Chapter 5
The Ecosystem Management Approach: Implications for Marine Governance
Monica Hammer

Introduction

Large marine ecosystems, including the four regional seas in Europe, provide an array of ecosystem services important to human well-being, such as fish production, nutrient cycling and recreation (Daily 1997, MA 2005). However, the effective functioning of marine ecosystems required to sustain these services is challenged by a range of human activities resulting in a complex mix of effects on the ecosystem (Costanza et al. 1998, Duda and Sherman 2002). To meet these challenges, natural resource management of marine ecosystems has changed considerably throughout the twentieth century. The oceans and seas were long considered to be vast and inexhaustible frontiers (Regier and Baskerville 1984, Hanna 1997). However, the post-war development with the intensive use of natural resources resulting in overexploitation and degradation of marine systems altered this view. For example, dramatic decline in some marine species as a result of over fishing provide striking examples of failed management, which partly result from a lack of knowledge, but also from inadequate governance institutions (Hammer et al. 1993, Pauly et al. 1998).

In the latest decades, new perspectives in ecological science, such as the recognition of the importance of periodic natural disturbances in ecosystems, along with changing social and economic conditions has altered governance perspectives. The traditional ‘command-and-control’ management approaches aim primarily for technical-economic organization and rely on good knowledge of the system and a high probability of regulating its behaviour (Holling and Meffe 1996). However, these approaches are not tailored to cope with the processes and dynamics of complex marine social-ecological systems (Scheffer et al. 2001, Folke et al. 2004).

At least three main reasons can be identified for the failure of traditional management: a focus on individual sectors or objectives, mismatches of administrative and ecological scales and boundaries, and overlooking the significance of ecosystem services and their life-supporting ecosystems in decision-making. The scope of what constitutes an environmental problem has broadened from a relatively narrow framing of management problems to ecosystem-based, multi-dimensional approaches which include ecological
as well as social and economic dimensions. An illustrative example of this
development is the Helsinki Commission Joint Action Plan (JCP) from 1992
and the recent HELCOM Baltic Sea Action Plan (BSAP) from 2007. While the
key part of the first Helsinki Action plan in 1992 was a list of hot spots, typically
consisting of pollution point sources, the Baltic Sea Action Plan formulated
fifteen years later instead focuses on sustainability and an ecosystem approach
to management, involving stakeholders and adaptive management (Hassler et
al. 2011). Hence, ecosystem management has slowly evolved by integrating
an increasing understanding of the dynamics of ecosystems, including the role
of humans, as well as changing societal priorities. Ecosystem management
approaches can be seen as a bridging concept linking human and ecological
systems, where the combination of ecological understanding and knowledge of
human systems provide a common governance framework for the integrated
social-ecological system (Berkes et al. 2003, Walker et al. 2004, Chapin III et
al. 2010).

The scientific base for an ecosystem approach to management is now strong
enough to be widely accepted in polices for governing marine systems (CBD
Rationales for ecosystem management include the need to jointly address
complex environmental problems, risks, and uncertainty in marine systems such
as fish stock depletion, hazards emanating from mixtures of different chemicals
and the long-term effects of nutrient overload. It provides a framework to
address interdependencies between a targeted natural resource, the ecosystems
providing the resource, and the trade-offs made by a complex human society.
For example, the EU Marine Strategy Framework Directive (MSFD) aims to
minimize pollution and protect marine life, while at the same time recognizing
that society’s use of the natural resources provided by the marine system must
be sustainable. Effective management decisions to deliver these disparate
objectives requires an integrated systems analysis that could be facilitated by an
ecosystem approach to management as described in the MSFD marine strategies
(EU 2008).

Ecosystem management approaches are now also featured in a number of
other marine policy and legal documents in the EU and elsewhere (European
the MSFD does not define the concept and there can be different views of what
ecosystem management encompasses and how it should be made operational.

Hence, there are still challenges regarding how ecosystem management
should be interpreted and implemented in practice. In this chapter, based on
a review of selected scientific literature and policy documents, I present an
overview of ecosystem management perspectives and analyse how ecosystem
management of marine systems is understood. Further, I examine and exemplify
how ecosystem management plays out in European marine governance and
discuss the main future challenges for implementation and development of this
approach.

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What is Ecosystem Management of Marine Systems?

Since the early 1990s, many definitions of ecosystem management, ecosystem-based management, or the ecosystem approach, both marine (e.g. Pikitch et al. 2004) and generic (Christensen et al. 1996, CBD 1998, 2004), have emerged. The definitions vary in their focus and comprehensiveness (Arkema et al. 2006, Meffe et al. 2002, Pitcher et al. 2008, Curtin and Prellezo 2010). For example, a narrow definition of the concept focuses on the effects of fishing on non-target species or other food web related issues (Pickitch et al. 2004). A broader view of ecosystem management includes both sustainability of natural resources, the recognition that these resources depend on a functioning ecosystem and the interdependencies with human society. For example, the UN Convention on Biodiversity (CBD) has adopted the ecosystem approach as the main framework for conserving biodiversity. The ecosystem approach in CBD is defined as, ‘a strategy for integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way’, whilst also emphasizing the economic and social aspects of the human system (CBD 2004).

A set of twelve principles, the Malawi principles, has been developed to further define the ecosystem approach according to CBD (CBD 1998: Table 5.1). These principles stress a management focus on functional relationships and processes in ecosystems, where benefit sharing should be enhanced, in particular among stakeholders. Adaptive management practices, including flexibility and learning are called for as change and uncertainties are inherent in social-ecological systems. The CBD guidelines also underline that ecosystem management needs to recognize the diversity of social and cultural factors affecting natural resource use. Further, management actions should be carried out at the scale appropriate to the issue at hand: including increased inter-sectoral communication and cooperation at a range of levels with decentralization to the lowest appropriate level. Stakeholder involvement, adaptive management and decentralization, when necessary, are key to the successful and sustainable management of social-ecological systems in this framework (CBD 1998, 2004). In systems such as the EU regional seas, where there are multi-level management arrangements as well as significant interdependences between resource users, joint management approaches involving stakeholders in some form of collaborative management is called for in the MSDF, the WFD, as well as HELCOM and OSPAR (Pinkerton 2009, Wilson et al. 2003, Hammer et al. 2011).

The concept, ecosystem approach, as used by CBD has been taken up by, inter alia, the Regional Seas Conventions, OSPAR, for the North East Atlantic and HELCOM for the Baltic Sea. The EU Marine Strategy Framework Directive uses the term ecosystem based approach and under the EU Common Fisheries Policy (CFP) both the terms ecosystem approach and ecosystem-based approach are used and seemingly inter-changeable (European Commission, 2009, 2011). Further, Arkema et al. (2006), reviewed the terminology used in 18 selected definitions of ecosystem management and evaluated the overlap and differences in how the
Table 5.1  The Malawi principles for the ecosystem approach in the UN Convention on biodiversity (CBD, 1998, 2004)

1. The objectives of management of land, water and living resources are a matter of societal choices.

2. Management should be decentralized to the lowest appropriate level.

3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

4. Recognizing gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem management programme should:
   a. Reduce those market distortions that adversely affect biological diversity;
   b. Align incentives to promote biodiversity conservation and sustainable use;
   c. Internalize costs and benefits in the given ecosystem to the extent feasible.

5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

6. Ecosystems must be managed within the limits of their functioning.

7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

8. Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

9. Management must recognize that change is inevitable.

10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

11. The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.
concepts ecosystem management, ecosystem-based management and ecosystem-based fisheries management were defined and found no principle differences regarding how the terms were used.

The ecosystem approach does not preclude other management approaches, such as the conservation of biosphere reserves or integrated coastal management, but could rather integrate them to deal with complex situations and trade-offs on a local, regional or global scale. A concept used in relation to ecosystem management literature is ‘integrated management’ (Garcia et al. 2003, de la Mare 2005). The ecosystem management and integrated management concepts can be seen as complementary in that they share many similar principles even though they have different emphases. Integrated management has typically focused on accommodating multiple sector activities to sustainably develop coastal and ocean areas. Ecosystem management, on the other hand, has its focus on the maintenance of ecosystem services and functions in complex marine ecosystems.

**Marine Ecosystems as Complex Adaptive Systems**

Ecosystem management ideas have a strong foundation in ecological research, and have been discussed since at least the early 1950s (Jansson 1972, Grumbine 1994, Elmgren 2001). From an ecological perspective, ecosystem management as a systems approach takes into account the full array of organisms and processes that characterize and comprise the ecosystem. It treats a target resource, such as a commercial fish species as an inseparable component of a complex network of processes and functions at different spatial and temporal scales (Christensen et al. 2003, Dale et al. 2003). It focuses on the capacity of ecosystems to sustain the delivery of natural resources and ecosystem services for human well-being and the capacity of society to cope with, adapt to and shape change (Holling 1973, Folke 2006).

In particular, the development of systems ecology and the theory of ecosystems as complex adaptive systems with inherent uncertainty and possibilities of threshold effects and multiple equilibrium states have been important (Holling 1973, Levin 1998, Levin and Lubchenco 2008). The understanding of how to address resilience, referring to the capacity of a system to absorb disturbance and reorganize while undergoing change, does then become key to sustainable governance (Gunderson and Holling 2002, Walker et al. 2004). The external conditions of particular ecosystems (e.g. climate, inputs of nutrients or toxic substances, harvesting of fish and shellfish and habitat fragmentation) often change gradually over time and decrease system buffer capacity or resilience (Scheffer et al. 2001, Folke et al. 2004). As a result of such gradual long-term loss of resilience, ecosystems may shift abruptly to alternative states. In the Central Baltic Sea for example, an ecological regime shift was considered to have taken place in the late 1980s. Overfishing, eutrophication and climate change diminished the cod fish stocks leading to a change in ecosystem structure from a cod to a sprat dominated food web in the Central Baltic Sea which resulted in
decreasing cod fish catches (Möllmann et al. 2009, Österblom et al. 2010). Hence, ecosystem management for large marine ecosystems requires a consideration of the food web and how this in turn affects ecosystem functioning, as well as the role of human activities.

In large marine ecosystems such as the regional seas in Europe, a number of environmental problems and risks involving uncertainty and ecological complexity can be identified such as the complex pattern connected to fisheries as exemplified above, even though the character of the individual problems varies substantially (see e.g. Gilek et al. 2011). Eutrophication, risks of chemical pollution and overfishing can be found in all European regional seas. Uncertainty exists in all these problems to various degrees and implies that future consequences cannot be fully predicted. In such cases, adaptive and flexible management practices are needed. Adaptive management is an approach designed to address inherent uncertainties in a system’s response to different management changes. It emphasizes management as a process of learning through monitoring the response from the ecosystem of a particular human action (Holling 1978, Folke et al. 2005). Adaptive governance in turn describes the governance process whereby feedbacks are addressed through collaboration and cooperation between different levels of government, non-governmental actors and individuals. In particular, adaptive governance is a process of resolving trade-offs and identifying a vision and direction forward (Boyle et al. 2001, Folke et al. 2005).

Marine ecosystems simultaneously produce a number of different ecosystem services that interrelate in various ways. A key challenge in ecosystem management is determining how to manage multiple ecosystem services and trade-offs between different management priorities across sectors (Bennett et al. 2009, Raudsepp-Hearne et al. 2010). For example, Atlantic salmon (Salmo salar) spawn in several rivers tributary to the Baltic Sea and are composed of numerous, genetically distinct local populations. The salmon migrate hundreds of kilometres in the Baltic Sea, during which time both offshore, coastal commercial as well as recreational fisheries exploit them. During the 20th century, most of the wild salmon populations in the Baltic Sea disappeared and the remaining ones were greatly depleted. This was mainly a result of over fishing and freshwater habitat degradation, in particular as a result of hydropower development limiting the salmon migration up the rivers to their spawning areas (Karlsson and Karlström 1994). In addition, high dioxin levels in salmon, has resulted in national dietary advisories for human consumption of Baltic salmon in several coastal countries (ICES 2006). Also, the trade-off between the interests of salmon fisheries and conservation policies directed towards Baltic seal populations has led to an increase in the seal population, which, in turn, has increased predation on coastal fish including salmon (Lunneryd et al. 2004). Wild salmon in the Baltic Sea contribute to a range of ecosystem services but are also affected by a number of different factors. Some of these are directly related to salmon fisheries, but also to other land-based human activities or changes in the supporting ecosystem.
affecting the fish stocks (which are more or less anticipated by managers) (Hammer 2009). Hence, in order to manage marine ecosystems services, their interrelations and the linkages between terrestrial and aquatic ecosystems in the drainage basins needs to be considered. This is apparent in, for example, the EU Water Framework Directive that adopts a drainage basin perspective to water management (European Commission 2000).

In summary, key aspects of ecosystem management relevant to the governance of marine ecosystems in Europe would include: a broader system-wide perspective, integrating ecological and human systems and boundaries, emphasis on the functioning of ecological systems, acknowledgement of uncertainties and risks in complex systems, integration across various spatial and temporal scales, and adaptive, flexible management processes and decision-making.

**Institutional Frameworks for Ecosystem Management**

The ecosystem approach puts new demands on management institutions at local, national and regional levels in Europe. These challenges consist of moving from governance based on geopolitical boundaries to governance based on ecosystem boundaries, which necessitates coordination, and multi-level collaboration across states and sectors, increased stakeholder participation and a capacity for adaptive co-management (Olsson et al. 2004, Nilsson and Langaas 2006, Hammer et al. 2011).

Over the last three decades, a number of steps consistent with moving towards a broader ecosystem approach in governance of marine resources can be identified in various policy frameworks and legal agreements as exemplified in Table 5.2.

Recent international legislation at the EU level, in particular the EU Marine Strategy Framework Directive (MSFD) (European Parliament, 2008) and the EU Water Framework Directive (WFD) (European Parliament, 2000) are important regulating factors in developing sustainable ecosystem governance of marine systems at the regional level. Prior to the MSFD and the WFD, legislation tended to focus primarily on a single activity or issue and national environmental policies dominated. Currently, there is a transformation towards the dominance of cross-border cooperation and transnational networking reinforced by the recent enlargement of the EU (Kern and Löffelsend 2004).

The MSFD is the first piece of legislation applied across Europe’s regional seas that requires assessment of the range of issues that should encompass overall marine environmental sustainability (Breen et al., 2012). The Marine Strategy Framework Directive aims to achieve a ‘good environmental status’ in the marine environment by 2020. In the MSFD, in addition to ecosystems, the concept marine region is used, defined as ‘taking into account hydrological, oceanographic and biogeographic features’ (MSFD 2008/56/EC, art 3(2)).
### Table 5.2  Steps towards the development of ecosystem management approach

<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
<th>Details</th>
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<tbody>
<tr>
<td>1982</td>
<td>The UN Law of the Sea Convention</td>
<td>Framework that requires coastal states to take into account effects on associated or dependent species in the marine ecosystem.</td>
</tr>
<tr>
<td>1992</td>
<td>The UN Rio Declaration and Agenda 21</td>
<td>Emphasizes multi-species management in marine systems.</td>
</tr>
<tr>
<td>1992</td>
<td>The OSPAR Convention, North East Atlantic</td>
<td>15 countries. Protection of the marine environment.</td>
</tr>
<tr>
<td>1995</td>
<td>FAO Code of Conduct for Responsible Fisheries, UN Fish Stocks Agreement</td>
<td>Requires conserving, protecting and safeguarding ecosystems, calls for implementing an ecosystem approach.</td>
</tr>
<tr>
<td>1998</td>
<td>UN Convention on Biodiversity (CBD)</td>
<td>Issues the Malawi principles for the ecosystem approach.</td>
</tr>
<tr>
<td>2000</td>
<td>EU Water Framework Directive</td>
<td>Europe’s waters should be managed according to ecological boundaries, good ecological water status by 2015.</td>
</tr>
<tr>
<td>2002</td>
<td>The Johannesburg Plan of Implementation, World Summit on Sustainable Development</td>
<td>Calls for an application of the ecosystem approach to management by 2010.</td>
</tr>
<tr>
<td>2003</td>
<td>Joint Ministerial Meeting of OSPAR and HELCOM ‘The Bremen Statement’</td>
<td>Defines the ecosystem approach and sets detailed plans for HELCOM and OSPAR to implement the ecosystem approach.</td>
</tr>
<tr>
<td>2007</td>
<td>HELCOM Baltic Sea Action Plan</td>
<td>Restore the Baltic Sea’s environmental status by 2021, ecosystem approach framework.</td>
</tr>
<tr>
<td>2008</td>
<td>Barcelona Convention</td>
<td>Adopted the ecosystem approach for the Mediterranean Sea.</td>
</tr>
<tr>
<td>2010</td>
<td>HELCOM</td>
<td>HELCOM, Initial holistic assessment.</td>
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</table>
In Europe, there are also four cooperation structures originally dating back to the 1970s that underpin the Regional Seas Conventions (RSC). They include the OSPAR convention for the North-East Atlantic, the Helsinki Convention for the Baltic Sea, the Barcelona Convention for the Mediterranean Sea and the Bucharest Convention for the Black Sea. In the regional seas in Europe, ecosystem services and the ecosystems they depend on are shared by a number of coastal nations. In order to operationalize the MSFD, the member states are required to coordinate at the regional level, using the existing Regional Seas Conventions. The Member States must cooperate closely on developing marine strategies both in the preparatory assessment stage that determines targets and indicators (by 2012), in the monitoring programme and soon (2015-16) the Programme of Measures (PoM) in the identified marine regions. However, there is no single governance structure for any of Europe’s regional seas.

Also, a healthy marine ecosystem is to a large part dependent on what happens in the drainage basin. The Baltic Sea, with a drainage basin four times the size of the sea itself, is a large heterogeneous socio-economic region. 14 countries, of which nine are coastal states and ten are EU members, share the Baltic Sea.

The EU Water Framework Directive (WFD), adopted in 2000, provides a common framework for water policy. For the first time land-use planning is linked to water resources in all member states and new administrative boundaries have been introduced based on the larger river basin districts (RBD). The WFD aims for more integration in water management and encompasses different water resources, such as surface waters, groundwater, estuaries and adjacent coastal waters to 1 nautical mile from the coast. Hence, the possibilities for achieving environmental objectives in the regional seas, such as no eutrophication, are largely dependent on altered activities on land within the framework of the WFD (see e.g. Wulff et al. 2007).

River basins often extend across national borders requiring international cooperation in these RBDs, also with states outside the EU. According to Nilsson and Langaas (2006) 33% of the RBDs are international and cover ca. 70% of the total district area. Since both the WFD and the MSFD are framework directives, they are further shaped by the national legislation developed for their implementation. The transnational governance cooperation requirements are, however, significant. The regional seas and the RBDs necessitate the further development of links between the Directive frameworks, the regional level and the national implementation processes. The main disparity in the EU governance framework is the allocation of competencies. Certain issues are the competence of the EU while others are the competence of the Member States and some are joint competence. The MSFD is an EU Directive adopted under EU competence, but many of the specifics of implementation are the competence of Member States. The way in which coordination should take place to ensure an effective system of multi-level governance to implement the directives is uncertain. This leads to institutional ambiguity, which is perhaps most noticeable in the Mediterranean Sea with its large number of bordering (and non EU) states (Van Leeuwen et al. 2012).
Further, in complex social-ecological systems such as regional seas, risks and uncertainties are inherent and there is a need to build a capacity for adapting to change, and to frame and handle risks. The regional seas can be characterized as common-pool resources often at risk, where different priorities and conditions make sustainable governance more complex (Ostrom et al. 2002, Dietz et al. 2003). Systemic risks, in contrast to traditional risks, require particular attention. Systemic risks are characterized by a high degree of complexity and uncertainty and are usually not confined to a single sector or nation state – this necessitates more holistic, reflexive and adaptive approaches (Olsson et al. 2004, Voss et al. 2006, Renn et al. 2011).

Systemic risks also often cause ambiguity, i.e. there are different legitimate views on how to evaluate the risk at hand. For example, oil discharges can be seen as a quite simple environmental risk in terms of the range of causes and sources. Eutrophication on the other hand combines complex changes in the ecosystem, involving an array of nutrient sources (e.g. agriculture, municipal and industrial waste water), with high scientific uncertainty in terms of long-term ecosystem outcomes. Still, despite large differences between various types of environmental problems and risks examined in the Baltic Sea, assessment and management interactions were found to apply a rather traditional view of risks, one assuming low uncertainty (Gilek et al. 2011).

A major issue in sustainable ecosystem management is how to handle trade-offs between bundles of ecosystem services. Differences among stakeholders may lead to considerable controversy and differences of priorities. In such cases participatory management involving stakeholders is recommended, in line with ecosystem management (Klinke and Renn 2002). The WFD, for example, emphasizes an integrated, iterative process with co-governance between different stakeholders and the responsible water management authority within the different river basin districts (European Parliament 2000). Member states are obliged to make information outlined in the river basin management plans available to the public, and to organize public consultation, while active involvement should be encouraged. In ecosystem management, a wider range of knowledge sources including local knowledge is important to manage ecosystem functions and respond to feedback signals from the ecosystems in an adaptive way. For example, suggested mitigation measures for reducing nutrient discharges into the Baltic Sea require trade-offs and decisions to be made among multiple actors. A suitable location for the creation of a wetland might mean loss of land for agricultural production—an issue that requires detailed local ecological knowledge, but one that can also lead to considerable conflict among local actors.

Further, the implementation of the WFD in, for example, Sweden, implies that some of the water issues are moved up to a regional RBD level. While the RBD aims for water governance with a better spatial fit between administrative and ecological boundaries, the cross-scale interactions and linkages are still unclear.
Challenges for the Practical Implementation of Ecosystem Management in Marine Systems

The utility of ecosystem management approaches ultimately depends on whether they actually inform and influence practical management decisions and actions. A number of frameworks for implementing ecosystem management have been developed in recent years to include empirically based insights to strategies that make transitions to such a form of management possible, whilst highlighting challenges (see e.g. Rosenberg and McLeod 2005, Murawski 2007, Levin et al. 2009, Tallis et al. 2010). Cury et al. (2005), for example, identified three main problems with implementation of an ecosystem approach to fisheries. First, to define proper long-term ecosystem related objectives; second, to define meaningful indicators and reference values for desirable and undesirable states; and finally to develop proper data collection, analytical tools, and models. Further, Arkema et al. (2006) found that management objectives and interventions in ecosystem management often tend to miss critical ecological and human factors emphasized in the scientific literature. Although ecosystem management represents a multidisciplinary approach to resource management, single objectives often miss connectivity between ecological concepts and the human dimension. For example, Österblom et al. (2011) analysed existing incentives in European fisheries and their role in stabilizing governance systems in sustainable or unsustainable trajectories. In European fisheries overcapacity of the fishing fleet, aggravated by subsidies, has resulted in pressure for short-term decision-making, which has, in turn, led to continued overcapacity and unsustainable fishing quotas. High biological uncertainty has contributed to the low status of the science meant to inform management (Wilson 2009, Österblom 2011). A governance system not tailored to address this uncertainty, combined with low transparency and resulting lack of legitimacy of decisions, may also contribute to reducing the incentives for compliance. In comparison, Österblom et al. (2011) found a different social-ecological feedback structure in the Norwegian and North American fisheries, where the decision-structure had a stronger focus on ecological sustainability and an emphasis on reducing subsidies and overcapacity. Improved scientific legitimacy also created a strong argument for a decision-making process focusing on ecological sustainability.

The ecosystem approach is relatively knowledge intensive and requires an understanding of the panarchy of an ecosystem’s structure and function, as well as the dynamics of ecosystem services and their driving forces in the integrated social-ecological system. Implementation of the EU Water Framework Directive by Member States entails routine data collection covering various information needs including the collection of comprehensive data covering the characteristics and state of water bodies, the various pressures caused by human activities and the resulting impacts as well as governance aspects such as public participation activities. In a case study on Sweden, Hammer et al. (2011) identified a number...
of challenges with respect to information and public participation including: problems in classifying the status of water bodies; a need to improve and co-
ordinate monitoring within River Basin Districts; and the development of means
to tackle and control diffuse sources of pollutants.

Ecosystem management as an integrated approach considers entire ecosystems
including humans. However, management has relied on a number of different
assessment and management techniques (such as total allowable catch quota
systems in fisheries) that needs to be reconciled within an ecosystem approach to
management. Hence, integrated assessments directed at ecosystem functioning
and feedbacks between human uses and ecosystems are needed. Frameworks for
aiding the ecosystem management process by integrated ecosystem assessment
have been developed recently (see e.g. Curtin and Prellezo 2010). Levin et al.
(2009), for example, use a case study from the Puget Sound to spell out a five-
step process to inform management decisions in marine ecosystem management
across sectors and at multiple scales: scooping, developing indicators, risk
analysis, management strategy and ecosystem assessment. The MSFD requires
a comprehensive set of indicators and related objectives to measure progress
towards a good environmental status. The OSPAR Convention for the North-
East Atlantic, applying the ecosystem approach, has worked towards an
integrated assessment of ecosystem health. As early as 1992, the OSPAR Joint
Assessment and Monitoring Program (JAMP) addressed the issue of how to
assess ecosystem health and human impact. In collaboration with ICES,
Ecological Quality Objectives (EcoQOs) have been developed for an integrated
assessment and to provide a link between human activities and the impacts of
biodiversity (Heslenfeld and Enserink 2008, OSPAR 2010). This process was
initiated as a learning-by-doing activity that was relatively non-committal for
the Member States, but has recently turned into a potentially legally binding set
of objectives with the adoption of the MSFD in 2008.

A central challenge in practical ecosystem management is developing useful
and straightforward approaches for balancing a range of, sometimes conflicting,
human uses of ecosystems. Implementing the Marine Strategy Directive in EU
Member States with extensive maritime domains, such as Spain demands a
signiﬁcant effort. Marine spatial planning (MSP) as a tool to allocate space to
a range of ecosystem services provided by marine ecosystems is developing as
a means to implement the EU Marine Strategy Directive. In Europe, MSP is
promoted by the EU Integrated Maritime Policy (European Commission, 2007,
2008). MSP, for example, provide an opportunity for comprehensive goal-
setting and may resolve potential human use conﬁicts in a proactive and future
oriented way. Further potential beneﬁts from MSP as identiﬁed by Gilliland
and Laflöley (2008) include more efﬁcient use of available marine space and
resources. However, the success of marine spatial planning relies to a large
extent on it’s ability to achieve integration of activities and sectors (Ehler and
Douvere 2009). A critical step in an MSP process is defining the scale and scope
(Portman, 2011).
Conclusions

Even though many governance and scientific challenges to practical implementation of ecosystem management in marine systems are yet to be resolved, the present policy framework within the EU is promoting a shift towards a more comprehensive ecosystem management of marine systems. This acknowledges the interconnections within ecosystems as well as links between ecosystems and humans. A challenge to the implementation of EU Directives such as the MSFD and the WFD (one experienced in other externally initiated programmes that often involve top-down structures) is that they are too rigid in structure and allow local actors such as farmers or fishermen less scope to adapt the systems to meet their needs. Even so, top-down enabling EU legislation can help to stimulate innovation and re-organize governance structures at the drainage basin level to the regional seas, as well as in their catchments as a whole. Further, an emphasis on stakeholder participation could encourage bottom-up, pilot initiatives from local to regional levels that can lead to a diffusion of innovation critical for a transition to ecosystem management.

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