be base on studies of destructive fishing gear by regional sea – sampling/ studies needed	Status of benthic species groups against medium to long-term historic trend, where they exist, or recent baselines where absent.	Bottom fishing by mobile gear inevitably damages the seabed and may reduce the diversity and processes. Whilst commercial fishing continues, greater restrictions to protect area from damage are needed on sustainability grounds, to protect and recover biodiversity and such features as spawning and nursery grounds
		Non-native species index	Numerical abundance and distribution	No - generic but data is regional seas dependent	Medium to long-term <u>trend</u> – policy and management measures in relation to shipping and climate CO <sub>2</sub> emissions).	Climate change will increase the risk of non-natives establishing by improving the favourability of environmental conditions and by removing or modifying barriers (sea ice, current distribution and length of sea voyages by ships) to their introduction.
		Climate change indicator	Distribution of indicator species	No – methodology is generic	Medium to long-term <u>trend</u> – policy measures in relation to climate (CO <sub>2</sub> emissions).	Key focus could be on fish, plankton and intertidal species on known sensitivity to temperature – plankton is covered by index set out above. Methodology and datasets for fish and intertidal species already exist

<b>GEnS/MEO regional sea objective</b>	<b>Headline indicator group</b>	<b>Headline indicator sets</b>	<b>Focus</b>	<b>Regionalisation needed?</b>	<b>Assessment of headline indicator target</b>	<b>Comments</b>
		Species health index	Biomarkers - chemo-physiological health of selected species	No – methodology for defined species can be generic	<u>Trend</u> - health in relation to known reference conditions	In the development phase with approaches being trailed through universities, agencies and funded research programmes
		Habitats condition Index	Can be obtained from Habitats Directive reporting	Yes – regional sampling needed but via Habitats Directive	<u>Trend</u> - condition assessment reporting standards	Already being implemented. – would need headline reporting.





**Figure 2** Representation of a possible process for implementing GEnS and MEOs.

Of particular note is the relationship between the definition of generic headline indicators at the European/national scale and the need for regional application and thematic reporting, and how this fits into a cycle of adaptive policy and management measures. European, national and regional policy and management measures will be required to address any issues that arise as a result of thematic reporting on the regionalised headline indicator set.



### **Developing the concepts of good environmental status and marine ecosystem objectives: some important considerations**

Report Authors: Laffoley, D'd'A, Brockington, S., Gilliland, P.M. Date: 2006

Keywords: Good Environmental Status, Marine Strategy Directive, headline indicators, Marine Ecosystem Objectives, Marine Bill, Ecosystem Approach, ecosystem structures, functions and processes

## **Introduction**

The 2005 proposal from the European Commission for a Marine Strategy Directive has at its core the need to meet Good Environmental Status (GENS). Similarly, in the UK, to underpin the proposed Marine Bill, are proposals for Marine Ecosystem Objectives (MEOs). Both concepts are objective-led processes that seek to define a minimum suite of regionally-relevant headline indicators that allow reporting on state. The difficulty in developing these new policy approaches is that they tend to look to the traditional science base or existing regulatory requirements to service the needs of the new policy. Whilst using existing scientific information is essential, new approaches are required that draw in the best existing science and advice that is available, but that are also more holistic in their efforts to encourage sustainable development. This report sets out some important considerations to create information resources that meet these policy needs.

## **What was done**

The report has drawn together knowledge in English Nature and synthesised these discussions into some important strategic considerations that should be addressed in developing both concepts. These include: the challenges of developing a forward looking framework for assessing ecosystem 'health', with recommendations on a common set of guiding principles to help devise such an approach; providing a simple conceptualisation model to help develop thinking and progress on both initiatives, and illustrating this with some example objectives and headline indicators for assessing GENs/MEOs; and offering some recommendations on reporting and assessment processes. This includes the need for a thematic reporting to underlie the implementation of both concepts, alongside the need to make strong linkages to marine climate change impacts assessments.

## **Results and conclusions**

This report concludes that:

14. Guiding principles and a conceptualisation model are needed to ensure that any proposals for GENs and MEOs are fit-for-purpose – we offer six principles and a simple model to do this.
15. The overall approach to GENs and MEOs should predominantly be threat-orientated ('activity/pressures'), but also ensuring that future regional sea-scale threats to ecosystem

16. quality, structures, functions and processes from climate change and surface ocean acidification are also encompassed.
17. Objectives for GEnS and MEOs should be simple, few in number, established for the regional sea as a whole, and assessed via headline indicators established for various component elements of the regional seas ecosystems.
18. Objectives for GEnS and MEOs should be assessed through a more balanced set, than is currently the case, of headline indicators focussed activity/pressures and the quality, structure, function and processes of the regional sea ecosystem.
19. The use of ‘headline indicators’ will streamline application and end assessment processes across regional seas.
20. A focus on regional sea ecosystem quality, structure, function and processes alongside impact indicators will need to draw in existing work, but will need to extend beyond the well established initiatives (eg from OSPAR) into other areas of relevant work.
21. Target reference points will need to be set for the headline indicators, and a mixture of ‘limits’ and ‘trend’ approaches will need to be used to assess progress.
22. It is difficult to measure ‘ecosystem health’, so any headline indicator set will need to encompass some measure of the diversity of communities and the health of individuals in populations.
23. It is possible to develop a generic set of headline indicators that is relevant across all regional seas. For most headline indicators it would be feasible to develop generic methodologies and, for some, provide central measurements across all regional seas.
24. Climate change and surface ocean acidification make it challenging to set meaningful target reference points, limits and trends, and a development of the current philosophy connected to climate impacts and what will characterise eventual ‘success’ is likely to be necessary.
25. Given the fact that headline indicators need to span ecosystem quality, structure, function and processes, the assessment of status will need to take the form of an integrated assessment.
26. Given the fact that ecosystems respond on different timescales and that considerable inertia may occur, a mixture of activity/pressure, and structure function and process headline indicators will be essential.
27. Assessment of ‘success’ may be aided by the use of a simple traffic light approach.

## **English Nature’s viewpoint**

It is hoped that this advice will be seen as an important contribution towards the current debate and that it will prove valuable to those charged with developing both approaches.

### **Further information**

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Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.  
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