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Farmer, A
Mee, L
Langmead, O
Cooper, P
Kannen, A
Kershaw, P
Cherrier, V

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KnowSeas

Knowledge-based Sustainable Management for Europe's Regional Seas

The Ecosystem Approach in Marine Management

Andrew Farmer[1], Laurence Mee[2], Olivia Langmead[3], Philip Cooper[4], Andreas Kannen[5], Peter Kershaw[6], Victoria Cherrier[7]

Introduction

The Marine Strategy Framework Directive (MSFD) (EU, 2008) seeks a comprehensive approach to delivering protection of marine biota and minimising pollution, while at the same time recognising the needs of society to benefit from marine resources and allowing sustainable use of those resources.

Taking effective management decisions to deliver these disparate objectives requires an integrated systems analysis provided by the Ecosystem Approach (EA). The management framework for marine protection under the MSFD is encapsulated in Marine Strategies which "shall apply an ecosystem-based approach to the management of human activities". This provides the legal foundation for placing the Ecosystem-Based Approach at the heart of this new obligation on Member States for marine management, but no further elaboration is provided.

Understanding the Ecosystem-Based Approach conceptually and how it is to be implemented practically is, therefore, critical for marine managers. However, the Directive does not define the concept and therefore there is the potential for divergent views over precisely what it encompasses and how it is to be made operational. Our basis for tackling these issues is that the Ecosystem-Based Approach cannot be distinguished from, and indeed we consider it synonymous with, the Ecosystem Approach (EA) and other

[1] Institute for European Environmental Policy
[2] Scottish Association for Marine Science
[3] University of Plymouth – Marine Institute
[4] University of Bath
[5] Helmholtz-Zentrum Geesthacht
[6] Centre for Environment, Fisheries and Aquaculture Science
[7] Institute for European Environmental Policy

comparable terms (Box 1). Thus, we draw on sources using the EA and these terms to inform our discussion of the Ecosystem-Based Approach required by the MSFD.

As will be seen below, the EA focuses on understanding the relationship between human society and the ecosystems that support it and how this can inform management decisions. The advantage of this approach is that it offers opportunities for identifying sustainable uses of the sea. This approach, however, requires better understanding of how marine social-ecological systems operate; how they generate services for human benefit; how well these benefits are captured and sustained; how human degradation of the systems affects human welfare and generates costs; and of the complex social relations and value systems underpinning human governance of marine systems. Thus, the concept can underpin the effort to devise clear criteria and mechanisms for making practical decisions on the management of complex marine systems. However, it requires clear definition if its power is to be properly appreciated and deployed, and to overcome any perception that the EA is a 'fuzzy' concept that is difficult to operationalise.

This document explores what is meant by the EA and the systems thinking underlying its application. It also explores the governance challenges of applying the EA in Europe's seas and makes recommendations for its practical use in implementing the MSFD.

Box 1. Different terms for the same concept?

The **Ecosystem Approach** is a term used by the Convention on Biological Diversity (CBD), by the Regional Seas Conventions of OSPAR and HELCOM, by the (EAM) Working Group on 'Guidance to the Application of the Ecosystem Approach to Management of Human Activities' which contributed to the development of the MSFD and, as we shall see, by others such as the Government of Ontario. However, the MSFD uses the term **Ecosystem-Based Approach**. In the US, marine managers and scientists tend to use the term **Ecosystem-Based Management** (COMPASS, 2005). Under the CFP two terms are used – Ecosystem Approach (European Commission, 2009) and Ecosystem-Based Approach (European Commission, 2011) – where the terms are used in the same context and seem, therefore, to be inter-changeable. We can identify no fundamental differences in the different terms that are used and, therefore, consider that each is trying to encapsulate the same systems concept into an easily communicable phrase. Therefore, the lessons learnt from seeking to define and elaborate all of these terms are equally applicable in clarifying the practical application of the EA that we set out here.

EU marine law

Important starting points for understanding the EA concept in the European context are the requirements and objectives of EU law on the marine environment.

Other than its important role within the implementation of the MSFD (described above), references to the EA in EU law are limited to the law embodied in the Common Fisheries Policy (CFP). The CFP has referred to the EA since 2002 (European Commission, 2002). This has recently become more firmly established with the proposal for a new Basic Regulation (European Commission, 2011). Article 2 of the proposal states "the Common Fisheries Policy shall implement the ecosystem-based approach to fisheries management" and Article 5

provides a definition "ecosystem-based approach to fisheries management means an approach ensuring that benefits from living aquatic resources are high while the direct and indirect impacts of fishing operations on marine ecosystems are low and not detrimental to the future functioning, diversity and integrity of those ecosystems".

While this definition is clearly focused on fisheries rather than wider marine management issues, it establishes the idea that the EA incorporates both maximising benefits to humans while minimising degradation of ecosystems arising from such use. – an idea which may therefore be seen as implicit in the Ecosystem-Based Approach of the MSFD. Nevertheless, it is important to note that the 2008 Commission Communication on progress on implementing an ecosystem-based approach (European Commission, 2008a) stated "The general boundaries of an overall ecosystem approach will be defined by identifying good environmental status through the implementation of the [MSFD]". Thus the conceptual approach within the CFP is projected as being limited to that legal framework and the concept set down in the MSFD is acknowledged as appropriate to broader thinking on marine management.

EU law, therefore, sets the foundation for use of the EA in delivering the objectives of the MSFD and the CFP. However, this legislation is not clear about the scope of the EA or how the different elements are to be analysed and coherent decisions are to be reached to deliver these objectives. This document aims to begin to fill this gap.

Other Sources for Defining the Ecosystem Approach

Box 2 provides examples of definitions of the EA (and similar terms), beginning with the CBD and elaborated by a variety of organisations, many focused on marine management. From these definitions it can be seen that there are two important elements of all definitions:

- The EA is a management approach to the environment.
- The EA brings together the human, biological and physical parts of the system for which management action is needed. Definitions emphasise the integration of these elements and the need to consider the processes underlying each element and their interconnectivity.

The EA is not, therefore, an academic activity, but a practical management approach to the whole system.

The definitions also contain other elements specific to their context, for example, the CBD states that the EA promotes conservation and sustainable use in an equitable way (equity being a particular concern of the CBD). These definitions, thus, introduce specific objectives into the definition but other aspects of these definitions are more generally relevant - the EAM definition states that the EA management approach needs to be adaptive, while the COMPASS definition introduces the concept of resilience.

We consider that, to support its general application, a definition of the EA should not include specific objectives (objectives should be added during application to deliver

management objectives and these would need to take account of specific legal obligations or practical constraints). Marine Board-ESF et al. (2010) effectively distinguish between the EA and the 'Ecosystem Approach to Management'. While this might be useful to emphasise that the EA should be applied in practical decision making, we consider that this is inherent in the concept of the EA itself.

It is also important for the definition to ensure as wide as possible an understanding of ecosystem function and the human dimension within it. Finally, the definition should not be prescriptive as to how analyses of the different elements of the EA are to be undertaken or characterised. Such analyses will change as new tools are developed and as practical circumstances allow.

For these reasons, we argue that a simple definition of the EA is most appropriate. Thus we consider that the definition from OMNR to be the most appropriate starting point. It is also fully consistent with the definitions elaborated by other organisations. The KnowSeas Advisory Board agreed, but it also recommended that the Ontario definition be amended to stress that the EA is an approach which is 'integrated', i.e. it does not simply identify the natural and human elements, but brings these together in analysis and decision making. Therefore the definition which we recommend is:

The Ecosystem Approach is "a resource planning and management approach that integrates the connections between land, air and water and all living things, including people, their activities and institutions."

In any given situation, marine managers may identify particular tools appropriate to their application of the EA or use it to optimise system outcomes with specific objectives, such as the requirement to achieve Good Environmental Status under the MSFD.

Box 2. Definitions

CBD (2000): The ecosystem approach is "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Application of the ecosystem approach will help to reach a balance of the three objectives of the Convention. It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems."

OSPAR & HELCOM (2003). The Ecosystem Approach is "the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity".

FAO (2003). The "Ecosystem Approach to Fisheries: "An ecosystem approach to fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries".

EAM Working Group (European Commission, 2004): The Ecosystem Approach is an 'integrated management of human activities in ecosystems, based on the best available science, to achieve sustainable use of ecosystem goods and services and the maintenance of ecosystem health. Management should be adaptive and will take account of environmental variation and change'.

The Communication Partnership for Science and the Sea (COMPASS, 2005): Ecosystem-Based Management is: "an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors".

The Ontario Ministry of Natural Resources (OMNR, undated): the Ecosystem Approach is: "A resource planning and management approach that recognizes the connections between land, air and water and all living things, including people, their activities and institutions."

The EA as a systems approach to management

Marine systems are inherently highly complex. They operate at a wide range of overlapping spatial and temporal scales, are interconnected, heavily influenced by human pressure, often display non-linear cause-effect relationships (some of which may be reversible) and have "memory effects", where the present system state may be a legacy of past practices. These characteristics of marine systems are therefore constituent parts of the conceptual framework of the EA.

The description of the EA provided above highlights its scope and complexity without indicating a specific framework for analysis. A systems approach is a way of understanding complex systems, such as marine social ecological systems. One of the most important steps in this approach is the development of conceptual models which are simple ways of capturing a wide range of peoples' perceptions about how the system works. These allow a dialogue between scientists from different disciplines and non-scientist stakeholders and can capture the dimensions of values, governance, etc. as well as information on natural systems and economics. Sharing an understanding of the EA with key stakeholders is an important step towards achieving a common view of how each system operates and would be a major step towards improved environmental management.

Developing a new interpretation of systems methodology that reflects the comprehensive nature of the EA is a required first step toward the approach. To do this it is necessary for empirical information and metadata (information on data holdings) to be gathered for the system/issues studied. It is also important to understand the whole human bio-physical system from two initial perspectives: (1) how it is perceived to operate (this may involve transferring knowledge through analogy of better-known systems), and (2) what scientific information and data are available about the system. Where there are insufficient data it will be necessary to adjust the modelling strategy to accommodate these data gaps. It is also important to understand that some systems cannot be modelled quantitatively according to well-behaved linear functions, rather they exhibit 'tipping points' (hence a need to consider

resilience in different aspects of the system) or are affected by governance decisions that respond to political rationales, which may be entirely divorced from the scientific viewpoint.

The lessons of systems analysis are, therefore, important in application of the EA. The complexities of the social and bio-physical elements of the marine systems to which an EA is applied do not simply reflect the number of those elements or the multitude of interactions between them. Systems approaches recognise additional complexities and emergent properties of systems and any coherent application of the EA must encapsulate these. Understanding such complexities and emergent properties may be critical in delivering coherent and effective management decisions for Europe's seas.

Implementing the EA: the need for adaptive management

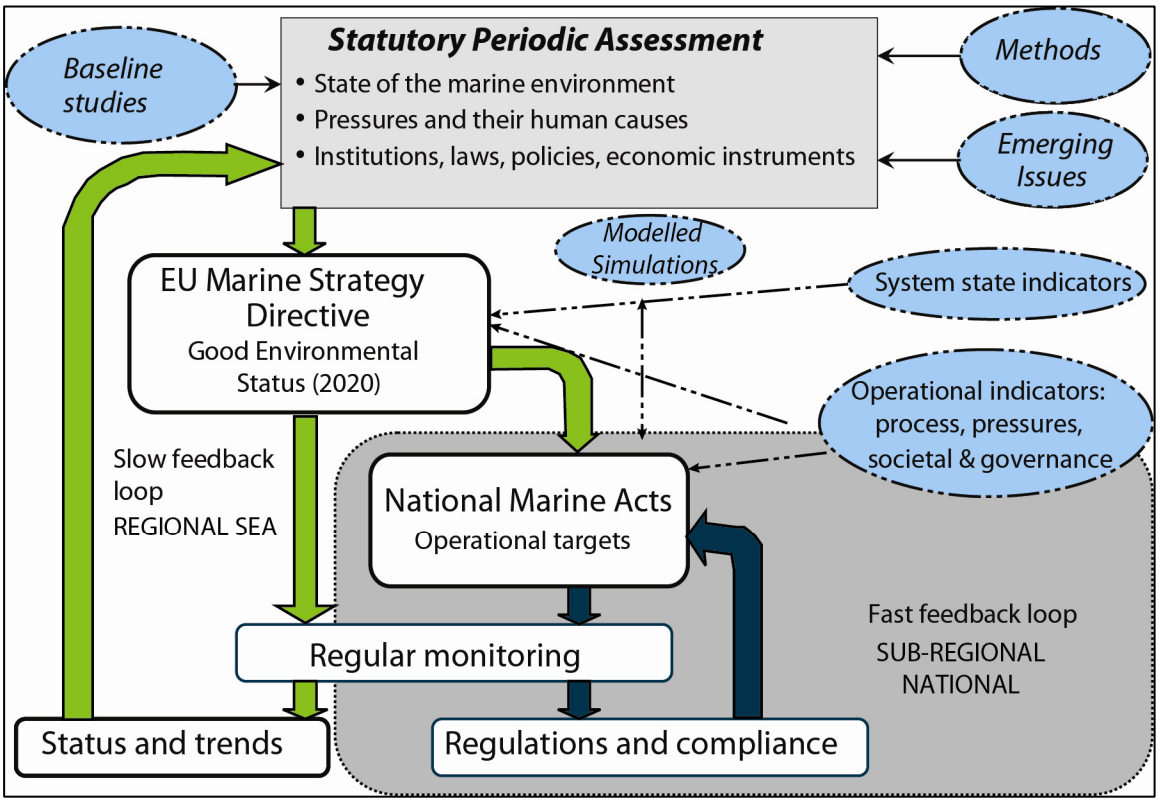
Adaptive management recognizes that long-term management decisions based upon conceptual modelling or knowledge of only a limited part of the system are unwise due to high levels of scientific uncertainty in natural systems (Holling, 1978; Mee, 2005). It offers the opportunity for taking a flexible and pragmatic approach to marine management since it actually treats a system as a management 'experiment', adapting management policies and goals based upon knowledge gained. It is one practical articulation of the EA and is integrated into the MSFD through its cycle of target setting, planning, implementation and review of Marine Strategies. Adaptive management can accommodate unexpected events by encouraging approaches that build system resilience (the capacity of a system to absorb change without losing its basic functionality) (Mee, 2005) for which systems analysis is able to provide an understanding. To do this, it integrates social, economic and ecological knowledge, all essential for development of realistic targets for ecosystem improvement as well as the building blocks for the EA. Thus, good scientific knowledge of the system is crucial in order to reduce management uncertainties and cooperation of all key actors in a marine region in order to achieve the success of an adaptive management plan (Mee, 2005).

Adaptive management sets both a long-term vision (supported by measurable environmental targets) as well as short-term goals (operational targets) for ecosystem improvement. The formulation of the long-term vision and environmental targets is often contentious. Even if consensus is reached on desired ecological states, they are not always achievable (Mee, 2005). For example, it is unlikely that goals based on a return to pristine conditions, even if they were considered socially desirable, could be achieved. so the process has to be forward looking and should rely on a dialogue with stakeholders about what is feasible in the future and how this relates to the maintenance of ecosystem services. This is contrary to top-down management schemes since environmental targets must be understandable by both the general public and stakeholders; and stakeholders are integral in the development of environmental targets and the operational targets needed to meet them (Mee, 2005). Progress towards operational targets and the responses of the socio-ecological system should be continually monitored; this information reduces uncertainty about management outcomes and helps policy makers to define the next management steps (Mee, 2005).

Long-term goals have to be revised periodically as new scientific information becomes available and as social values change. In the MSFD, the goals are Good Environmental Status with a target year of 2020. Figure 2 shows how the step-by-step iterative process of implementing the MSFD works and interacts with the science required to support it. The long-term goals are reached by a stepwise process of setting 'hard' operational targets, often at a sub-regional or national level, in some cases through implementation of other EU Directives.

We argue that adaptive approaches to marine management are essential to the practical application of the EA. The integrated analysis of the different elements of the EA within a systems approach will improve over time as new information and tools become available. Furthermore, new challenges to marine systems will emerge (and some existing ones might diminish). Application of the EA is not, therefore, a 'one-off', but is an iterative process and requires adaptive management approaches, such as those mandated under the MSFD.

Figure 1. The processes for implementing the MSFD and the scientific analysis necessary to support this. A framework for Adaptive Management based on follow-up studies to ELOISE (Mee 2005), showing the relationship between long-and short-term actions and regional and sub-regional scales. Ellipses with hatched outlines show the science support to the process. Note that stakeholder dialogue is essential for agreeing goals and operational targets



Implementing the EA: the governance challenge in a European context

The EA is an approach to environmental management that seeks to bring together ecological, social and economic objectives and decision making into a coherent analytical and decision making framework. This framework needs to be adaptive in its responsiveness and contain the correct tools to deliver robust management decisions. At a theoretical level this presents a number of challenges, such as whether the tools are sufficient and how to bring the disparate elements of an EA together in a robust and acceptable way. However, even if these challenges can be met, the operationalisation of an EA is dependent upon the governance frameworks for the area of the environment to which it is being applied. In the case of Europe's regional seas the governance framework is particularly problematic.

There is no single governance structure for any one of Europe's regional seas, even taking into account the fact that all of the seas have littoral states that are not EU Member States. International governance structures exist, such as the regional seas conventions, the International Maritime Organisation (IMO), etc. Their governance structures vary. However, international structures provide both opportunities and constraints with regard to the EA. Regarding shipping for example, it is difficult for the EU to take decisions outside of the IMO framework. However, if IMO decisions are taken, they provide a more coherent framework for control of vessels not registered in the EU, but transiting EU waters. The enforceability of decisions under the conventions is limited; some have a proven track record for collaborative and integrated analysis and decision making that would be essential within an EA, while others have limited effectiveness.

The main disparity in the governance framework within the EU is the result of the allocation of competencies in the EU Treaty. Certain issues are the competence of the EU (developed through its institutions), some the competence of Member States (each with its own complex competencies) and some are effectively joint competence. Many aspects of economic decision making (though this is changing) and social decision making are the competence of the Member States, though EU spending can influence these. Spatial planning is also a Member State competence. In contrast issues such as off-shore fisheries management are an EU competence. The MSFD is obviously an EU Directive adopted under EU competence, but many of the details of the implementation are Member State competence. A few structures have limited EU competence; the IMO for example, involves those Member States that operate vessels under their flags, but has limited involvement of the European Commission.

Given that the EA requires an integrated analysis and management framework, this division of competence is a major challenge (and this is without the complexities of issues subject to wider international organisations). The approach of the EU to attempt to provide a framework for this decision making in the form of the Integrated Maritime Policy (IMP) (European Commission, 2007) is a positive development and some actions within this (such as improved information provision) will assist this process. However, the IMP has limited influence where governance structures clash.

Fisheries governance is also complex. With a range of EU and Member State/regional bodies involved in objective setting, enforcement, etc., achieving coherence is a major challenge. In

particular, the split competencies between inshore and offshore fisheries present a constraint on integrated systems management. Of course this is only a sub-set of marine management, but it demonstrates the difficulties of taking forward the EA.

Different bodies at different governance scales with different constituent interests are all involved, each making, or contributing to, decisions affecting Europe's regional seas. Furthermore decision making within a marine region is spatially fragmented. None of the decision making bodies has competence to make fully integrated decisions based on the EA.

It is also important to note that where governance for a specific issue is located at one governance level this does not mean that there is a coherent approach to integrated decision making. Two examples illustrate this.

The CFP is the competence of the EU. There is also competence at EU level with regard to the MSFD, such as setting the broad legal framework, supporting Decisions, interpretations of the European Court of Justice, etc. However, this does not mean that the decision making regarding the MSFD and CFP, at EU level, is necessarily coherent and consistent. While the main institutions (Commission, Parliament and Council) are common governance elements to both policies, the Directorates General, Parliamentary Committees and Council formations differ between them. This has not, in the past, lent itself to consistent decision making and, even with the general framework of the IMP in place, inconsistency of approach is likely to continue. In particular, the relative importance of the environmental, social and human dimensions of the EA will likely continue to be viewed differently by these bodies, as will the conclusions of analyses of these issues.

Where decision making is undertaken within a Member State, this also does not mean that such decisions are coherent and consistent. Overall plans, economic plans, local community development, decisions on controlling pressures, enforcement action, etc., all may be undertaken by different organisations at different governance scales (and this includes temporal scales as different structures set their own balance between long and short term interests). The degree of co-operation and co-ordination between them will vary. Local decision making will always have a different perspective from national decision making. Thus the challenge remains in bringing together a coherent analytical and decision making approach to the EA for marine waters. One potential approach to providing a more coherent management framework is explored in the following section.

In an ideal system, the EA should encompass a comprehensive and integrated analysis of marine systems leading to clear objectives for different parts of the human and biophysical parts of the system and set out the management decisions necessary to achieve these. EU governance is a challenge to delivering this. The MSFD recognises this. Effectively, it requires the first part of the EA – the need for a comprehensive and integrated analysis of marine systems as well as objective setting. However, in developing Programmes of Measures in Marine Strategies it recognises that some decisions are not the competence of Member States. Where decisions are made outside of the competence of Member States (e.g. within the CFP), then expectations and decisions may need to be revised. This would form a critical element of the adaptive management character of Marine Strategies.

Marine/Maritime Spatial Planning (MSP) as a tool for Marine Governance

MSP has emerged as a relatively new instrument for managing the increasing diversity of marine uses. According to UNESCO-IOC Marine Spatial Planning Initiative, MSP is defined as a "public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process" (UNESCO, undated). In this sense MSP is understood as a normative approach to the development, ordering and securing of space (Douvere & Ehler, 2009). As some applications of marine spatial planning go beyond internal waters and territorial seas, international legal frameworks such as the UN Law of the Sea (UNCLOS), international conventions such as the Convention on Biological Diversity (CBD) and international policies, e.g. on fisheries, may also need to be considered (Maes, 2008).

In Europe MSP is promoted by the EU Integrated Maritime Policy (European Commission, 2007). Subsequently, in 2008, the Commission adopted a Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU (European Commission, 2008b). The Commission views MSP as a potentially important tool for Member States to support certain aspects of MSFD implementation, including cross-border coordination of Marine Strategies, links between the spatial measures of the MSFD and the implementation of other objectives, such as the Birds and Habitats Directives. The focus of MSP defined in this manner is to resolve potential human use conflicts and there is a clear need to set this in the wider context of the EA .

As stated in the BaltSeaPlan Vision 2030 for the Baltic Sea MSP, it needs to be noted that in practice "MSP is pro-active and future oriented. It delivers the desired outcome of sustainable socio-economic development within a healthy marine environment by balancing all relevant interests in a fair and unbiased manner" (Gee et al., 2011). MSP therefore is not an environmental planning measure, but an integrated one, which aims for "optimizing sea use and ensuring the integrity of the ecosystem at the same time" (Gee et al., 2011) based on the recognition of environmental, economic and social goals formulated by society.

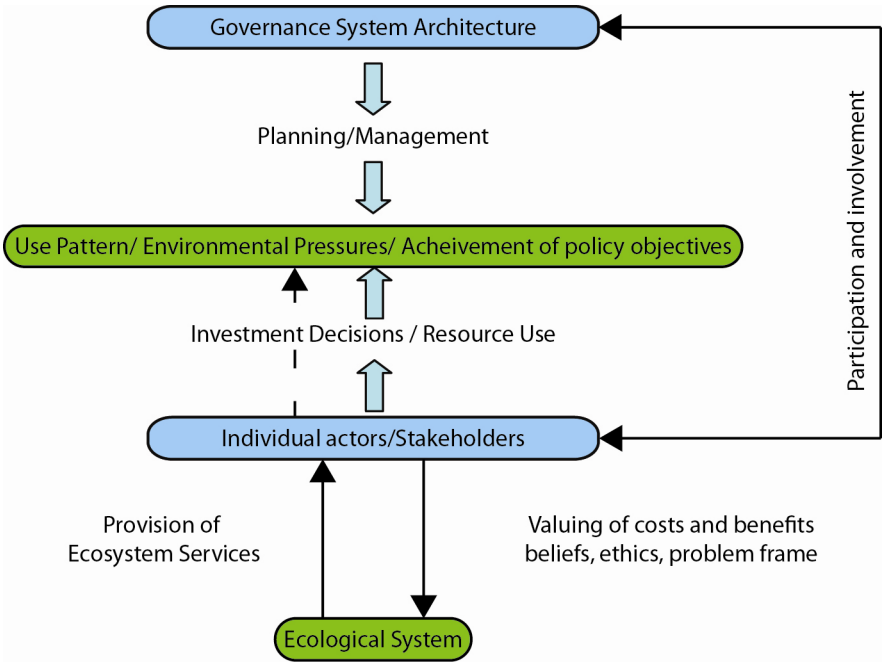
However, what needs to be noted for nearly all of the European Regional Seas is the need for transnational cooperation in MSP (as in environmental planning and Directives such as the MSFD). BaltSeaPlan has developed a vision for MSP in 2030 for the Baltic Sea space (Gee et al. 2011), including three key principles:

- Pan-Baltic Thinking, which requires MSP to take a holistic approach, putting long-term objectives first, be guided by formulated objectives and targets, recognise spatial differences between different regions, fair distribution of advantages and disadvantages of human sea use and harmonisation of sea space planning and adjoining terrestrial areas;
- Spatial Efficiency, which implies the promotion of the co-use of multiple activities within sea areas, avoidance of the use of the sea as repository for problematic land uses and priority for immovable sea uses and functions; and
- Connectivity Thinking, focussing on the connections that exist between areas and linear elements, e.g. shipping lanes and ports, connections between habitats, breeding grounds and feeding grounds (e.g. blue corridors and migration routes).

Figure 2 explores some key interactions which conceptually frame the development of spatial sea use patterns and the application of MSP from a governance perspective and which encompass the conceptual and decision making framework of the EA. Ecological systems provide ecosystem services, which are used by individual actors or groups of the society based on their personal trade-offs, including costs and benefits, but also beliefs, personal values, ethical considerations and their individual perception of issue and area (Kannen et al. 2010). Together with existing regulations, jurisdictions and planning restrictions (as noted in the previous section) their decisions affect the existing use pattern in the particular marine area, the resulting environmental pressures and finally the environmental status.

In one or other way actors and stakeholders are participating in and/or influencing the governance system (as participants in discourses, lobbying, involvement in networks etc.). The reaction of the governance system in terms of planning and management (using MSP as a core instrument of planning) is framed here as a collective or institutional activity, not an individual activity because even though a single authority might have the administrative responsibility, many actors can influence this decision making process. Different forces can dominate the rules and the tools applied, including statutory planning regulations, market forces and civil societal demands. The value of ecosystem services depends on how they are perceived by people and institutions and the resulting recognition by policy makers and stakeholders, who influence the relevant discourses and directly or indirectly decision making within governance systems. These discourses and decision making are reflected in MSP and are integral to application of the EA. For example, in many cases different stakeholders might have conflicting views concerning tradeoffs, which are explicitly or implicitly made in planning and management decisions. Furthermore, the costs and benefits of ecosystem services might be compromised in the recognition of many stakeholders with culture, tradition as well as moral and ethical values (see e.g. Gee, 2010).

Figure 2. A basic conceptual model describing relevant interactions for governance of social-ecological systems (Kannen et al. 2010).



Conclusions

This document has examined the principles and concepts underlying the EA and the challenges and opportunities of its implementation in a European marine governance context. It can be seen that there is some divergence of views on the nature of the EA, although there is probably consensus on fundamental principles. Application of the EA requires a systems approach to marine management and the management framework needs to be adaptive to changing information, tools, objectives and challenges. Practical application of the EA has to reflect the opportunities and constraints of Europe's marine governance, although integrated approaches such as MSP provide one possible way forward in some circumstances.

Effective application of the EA requires detailed analysis of many different aspects of the human and bio-physical aspects of marine systems and the relationships between them. There are many tools in place to assist in this and new ones will need to be developed. An extremely useful analysis of the tools and approaches appropriate to different aspects of marine systems is provided by Marine Board-ESF et al. (2010).

Even with a robust analytical framework, the fragmented governance framework for marine management presents a significant challenge in implementing an EA. However, the number of actors involved also presents an opportunity if their interests and expertise can be brought together in an integrated approach to managing our regional seas. The effective application of MSP will assist in this process and principles such as those developed in the BaltSeaPlan vision may help with transnationally coordinated implementation.

In conclusion, there are a number of issues or challenges for marine managers to addressed in applying the EA:

1. Identifying the range of elements of human and bio-physical systems necessary to ensure a coherent comprehensive understanding of the EA in Europe's regional seas.

2. Identifying the types of information necessary to assess the characteristics (e.g. scale, trends) of each of the elements and whether the data are available, in the right format.

3. Determining the nature of the interaction(s) among these elements and performing a systems analysis of the whole, in particular understanding system complexities and emergent properties and how these may change over time so as to inform an adaptive management approach.

4. Identifying the types of information/data necessary to understand and analyse these interactions and systems processes and the tools (e.g. models, statistical procedures, etc.) to support understanding and analysis.

5. Determining the consequences of application of the EA for governance structures for the marine environment and, conversely, the limitations of those governance structures for applying decisions arising from application of the EA.

6. Determining the most effective way to involve stakeholder representatives in the systems analysis and to communicate the results to stakeholders in order to inform the decision making process.

Finally, we wish to stress that the EA, achieved through Adaptive Management, is an iterative process. The current first iteration requires Good Environmental Status to be achieved by 2020 and by that time important lessons will be learned for setting new goals for the second iteration. The incomplete information currently available will require considerable pragmatism during the first iteration, but it also provides an opportunity to test and refine methodologies that will enable a more robust use of systems science in the future. With each iteration, more information should become available to demonstrate that human use of Europe's marine environment has become increasingly sustainable.

References

CBD (2000). Conference of the Parties. COP 5 Decision V/6. Convention on Biological Diversity.

COMPASS (2005). COMPASS Scientific Consensus Statement on Marine Ecosystem-Based Management. 21 March 2005.

Douvere, F. & Ehler, C. (2009). New perspectives on sea use management: Initial findings from European experience with marine spatial planning. Journal of Environmental Management 90: 77-88.

European Commission (2002). Communication from the Commission setting out a Community Action Plan to integrate environmental protection requirements into the Common Fisheries Policy. COM(2002) 186, 28.5.2002.

European Commission (2004). Guidance to the application of the ecosystem approach to management of human activities. Report of the Working group on the Ecosystem Approach to Management. European Commission, Directorate-General, Environment: Brussels.

European Commission (2007). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. An Integrated Maritime Policy for the European Union. COM(2007) 575, 10.10.2007.

European Commission (2008a). Communication from the Commission to the Council and the European Parliament: The role of the CFP in implementing an ecosystem approach to marine management. COM(2008) 187, 11.4.2008.

European Commission (2008b). Roadmap for Maritime Spatial planning: achieving common principles in the EU. COM(2008)791

European Commission (2009). Green Paper. Reform of the Common Fisheries Policy. COM(2009)163, 22.4.2009.

European Commission (2011). Proposal for a Regulation of the European Parliament and of the Council on the Common Fisheries Policy. COM(2011) 425, 13.7.2011.

EU (2008). Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

FAO (2003). Technical guidelines for an ecosystem approach to responsible fishing. FAO, Rome.

Gee, K. (2010). Offshore wind power development as affected by seascape values on the German North Sea coast. In: Land Use Policy 27(2) pp 185-194.

Gee, K, Kannen, A, & Heinrichs, B (2011): BaltSeaPlan Vision 2030 for Baltic Sea Space. Hamburg, Autumn 2011.

Holling, C.S. (ed) (1978) Adaptive environmental assessment and monitoring. Wiley, New York.

Kannen, A, Gee, K, & Bruns, A.: Governance Aspects of Offshore wind Energy and Maritime Development. In: Lange, M., Burkhard, B., Garthe, S., Gee, K., Lenhart, H., Kannen, A., Windhorst, W. (Eds.) (2010). Analysing Coastal and Marine Changes – Offshore Wind Farming as a Case Study: Zukunft Kueste – Coastal Futures Synthesis Report. LOICZ R & S Report No. 36, pp 170-190.

Maes, F. (2008). The international legal framework for marine spatial planning. Marine Policy. 32: 797-810.

Marine Board-ESF, ICES & EFARO (2010). Science dimensions of an Ecosystem Approach to Management of Biotic Ocean Resources (SEAMBOR). Position Paper 14.

Mee, L.D. (2005) Assessment and monitoring requirements for the adaptive management of Europe's regional seas. In. Vermaat, Bouwers, Turner and Salomons (Eds) Managing European coasts: past, present and future Springer, 227-237.

OMNR (undated). Glossary. Ontario Ministry of Natural Resources. http://www.mnr.gov.on.ca/en/Business/FW/2ColumnSubPage/STEL02_168425.html

OSPAR & HELCOM (2003). Statement on the Ecosystem Approach to the Management of Human Activities. Towards an Ecosystem Approach to the Management of Human Activities.

UNESCO (undated). Marine Spatial Planning Initiative. http://www.unesco-ioc-marinesp.be/