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Abstract

The Marine Strategy Framework Directive (MSFD) requires the achievement of Good Environmental Status (GES) by 2020 and the adoption of the Ecosystem Approach. The former sectoral approach to management must be transformed to adhere to the requirements of the new directive. Fishery is a particularly important example, because it relies heavily on the ecosystem, sustains many coastal communities and still has large economic impacts at national level. We examine the cod fishery in the Eastern Baltic and the feasibility of integrating the intermediate and final ecosystem services and benefits associated with the fishery into the 'programmes of measures'. We use Decision Space Analysis to visualize the spatial challenges concerning competing priorities and expectations for uses of the marine area, as well as the temporal challenges of achieving GES under the very short time constraints of the MSFD.

Chapter 16
Integrating the Common Fisheries Policy and the Marine Strategy for the Baltic: Discussion of Spatial and Temporal Scales in the Management and Adaptation to Changing Climate

Tim O'Higgins and Eva Roth

Abstract The Marine Strategy Framework Directive (MSFD) requires the achievement of Good Environmental Status (GES) by 2020 and the adoption of the Ecosystem Approach. The former sectoral approach to management must be transformed to adhere to the requirements of the new directive. Fishery is a particularly important example, because it relies heavily on the ecosystem, sustains many coastal communities and still has large economic impacts at national level. We examine the cod fishery in the Eastern Baltic and the feasibility of integrating the intermediate and final ecosystem services and benefits associated with the fishery into the 'programmes of measures'. We use Decision Space Analysis to visualize the spatial challenges concerning competing priorities and expectations for uses of the marine area, as well as the temporal challenges of achieving GES under the very short time constraints of the MSFD.

Abbreviations

MSFD	Marine strategy framework directive
GES	Good environmental status
CFP	Common fisheries policy
EEZ	Exclusive economic zone
CAP	Common agricultural policy
NPV	Net present value
MSY	Maximum sustainable yield
MEY	Maximum economic yield
TAC	Total allowable catch
ITQ	Individual transferrable quota

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16.1 Introduction

The Baltic Sea has supported human populations and provided a source of food (in particular cod) to humans since prehistoric times (Limburg et al. 2008). The Baltic Sea Basin is now home to about 85 million individuals with over 26 million living within 50 km of the coast and 15 million within 10 km (Sweitzer et al. 1996). The modern residents of the Baltic continue to benefit from the local marine environment and the many services it provides, from active uses such as commercial harvest of food, to recreation and tourism as well as passive use services such as the existence value of the sea and its inhabitants. In recent decades the Baltic has, amongst other, been used as a sink for waste products from agricultural land, and for the extraction of cod and other fish. However the benefits of economic and social exploitation of the Baltic have not been without environmental costs. The damage caused to the Baltic Sea ecosystem by human activities has long been recognised (Elmgren 2001).

The Baltic has the largest anthropogenic hypoxic area in the world (Diaz and Rosenberg 2008). The area of hypoxia is related to both natural fluctuations in climate as well as anthropogenic effects (Conley et al. 2009) with the chief anthropogenic sources being oversupply of wastewater and agricultural run-off. Despite recent attempts at alleviating nutrient pressures, existing loads of nutrients within the system (Neumann 2007) as well as continuing supply of nutrients from diffuse sources (Humborg et al. 2007) mean that the eutrophication problem is likely to persist for many years (Neumann 2007) and the system is unlikely to follow a simple trajectory to its pre-eutrophied state (Duarte et al. 2008).

Eastern Baltic cod stocks, the natural resource base of the most valuable of the Baltic fisheries, have suffered severe decline due to human activities. The collapse in cod stock has been linked to overfishing as well as environmental conditions (MacKenzie et al. 2007). Recruitment and recovery of the fishery are dependent on the 'spawning volume' (Plikshs et al. 1993) which is determined by the prevailing physical structure and oxygen conditions of the water column and by natural stochastic oceanographic processes as well as anthropogenic oxygen depletion (MacKenzie et al. 2000, Conley et al. 2009). Anthropogenic Climate Change also threatens to radically alter the functioning of the Baltic Sea ecosystem. Though there is great uncertainty in predictions, the most widely accepted scenarios see a reduction in salinity of eastern Baltic waters due to increased freshwater inflows. This will profoundly alter the physical structure of the sea and make the prevailing hydrographic conditions less favourable to cod (HELCOM 2007).

If the long term abundance of cod is to be achieved the changing conditions brought about by Climate Change mean that the resistance and resilience of the species could be highly dependent on the genetic diversity in the surviving population. Since the changes in climate are not known and the levels of diversity required to meet the demands of climate are not known, sustaining the long term abundance of cod will require maximizing genetic diversity as insurance against complete collapse of the stocks.

The recognition of the anthropogenic threats to environmental conditions has lead to pan-European attempts to regulate the anthropogenic pressures on the

ecosystems through legislation. Several existing European laws, the Birds Directive (EU 1979), the Habitats Directive (EU 1992) and the Water Framework Directive (WFD) (EU 2000) deal with the protection of various elements of the marine ecosystem. In 2008 the Marine Strategy Framework Directive (MSFD) came into force (EU 2008). This directive is the first comprehensive law focused specifically on management of the environmental quality of Europe's regional seas. The overall aim of the MSFD is to promote sustainable use of the seas. The directive encompasses most human activities relating to the seas, provides a more coherent basis for management and protection of the marine environment and unifies the previous legislation. The founding concept of the MSFD is that of the Ecosystem Approach (to management) recognising the connections between the environment and human activities, institutions, social and economic structures. The goal of the directive is to achieve Good Environmental Status (GES), a concept necessitating value judgements on the desired state of the environment (Mee et al. 2008). The MSFD takes effect at the level of member states' Exclusive Economic Zones (EEZs), and provides for cooperation between nations on a regional seas basis. The Ecosystem Approach replaces the previous sectoral approach and aims to account for the costs of damage to the environment (which are commonly economic externalities) as well as the benefits (ecosystem services) resulting from marketed commodities and other active and passive use values associated with marine ecosystems (Millennium Ecosystem Assessment 2005, Fisher et al. 2009). The MSFD is the 'environmental pillar' of the EU Integrated Marine Policy with a reformed Common Fisheries Policy contributing the economic pillar (Mee et al. 2008) and reflects a change in European values from food security toward other concerns (Suarez de Vivero 2007).

Though the Ecosystem Approach has rapidly gained popularity, few examples exist of a comprehensive application of such an approach at a regional scale as mandated by the MSFD. As such the MSFD represents an experiment in application of the Ecosystem Approach to management. Below we describe the essential steps of the MSFD, and examine the implications of an Ecosystem Approach for the reform of the Common Fisheries Policy (CFP).

16.2 The Plan for Implementation of the Marine Strategy Framework Directive

A timeline showing the obligations of the European Commission and the European Union member states under the MSFD is set out in Fig. 16.1. There are five major steps which contribute to the final delivery of Good Environmental Status in 2020. The first step concerns the definition of methodological criteria and standards (by July 2010). GES is to be assessed on the basis of 11 descriptors contained in Annex 1 of the directive (Table 16.1) and the criteria for these descriptors have been laid down in a recent Commission decision (EU 2010). The second step, setting targets and indicators (by July 2012) will establish the vision for what 'Good Environmental Status' should resemble, and will require choices about the

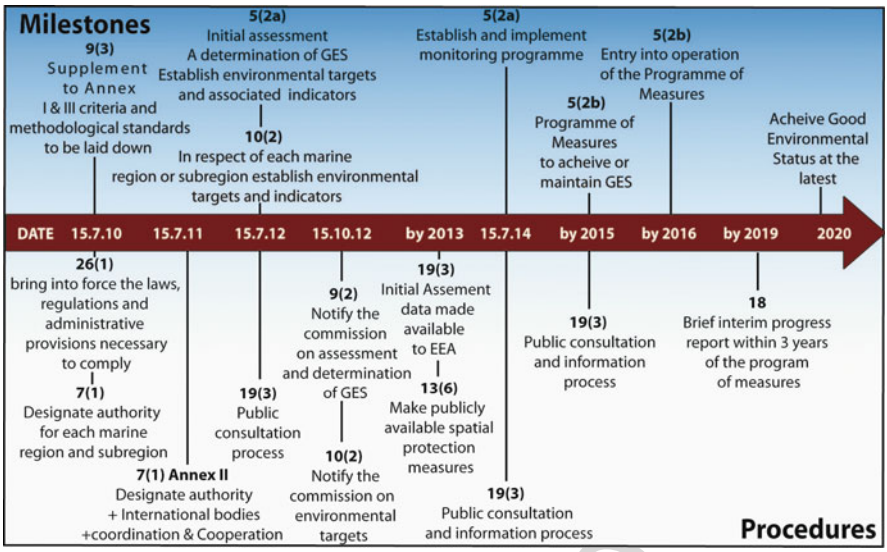

Fig. 16.1 Timeline for the implementation of the Marine Strategy Framework Directive

desirable status of the ecosystem (Mee et al. 2008). Once the targets are established the remaining steps involve assessment of the current situation through monitoring (by July 2014); development (by 2015) and implementation (by 2016) of a program of measures to reach the target of GES by 2020. The directive specifies as a first step toward the preparation of a program of measures, an economic and social analysis on the use and cost of degradation of the marine environment. The scope of the program of measures is set out in Annex VI of the MSFD. It includes input, output and spatial control measures; management coordination measures; measures to improve traceability of pollutants; economic incentives; mitigation measures and methods for communication and stakeholder involvement.

16.3 The Development of the New Common Fisheries Policy

The Common Fisheries Policy (CFP) was established in 1983 and the present reformed version stems from the 2002 reform of the CFP. The policy covers direct fisheries management aimed at ensuring long term sustainable exploitation of the living aquatic resources. Furthermore, the policy includes market measures and a structural policy aiding and coordinating fishing fleets' development and modernisation of on-shore installations. The 2002 reform allowed for a long-term approach especially targeted at multi-annual recovery plans and for progressive implementation of an ecosystem-based approach to fisheries management.

Table 16.1 Descriptors of environmental status from Annex I of the MSFD. An asterisk marks those particularly relevant to fisheries in the Baltic

	Descriptors of good environmental status from Annex I of the MSFD
1*	Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions
2	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems
3*	Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock
4*	All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity
5*	Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters
6	Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected
7	Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems
8*	Concentrations of contaminants are at levels not giving rise to pollution effects
9*	Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards
10	Properties and quantities of marine litter do not cause harm to the coastal and marine environment
11	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

AQ1

A second reform process was launched in 2009 both as a public consultation process and an impact assessment comparing different scenarios for future policy changes of the CFP. The Green Paper (EU 2009) argues that:

> Rethinking the CFP requires us all to take a fresh look at the broader maritime picture as advocated by the Integrated Maritime Policy (IMP) and its environmental pillar, the Marine Strategy Framework Directive (p. 5).

Current specific targets for fisheries management were set at the world summit on sustainable development (2002) and the current goal is to restore fish stocks to Maximum Sustainable Yield by 2015. This target is clearly not in line with the Ecosystem Approach as it continues the practice of management to deal with fish stocks individually and to maximise potential harvest with no consideration of the economic potentials (resource rent, costs of production) and long term welfare of the fishing communities. The descriptors of the MSFD specify that 'all elements of the marine food webs occur at normal abundance and diversity'. This requirement is not consistent with management of stocks on an individual basis.

The Green Paper describes the inherent problems faced by the fishing industry. The measures to ensure long term ecological and economic sustainability build

on traditional measures, but a clear change in responsibility to the private sector is envisaged. The interests of the sector of both short term and long term income possibilities does not change with a shift toward the private sector, but the collective behaviour of the sector may change. It is however still an open question whether this vision for future stakeholder involvement can encompass measures targeting intermediate and final services (generally not marketed) in addition to securing benefits with direct use value.

16.4 The Ecosystem Approach

Ecosystem services are the aspects of ecosystems utilized (actively or passively) to produce human well being (Fisher et al. 2009). Human welfare and survival is dependent on an adequate supply of ecosystem services. Food, water and habitable climate are some amongst many of the services provided by nature, yet human activities frequently result in damage and degradation of the ecosystems which provide these services. Recognition that ecosystems are essential to the sustainable development of human activities and growing understanding of the severe ecosystem damage caused by these activities has lead to an increased awareness of the benefits provided by nature (Millennium Ecosystem Assessment 2005). The concept of the Ecosystem Approach to management (which is synonymous with 'Ecosystem Approach' and 'Ecosystem Based Management') is based on the recognition that humans live in coupled social-ecological systems. (Daily 1997, Daily and Walker 2000, Boumans et al. 2002, Ehrlich and Ehrlich 2008).

While there is a sound conceptual basis for an Ecosystem Approach and the concept has grown rapidly in popularity in many circles, the practice of the approach is still in its infancy. With the introduction of the MSFD there has been a very real mandate to put the Ecosystem Approach into practice. However there is no universally accepted definition or set of standards. We chose the following broad definition of the Ecosystem Approach

> 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.[1]

Key to the definition is the integration of the connections between natural resources (biotic and abiotic) and human activities. Successful implementation of an Ecosystem Approach must recognise (and account for in management practices) the complexities within the ecosystem. Ecosystems exhibit non-linear behaviour, positive and negative feedback mechanisms, time lags and scale dependent processes; and these affect the flows of ecosystem services to humans.

[1]This is the working definition of the KnowSeas project adapted from that of the Ontario ministry for natural resources. A full rationale for the choice of the definition is contained in KnowSeas deliverable 2.1 which may be obtained by contacting the authors.

Appropriate methods for integrating the supply of nature's services (most of which are not marketed) with existing economic activities has not proved simple. To examine ecosystem services it is essential to classify them according to a typology. While many typologies have emerged for different purposes (Costanza et al. 1997, Millennium Ecosystem Assessment 2005, Boyd and Banzahf 2007, Fisher and Turner 2008), the 'Classification of Ecosystem Services for Decision Making' (Fisher et al. 2009) is best suited to our purpose. This classification provides a clear delineation between intermediate services, final services and benefits thus avoiding double counting. This scheme also recognises that ecosystem services are benefit dependent allowing the focused selection of benefits and the final and intermediate services which underpin them. Table 16.2 shows our classification of services related to fisheries in the Baltic.

Though we identify seven distinct intermediate services, the final services and benefits which these support are 'joint products' of these services i.e. in reality the intermediate services are interlinked and exhibit dynamic interactions which combine in complex ways to provide the final services and ultimately the benefits to humans. The complex interactions between nutrient cycling and primary productivity in the Baltic and the relationship between eutrophication and nursery and breeding conditions for Cod have been well studied (Plikshs et al. 1993, Vallin et al. 1999). Similarly there is a good understanding of how climatic conditions affect habitat conditions for Cod in the Baltic and how these might change with global warming but the exact nature and timing of the changes is uncertain (HELCOM 2007).

The complexity and uncertainty associated with ecological processes in the Baltic ecosystem and the joint nature of the services they provide reduce our ability to predict how the systems will behave in the future. Recognition of the linkages between ecosystem components must be central to management in order to achieve

Table 16.2 Classification of intermediate and final services and benefits related to fisheries the superscripts indicate the relevant descriptors from Annex 1 of the MSFD (Source: Modification from Fisher et al. 2009, Hanley and Barbier 2009 in Kronbak and Roth 2010)

AQ2

Intermediate services	Final services	Benefits
		Active use:
Primary production[4,5]	Fish production[3]	Commercial harvesting of species and their consumption[3]
Nursery and breeding[5]	Maintenance of beneficial species[4,1]	Commercial growout of fish and crustaceans (mariculture)
Habitat provision		Recreational fishery
Predator-prey relationships[4]		Non-consumptive use (e.g. visual benefits/cetacean and seal tourism activities)
Sea water quality[8,9]		Passive use
Nutrient cycling[5,6]	Maintenance of Biodiversity[1]	Existence value of species[1]
Climate regulation	Resistance and resilience[1]	Option value[1]
		Bequest value[1]

an Ecosystem Approach. Integration of the complexity (and attendant uncertainties) associated with ecosystems into management actions can be seen as success criterion for implementation of an Ecosystem Approach.

16.5 Can the Marine Strategy Framework Directive Accommodate the Ecosystem Services Classification?

The stated aim of the MSFD is to achieve an Ecosystem Approach but the legal obligation for member states under the MSFD is to achieve Good Environmental Status (GES). GES is described by the 11 descriptors (Table 16.1) in the directive and is to be assessed according to recently published criteria (EU 2010). The degree to which the MSFD can deliver an Ecosystem Approach in the Baltic is dependent on the applicability of the descriptors of GES to the selected ecosystem services.

Descriptor 1 directly addresses three of the ecosystem services in our typology. It is a direct mandate to maintain *biodiversity* at the species, habitat and ecosystem level (EU 2010). Maintenance of biodiversity also adds to the *resistance and resilience* of the ecosystem (Tilman and Downing 1994, Naeem and Li 1997, Hughes and Stachowiz 2004, Tilman 2005). The stability provided by resistance and resilience ensures continued supply of ecosystem services over time. Within a species genetic diversity also enhances resistance and resilience over time, and preservation of genetic diversity with eastern Baltic cod stocks would enhance the ability of the stock to survive Climate Change (Johannesson and André 2006). Maintenance of biodiversity also ensures the *maintenance of beneficial species.* These include species which have non-consumptive use and passive use values.

Descriptor 3 (concerning commercial fisheries) is directly relevant to the final services of *fish production* as well as the active use benefits of *commercial harvest*, but the emphasis on commercial fisheries means that it is unlikely to achieve balance in predator prey relations. This descriptor is anthropocentric.

Desciptor 4 (food web structure) addresses the intermediate services of *primary production*, and *predator prey relationships* and is also relevant to the final service of *maintenance of beneficial species* as well as *biodiversity*. By contrast to descriptor 3 the focus on food web structure is bio-centric.

Descriptor 5 (minimisation of eutrophication) is relevant to the intermediate services of *primary production, nursery and breeding, habitat provision,* and *nutrient cycling* and to the final services of *biodiversity, resistance and resilience*.

Descriptors 8 and 9 (reduction in pollutants) deal with the intermediate service of *sea water quality*.

Management of each of the services listed in Table 16.2 is well within the scope of the MSFD descriptors. Though not explicitly mentioned in the MSFD or in the guidance on descriptors (EU 2010), all but one of the final and intermediate services we identified as relevant to Baltic cod fisheries are captured by just 5 of the 11 descriptors of GES. At least for this example, it appears that the descriptors are

suitably broad to support an Ecosystem Approach. The single service in our list not encompassed by the descriptors is climate stability. Climate regulation is of vital importance but is a global phenomenon and cannot be managed at the scale of European regional seas. While the Baltic Sea can contribute directly to the mitigation of Climate Change through storage of CO_2 and indirectly through the provision of space for mitigation activities such as the construction of offshore renewable energy technologies, particularly wind farms, these are not addressed within the directive.

The relevance of the descriptors to the ecosystem services in question, though encouraging, is not the only criteria by which we may judge the ability of the MSFD to deliver an Ecosystem Approach. These descriptors define the scope of the directive. The goals and the means of achieving these goals are set out in the environmental targets and the programme of measures.

The environmental targets will reflect a vision of what constitutes 'Good Environmental Status'. In a complex system with many competing human interests and associated drivers and pressures and subject to forcing by stochastic process of climate, there are many possible desirable ecosystem states. Therefore the definition of GES is not a trivial matter.

Descriptor 3 proscribes that commercially exploited fish stocks should have age and size distribution indicating a healthy stock, while descriptor 4 requires 'normal abundance and diversity' of all elements of marine food webs. Current fishing practices preclude 'normal' abundance of those fish commercially caught and the balance between achieving GES for each of these objectives will require a tradeoff between the interests of commercial fisheries and the interests of a 'normal' ecosystem. In the Baltic significant anthropogenic alterations to the food web have been apparent for the last century (Conley et al. 2009). Characteristics of a more natural food web would involve higher numbers of top predators and these in turn would require prey, naturally cod (MacKenzie et al. 2007). Eutrophication also represents a shift in the food web structure (which is contrary to the goals of descriptor 4), from the perspective of the cod fishery however a degree of anthropogenic eutrophication may be beneficial since increased primary production may increase fish biomass (through increased food availability) (Thurow 1997) while over supply of primary production leads to reduced oxygen concentrations and adversely affects cod recruitment.

Since the food web of the Baltic is already so radically altered, the vision for Good Environmental Status or indeed for a "normal" food web, is a matter of choice. Balancing food web elements and fisheries will necessitate trade offs and prioritisation of interests. Provisions for stakeholder engagement are made within the MSFD. The directive proscribes 3 public consultations. Stakeholder engagement mechanisms are also specifically mentioned as instruments to be used in the programme of measures. The success of the MSFD requires a socially acceptable choice of GES.

Furthermore, once these targets are set, an economic and social analysis must be carried out as a first step towards the preparation of a program of measures and the directive provides for non-compliance with targets on the basis of economic criteria (MSFD, article 14, 4).

The choices of achievable GES targets available to us are constrained by certain biological and social realities. Our ability to manage the ecosystem is dependent on the spatial and temporal scale of the existing processes in the environment as well as the existing social and economic structures which act towards or against management activities.

Using Decision Space Analysis we examine the temporal and spatial scale for environmental and social phenomena relevant to the management of cod and eutrophication. We identify the consequences for setting environmental targets. Setting appropriate targets in the system requires a cohesive response to the following question: What kind of ecosystem do we want? And how can we use the programme of measures to achieve it?

16.6 Decision Space Analysis

Decision Space Analysis is a technique for analysing and communicating spatial and temporal mismatches between environmental problems and the decisions which regulate them. It is based on the idea that, for any given management issue there exists a particular spatial and temporal scale over which management objectives may be achieved. By understanding the relevant spatial and temporal scale a 'decision space' may be identified. Understanding the degree to which environmental objectives may be achieved within this 'decision space' allows decision makers to make more informed judgement as to the best options for management. While the technique of Decision Space Analysis can apply to any management issue, we focus here on the time and space scales of the MSFD and the issues of eutrophication and cod in the Baltic.

16.6.1 Temporal Scales

The temporal requirements of the MSFD have been discussed earlier; the onus on member states is to achieve GES by 2020, 4 years after the implementation of the program of measures. Though specific targets have not yet been set for determination of GES, achievable goals should incorporate the existing knowledge on eutrophication and cod stocks as well as the uncertainties associated with likely future challenges caused by changing global climate.

Despite recognition of the eutrophication problem in the Baltic in the late 1960s and attempts at alleviating nutrient pressures (Elmgren 2001) nutrient budgets for the Baltic remain substantially unchanged since the peak eutrophication period in the 1980s and nutrient reduction policies have shown little effect on eutrophication (Aritoli et al. 2008). Restricted exchange with ocean waters mean that existing pools of nutrients in the Baltic Sea may have residence times of up to 30 years (Neumann 2007). This fact combined with other 'memory effects', such as nutrient saturation within terrestrial and freshwater sources, ensures continued elevated concentrations of nutrients in Baltic. Increasing livestock densities in newly acceded EU nations,

with higher demand for animal protein may mean that nutrient supply to the Baltic may actually increase in the near future (Humborg et al. 2007). It is highly likely therefore that the drivers and pressures of eutrophication in the Baltic will continue. Substantial improvements in eutrophication are unlikely without radical efforts to reduce the emerging drivers of this new wave of eutrophication. Given the emerging new sources of nitrogen and the significant residence time for nutrients within the Baltic, a timescale in the order of several decades is more appropriate to solving the problem of eutrophication. The program of measures for the MSFD must therefore tackle the root pressures of the problem, in particular agriculture. Expectations for improvement of the eutrophication status of the sea should be modest within the timescale of the MSFD and GES targets must be modest if they are to be achieved.

There is a great degree of uncertainty regarding the timing and magnitude of future changes in environmental conditions which accommodate cod recruitment and survival in the Baltic. Coupled atmosphere-ocean models project an increase in temperature and a decrease in salinity. Salinity in the Baltic is projected to decrease by 4–45% by the year 2100 (HELCOM 2007). These changes are likely to result in Baltic cod recruitment becoming increasingly stressed (MacKenzie et al. 2007). Modelled scenarios of Climate Change and fishing effort suggest that stock collapse of eastern Baltic cod cannot be prevented and that with 'fishing as usual' and rapid Climate Change scenarios the stocks could collapse entirely by 2026 (Röckmann et al. 2007). However with appropriate closures, the stock may be buffered from the effects of Climate Change for at least 20 years. It is clear given the uncertainty of future conditions and the possibility of rapid collapse that urgent action will be required to control fishing mortality in the timeframe of the directive. However given the uncertainty associated with Climate Change the measures to be taken should be adaptable on short timescales to accommodate climatic events as they occur.

AQ3

16.6.2 Spatial Scale

Figure 16.2 illustrates a Decision Space Analysis map of the Baltic focused on the issues of cod fishing and eutrophication.

The map uses a variant of the classic Driver Pressure State Impact Response (DPSIR) causal framework for analysis, which has been adopted by the European Environment Agency. In this modified version of the framework the Impact (I) is replaced with Welfare (W) to avoid ambiguity between environmental and economic impacts.

For cod the major pressure is catch (symbolised by the cod image in the red oval). The size of the symbol is scaled based on the most recently available catch data for each of the ICES statistical areas (ICES 2010). Similarly the state of the cod stocks (symbolised by the cod image) is taken from the most recent ICES data (ICES 2010); the stocks are assessed for the eastern and western areas separately hence two symbols on the map. Total EU fishery subsidy (under the CFP) is used as a proxy for the welfare generated by the fishery. Data are based at the NUTS III level (this EU nomenclature of territorial units for statistics) and are derived from

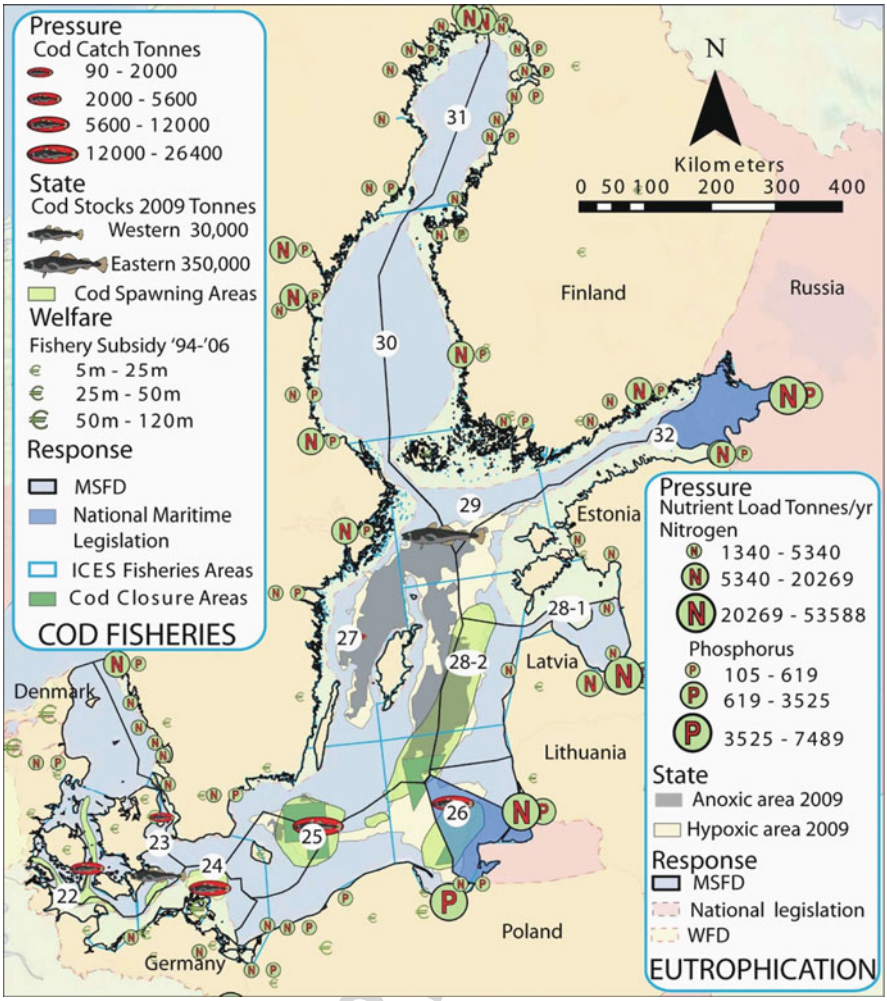

Fig. 16.2 Decision space analysis map for cod fisheries and eutrophication in the Baltic Sea (a detailed explanation is contained in the text)

an online database of EU fishery subsidy (http://fishsubsidy.org). The potential for response is mapped according to the jurisdiction of legislative instruments. For the MSFD (the member state EEZs are shown as light blue areas delineated by black), areas under national legislation where the MSFD does not apply are shown in darker blue. Current cod closure areas are shown in dark green.

For eutrophication the main pressures are nutrient inputs. The symbols (red letters N and P) are scaled according to measured riverine nutrient loads using data from the geospatial portal of HELCOM. Eutrophication State is illustrated by the extent of anoxia and hypoxia in 2009 (georeferenced from Hansson et al. 2009).

As with the cod example, potential for response is mapped according to the legislative jurisdiction. The Water Framework Directive is delineated in dark red (filled with yellow on land and light green in coastal waters) areas under national legislation are shown in red.

The map serves as a decision support tool, allowing easy reliable and informative visualisation of the geographic scope and scale of the two problems as well as the sphere of influence of the relevant legislation.

Though most of the Baltic Sea area is under the jurisdiction of the MSFD as indicated by the light blue EEZs, significant portions of ICES boxes 26 and 32 are subject to the national maritime legislation of Russia. Russia's EEZ off Kalinigrad also contains a large part of the cod spawning ground in the area.

Hypoxia is more prevalent in the eastern Baltic (ICES areas 26, 27, 28 and 29) and the expected decreases in surface salinity are likely to increase hypoxia through reinforced vertical stratification of the water column these areas are also expected to experience lower salinity conditions with Climate Change than the ICES box 25. Similarly the spatial distribution of nutrient inputs indicates higher loads, particularly in the areas not covered by national legislation for nutrient levels (shown in pink).

This illustrates that the most while ICES boxes 27 and 28–2 are of great importance and that nutrient pressures from many individual nations could be the focus of response measures. Effective policies to manage cod stocks under the jurisdiction of the MSFD for the eastern Baltic should continue to focus on the ICES zone 25 and would require cooperation between Poland, Sweden and Denmark.

16.7 Discussion and Results

The MSFD represents a first step towards an Ecosystem Approach. The list of descriptors of GES in the directive was able to accommodate the intermediate and final ecosystem services relevant to cod fisheries in the Baltic and the directive seems to have the potential to integrate the developing Ecosystem Services framework. However in order to be workable and to attain an Ecosystem Approach the Common Fisheries Policy must also be integrated. There is great potential for conflict between the interests of fishing and the descriptors of GES as set out in the MSFD. In particular pursuing fisheries and maintaining a normal abundance and diversity of food web elements (descriptor 4) is problematic.

An Ecosystem Approach does not offer a panacea. Optimizing the benefits achieved from the ecosystem will involve trade-offs between competing objectives and there will be clear winners and losers.

For example, in the Baltic, top down pressures on fish stocks was removed in the twentieth century (Elmgren 1989) with the reduction in numbers of marine mammals and resulted in increased cod biomass. Increase in primary producers and release of the bottom up control of fish biomass have also occurred. A return to more normal/natural levels of abundance and diversity could thus increase mammalian

predators (with their attendant non-consumptive use values) and reduce primary production resulting in a cod stock at levels lower than present. Achievement of GES might then represent a loss in benefits for commercial exploitation of fisheries. On the other hand, building up the cod stocks do give promise of future higher yield in the cod fishery without violating sustainability objectives.

The choice of targets for GES which will occur in 2012 will essentially require a vision for how our oceans are to be used. The MSFD makes provision for stakeholder engagement through public consultation at the point when environmental targets are set (Fig. 16.1). Inclusivity (or lack thereof) in this process will play a role in determining the national targets for GES, however the means of public engagement in the consultation process will be critical to determining the outcomes of these tradeoffs. Given the lack of appreciation by the general public of the importance of undersea landscapes in parts of Europe (Rose et al. 2008) and the loud national voice of those stakeholders involved in direct resource extraction, trade-offs are likely to be weighted in favour of the direct users of the marine environment. GES shall not be implemented at any costs. To safeguard unintended and unnecessary costs of implementation, as well as inefficient use of public funds; 'Member States shall ensure that measures are cost-effective and technically feasible, and shall carry out impact assessments, including cost-benefit analysis, prior to the introduction of any new measure' (EU 2008, chapter 13, article 13.3)

The targets must be set with specific ecosystem goals in mind. Given the uncertain future of the Baltic ecosystem in the face of Climate Change it is prudent to manage the resource to protect and enhance resistance and resilience to change. Ecological theory suggests that this might be best carried out through protection and conservation of biodiversity. For example if the long term abundance of cod is to be achieved the changing conditions brought about by Climate Change mean that the resistance and resilience of the species could be highly dependent on the genetic diversity in the surviving population. Since the changes in climate are not known and the levels of diversity required to meet the demands of climate are not known, sustaining the long term abundance of cod will require maximizing genetic diversity as insurance against complete collapse of the stocks.

Whatever the eventual targets are, the ability to achieve major environmental improvements within the tight timeframe of the directive is limited. Baltic eutrophication in all its complexity offers a particularly good example of an environmental problem that despite great efforts has not been possible so far to reverse even given the decadal timescale of the remediation efforts.

The directive requires implementation of all elements of the MSFD (Article 14, 4) except where 'costs would be disproportionate taking account of the risks to the marine environment'. This statement provides a necessary possibility of dispensation from the general rules, but also a loophole whereby member state may refrain from implementing part of the directive. The requirement of 'proof' in the form of a cost-benefit analysis further strengthens the legal framework.

Economic analysis of the benefits obtained from environmental remediation projects may reveal that costs of remediation outweigh future benefits at a level incompatible with public interest. Given the two main environmental problems in

the Baltic, collapse of the cod stock and eutrophication, are directly related to active use benefits which result in market values (fishing supported by the CFP and agriculture supported by the Common Agricultural Policy (CAP)) and that the benefits (including expected built up of cod stocks and higher future yearly yield) accruing from remediation will be mostly non-marketed (such as visual benefits and existence values) it is likely that many of the remediation actions to be taken under the MSFD will have negative Net Present Value. Even though standardized methods to measure non marketed active use values and passive use values are available, it will also be costly to establish these parameters, as very few valuation studies of these benefits have been carried out.

The crucial factor of these long term investments is the numerical scale of the discount rate (Stern 2006, Hoel and Sterner 2007). Discount rates are weights given to future costs and benefits in order to overcome time differences and measure Net Present Value of for example environmental investment projects. The higher the discount rate, the lower the value placed on benefits accruing in the future. The rationale for a societal discount rate has two sources, the societal time preference rooted in the pure time preference (impatience and the assumption of richer future societies) as well as the productivity of capital (positive yield of invested capital/opportunity cost) (Pearce and Turner 1990). The longer the time horizon of the investment, the more important the discount rate (ρ) becomes in determining the Net Present Value (NPV) of the investment. Hoel and Sterner (2007) point out that use of environmental goods may lead to scarcity over time and influence the relative prices of the environmental goods. This may mean that the discount rates used should have lower values.

$$NPV = \sum_{t=0}^{n} (B - C)(1 + \rho)^{-t}$$

Where NPV is Net Present Value, B is yearly gross benefits, C is yearly gross costs, ρ is the discount rate and t is the time.

Thus given the relatively long expected timeframe for recovery of the marine environment, the choice of discount rate and the length of the time horizon selected for analysis are crucial to the outcome of the cost benefit analysis.

Less focus has been allotted to the time profile of the investment projects. Most investment projects exhibit a time profile of an initial investment (cost) and future benefits. The most common time profile of any investment is large costs at the beginning followed by a stream of net benefits over a longer period of time. A positive scrap value of the initial investment might conclude the project. However investment projects may exhibit different time profiles. Nuclear power plants for example show a huge initial investment, followed by a stream of net benefits over a long span of years of power generation and huge costs of dismantling the plant and storing or reprocessing excess nuclear material.

The largest social investments in Europe over the past 60 years have been the establishment of welfare societies, where self-sufficiency in food production was particularly high on the agenda. The public investments in farming, farming

technology and fishery technology driven by the Common Agricultural Policy (CAP) and Common Fisheries Policy (CFP) have essentially eradicated hunger, malnutrition, infant mortality etc. but the time profile of these investments has not yet been fully catered for. The initial costs have been covered and the stream of benefits enjoyed, but the backlog of final costs of these investments are not yet paid. The costs of this historically very rapid social development project are pollution and eutrophication of both freshwater and the marine environment and the fisheries management through the CAP has not been able to counteract the overfishing developed through the former 'open access fisheries regime', whilst aiding the technological and market development.

Thus the implementation of the MFSD cannot be viewed simply as a social environmental investment project subject to only future time preferences of goods and services rendered from the marine environment but can more reasonably be viewed over the longer time scales associated with the CAP and CFP. These final costs of the original European project (broadly food security) seem to have been omitted as costs of the long term societal development project and included in the cost benefit analysis of the future goods and services of the marine environment. This point of departure analytically therefore hampers the implementation of Good Environmental Status for Europe's seas. The underlying conceptual model of the present MSFD is skewed and the consequences may be that many of the environmental investment projects planned for implementation as part of the Marine Framework Strategy Directive will show a negative Net Present Value at the outset. The question is not whether the investments are beneficial in the narrow sense, but whether society is willing to bear the costs associated with our past use of the marine environment.

16.7.1 Integrating the CFP into the MSFD

A recent Commission decisions on the descriptors (EU 2010) states that fishing mortality should be equal to or lower than the level capable of achieving Maximum Sustainable Yield (MSY). The decision makes a provision for catch levels lower than MSY in mixed fisheries in order not to prejudice the exploitation of MSY in other species and thereby acknowledges multispecies interactions.

It is more important however in the context of the Ecosystem Approach to balance both active and passive use values as specified in Table 16.2. Consistent assessment and valuation methodologies may aid the policy process, but the ethical and allocative decisions rest with the political system.

For an integrated management approach to commercial fisheries the choice of MSY as a target for fisheries policy is unlikely to be consistent with an Ecosystem Approach. It does not integrate the connections between human activities and institutions with the ecosystem. Maximum Economic Yield (MEY) would represent a goal more closely aligned with integration of human activities and institutions with the ecosystem, as it aims to maximize the benefit (catches the resource rent) from the commercial fishery rather than optimize the volume of fish caught from the fishery.

The use of MEY would also provide a further safeguard to endangered stocks, as reaching MEY under present cost conditions would require less fishing effort than targeting the MSY as a management objective.

The present decisions on TAC (Total Allowable Catch) and the consequent quotas allocated to the individual EU countries builds on recommendations from ICES based on individual species stock assessment. The knowledge and vision for an improvement of the scientific recommendations has been present for the last generation. Multispecies and multifleet fisheries models have been shown (Flaaten 1991, Gislason 1999) to be superior to the present single species models used.

The inclusion of economic assessment for maximizing economic rent in the fishery would further improve the basis for sound advice and more robust political solutions.

The scientific effort has been limited in the sense that neither the multispecies assessment models nor the evaluation of economic impact (economic rent and allocative impacts) have reached a stage where they are generally applicable to be implemented in the Common Fisheries Policy. Worldwide there are many fisheries that have included economic rent in the policy decisions; Shrimp in Greenlandic waters (Vestergaard et al. 2010) and the mussel fishery in the Limfjord – an estuary in Denmark (Frost et al. 2009). Economic assessment of fisheries prior to the introduction of Individual Transferable Quota-systems (ITQs), where property rights are most often allocated to individual vessel owners with historical fishing rights can create the condition for capturing resource rent in the fisheries. The ITQ system has been introduced in many fisheries, e.g. Iceland, New Zealand and individual fisheries in many European countries.

There are many reasons for continuing the historical practices of ICES and the EU. One reason may be the inadequacy of the scientific community to communicate the benefits of developing the very complex model tools necessary for qualifying policy decisions in the future (science translation). Another factor may be institutional inertia. The ICES practice of recommendations to the EU follow the management system of single species 'Total Allowable Catch Quotas' allocated between the countries in a fixed proportion. This system of regulation (quotas on each individual species) has led to EU policy decisions with unintended problems of by-catch, discard, and high-grading. Development of new more efficient fishing technology, investment subsidies and open access conditions have led to dissipation of resource rent, overcapitalization and both economic and ecological overfishing in most fisheries within the EU waters.

An ecosystem management approach for the Common Fisheries Policy and an integration of the CFP with the Marine Strategy Framework Directive can hardly be reached without a radical political decision to do just that. The Green Paper does not in itself facilitate a more research based approach for the fisheries to comply with the descriptors 1 and 3. Both presuppose a multispecies model approach to fisheries, as Good Environmental Status implies a naturally sound distribution and abundance of species an which objective may not be reached without a radical change of both management and its underlying advisory capacities.

16.8 Conclusions

While the MSFD has the scope to manage the problems associated with eutrophication and cod fisheries in the Baltic, it does not have the capacity to deal specifically with climate mitigation in the Baltic.

The integration of economic and ecological aspects of management has the potential deliver GES for the Baltic, but achievement of this status will require societal choices. The trade-offs required to reach GES may not deliver economic benefits in the short-term but can be seen as a clean –up cost of historical European investment in food security involving.

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Chapter 16

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