Marine sustainability in an age of changing oceans and seas

European Academies Science Advisory Council

Summary

Introduction

Oceans and seas are essential components of the biosphere. Marine sustainability and human society are intrinsically interlinked. The oceans are crucial for global food security, human health and regulation of climate. The livelihoods of over 3 billion people worldwide depend upon services from marine and coastal biodiversity. Under the European Union (EU) Blue Growth strategy, new marine goods and services, such as marine renewable energy, marine biotechnology and marine minerals, are seen as important sources of employment, economic security and sustainable development.

Over the past 10 years there has been increasing focus on marine and maritime governance both within the European Union and beyond. The fundamental challenge that European policy-makers must address is how to achieve a sustainable use of the oceans that ensures marine goods and services are available for future generations, while meeting the demands of human population and economic growth.

Policy development and implementation for marine sustainability

While we focus in this study on marine and maritime policies, it must be highlighted that ocean absorption of increased atmospheric heat and carbon dioxide resulting from human activities will significantly deepen the challenge of achieving marine sustainability. An intensification of climate change and acidification of the oceans can be expected to have stark consequences for marine biodiversity and productivity at regional and global scales.

The EU Integrated Maritime Policy (IMP) and Marine Strategy Framework Directive (MSFD) already express a determination to use an ecosystem approach for the integrated management of human activities. This provides a key means of fostering marine sustainability. Ecosystem-orientated perspectives are commensurate with the inherently interconnected character of physical, biogeochemical and ecological processes in the sea and human interactions with them. However, the scientific understanding of marine systems is constantly evolving and there remain considerable uncertainties in the basic characterisation of marine ecosystem structure and function and in key physical and biological drivers. Policy-making and policy implementation must recognise these uncertainties and drive efforts to address them.

An effective implementation of the MSFD will be key for ensuring sustainable use of the seas through its use of an ecosystem approach and emphasis on ecosystem health, expressed through the concept of good environmental status. The first steps in implementing the MSFD must be built on and used to strengthen the development of the IMP and the implementation of the EU Directive on Marine Spatial Planning.

The revision of the Common Fisheries Policy must be used as a base for securing an end to overfishing both within EU waters and beyond, and to minimise harmful impacts of fishing on marine ecosystems. Growing populations will demand more food from the seas and further steps are needed to improve the ecological efficiency of marine harvest.

Marine Protected Areas are currently used as conservation tools under the EU Nature Directives, but so far most attention has been on benthic (seabed) habitats. The networking of Marine Protected Areas on the basis of pelagic (water column) connectivity has been little explored as a means to enable recovery of fish stocks and to support good environmental status at sea-basin scale.

EASAC – with support from the European Commission's Joint Research Centre (JRC) – is making the following recommendations for the further development and implementation of policy for marine sustainability.

Climate change

1. Carbon emission mitigation is a prerequisite for the sustainability of marine ecosystems. We, therefore, *emphasise* that European policy-makers must use all opportunities to drive the transformation to a carbon-free economy by advancing measures for carbon emission mitigation, enforcing carbon emission reductions and stimulating alternative technologies.

Implementing ecosystem-based management

2. We *urge* that the ecosystem approach is applied in a holistic manner to strengthen the EU IMP through concerted application of the common

framework of goals for good environmental status under the MSFD. This framework for ecosystem health should be used to achieve a closer integration of EU marine environment, maritime, marine fisheries and marine nature policies.

3. We *recommend* that ecosystem-based marine and maritime governance under the IMP and the MSFD is developed through sustained commitment to a step-by-step adaptive implementation, which:

   - makes use of the best-available current scientific knowledge about marine ecosystems and their dynamics, and tools for understanding influences critical to ecosystem health;
   - is embedded in awareness of uncertainties and limitations in characterising marine ecosystem structure and function and key physical and biological drivers;
   - recognises the complexity and inter-connections in the sea and the limitations in developing scenarios of environmental change;
   - does not delay management action on account of uncertainty but makes appropriate use of precaution to avoid unintended impacts;
   - has real scope and incentive for innovation and improvement taking advantage of constantly evolving scientific knowledge and capabilities;
   - gives increased attention to the role of pelagic habitats and systems in generating functional change within marine ecosystems, including using the concept of cells of ecosystem functioning in the definition of spatial management areas.

Impact assessment and maritime spatial planning

4. We *recommend* an integrated implementation of the MSFD, Marine Spatial Planning Directive and Nature Directives that provides for a coordinated planning and management of the seascape. Spatial and operational management of activities should be based on the goals for ecosystem health at the sea-basin scale developed under the MSFD. Policy-makers and scientists need to work together to define what level of disturbance constitutes too much disturbance. This must also take into account the connectivity of the marine system within and between Member States' marine waters.

5. We *recommend* that independent analysis is needed to inform policy choices that promote specific resource uses or societal behaviours that are linked to the oceans. The uncertainties inherent in these choices should be identified at an early stage and continually reviewed, taking into account information from research and development activities. Policies such as those on deep-sea mining and marine renewable energy development need to be informed by ongoing analysis of the impacts of different policy options that internalise environmental costs and uncertainties and build in new learning.

Towards increased and sustainable ocean harvest

6. We *strongly recommend* that the revised Common Fisheries Policy is used to bring current fisheries exploitation to sustainable levels by ending overfishing and minimising the harmful impacts of fisheries on marine ecosystems. Scientific advice on fisheries management and stock recovery needs to be followed.

7. To anticipate demands for increased food biomass from the sea that will come from human population growth, we *recommend* greater commitment to policy development and knowledge building on how to improve the ecological efficiency of ocean harvest. This includes exploring the potential for ecologically efficient aquaculture and sustainable seafood from species groups from the lower levels in marine food webs.

Networks of Marine Protected Areas

8. We *highlight* that networks of Marine Protected Areas need increased attention as tools within overall ecosystem-based management, including at sea-basin scale. This requires substantially increased commitment to understand water movements and ecological connections between ecologically important and vulnerable areas. This knowledge needs to be built into the development of networks of Marine Protected Areas, which can play a strong role in securing good environmental status.

Organising and focusing marine science to support marine sustainability

EU Research and Technological Development programmes have much important marine science. Horizon 2020 continues this tradition with a strong emphasis on research to support EU policy-making in marine and maritime governance. The IMP has

recognised through its Marine Knowledge 2020 initiative that improved marine knowledge is key for fostering innovation in the marine and maritime economy. These efforts must be continued to realise the ambitions for EU marine data infrastructures and the systematic management of marine data. Horizon 2020 should be used as a key mechanism for improving marine knowledge to support the MSFD and IMP. To support integrated marine and maritime governance a fundamental shift in marine science towards holistic and integrative research is needed. This must combine continued work to characterise and understand ecosystem structure and functioning with the means to characterise ecosystem health and provide scenarios of the environmental, economic and societal impact of different choices in human use.

EASAC and JRC make the following recommendations on organising and focusing marine science to support marine sustainability.

Building knowledge on increasing ecological efficiency of ocean harvest

1. We *recommend* that a major research initiative is urgently initiated into ecosystem-orientated approaches to ocean harvest that can address the demands for increased food biomass from the oceans to meet demographic and economic development. This research should build knowledge to inform options for increasing the overall ecological efficiency of ocean harvest and thereby the sustainable yield from the ocean. These options include examining the potential of sustainable seafood biomass from lower levels in the marine food webs and developing ecologically efficient aquaculture.

Building an integrated knowledge base for marine sustainability

2. We *recommend* the implementation of a sustained European strategy for marine ecosystem observation that incorporates biological observations alongside ongoing physical and chemical programmes. This will fulfil the goals of understanding the state of the environment and its component ecosystems needed to define good environmental status under the MSFD. Biological observations, representative of all trophic layers, should be based on a sustained, long-term network of time series, including observatories at coastal marine research stations, within Marine Protected Areas, and along ocean transects. Oceanic observing sites where the effects of global changes are monitored in a systematic fashion should form an important part of this strategy.

3. We *recommend* that habitat mapping takes into account not only the seabed habitats in the benthic domain but also the habitats in the water column and their dynamics that generate much of the functional changes within marine ecosystems.

4. We *recommend* that the large and diverse datasets assembled by EU data infrastructure projects need to be tested to support knowledge-building across research and operational activities. Concerted efforts are needed to open up access to marine data, so that the benefits of these infrastructures can be realised. Substantial support is needed for efforts to improve the quantity and quality of biodiversity data, such as those relevant for the MSFD, which are scarce compared with other data types.

Science support for marine sustainability

<u>Research set-up</u>

5. *We recommend* that organisational structures for stimulating and funding European marine research programmes should be coordinated to reflect the inter-connectedness of the sea, with a slim administrative structure ensuring effective governance of the programmes and effective cooperation between the projects, the EU Commission and national authorities. Shared funding from European Union and national resources should secure:

   - the possibility to perform research at an international level;
   - effective selection mechanisms ('one-stop evaluation') of international programmes based on quality; and
   - the sustained viability of national marine research by the Member States.

<u>Research priorities</u>

6. We *recommend* that the key priorities for holistic and integrative research include:

   - consolidating the scientific description and characterisation of marine biodiversity, including extending habitat mapping to address habitats in the water column and their dynamics;
   - building comprehensive and coherent ecosystem-based indicators that recognise

interactions between species, habitats and ecological processes, and the work towards a complete realisation of the concept of good environmental status under the MSFD;

- quantifying marine species' interactions and how they adapt to changing conditions in marine environments, including benthic–pelagic coupling;
- developing end-to-end integrated models that characterise socio-economic benefits from the sea, the supporting ecosystems and biodiversity, and the human and natural pressures that threaten them;
- building scenarios that explore future responses of marine ecosystems under anthropogenic and natural forcings and that help to define the controls and limits of ecosystem resilience;

7. To support efforts to mitigate the effects of climate change, we also highlight the need to support research that cautiously considers the potential of marine experimental geoengineering.

Human-capacity building

8. We *recommend* that greater attention needs to be given to developing human expertise in combining and integrating individual marine sciences to support data interpretation. This requires:
   - enhanced training of specialists in key disciplines and steps to ensure their retention as a valued part of the marine science structure.
   - focused training of graduate scientists capable of inter-disciplinary integrative marine science.
9. We *recommend* that a European Marine University is established as a virtual institution charged with leading the development of enhanced graduate education, training and research in inter-disciplinary integrative marine science. The European Marine University should coordinate a coherent and sustained European-wide curriculum and develop harmonised goals for marine science. In support, we recommend that a specific focus of the Erasmus Mundus cooperation and mobility programme should be an interdisciplinary graduate marine research programme that focuses on the issues specified in this EASAC–JRC report.

Science in society

10. We *recommend* that efforts are intensified to develop ocean literacy in Europe, building on the work of the European Marine Science Educators Association. This work must be used to enhance public understanding of the importance of the ocean to mankind as the basis for a better appreciation of the environmental costs of economic development.
11. We *highlight* that to support this:
    - improved information is needed on the current knowledge of ocean issues in the European population to guide ocean literacy and citizen science initiatives;
    - outreach from EU and national research needs to be given more attention during funding decisions, with more emphasis placed on the development of communication and outreach skills.

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