Making the European Fisheries Ecosystem Plan Operational

NORTH WESTERN WATERS

FISHERIES ECOSYSTEM PLAN:

WORK PACKAGE 7 REPORT

EC FP7 PROJECT # 212881

"....we need to make sustainability our primary goal; we need to base our management decisions strictly on science; we need to adopt an ecosystem approach that is geographically specified, adaptive and capable of balancing diverse social objectives....forgive me for borrowing a somewhat trite old saying: when the wind of change is blowing, some build walls, others build windmills."

Maria Damanaki

European Commissioner for Maritime Affairs and Fisheries
Brussels, 16th November 2010

Please cite as:

Bloomfield, H., Nolan, C., Le Quesne, W.J.F., Raakjær, J., Christensen, A.S., Aanesen, M., Armstrong, C., Piet, G.J. & Frid, C. (2011) *Fisheries Ecosystem Plan: North Western Waters*. Making the European Fisheries Ecosystem Plan Operation (MEFEPO): Work Package 7 Report. http://www.liv.ac.uk/mefepo/reports-and-outputs/wp7/

EXECUTIVE SUMMARY

Science based fisheries management developed late in the 19th century with a narrow focus on the dynamics of fish stocks. Now, early in the 21st century fisheries management is becoming integrated into wider environmental management. The July 2011 Green Paper on the Reform of the Common Fisheries Policy (CFP) identified the need reform European fisheries management and advocated the application of an Ecosystem Based Fisheries Management (EBFM) approach to deliver ecological, social and economic sustainability, stated an intention to move towards a longer term approach to fisheries management, and made commitments to greater stakeholder involvement in management. The Marine Strategy Framework Directive (MSFD) defines environmental objectives for European seas, based on sustainable utilisation of healthy marine ecosystems in support of sustainable development, and the Integrated Maritime Policy requires that individual sectors (e.g. fisheries) need to support MSFD objectives.

The Making the European Fisheries Ecosystem Plan Operational (MEFEPO) project was conceived to further the development of a framework, and the supporting evidence base (natural and social science), required to integrate the MSFD objectives within a reformed CFP in the context of sustainable ecosystem based fisheries management (EBFM). Fisheries Ecosystem Plans (FEPs) have been developed as a tool to assist managers and stakeholders simultaneously consider the ecological, social and economic implications of management decisions within a framework supporting EBFM. The aim of FEPs is to provide managers with a strategic rather than prescriptive plan for the adoption of EBFM. Through structured interaction with stakeholders, the MEFEPO project developed this FEP for the North Western Waters (NWW) Regional Advisory Council area.

Ecosystem impacts of fishing activities on the North Western Waters

As a first step towards the development of a FEP for the NWW we assessed to what extent the ecological policy objectives for this region were compromised by fishing. For this we focussed on the four MSFD descriptors that were considered to be affected by fishing: (1) biodiversity, (3) commercial fish and shellfish, (4) foodweb and (6) seafloor integrity and attempted to assess their current status using the most appropriate available indicators.

The selected indicators were applied to the NWW Regional Advisory Council (RAC) region to (i) trial combined simultaneous assessment of environmental status across a large multi-national region to examine the practicality of operationally implementing the approach; and to (ii) attempt to assess the current status of the NWW RAC region in relation to the impacts of fishing on GES.

The two survey based indicators, the conservation status (biodiversity) and large fish indicators (food webs), could be applied across this region, and the status of commercial stocks indicator (commercial fish and shellfish) could be applied to the extent that stock assessments are available. Applying the indicator of the proportion of area not impacted by mobile bottom gears (seafloor integrity) proved problematic as VMS data is required from individual nation states and national datasets were not made available to all partners.

Whilst there are a number of limitations in terms of data availability, and lack of guidance on how to combine assessments within a descriptor and across descriptors, this preliminary assessment concluded that GES is currently compromised within the NWW RAC region by fishing activities. Thus there is a clear requirement for Fisheries Ecosystem Plans (FEPs) to assist in working towards GES for the NWW region.

Supporting governance structure

The transition to EBFM requires appropriate institutional structures. Through structured interaction with stakeholders, the MEFEPO project developed a proposed institutional framework based on a decentralised management structure with decision-making power devolved to regional cooperating groups of Member States (MS), supported by enhanced (Regional) Advisory Councils (ACs) with appropriate scientific support, and a more collaborative approach between MS, ACs and scientists to develop management plans. Whilst the institutional structure and formal distribution of powers remains largely unchanged, this model would: enhance stakeholders' participation in management at the regional scale; facilitate stakeholder involvement in the development of management objectives and appropriate descriptors for all three pillars, and in the evaluation of management strategies; and thus give greater credibility to the management process and foster stakeholder support for management decisions.

Management strategy evaluation approach

Central to the development of the FEP is a management strategy evaluation matrix, a management support tool that allows simultaneous consideration of the potential impacts of different combinations of management measures on the ecological, social and economic status of the system. 'Descriptors' for the ecological, social and economic status of the fisheries were developed and utilised within the matrix.

Ecological descriptors were drawn directly from the MSFD and were selected at a MEFEPO stakeholder workshop as those most impacted by fishing activities (biodiversity, commercial fish, food-webs and seafloor integrity). Social and economic descriptors were defined to monitor the main aspects of fishing contributing to the economic and social wellbeing of society, in particular coastal communities. Economic descriptors focus on fishers' ability to maximise economic efficiency of fishing operations (efficiency) and minimising fluctuations in harvesting possibilities over time (stability). Social descriptors monitor employment opportunities within the catching sector (community viability) and securing catch potential for human consumption (food security).

The potential performance of a limited suite of case-study specific management strategies was evaluated against these descriptors; management strategies comprised of "business as usual" (BAU) and alternative strategies, applying different management tools. Four cases study fisheries were used as examples of matrix application within the North Western Waters (NWW) region: (1) Nephrops, (2) scallops, (3) northern hake, and mackerel. The case study fisheries examined should be seen as heuristic examples and not definitive assessments of the potential effects of different management strategies. The case study fisheries examined should be seen as heuristic examples and not definitive assessments of the potential effects of different management strategies. Matrices were completed based on best available evidence (modelled, empirical and expert judgment), which for the NWW case studies predominantly focussed on expert judgement and empirical data due to low accessibility/availability of quantitative data.

Case study fisheries

Consideration of alternative management strategies for case study fisheries indicated that there was scope to improve the status of ecological descriptors without significant deterioration in social and economic descriptors. For example, in the *Nephrops* fishery, an increase in the use of creels and associated reduction in the use of trawls was predicted to provide improvement in the status of all ecological descriptors. The strategy was also predicted to provide improvement in terms of stability of catches and food security, due to improvement in commercial stocks.

However, some of the alternative management strategies were predicted to have considerable negative effects on the status of social and economic descriptors. For example, the introduction of improved fishing technology and a total allowable catch (TAC) within the scallop fishery was predicted to yield benefits in terms of ecological status but significant negative social and economic effects due to a "race to fish", potential increased vessels numbers, and inefficient fishing activities.

The outcomes of these management strategy evaluations for the North Western Waters case studies show that there is scope for EBFM in order to achieve (or at least progress towards achieving) the ecological policy objectives as stated in the MSFD. Crucially, application of the matrix approach demonstrated the complexity of interconnections among descriptors, and highlighted that trade-offs among objectives are required. Due to the nature of the trade-offs, it may not be possible to satisfy all stakeholder groups or objectives simultaneously.

Steps required for implementation of EBFM

The MEFEPO project has demonstrated the application of a management strategy evaluation matrix approach to the development of regional Fisheries Ecosystem Plans (FEPs) to help decision-makers to simultaneously consider ecological, social and economic implications of decisions, and to inform the development of ecosystem based fisheries management (EBFM) for European fisheries. Five key steps make ecosystem based fisheries management a reality for European fisheries have been identified:

- Develop long-term management plans (LTMPs) for each of the region's fisheries considering the ecological, economic and social implications for ecosystem components. LTMPS should be integrated into regional FEPs.
- Develop closer integration among stakeholders, fisheries scientists, ecologists, social scientists and economists to develop effective management advice for LTMPs. Social and economic descriptors, and appropriate (region specific) indicators, require further scrutiny and development.
- Develop qualitative assessments and expert judgement to supplement analytical modelling to meet the increased data requirements of LTMP development and make them operational in the short term.
- Ensure that the management framework is adaptive and able to respond to new information and understanding to allow decisions based on the best available evidence.
- Implement appropriate governance mechanisms that facilitate true stakeholder engagement to generate credibility in the management process and foster stakeholder support, this includes both in definition of objectives and indicators as well as the development and evaluation of LTMPs.

Fisheries Ecosystem Plans and non-technical summary documents

This report is one a series of 3 Fisheries Ecosystem Plans (FEPs) produced by the MEFEPO project; the other two FEPs cover the North Sea and South Western Waters RAC regions.

Stakeholder summary documents have been produced for each FEP to accompany this technical report and can be accessed via the project website at http://www.liv.ac.uk/mefepo/reports-and-outputs/wp7/

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GLOSSARY and ACRONYMS

BAU	Business as usual
CFP	Common Fisheries Policy
EBFM	Ecosystem based fisheries management
EC	European Commission
EU	European Union
FEP	Fisheries Ecosystem Plan
GES	Good Ecological Status (defined by the MSFD)
LFI	Large Fish Indicator
Management objectives	Overarching objectives (would be set/decided by managers/society)
Management scenario	Possible (sets of) operational targets for management
Management strategies	Management tool(s) proposed to meet management scenarios
Management tools	Input/output/technical measures
MS	Member State
MSFD	Marine Strategy Framework Directive
MSY	Maximum Sustainable Yield
SBL	Safe biological limits

ACKNOWLEDGEMENTS

This research was undertaken by the EC-FP7 funded Making the European Fisheries Ecosystem Plan Operational (MEFEPO) project (Project number: 212881), co-ordinated by the University of Liverpool, UK (www.liv.ac.uk/mefepo). The MEFEPO team would like to thank our colleagues outside of the core project team, and external experts, who provided input in the development of the case study fisheries in the development of the MEFEPO Fisheries Ecosystem Plans. The MEFEPO project would like to thank all stakeholders who have taken part in interviews and workshops, and the MEFEPO Advisory Committee who provided invaluable guidance throughout the project.

1.1. European fisheries

The EU fishing industry is the fourth largest producer (fisheries and aquaculture) in the world, accounting for 4.6% (6.4 million tonnes live weight) of the global production in 2007 (EC 2010). The EU currently consists of 27 Members States (Fig. 1.1.1), and fishing and associated activities (e.g. processing) provide jobs for more than 400,000 people[1]. The number of (full-time equivalent) people employed in the fish catching sector was estimated at 141,110 in 2007 (< 0.1% of total employment in the EU[2]), with a further 126,000 (full-time equivalent) employed in the processing industry (EC 2010). The total income generated by EU fisheries sector in 2005 was EUR 10.9 billion(EC 2009a), approximately 0.1% of EU GDP; the majority of this income was concentrated in a small number of coastal areas. The overall value of the outputs of the processing industry in 2007 was estimated at EUR 23 billion (~US$ 32.5 billion), approximately 3 times the value of the catch. Spain (1.0m tonnes), France (0.8m tonnes) and the UK (0.8m tonnes) are the top 3 producers, together accounting for ~40.5% of total production (EC 2010). Spain, Denmark and the UK dominated the catches (Fig. 1.1.1; EC 2010) and Spain is by far the greatest recipient of fisheries funds, receiving almost half of EU subsidies[2].

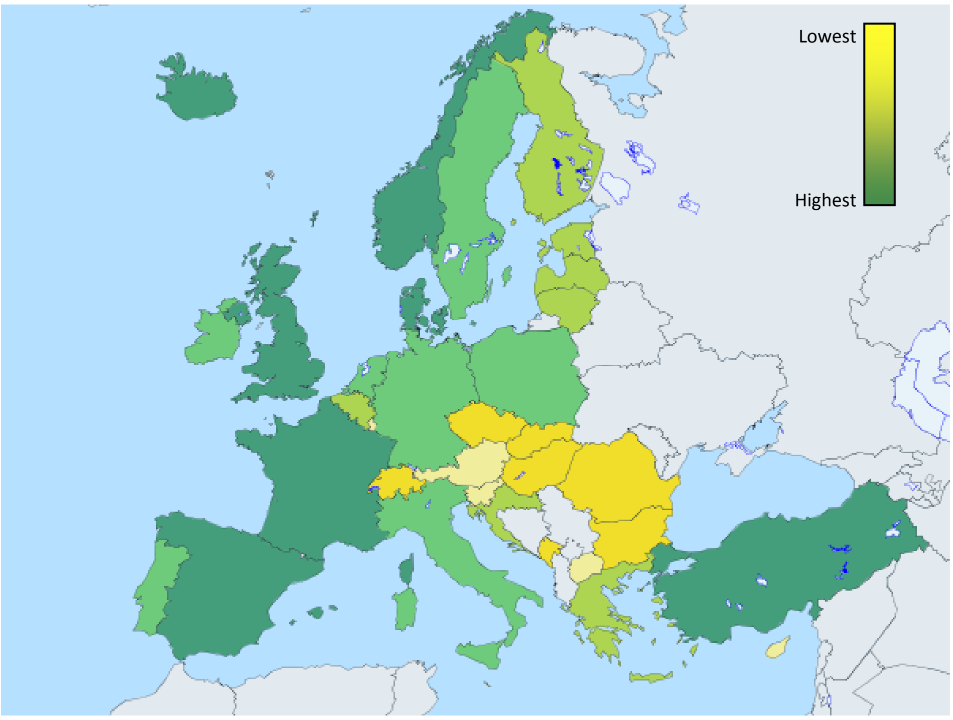


Fig. 1.1.1 Relative annual catches (based on live weight equivalent of landings) of fishery products by EU Members States, Iceland and Norway and other major fishing nations, in 2009. Data excludes any products which, for a variety of reasons, are not landed (Source: Eurostat[3]).

Employment in marine fisheries is concentrated in a handful of countries in the EU. In 2007, Spain accounted for ~25% of the total employment in the fish catching sector (35,274 full-time equivalent)

1 http://europa.eu/pol/fish/index_en.htm (accessed 07/08/11)

2 http://www.cfp-reformwatch.eu/category/top-menu/sea-facts-and-figures/ (acccessed 07/08/11)

3 http://epp.eurostat.ec.europa.eu/guip/mapAction.do?mapMode=dynamic&indicator=tag00076#tag00076 (accessed 02/08/11)

and the top 3 EU countries (Spain, Greece and Italy) accounted for 60% of EU employment in this sector. Spain, the UK and Italy lead in terms of processing value, and employment numbers in the processing sector by Member State broadly reflect processing value (EC 2010). Spain, Greece and Italy also account for ~50% of the vessels in the European fleet (EC 2010), which range from small artisanal boats focussed on activities in inshore waters to large factory ships operating in international waters.

Fleet capacity has decreased over the last 2 decades, at an annual average rate of just below 2% (tonnes and engine power) and in 2009 was estimated at 85,000 vessels (EC 2010). However, the reduction in fleet size has potentially been compensated by technological advances and increased efficiency ("technology creep") estimated at 2-4% per annum (Sissenwine & Symes 2007). Fleet overcapacity remains a fundamental problem in EU waters, with the number of vessels (and associated effort) considered to be too high for the resources available (EC 2009b; EC 2011).

The EU fleet operates worldwide but catches are predominantly taken in the Eastern Atlantic and the Mediterranean. In terms of tonnage, catches are dominated by the Atlantic herring and sprat which accounted for almost a quarter of the total landed catch (Fig. 1.1.2). However, catches vary considerably among Member States and fishing regions in terms of quantities and species caught (EC 2010; Table 1.1.1).

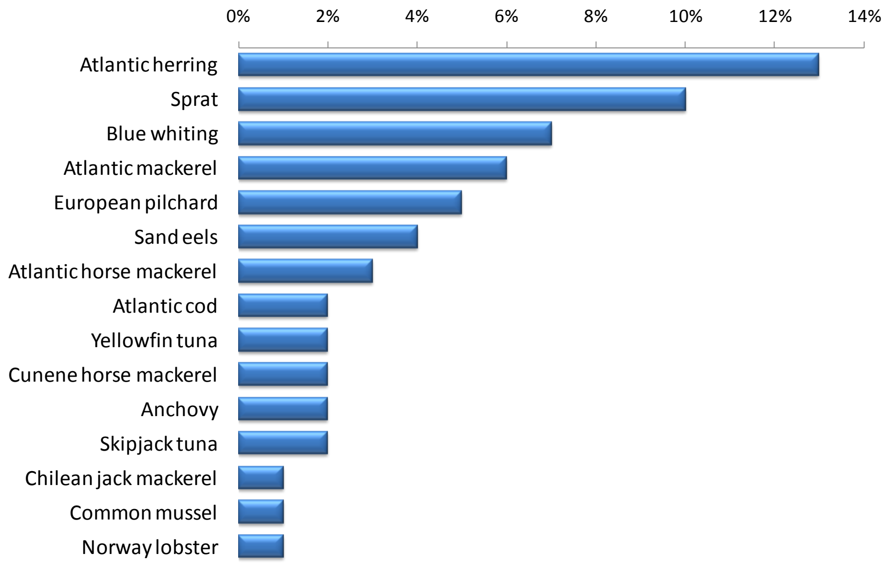


Fig. 1.1.2 The 15 main species caught and their contribution to the total EU production (6.4m tonnes based on live weight) in 2009 (EC 2010; Source: Eurostat).

Table 1.1.1 Examples of the diversity of catches by Member States based on the three main species caught by the fleet of each nation (% of tonnes (live weight) based on total catch of that species across the EU; EC 2010).

Denmark Sand eel *Ammodytes* sp. (26%) Sprat *Sprattus sprattus* (22%) Atlantic herring *Clupea harengus* (18%)	**France** Yellowfin tuna *Thunnus albacares* (8%) European pilchard *Sardina pilchardus* (7%) Skipjack tuna *Katsuwonus pelamis* (7%)
UK Atlantic mackerel, *Scomber scombrus* (22%) Atlantic herring *Clupea harengus* (15%) Blue whiting *Micromesistius poutassou* (9%)	**Portugal** European pilchard *Sardina pilchardus* (36%) Chub mackerel *Scomber japonicus* (11%) Atlantic horse mackerel *Trachurus trachurus* (5%)
Netherlands Atlantic herring *Clupea harengus* (25%) Blue whiting *Micromesistius poutassou* (20%) Atlantic horse mackerel *Trachurus trachurus* (15%)	**Spain** Yellowfin tuna *Thunnus albacares* (10%) Mackerel *Scomberomorus* sp. (8%) European pilchard *Sardina pilchardus* (8%)

1.2. Management of European Fisheries: the Common Fisheries Policy

The Common Fisheries Policy was established in 1983 (Regulation (EEC) No 170/83) to provide an integrated framework for the management of European fisheries *"....which enshrined commitment to EEZs, formulated the concept of relative stability and provided for conservatory management measures based on total allowable catches (TACs) and quotas"* (Olivert-Amado 2008). The CFP is subject to review every 10 years (Box 1), and in 1992 was reformed (Regulation (EEC) No 3760/92) with the intention of remedying the serious imbalance between fleet capacities and catch potential through fleet reduction and associated structural measures to alleviate social and economic impacts. The *"...concept of 'fishing effort' was introduced with a view to restoring and maintaining the balance between available resources and fishing activities in response to changes in EU membership and associated fleet structure".*

Box 1 Summary of the development of the Common Fisheries Policy

1970 First common measures for EU waters agreed which allowed EU fishers equal rights to exploit Member States' waters, with the exception that local fishers had exclusive fishing rights to 6 miles.

1976 MS rights were extended from 12 – 200 miles in line with international agreements in 1976; 6 to 12 miles was restricted to local vessels and vessels from MS with historic entitlements (Styring 2010)..

1983 Common Fisheries Policy (CFP) established with stated overarching aim to "*...the protection of fishing grounds, the conservation of biological resources of the sea and their balanced exploitation on a lasting basis and in appropriate economic conditions.*" (Regulation (EEC) No 170/83)

1992 First reform of the CFP stated an overarching objective to *"...protect and conserve available and accessible living marine aquatic resources, and to provide rational and responsible exploitation on a sustainable basis, in appropriate appropriate economic and social conditions for the secgtor, taking account of its implications for the marine ecosystem, and in particular taking account of the needs of both producer and consumer."* (Regulation (EEC) No 3760/92)

2002 Second reform of the CFP stated an overarching objective to *"...provide for sustainable exploitation of living aquatic resources and of aquaculture in the context of sustainable development, taking account of environmental, economic and social aspects in a balanced manner*." (Council Regulation (EC) No 2371/2002)

However, these measures were not effective; they failed to prevent overfishing and further depletion of many fish stocks accelerated. In response, the major challenge of the 2002 reform (Council Regulation (EC) No 2371/2002) was *"....tackling simultaneously the risk of collapse of certain stocks, the impact on marine ecosystems, significant economic losses for the industry, the fish supply to EU markets and the loss of jobs."* These reforms also sought to address the increasingly acrimonious and polarised positions of managers and the fishing industry. Governance reforms included the provision of greater industry scrutiny of the advisor process and the establishment of Regional Advisory Committees consisting of representatives from the commercial fishing industry and non-governmental organisations. The 2009 Green Paper on the Reform of the CFP identified key failures of the 2002 reforms in relation to overfishing and stock depletion, fleet overcapacity, continued heavy subsidies, low economic resilience and decline in the volume of fish (EC COM(2009)163 final).

Most EU fish stocks have been fished down to below levels considered sustainable, with 88% being fished beyond MSY and 30% considered to be outside safe biological limits (EC COM(2009)163 final). The 2002 Reform has also been criticised due to the absence of guidance in terms of scaling and trade-offs between ecological, social and economic objectives, and for failing to specify what timeframe should be used when considering these objectives (Sissenwine and Symes 2007). For example, long term sustainability of fish stocks has the potential to deliver long-term ecological, social and economic benefits but may have short term economic and social costs which potentially jeopardize economic and social sustainability (Sissenwine and Symes 2007).

Box 2 Five key structural failings of the CFP identified in the Green Paper on the Reform of the CFP (EC COM(2009)163 final)

1. Deep-rooted problem of fleet overcapacity;
2. Imprecise policy objectives resulting in insufficient guidance for decisions and implementation;
3. Decision-making system that encourages a short-term focus;
4. Framework that does not give sufficient responsibility to the industry; and
5. Lack of political will to ensure compliance and poor compliance by the industry.

The recently published Communication on the 2012 Reform of the CFP (COM(2011) 417 final) states an overarching objective,

> "*By bringing fish stocks back to sustainable levels, the new Common Fisheries Policy (CFP) aims to provide EU citizens with a stable, secure and healthy food supply for the long term. It seeks to bring new prosperity to the fishing sector, end dependence on subsidies and create new opportunities for jobs and growth in coastal areas. At the same time, it fosters the industry's accountability for good stewardship of the seas.*"

1.3. Ecosystem based management and integration of the CFP with other marine policies

The concept of Ecosystem Based Management (EBM) has been recognised in a number of international agreements, and derives from the 1992 Convention on Biological Diversity and the subsequent 2002 World Summit on Sustainable Development. EBM is also central tenant of the FAO (UN) Code of Conduct for Responsible Fisheries (FAO 1995), and new policies are being developed in response to these drivers to integrate management across sectors (e.g. Canada's Oceans Act 1997; Australia's Oceans Policy 1998; DEFRA 2002; EC COM(2008) 187) rather than focussing on a particular sector (Pascoe 2006). Fisheries management can no longer be seen in isolation and the 2008 (COM(2008) 187) and 2011 (COM(2011) 417 final) Communications on the Reform of the CFP acknowledge the interaction between fisheries and other maritime sectors, highlighting the importance of ecosystem based approach to marine management, covering all sectors, and states:

> "*The future CFP must be set up to provide the right instruments to support this ecosystem approach.*" (COM(2008) 187)

Within the EU, the cross-sectoral approach is being pursued under the Integrated Maritime Policy (IMP; COM(2007) 575 final) which has been implemented to take account of the multiple pressures from the different sectors and address interactions between European policies and maritime affairs (EC 2007). The Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC) forms the environmental pillar of the IMP and is the thematic strategy for the protection and conservation of the marine environment "*with the overall aim of promoting sustainable use of the seas and conserving marine ecosystems*" (EC 2008). Economic and social sustainability are acknowledged as dependent on productive fish stocks and healthy marine ecosystems, and the Green Paper sets out a commitment to manage European fisheries within the constraints of the MSFD to achieve good environmental status (GES), defined as,

> "*environmental status of marine waters where these provide ecologically diverse and dynamic oceans which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations…*" (Article 3(5); EC 2009b).

The EU is a signatory to 2002 World Summit on Sustainable Development target for fish stocks to be exploited at maximum sustainable yield (MSY), and achievement of this objective would also enable the reformed CFP to contribute to achieving GES in the marine environment, in line with the provisions of the MSFD (EC 2011).

Commitments through OSPAR and the 2002 World Summit on Sustainable Development call for the establishment of a representative network of marine protected areas (MPAs) by 2012 to help restore degraded marine ecosystems and fish stocks to sustainable levels (WSSD 2002; Pita *et al.* 2011), and there is growing support for zoning of marine activities in the context of ecosystem based marine management (Charles 2001).

1.4. Developing Ecosystem Based Fisheries Management: Fisheries Ecosystem Plans

The 2009 Green Paper on the Reform of the Common Fisheries Policy (EC 2009):

- identified the need for ecosystem based fisheries management (EBFM);
- stated an intention to move towards a longer-term approach to fisheries management;
- made commitments to greater stakeholder involvement and management to support the three pillars of sustainability: ecological, social and economic.

Understanding of the links between ecological, social and economic systems is essential in order to ensure that management decisions are appropriately informed. One of the greatest challenges of management, and to managers, is finding ways to achieve objectives simultaneously; in practice achieving multiple objectives is difficult and trade-offs have to be considered.

In the US, Fisheries Ecosystem Plans (FEPs) were developed to further the development of the ecosystem approach in fisheries management as a tool to assist managers to consider the ecological, social and economic implications of their management decisions (Fluharty *et al.* 1999). The core concept of the Making European Fisheries Ecosystem Plans Operational (MEFEPO) project is the development of operational Fisheries Ecosystem Plans (FEPs) for three regional seas (North Sea, North West Waters and South West Waters) to support the transition to EBFM, building upon lessons learned from previous EU project (e.g. European Fisheries Ecosystem Plan, EFEP, completed in 2005) and international experience (e.g. Fisheries Ecosystem Planning for Chesapeake Bay[4]).

The aim of FEPs is to provide managers with a strategic rather than prescriptive plan for the adoption of EBFM. FEPs are thus a guide for use in FM planning and development (or amendment of fisheries management plans), and should realistic, focussing on critical features and processes of ecosystem vital in managing fisheries resources (Link 2002).

1.5. Making the European Fisheries Ecosystem Plan Operational

The Making the European Fisheries Ecosystem Plan Operational (MEFEPO) project team has been supported by an Advisory Committee, consisting of senior figures from the industry and management organisations, engagement with 4 Regional Advisory Councils and stakeholder interviews and workshops. Through structured interaction with stakeholders, the project has developed Fisheries Ecosystem Plans (FEPs) for three regional seas (North Sea, North West Waters and South West Waters) to support the transition to EBFM. These regions were selected as they represent a range of challenges in terms of: knowledge; data availability; the number of national interests; spatial extent; and a broad range of physical and biological characteristics.

Central to the FEPs is a management strategy evaluation matrix, developed with stakeholders (see van Hoof *et al.* 2011), which can be used to explore the potential impacts of different combinations of management measures on ecological, social and economic descriptors, and assist managers to understand the ecological, social and economic implications of their decisions. This management support tool is demonstrated using case study fisheries within each region (Table 1.5.1) and gaps in

4 February 2004 the FEP was published [provide details].

knowledge (ecological, social and economic) which may limit the ability to successfully implement EBFM are identified.

Table 1.5.1 Regional Advisory Councils and associated case study fisheries

North Sea	**North Western Waters**	**South Western Waters**
Mixed flatfish beam trawl	North East Atlantic mackerel	Purse seine fishery
Sandeel industrial fisheries	Dublin Bay prawn (*Nephrops*)	Mixed demersal trawl fishery
Herring pelagic fisheries	Northern hake	Mixed demersal line fishery
Cod-otter trawl fishery	Scallops	*Nephrops*

This report focuses on the North Western Waters and case study fisheries and is one a series of 3 Fisheries Ecosystem Plans (FEPs) produced by the MEFEPO project; the other FEPs focussing on the North Sea and South Western Waters RAC regions. Stakeholder summary documents have been produced for each FEP to accompany this technical report and can be accessed via the MEFEPO project website at http://www.liv.ac.uk/mefepo/reports-and-outputs/wp7/

Whilst the geographical focus of the FEPs is different, the structure remains the same and draws upon the wealth of information and outputs from the MEFEPO project, consisting of:

- Section 3 provides an overview of the critical ecological, economic and social ecosystem components of the North Western Waters;
- Section 4 provides a summary of the ecological state of the North Western Waters ecosystem;
- Section 5 examines the regional case studies and provides an introduction to the fisheries and state of the stock, current management tools and performance, evaluation of alternative management strategies against ecological, social and economic descriptors, and management guidance; and
- Section 5 considers the next steps required for implementation of EBFM.

The MEFEPO project has also examined stakeholder views on the governance and institutional frameworks in European Fisheries (Raakjaer *et al.* 2010) and, with stakeholders, developed an operational model for a regionalised CFP to support successful implementation of an EBFM in Europe (van Hoof et al. 2011). The proposed model is common to all of the FEPs and is presented in Section 2.

2.1. Governance challenges

Although the extent of the failure of the Common Fisheries Policy (CFP), the fisheries policy framework of the EU, can be debated, it is clear that the policy has not delivered satisfactory results.

Recent reflections on the CFP (Sissenwine & Symes 2007), the Green Paper (EC 2009b) and Raakjaer (2009) paint a rather depressing picture of the performance of the CFP. Many fish stocks are fished to the limits and some stocks are overfished and on the brink of collapse, although it should be noted that there is evidence of improvements in some small pelagic stocks following implementation of long-term management plans (LMPs). The EU fisheries sectors are characterised by poor profitability with sector employment steadily declining according to the Commission (EC 2009b) . In addition, the EU fishing sector is facing intensive competition from freshwater and marine aquaculture production, making the market extremely competitive. The lack of success of the CFP is primarily caused by a lack of political will and ability among Member States to reduce fishing efforts and alter the present management path (Hegland & Raakjaer 2008). Further shortcomings of the present CFP that need to be considered when reforming the governance system by the end of 2012 include:

- Lack of clear principles and long-term objectives
- Mismatch between the scale of the governance and the ecological systems
- A tendency to apply one-size-fits all-solutions
- Micro-management trap
- Low legitimacy among fishermen
- The type of co-management introduced has not led to responsible behaviour among fishermen
- Problems of 'implementation drift' and inconsistent enforcement exist in the member states
- Discrepancies in the ways administrators and fishermen view the goals and means of the management regime

Over the last couple of years, *the governance option of regionalising the Common Fisheries Policy* (CFP) has become one of the hot topics in the debate about the content of the upcoming reform of the CFP. The recent Green Paper from the Commission has been instrumental in putting regionalisation firmly on the reform agenda. Spurring from the nature of the shortcomings facing the CFP and the focus of public discussions on introducing new modes of governance generally to the EU, discussions of further regionalisation of the CFP (in line with the principles of subsidiarity) have increased considerably over the years. Stakeholders, researchers, administrators, and politicians still struggle to find long-lasting and innovative solutions to put the CFP on a sustainable track and create a governance structure that facilitates the move towards ecosystem-based fisheries and marine management in accordance to the Johannesburg Declaration (United Nations 2002).

2.2. Meeting the governance shortcomings of the CFP

Understanding the structural failures of the CFP is closely related to the mismatch in scales of governance, particularly the lack of ability to find the 'right fit' of scales for governance intervention. Additionally, allocating power and responsibility to the best-suited scale of governance in line with the principle of subsidiarity has become an increasingly challenging task in the light of adopting ecosystem-based management in EU fisheries. Regionalisation has been seen as one answer to solve this problem.

Regionalisation of the CFP has been discussed at varying intensities beginning in the mid-1990s (e.g. Symes 1997) through the 2002 CFP reform, which made the first move in this direction by establishing Regional Advisory Councils (RACs). Since 2004, seven RACs have been established, organised along either specific sea areas roughly corresponding to large marine ecosystems (Baltic Sea RAC, North Sea RAC, South Western Waters RAC, North Western Waters RAC and Mediterranean RAC) or specific types of fisheries (Pelagic RAC and Distant Waters RAC). The RACs were introduced to provide a forum for stakeholders to discuss particular issues in their region and bring attention to those issues and convey advice to managers and decision-makers in the central EU institutions as well as the member states.

The discussions on regionalisation of the CFP are complex and compound. In Raakjær *et al.* (2010), we focused attention on the issue of regionalisation of the CFP by identifying and organising explanations for why particular actors with an interest in EU fisheries management would want to (or not want to) regionalise the governance system. Strikingly, the discussions of regionalisation in relation to the CFP have shown that the concept has been employed in both a multi-faceted manner—in the sense that it subsumes several discussions under one heading—and in an ambiguous manner—in the sense that as a description of a way of governing, it means different things to different people. In short the concept of regionalisation subsumes three interrelated discussions pertaining to who, where, and what—although achieving this separation can be difficult in practice.

The discussion of where to regionalise is related to the relative importance of different geographical levels in a perceived politico-administrative hierarchy of the CFP. The governance system of the CFP operates across three politico-administrative levels: the member state level, the intermediary level of regional EU seas (or the RAC areas), and the EU central level. One of the present challenges is that the scale of the governance system often does not correspond to the ecological system being managed. Matching the scale of the natural system with the scale of the governance system is essential and this supports calls for regionalisation in the shape of strengthening the intermediary (generally sea basin) level between the EU central level and the member state level.

The discussion whom to regionalise to has primarily focussed on the extent to which stakeholders should be involved in the fisheries management process of the CFP or merely subject to it. In the EU it is commonly accepted that those dependent on fishing for their livelihood ought to be well-represented in the management process. In scientific fisheries management literature, many different setups for devolution of management exist. Hegland *et al.* (2012) describes five different setups: 1) Top-down hierarchical management by the state where mechanisms for dialogue with users and stakeholders might exist, but only minimal exchange of information takes place and EU/National governments decide what information to share. 2) Co-management by consultation where extensive formal mechanisms for consultation (and feedback on use of recommendations) with users and stakeholders exist, but all decisions are taken by EU/National governments. 3) Co-management by partnership where EU/national governments, users, and stakeholders cooperate as decision-making partners in various aspects of management. 4) Co-management by delegation where EU/national governments have devolved de facto decision-making power to users and stakeholders in relation to various aspects of fisheries management. And 5) industry self-management with reversal of the burden of proof where government has devolved wide-ranging management authority to users and stakeholders, who must demonstrate to EU/national governments that management decisions are in accordance with the given mandate.

The question of what to regionalize has mainly evolved around what tasks need to be kept at a central level and which can be devolved. Many different kinds of decisions have to be made in European fisheries management. The decisions can be ordered in a system starting at the top layer, which covers the general conditions and frameworks (e.g. the Basic Regulation of the CFP), going down to a layer that contains policymaking and management plans (e.g. stock recovery plans), and finally down to a layer of formulation of the national obligations (e.g. distribution of quotas or days-at-sea). In reality the layers interact and are difficult to separate (there may even be more layers). However, the layers help to visualise the management; as you go down the layers, the number of details in the regulation increases but the span of influence decreases. Currently the CFP suffers from an approach to governance that requires the upper levels to take decisions on detailed issues (e.g. mesh sizes) with little span of influence in specific sea areas.

Given the complexity and multidimensionality of regionalisation of the CFP, there are a number of different ways in which the political aim of regionalisation could be made operational. We initially focused on five different models of regionalisation; 2 of the models (Regional Fisheries Management Organisation and Regional Fisheries Co-Management Organisation) were identified as having the greatest stakeholder support following interviews with RAC participants (Raakjaer *et al.* 2010). Each of these 2 models has advantages and disadvantages, but implemented in the right way any of these models could be put into practice and deliver many of the benefits that people are seeking in relation to regionalisation. It is notable that both models build on the matching of ecosystem scale and governance levels and therefore, in contrast to the current system, could facilitate the adoption and implementation of regionally distinct, tailor-made management approaches.

It is important that the chosen model can work as a common framework for all regions but also that the model incorporates flexibility to accommodate regions who develop their own regional governance approach. Based on our findings it seems likely that for some time it will be necessary to retain the 'default option' of the present system to allow regions who do not current have the capabilities/resources to take on extra authorities presented by a more ambitious model freedom to mature and develop at their own pace.

2.3. Operational challenges – and their regional differences

2.3.1. Legal challenges

It is important to note that some models for regionalisation may pose legal challenges due to the Lisbon Treaty. Long (2010) describes the uncertainty about the legal limitations imposed by the overall policy framework of the Lisbon Treaty in relation to increasing the regional scope of the governance system of the CFP.

However, the legal challenge is also considered one of the defining elements of the regionalisation debate; the question of the level of de facto authority that the regional level should have. There are differences in opinion on this, one position being that the member states cooperating at the regional level should be in a position—although subject to approval at the central level—to decide on vital issues such as whether and how to use quotas and/or effort regulation to reach long-term management targets. At the other end of the spectrum, it has been argued that the regional structure should basically be restricted to something that can facilitate member states cooperation on issues of implementation.

2.3.2. Challenges of increasing administration costs

Regionalisation of the CFP is likely to increase the administrative costs of the management system and the costs for stakeholders participating in the management processes. Both stakeholders from the fishing industry and managers from the national administrations have expressed concerns in this regard (van Hoof *et al.* 2011).

These costs could be mitigated by shifting towards a management approach where the industry carries a larger share of the burden of management by introducing result-based management, possibly combined with reversal of the burden of proof. In general this approach entails that the industry is presented with certain targets or limits that they have to comply with and—as long as respecting those limits—the industry itself may decide on how it wants to do management. If this is combined with a reversal of the burden of proof, the industry itself would have to cover the costs of documenting that they are within the limits. This way of perceiving regionalisation also links it to the issue of financial efficiency by giving the industry more manoeuvrability and self-determination with the caveat that the industry takes over (some of) the costs associated with fisheries management.

2.3.3. How can the institutional set-up foster ownership and facilitate compliance of management measures?

It is not only the direct, goal-achieving value of more tailor-made management from regionalisation that is important; the value of regionalisation also responds directly to another key problem of low legitimacy of the CFP, which has contributed to the failure to cultivate a culture of compliance. It is important to distinguish between two kinds of legitimacy when discussing fisheries management: process (or procedural) legitimacy refers to the legitimacy that fisheries management measures derive from being the product of a governance process perceived as fair and just (Jentoft 1989; Jentoft 1993; Jentoft & McCay 1995; Raakjaer Nielsen & Mathiesen 2003); and content legitimacy broadly refers to the legitimacy that a measure can derive from being perceived as reasonable and appropriate by those subjected to it or with an interest in it. Many stakeholders perceived that a regionalised governance process has the potential to strengthen the process legitimacy of the CFP and the improved outputs capable of strengthening the content legitimacy—at best this could break the cycle of failed management, low legitimacy, and non-compliance that the CFP has for long found itself in.

2.3.4. Challenges of differences in the organisational capabilities of various stakeholders

Major differences exist among EU member states on many levels, e.g. culture, framework conditions, organisational structures. Regionalisation of the CFP poses a new set of institutional and structural challenges for the stakeholders involved as well as for the governments of member states. In the southern part of Europe, the fishing fleets are composed of many small scale actors and their capacity is considered to be relatively weak. In contrast, in northern Europe the traditions and mechanisms for decentralised decision making are much stronger. These differences have to be considered when making an operational model for a regionalised CFP and the incentives for tailor-made management to suit regional needs minimising one-size-fits-all solutions.

2.3.5. Experiences from the RACs

A key focus of the MEFEPO project is how best to make current institutional frameworks responsive to an ecosystem approach to fisheries management at regional and pan-European levels in accordance with the principles of good governance. The principles of fisheries policies and management (CFP) should be consistent with and complement other EU legislation (e.g the Marine Strategy Framework Directive (MSFD), Habitats Directive etc.) rather than additive or contradictory. However, for the development of Fisheries Ecosystem Plans one does not necessarily have to involve all the other industries in the marine environment.

The RACs are relatively new bodies created by the 2002 CFP reform. The RACs consist of fisheries stakeholders mainly the fishing industry and eNGOs. As such the RACs are naturally oriented towards fisheries and are maturing as fisheries advisory bodies. This process presents a number of internal challenges (see below), however, this process is under pressure as fisheries is just one of the many sectors exploiting the marine environment and environmental Non-Governmental Organisation (eNGOs) are pushing for more restrictive regulations o protect the marine environment. Thus questions are being asked as to whether the RACs can continue to operate as a stand-alone advisory body or will be 'forced' to merge into more integrated marine co-management bodies with broader representation. If so, how could or should this be achieved? Unfortunately, these questions are outside of the remit of the MEFEPO project due to our focus on fisheries management; however it is clear that the RACs will play a key role in the future for wider marine ecosystem based management.

Various stakeholders (e.g. industry representatives and eNGOs) and both EU and national managers participated in an email survey on regionalisation and the work of the RACs. In the questionnaire, the respondents were asked for their views on a number of challenges for the RACs including: 'reaching consensuses', 'communicating in different languages and across cultures', 'balancing small-scale vs. large-scale fishing priorities', 'addressing different national catching sector priorities', 'responding to specific advice requests' and, 'cultivating better cooperation between industry and non-industry interests'. The survey totals 138 observations, of which 100 participants completed an online questionnaire, 30 completed a paper version, and eight partially responded online providing enough answers to merit inclusion. The response rate for the survey stands at 41.9 % (138/329). The respondents were asked different questions in the survey: basic questions about their background and their way of working, questions on their views on different models of regionalisation, questions on their view on the RACs work and the challenges of the RACs. The answers from the last group of questions that are synthesized below focusing on the regional differences between the RACs (Table 2.5.3.1).

Table 2.3.5.1 The table shows the averages of the rankings of the challenges for each of the RACs and the overall average. Respondents are asked to state how challenging they find various aspects of the RACs from one (very easy) to five (very difficult); hence the average is three. The table shows the averages in the answers from each RAC – green marks that the average is 'below 3' (easy or very easy) and red marks that the average is above three (difficult or very difficult).

	Reaching consensuses	Balancing small-scale vs. large-scale fishing priorities	Addressing different national catching sector priorities	Responding to specific advice requests	Communicating in different languages and across cultures	Cultivating better cooperation between industry and non-industry interests
NWW RAC	4.00	3.45	3.63	3.44	3.00	3.60
SWW RAC	3.78	3.77	3.27	2.91	2.60	3.52
NS RAC	3.60	3.38	2.83	3.45	2.67	3.67
Pelagic RAC	3.38	3.36	3.32	2.95	2.76	3.16
All RACs	3.72	3.52	3.29	3.19	2.76	3.51

2.3.6. The experiences on reaching consensuses

RACs were put in place as advisory bodies as an initial step toward more stakeholder participation in developing EU fisheries policy. The idea being that the stakeholders on a RAC will seek consensus on issues to do with fisheries management and policy, and thereby allow DG MARE to weigh the political advantages of following the RAC's consensus against any differences between the consensus and other preferences of DG MARE (Hegland & Wilson 2009). Hegland (2009, p. 13) argues '*…the main tool of the RACs in relation to gaining an impact on the decision-making process remains the alternative instrument of consensus-building: in the first instance the RAC needs to build consensus among the various stakeholder groups within it; at the same time, however, the RAC needs to anticipate the Commission's position so that the RAC's consensus does not fall too far from that. If a consensus or a 'close-to-consensus' can be found between the RAC and the Commission, it could be argued that the member states (or smaller groups of member states) in the Council would find it politically too costly to overrule that consensus. It could be argued that this represents a dispersion of power from the central state governments to other actors, i.e. the Commission and the RACs, which are in turn becoming increasingly interdependent (vertical and horizontal interdependence)*'. Indicating the RACs can gain political impact if they could reach consensus or at least establish a situation of 'close-to-consensus'.

Despite the potential for increased political impact – or perhaps because of it – respondents in all four RACs ranked 'reaching consensus' as one of the two most difficult challenges; this challenge was ranked most difficult by respondents in the NWW RAC and least difficult for respondents in the Pelagic RAC.

2.3.7. The experiences on balancing small-scale vs. large-scale fishing priorities

Along with fostering consensus, the SWW RAC has the greatest difficulty with 'balancing small-scale versus large-scale fishing priorities'. A majority of the SWW respondents rank the measure somewhat difficult to 'very difficult'; while in the other RACs such answers less than half of responses. In addition to the difficulty, a quarter of the SWW participants select this challenge as the most critical to the RAC's success. Notwithstanding, geographic affiliation highlights a starker contrast for the difficulty associated with the proposed obstacle. A third of the survey participants from the North rate the challenge as more difficult than neutral; in comparison two thirds of those from the South rank it as more difficult than neutral. Like in the case of the SWW RAC, more than a quarter of the 52 South category participants believe the issue of scale is the most critical to the RAC's success while none in the North category regard scale as the most important challenge.

This challenge demonstrated one of the more pronounced cleavages between northern (e.g. NS and NWW RACs) and southern (SWW) perspectives among our results.

2.3.8. The experiences on addressing different national catching sector priorities

'Addressing different national catching sector priorities' was identified as a key challenge within the NWW RAC while the NS RAC stands apart from the other three RACs on this measure because of the below average. Two thirds of the NWW respondents rank the challenge as somewhat 'difficult' to 'very difficult' compared to approximately one quarter of the NS RAC respondents. Nearly half of the Pelagic RAC respondents ranked this challenge as neutral. Half of the NS RAC respondents found the challenge of addressing different national catching sector priorities 'somewhat easy' or 'very easy'; whereas few respondents from the other RACs (NWW, SWW and Pelagic) selected these responses.

2.3.9. The experiences on responding to specific advice requests

There was disagreement among RACs on the difficulty of "*responding to specific advice requests ('fire fighting')*". Respondents from both the NS and NWW RACs experienced greater difficulty with this challenge compared to those from the Pelagic and SWW RACs. It could be speculated that this divide is due to the precarious situation of several stocks in the NS, and to a lesser extent the NWW, has led to more demands on providing advice to specific requests, often referred to as 'fire fighting', compared to the Pelagic and SWW RACs. However, few participants from each of the RACs selected this challenge as the most critical; highlighting that is in any case not one of the most salient issues to RAC participants

2.3.10. The challenge of communicating in different languages and across cultures

The survey included a question on the difficulty of '*communicating in different languages and across cultures*' to examine whether RACs with more diverse composition of countries and languages, such as the NWW RAC, struggle with this factor more than a RAC that is able to communicate almost entirely in one language, for example, the NS RAC where English is the dominant language. To a degree this question also gauges the North-South divide without explicitly naming the ostensible phenomenon. The mean score for the NWW RAC as higher, indicating that communication was perceived as more of a challenge for this RAC than the NS, Pelagic and SWW RACs. However, the NWW RAC mean score reflected a neutral rating overall. Therefore, communicating in different languages and across cultures does not seem to pose a major challenge in the perception of participants for any of the RACs. Somewhat surprisingly the SWW RAC averages the lowest in terms of difficulty, but is in close proximity to the North Sea RAC and the Pelagic RAC averages; moreover, there is little difference in the frequency distribution of answers along North-South lines. Communicating in different languages and across cultures does not seem to pose a major challenge in the perception of participants for any of the RACs.

2.3.11. The experiences on cultivating better cooperation between industry and non-industry interests

Survey responses indicated that all RACs struggle with the challenge of "cultivating better cooperation between industry and non-industry interests". This challenge is closely related to the challenge of 'reaching consensus' as it is – most frequently – the industry and non-industry stakeholders' positions that are hard to combine. Respondents from the NS RAC ranked this challenge the most difficult challenge of all challenges presented but the NWW RAC and SWW RAC fall close to the overall mean. These results from these three RACs are fairly close; however the Pelagic RAC averages the lowest of the RACs on the industry and non-industry challenge. Probably the main explanation for this situation is that the industry stakeholders pre-dominate the composition of Pelagic RAC respondents with few other stakeholders counterbalancing. The Pelagic RAC's small size and relative stakeholder homogeneity may also contribute to the tightness of the range in difficulty for the presented challenges.

2.3.12. Differences in experiences between the RACs

There is no significant association between the choice of most critical challenge and the RAC membership; however, the North-South divides proved a strong relationship. Overall, respondents from NS, NWW, and Pelagic RAC ranked the consensus measure and the cooperation between industry and non-industry members as the first or second most critical challenge to the RAC's success (approximately one third of respondents within each RAC). While SWW participants recognise reaching consensus as a critical challenge, a higher proportion of respondents from this RAC (25%) selected 'balancing small- versus large-scale priorities' as the most critical challenge. The North-South divide demonstrated division over scale; none of the respondents the north (NS, NWW, and Pelagic RAC) viewed scale as the most critical issue, compared to more than a quarter of the respondents from the south (SWW). There was also significant association between geographic affiliation and the most critical challenge, with respondents from the north more concerned about consensus and cooperation between industry and non-industry members, and respondents from the south more concerned about scale issues (82% of respondents in this region ranked this as the most critical issue). The challenges of 'reaching consensus' and 'addressing different national catching sector priorities' were also considered to be critical by respondents from the south.

2.4. Operational model for a regionalised CFP[5]

The suggested model for regionalisation by establishing Decentralized Fisheries Management Boards (DFMBs) is drawing closely on the model Raakjaer *et al.* (2010) labelled "Cooperative Member State Council" and what Symes (2009) labelled "Standing Conference of member states administrators". The DFMB model this was developed with stakeholders from a range of backgrounds and regions as part of WP6 (van Hoof *et al.* 2011). This model will largely keep the institutional structure and formal distribution of powers unchanged. The model is based on voluntary agreements, soft law and de facto authorities based on quality of input rather than de jure authority to take decisions. Thus, regionalisation will have to be seen in the light of implementation, where the Council and the Parliament will take all essential decisions and set the high level objectives.

The aim of Fig. 2.4.1 is to illustrate how regionalisation of the CFP could be institutionalised. Regionalisation is considered a vehicle to overcome the present shortcomings of the CFP and not a mean in itself. It is acknowledged that the move to ecosystem approaches in fisheries management requires appropriate geographical scale, both in terms of the eco-system per se and the governance system responsible for management. Regionalisation, as outlined here, would be a step towards introducing tailor-made regulations based on an understanding of the dynamics of specific fisheries and ecosystems and creation of an institutional framework wherein the CFP becomes a suite of de facto eco-region fisheries policies to address many of the political challenges the CFP is currently facing.

[5] In MEFEPO WP 4 (Raakjaer *et al.* 2010) a set of models for regionalisation of the CFP developed and tested by stakeholders in four RACs (NWW, SWW and NS and Pelagic) and two/three models emerged to have potentials. These were presented and discussed at a workshop with broad stakeholder representation a part of WP 6 (van Hoof *et al.* 2011) and that lead to shared agreement among stakeholders and project scientists for proposing one model. It is important to remember that in the drafting this document we have no knowledge about how proposal from the Commission on the CFP reform will deal with regionalisation.

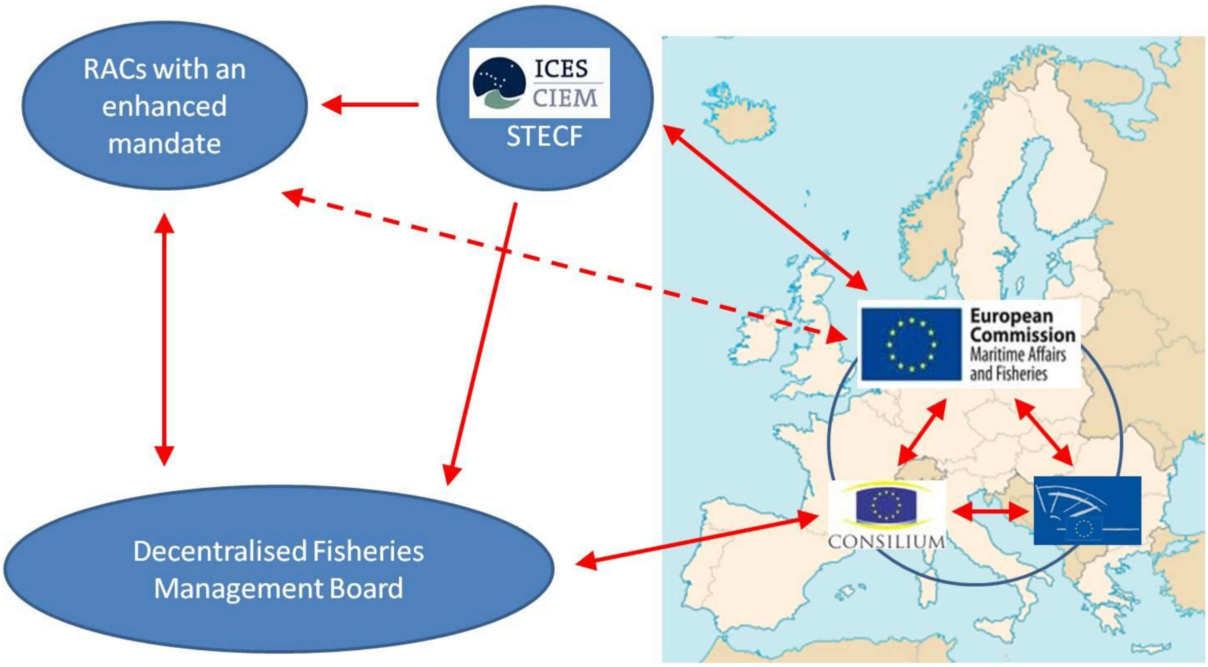


Fig. 2.4.1 Governance model for regionalisation of the Common Fisheries Policy developed by stakeholders at the MEFEPO workshop in Haarlem, April 2011. Decentralised Fisheries Management Board (FMB) similar to the 'Cooperative Member State Council' model put forward by Raakjaer *et al.* (2010) but supported by RACs with an enhanced mandate.

Based on development with stakeholders, the MEFEPO project recommends that Decentralised Fisheries management Bodies (DFMBs) are established for each of the existing 5 geographical RACs (Baltic Sea, North Sea, North Western Waters, South Western Waters and Mediterranean Sea) and for the two RACs (Long Distance Waters and Pelagic) dealing migratory stocks covering more than one of the present geographical RAC areas (Long Distance Waters and Pelagic). DFMB would address fisheries management issues specific to their geographic area or stock, and member states with fishing interests in a regional sea or migratory stocks would become members of the respective DFMB. The mandate of the DFMBs would be to draft long term management plans (LTMPs) and establish implementation strategies and thus become de facto involved in drafting proposals. This setup is close to what has previously been described as co-management by informal partnership (Raakjær *et al.* 2010), and would provide RACs with an enhanced mandate to be involved in the decision-making process and create incentives for tailor-made management to suit regional needs reducing off-the-peg and one-size-fits-all solutions in European waters. This framework between the EU institutions and the member states would enable the model to meet the shortcoming of 'implementation drift' and lack of enforcement that exists in the member states.

The DFMB provides proposals to the Commission on LTMPs and their implementation. The DFMBs will consist of members from fishing member states and observers from enhanced RACs. The exact numbers depend on member states having fishing interests in the management area. The DFMBs would forward their recommendations for LTMPs and implementation to the overall EU Fisheries Council for formal approval. RACs with enhanced mandate make recommendations to the DFMBs and the Commission.

RACs would become a working group for DFMB, and indirectly to the Commission, and provide input to and suggestions for LTMPs and their implementation. RACs would also identify and put forward requests for provision and improvement of scientific advice. In most cases, the enhanced RAC would advise the DFMBs rather than the central EU institutions. The exact extent to which stakeholders' input is given weight in the recommendations of the mini-council is up to that mini-council on a case-by-case basis. Representatives of the RACs will be granted 3 observer seats at DFMBs: the RAC chair and two others from the RAC maintaining the 2-1 balance between industries and NGOs as presently used to determine representation in RACs. If effectively implemented, this structure should serve to increase the legitimacy of the CFP and associated regulations among stakeholders (which presently is low) and reduced conflict between administrators and the industry due to differences in how these groups view the goals and means of the management regime. It is envisaged/hoped that this may lead to more responsible behaviour among fishermen. The DFMB model would allow each region to calibrate the model to their situation, providing a high degree of flexibility within the present structures despite based on de facto delegation of authority.

The approval of LTMPs would remain with the Commission which is responsible for auditing that existing, proposed and future plans are implemented in accordance to the principles and long-term objectives that have been decided by the EU.

2.4.1. Migratory Stock RACs

For the majority of migratory stocks, the EU needs to collaborate with other (non-EU) countries and mechanisms to address how these stocks and countries should be dealt has to be considered in a regionalized CFP. One solution could be that the North East Atlantic Fisheries Commission (NEAFC) is transformed into an equivalent to the Decentralised Fisheries Management Board and a management set-up with an advisory structure covering all relevant countries in a similar way to that proposed above for the regional RACs. These different options have not been fully explored and we therefore recommend that that more attention is directed to the issue of migratory stocks and third countries.

3.1. Introduction to the region

The North Western Waters (NWW) area is situated in the north east Atlantic off the west coast of Ireland and Scotland, and extends into the Celtic Sea, Irish Sea and the English Channel (Figure 3.1.1). The NWW covers approximately 1.15 million km^2 and comprises 12 ICES Divisions and three OSPAR regions. Parts of the EEZ (Exclusive Economic Zone) of three countries (UK, Ireland and France) make up NWW. The majority of the NWW area is less than 100m deep (20%), while 17% lies between 100m and 200m and 20% between 1,000m and 1,500m.

The dominant seabed feature of the western part of NWW area is the Rockall Trough. This opens into the Porcupine Abyssal plane at its southern end and further south is the Porcupine Seabight. Eastward of these seabed features lies the continental slope and shelf. The shelf area comprises the semi enclosed Irish Sea, the Celtic Sea off the south coast of Ireland and the English Channel between France and the UK.

The main ocean current affecting the NWW area is the Gulf Stream System that draws warm water up from the Gulf of Mexico to the north east Atlantic via the North Atlantic current. This transfers heat to colder areas of the north Atlantic and has a moderating influence of the climate of the area.

The sea bed habitats of the NWW are varied. There are extensive areas of gravel in the Irish Sea and English Channel. Areas of sand occur extensively on the Porcupine and Rockall Banks, the Celtic Sea and in the Irish Sea. Muddy sediments occur in the Irish Sea, the Atlantic Basin, Rockall trough and the Irish Sea.

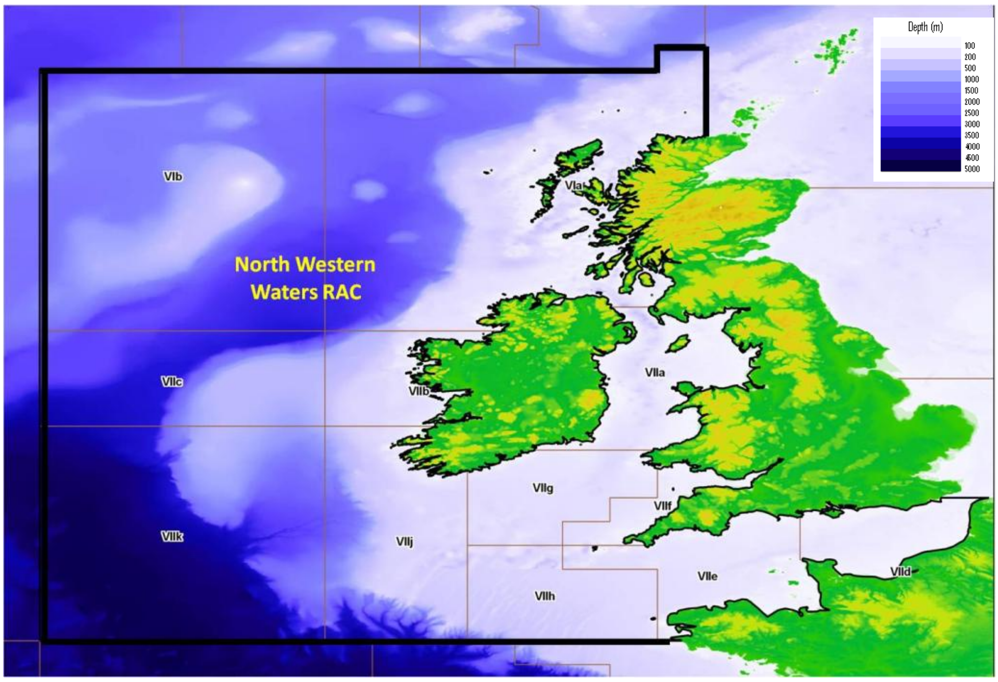


Fig. 3.1.1 Depth and ICES Areas in the North Western Waters (NWW) region (GIS Source: Bathymetry data from gebco_08_Grid ver. 20100927 www.GEBCO.net. ICES Divs. from DIFRES).

3.2. Ecological

In the NWW area, there has been a large increase in Harmful Algal Blooms (HAB) in recent years. These phytoplankton blooms include those connected with Paralytic Shellfish Poisoning (PSP). HAB events may be associated with changes in salinity, sea surface temperature and wind speed. There has been an increase in NWW sea surface temperatures when the means from 2003 to 2007 are compared to the means from 1978 to 1982. There has also been a shift northwards in certain "cold water" plankton communities and an influx of "warm water" plankton communities in the NWW.

The sea and the extensive and varied coastline of the NWW are important for birds year round, including nationally and internationally important species and assemblages. The coastal and offshore waters of the NWW area provide rich feeding grounds for local breeding and non-breeding seabirds, and passage migrants, particularly near coastal upwelling and frontal systems (e.g. along the Irish Shelf Front; north of the Porcupine Seabight). Off the west of Ireland and Scotland, petrels, shearwaters, skuas, gannets, gulls and auks dominate. The majority of these birds breed in colonies located in the NWW area, although shearwaters and skuas are passage migrants that only use the NWW area as a migratory corridor.

The NWW support a rich diversity of cetaceans (whales, dolphins and porpoises), making this area one of the most important in Europe for cetaceans. A number of these cetaceans including the harbour porpoise, the common, bottlenose, Risso's, Atlantic white sided and white beaked dolphins as well as long finned pilot whale breed in the NWW area. Others, including the blue, fin and humpback whales are not thought to breed in the area, but pass through it each year.

Two seal species regularly occur in the NWW area, the grey and harbour (or common) seal. Both species have established themselves in terrestrial colonies along the coastlines of Ireland and the UK. They leave these areas when foraging or migrating and return to rest ashore, rear young and engage in social activity. The leatherback turtle is regularly seen in NWW area and while they are reported in every month, sightings peak over the period June to October. They breed in tropical areas and are the only species of marine turtle to have developed adaptations to life in cold water. NWW contain populations of some elasmobranch species listed as critically endangered (Angel Shark) and vulnerable (Porbeagle and Common Smooth-hound) by the IUCN. The landings of sharks, skates and rays in NWW are decreasing due to declining stokes and increasing regulations. Most skates and rays are caught as valuable bycatch in mixed fisheries however there are some targeted fisheries in VII.

The NWW area is a key spawning area for many commercially important fish species. Mackerel, horse mackerel and blue whiting aggregate in vast schools in this area to spawn each year. The continental shelf area off the southwest of Ireland is also a very important spawning ground for hake and there are important cod spawning areas in the Irish Sea and in the Celtic Sea. Monkfish spawn along the shelf edge off the coast of Ireland and Scotland. Herring spawn on the gravel beds off the south and off the west of Ireland and Scotland. The shelf and inshore waters are also important habitats for juvenile haddock, whiting, cod, monkfish, megrim, hake, mackerel and horse mackerel.

Landings from the NWW area were estimated at 1.3 million tonnes in 2009. The main countries exploiting the demersal species are France, Spain, UK, Ireland and Belgium. The main countries exploiting the pelagic species are UK, Norway, Netherlands and Ireland. In Sub Area VI, the main pelagic species caught are blue whiting, mackerel and horse mackerel. The main demersal species taken are haddock, pollock, ling and monkfish. In Sub Area VII, the main pelagic species taken are blue whiting, horse mackerel and herring. The main demersal species taken are whiting, hake, monkfish, skates and rays and squid. Other important species taken in VI and VII include scallops, crabs, and *Nephrops*. Discards in the waters west of Ireland and UK (Scotland) vary between 31% and 90%, compared to the global amount of 8%.

There are significant finfish and shellfish mariculture production areas in the coastal areas of NWW. Shellfish production is most significant along the north coast of France while finfish production is most significant on the west coast of Scotland. The production of farmed salmon has seen the largest increase in NWW over the past two decades.

Special areas protected under the EU Habitats and Birds Directive exist throughout the NWW including OSPAR designated habitats such as *Lophelia* reefs, maerl beds, intertidal mudflats, deep-sea sponge aggregations and *Zostera* beds. Thirty six species of invertebrates, birds, fish, reptiles and mammals identified by OPSAR as threatened or declining also occur in NWW.

3.3. Social

Employment may be measured in different ways. In most statistics it is measured as the number of persons being (legally) employed or self-employed. However, as this may hide the fact that many of these persons work only part-time, it does not necessarily give a good picture of the total labour (measured in e.g. working hours) generated in the economy. An alternative measure is thus full time employment (FTE), which translates the work the persons employed in a specific sector, e.g. fisheries, carry out into full time jobs. This translation is especially important in a sector like fisheries, as, due to input restrictions and other regulations, many of the persons employed in the sector do not work full time.

Table 3.3.1 summarised employment, measured as FTE, in the fishery sector for the NWW fishing nations and the contribution of employment in the fisheries sector to total employment to provide a measure of the relative importance of this sector to each nation's economy. Admittedly, the fisheries' relative share of total employment underestimates this sector's real importance for employment. The reason is that total employment in the economy is measured as number of employed persons and thus does not correct for part time working, whereas the fisheries employment is measured in full time equivalents.

Employment in the fishing sector as a percentage of the total employment in the economy varied between 0.03% and 0.2% between the countries and had an average of 0.09%. Due to different measures for employment these shares are underestimates, but still can not hide the fact that the direct fishery related employment means very little to the total national employment in all the selected countries. Including processing does not change the picture substantially, as it only increases the relative shares up to a maximum of 0.4%. Similar figures are found in all other MEFEPO partner countries.

Table 3.3.1 Total employment (2006 data), employment in the fisheries (2006 data) and employment in fish processing (2003 data) for the NWW countries (Source: Preparation of Annual Economic Report (SGECA 08-02), Employment in the fisheries sector: current situation (FISH/2004/4), Eurostat: Persons: income, employment and social conditions).

	Total employment (1000 persons)	Full time equivalent employment in the fisheries	FTE employment in the fisheries in % of total employment	Employment in fish processing (# of persons)	Employment in the fisheries and in fish processing as a % of total employment
France	25,173	13,462	0.05	21,676	0.14
Ireland	2,039	3,994	0.20	3,439	0.40
UK	28,931	7,973	0.03	18,180	0.09

According to the 2010 STECF annual economic report, the Irish fleet employed 3,838 people in 2007 on 1,699 registered boats. The average crew wage was estimated to be €11,600. The total UK fishing fleet employed the equivalent of 12,608 people full-time in 2008 on 6,676 boats. The average wage was estimated to be €15,000. The French fleet comprised the equivalent of 13,100 full-time employees in 2008 on 4,485 vessels, giving an average wage of €33,570. (Note: the average wages presented are based on an average wage per total employed in the sector. Average wages per full time employee were €26,366 in France and €31,010 in the UK in 2007. Average wage per FTE not available for Ireland.) The structure of the fishing fleet in each country in NWW is discussed in the following section on economics.

When discussing fisheries and their socio-economic importance it is necessary to note the contrast between the unimportance of the sector in a national context and the huge importance it has in some local communities.

3.4. Economic

The most basic socio-economic variable is production, as measured in nominal terms. Production is often measured as sales value. The disadvantage with this measure is that it encompasses input produced elsewhere in the economy and thus not a part of the values generated by the specific sector activity, e.g. fishing or fish processing. As an alternative, value added may be used, as this variable expresses the contribution to the value of the product (e.g. fish) made by labour and capital. Gross value added is the (sales) value of the product when all input except for labour and capital (profits and capital depreciation) is deducted. Gross value added is the basic measure in the national accounts, and an international standard for how to calculate this variable secures comparability between countries.

Table 3.4.1 summarises the gross value added to the economy (GDP) and the value added by fisheries for the NWW fishing nations; the proportion of the value added by the fisheries sector to the total GDP has been calculated to given an impression of the relative importance of this sector to each nation's economy.

Table 3.4.1 Gross domestic product (GDP) and value added in the fisheries in NWW countries, current prices, 2006 (Source: Preparation of Annual Economic Report (SGECA 08-02), Eurostat: National accounts).

	Gross value added in the economy (GDP), mln EUR	Gross value added in the fisheries, mln EUR	Gross value added in the fisheries in % of GDP
France	1,807,462	672	0.03
Ireland	177,268	126	0.07
UK	1,938,979	354	0.02

The value added in the fishery sector as shown in Table 3. only encompasses the catching sector. No processing or transportation is included in these figures. With this in mind, it is obvious that fisheries do not constitute a substantial part of the national economy in any of the NWW countries. Typically, it contributes below 0.1% to total GDP. On average the direct fishing activities counts for 0.04% of GDP.

The EU as a whole is a large net importer of fish, with a net import in 2006 amounting to 13,680 mln EUR[6]. Measured in nominal values Norway, Denmark, Ireland and Netherlands were net exporters of fish products (Denmark, however, was a net importer when measured in tonnes), whereas the other countries were net importers of fish products. Table 3.4.2 shows that fish products constitute a more significant share of total exports compared to their share of GDP[7]. Though aquaculture is included in the export data, it is still likely that this conclusion holds also for harvested products as the export share at average equals 1.17% compared to the GDP share with an average of 0.08%. As can be seen from for all countries the export share of fish products exceed their share of GDP. This indicates that fish products may be more important for the foreign trade of the member states (plus Norway) than for the national production (gross value added as expressed by GDP).

Table 3.4.2 Total exports and exports of fish products for NWW countries, current prices, 2006 (Source: Eurostat: National accounts).

	Total exports, mln EUR	Exports of fish products, mln EUR	Export value of fish products in % of total export value
France	484,545	1,360	0.3
Ireland	141,663	359	0.25
UK	552,101	1,405	0.25

[6] For the 25 EU-member states total imports of fish products in 2006 amounted to EUR 17,195 mln, whereas total exports amounted to EUR 3,516 mln.

[7] The shares are not completely comparable as the figures for export include aquaculture whereas the figures for value added only encompass harvested products. However, in all countries aquaculture products constitute a minor share of total production of fish products when measured in tonnes.

To put the contribution of fishing activities to national economies in context we will compare it with that of another sector. As fishing is a primary production sector, we will compare it with agriculture. Table 3.4.3 shows that the agricultural sector clearly contributes more significantly to the national economy, in terms of gross value added and employment, compared to the fishing sector. On the other hand, when it comes to labour productivity the fishing sector far surpasses the agricultural sector. This means that the contribution per worker to GDP is higher in the fishing sector compared to the agricultural sector. Taking into consideration the subsidisation of the sectors, this conclusion is strengthened.

Table 3.4.3 Gross value added in the agricultural sector, farm labour force and productivity in the agricultural sector and the fishing sector, 2006 (Source: Eurostat: Yearbook 2008).

	Gross value added in the agricultural sector in % of GDP	Total farm labour force in % of total employment	Productivity (gross value added per employee) in the agricultural sector, EUR per worker	Productivity (gross value added per employee) in the fishing sector, EUR per worker
France	1.3	3.4	27,065	49,920
Ireland	1.0	7.5	12,150	31,545
UK	0.4	1.2	23,235	44,400

Though official statistics show that nominally the fishing sector (catching the fish) is of limited importance to the national economy in most EU-countries with a substantial fishing sector, it is a premature conclusion that the fishery activities are not important to these nations. The fishery sector generates substantial economic activity in other sectors, and this activity may exceed the value added generated in the sector itself. Due to difficulties in providing data we are not able to quantify indirect and induced effects of the fishery sector[8]. However, the narratives connected to the cases presented in the WP 1 technical report will give some (qualitative) information about such effects.

The following summaries of national fleets and economic indicators for countries in NWW were sourced from the STECF Annual Economic Report, 2010. Note: not all landings and income sourced from NWW.

3.4.1. Ireland

In 2007, 1,699 fishing vessels were registered in Ireland, making up a gross tonnage (GT) of 66,550 and a total power of 152,000 kW. The average vessel age was 25.4 years and decreasing. A total of 179,000 days at sea were reported, which resulted in 243,000 tonnes of landed seafood. Mackerel was the most valuable species, accounting for €40 million of income in 2007. Income from *Nephrops* was €31 million Euros. In total, the landings amounted to roughly €200 million, of which about 18% went on fuel costs and 25% on crew wages.

[8] To quantify such effects estimations executed by comprehensive input-output models for the regional or national economy have to be used.

3.4.2. UK

In 2008, 6,676 fishing vessels were registered in the UK; 217,000 GT and 869,000 kW. The average age of these boats was 24 years and increasing. There were 12% less vessels than in 2002 due to decommissioning. 95% of fishing enterprises in the UK are single vessel operations. 604,000 days at sea in 2008 resulted in seafood landings of 574,000 tonnes. The highest value species was *Nephrops* at €148 million, followed by mackerel (€129 million) and anglerfish (€54 million). The total income generated was €810 million. This consists of €736 million in landings values, €10million in fishing rights sales, €31 million in non fishing income, and €33 million in direct subsidies.

3.4.3. France

In 2008, 4,485 fishing vessels were registered in France; 175,000 GT and 737,640kW. The number of vessels decreased by 13% between 2002 and 20008. The fleet is ageing and average age of vessel continues to increase. It is currently 23.4 years. The French fleet is extremely diverse and the most common gears used by the vessels in 2008 are drift nets and fixed nets (27%), demersal trawl and seine nets (19%), pots and traps (10%), gear using hooks (9%) and dredges (6%).The vast majority of enterprises are single vessel operations. 764,000 days at sea in 2008 resulted in 342 million tonnes of landed seafood. Anglerfish was the most valuable at €94 million, followed by common sole (€82 million) and scallop (€56 million). In total an income of €1,118 million was generated. 35% was spent on crew cost and 18% on fuel.

4.1. Introduction

The goal of the Marine Strategy Framework Directive (MSFD) is to achieve or maintain good ecological status (GES) across all European waters by 2020. GES is defined as "*the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations*." The MSFD identifies eleven qualitative ecosystem descriptors with which to measure GES, which range from marine biodiversity to underwater noise levels. The MEFEPO project (see WP 2 Technical Report) identified four of these descriptors as being significantly affected by fishing activity and attempted to assess their current. This assessment is summarised below.

4.2. Biodiversity

MSFD GES Descriptor 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.

The indicators chosen to assess this descriptor were two variations of the conservation status of fish species (CSF). Slight modifications to the method described in COM(2008) 187 were made to each indicator calculation (Nolan *et al.* 2010). The calculations were based on the findings of five fishery independent surveys covering the NWW: Scottish Ground Fish Survey, Northern Irish Survey, French EVHOE Survey, Irish Ground Fish Survey and Scottish Rockall Survey.

CSF A

The CSFa indicator is a composite indicator, reporting the average abundance trend of large fish species in the survey assessed according to the IUCN decline criteria (Fig. 4.2.1). A CSFa score of one indicates all species in the list are considered threatened; a score of three indicates all species are endangered. The target for the CSFa indicator is a score less than one.

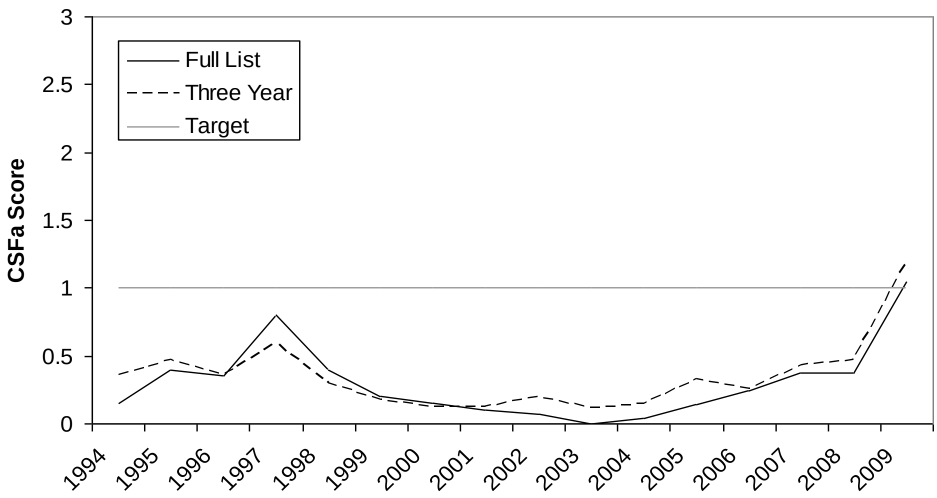


Figure 4.2.1 Average CSFa score for the full time series in all surveys in NWW.

Note: the "full list" and "three year list" refer to two different methods of choosing fish species to be included in the analysis. The "full list" of species is calculated as in COM(2008) 187 and the "three year list" is modified to ensure species that are declining (or disappear) over the time series are included, despite not reaching the original minimum abundance threshold.

CSF B

CSFb is a comparison of the relative survey abundance of each species, each year relative to a reference level (mean catch of first three years) (Figure 4.2.2). There is no target for the CSFb indicator but an increasing trend indicates an improvement in the populations of large fish species.

Figure 4.2.2 CSFb score for the full time series in all surveys in NWW.

4.3. Commercial stocks

GES Descriptor 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.

The indicator used to assess status against this objective is the proportion of commercially exploited stocks within safe biological limits. This indicator was calculated according to the method developed by Piet & Rice (2004) apart from slight modifications detailed in the technical report (Nolan *et al.* 2010). Only stocks for which SSB ≥ SSBpa and F ≤ Fpa are considered to be within safe biological limits. The initial reference point for this indicator is that 100% of assessed stocks should be within safe biological limits as this reference level is inherent in the wording of GES descriptor 3 where it says "populations of *all* commercially exploited…"

Within NWW seven assessed stocks met the criteria for inclusion in this indicator. Figure 4.3.1 shows the proportion of these stocks within SBL over time. Currently only 40% of NWW stocks are within SBL, a figure far below the 100% target (and even below a reduced 75% target that could be set; see WP 2 Tech. Report for discussion). The trend in the last decade has been positive however.

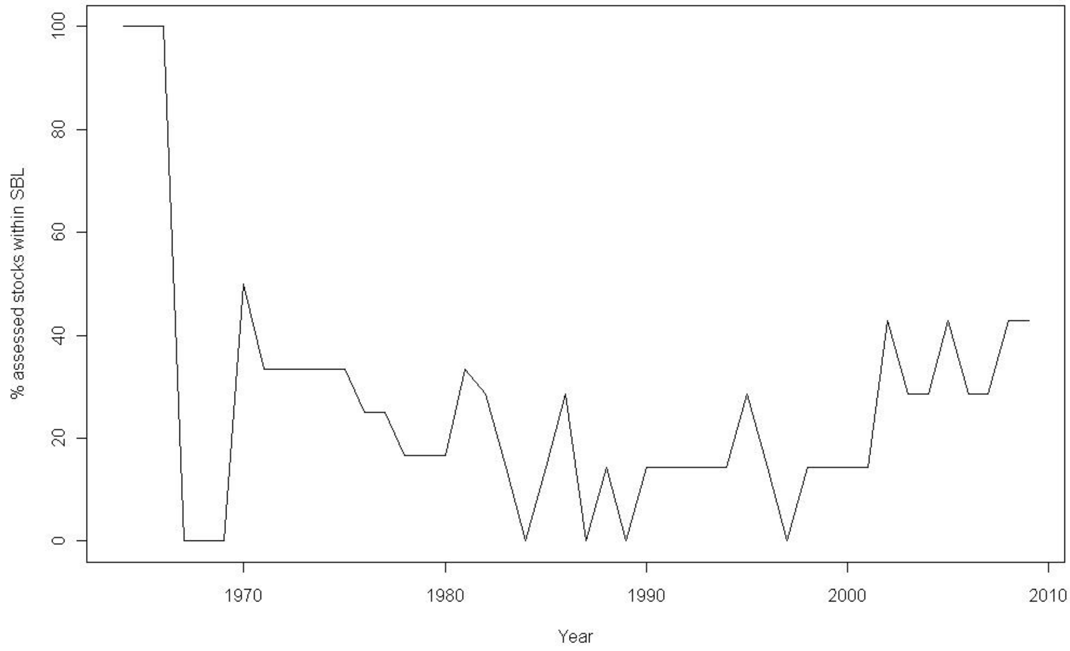


Fig. 4.3.1 Proportion of assessed NWW stocks within safe biological limits.

These seven stocks represent roughly 10% of the landed weight of fish in NWW. Coverage could be extended to roughly 75% by the inclusion of wide-spread pelagic stocks, such as mackerel, horse mackerel and blue whiting, which straddle the NWW boundaries. However, re-analysis including such species gives a similar result of 30-40% of stocks being within SBL.

4.4. Food webs

GES Descriptor 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.

The indicator chosen for the assessment of this descriptor was the large fish indicator (LFI). Calculation of the LFI is based upon fishery independent trawl survey data that reports catch per unit effort of species by length. The surveys and data used for this indicator are the same as those described in *Biodiversity*. The formula used to calculate the LFI for each year was:

$$LFI = \text{Weight of fish} \geq 40\text{cm in length} / \text{Total weight of fish}$$

The limit reference level for the LFI for the North Sea, as implement by OSPAR, is for the LFI to be 0.3 or greater. This reference level was originally defined for the North Sea, further analysis is required to establish if this reference level is also appropriate for use in NWW. To investigate the influence of small pelagic species with highly-variable catch, this indicator was also calculated excluding small pelagics.

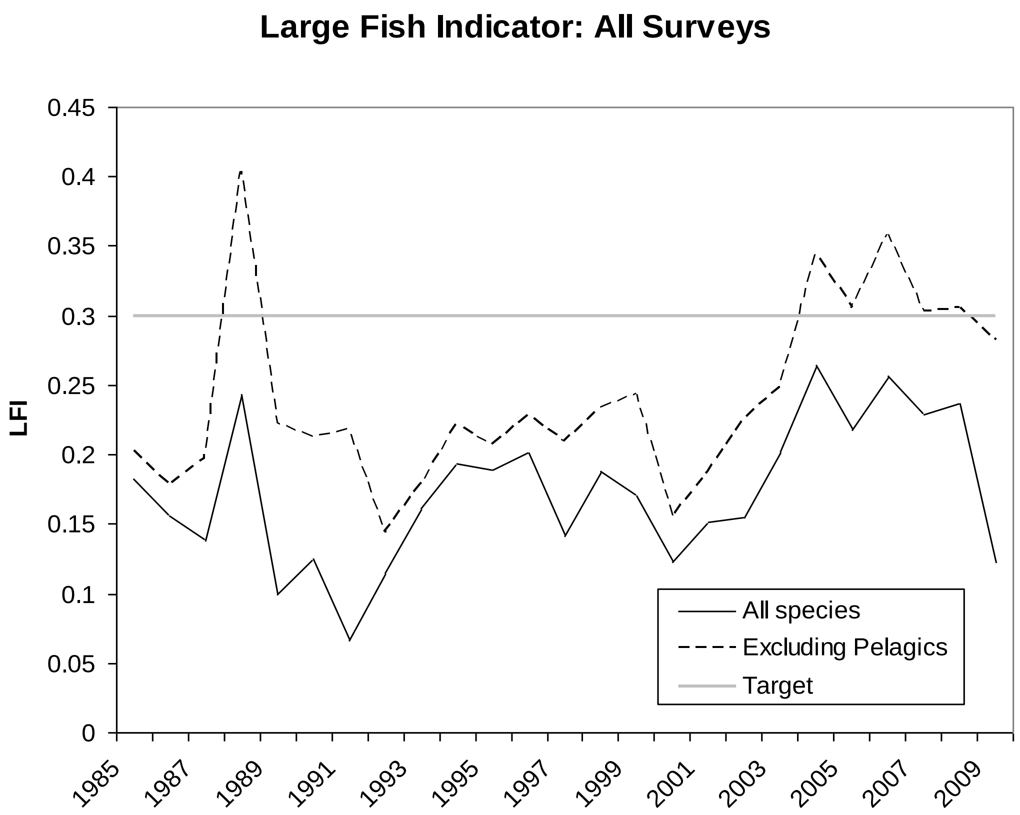


Fig. 4.4.1 Proportion of assessed NWW stocks within safe biological limits.

The LFI has been below the target level since the beginning of the time series, apart from six years when small pelagic species are excluded (Fig. 4.4.1). Up until 2009 there was a general positive trend from the low around 1990, but results vary between surveys, and therefore geographical areas.

4.5. Seafloor integrity

GES Descriptor 4: 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.

The indicator used to assess this descriptor was the proportion of area not impacted by mobile bottom gears. This is calculated using vessel monitoring systems (VMS) and provides a direct measure of the main pressure on benthic systems. However, it provides no indication of the actual state of the benthic habitat. Currently there are no robustly justified reference levels as target or limit values for this indicator. The acceptable level of mobile bottom gear impact will depend on the resilience and susceptibility of the habitat to damage, thus a single reference level may not be applicable across all habitat types. Until justified reference levels are developed the target reference direction for the indicator is for the proportion of area not impacted by mobile bottom gears to remain constant or increase.

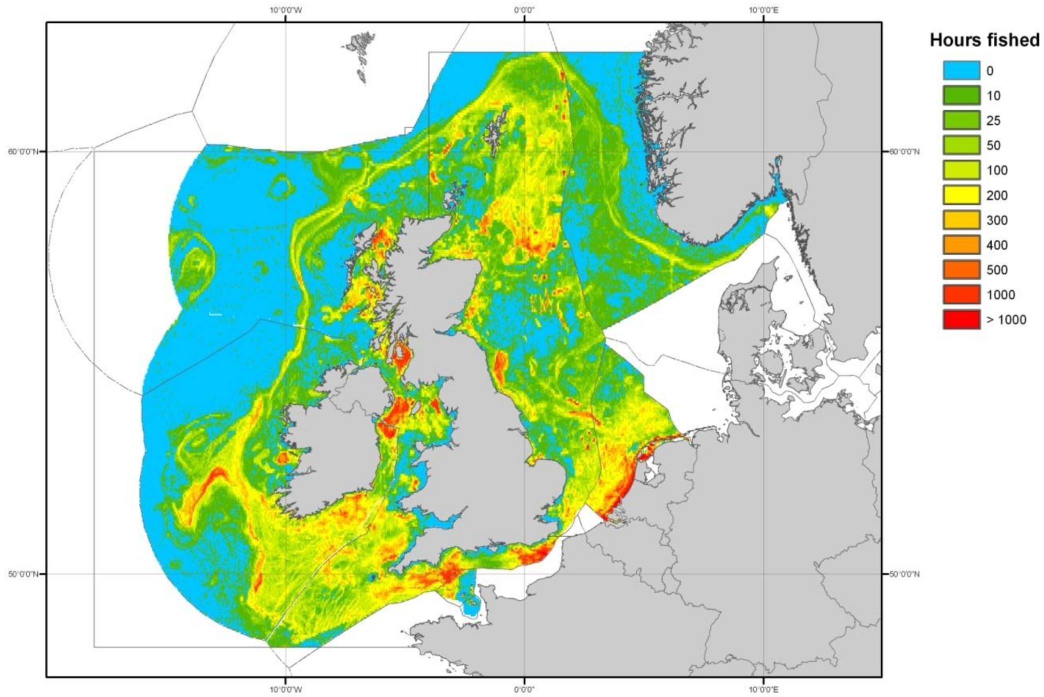


Fig. 4.5.1 Distribution of fishing effort by mobile bottom gears in UK and Irish waters for 2007 by 3'x3' cells based on VMS records.

Table 4.5.1 Percent of area not impacted by mobile bottom gears by combined depth band and sediment type for the NWW RAC region for 2007. Blank cells indicate areas where the sediment type did not occur in that depth band. Green indicates increase by more than 5% over 2006 levels, red indicates decrease.

		Depth					
		0 to 20m	20 to 50m	50 to 80m	80 to 130m	130 to 200m	>200m
Habitat	Gravel		0.5	17.5	1.2		100.0
	Mud	59.9	16.2	14.4	10.5	98.7	97.7
	Sand	98.7	78.3	48.2	62.0	48.0	52.3
	Mud and Sand				54.2	26.0	83.5
	Mud and Gravel						93.1
	Sand and Gravel	58.7	47.0	31.9	38.6	63.8	78.7
	Mud, Sand and Gravel	81.1	43.7	36.7	26.7	64.3	98.1
	Rock, Gravel and Sand	63.0	59.7	55.6	69.2	71.4	64.2

The combined VMS data (Figure 4.5.1) reveal the bottom-fishing 'hotspots' in NWW, particularly trawling for *Nephrops* in mud patches around the Irish and Scottish coasts and the Porcupine Bank, and dredging for scallop in gravel south-east of Ireland. The breakdown in Table 4.5.1 confirms this, with very low percentages of unfished gravel and mud in the shallower depth bands. Overall, very little mobile bottom gear activity impacted habitats deeper than 200m and the intensity of fishing pressure remained stable for the vast majority of cells.

4.6. Summary/limitations

The NWW do not achieve GES according to the terms of this assessment (Table 4.6.1).

Table 4.6.1 Summary of current GES status for the four fishing related descriptors.

GES Descriptor	Associated indicator	Current status
GES 1: Biodiversity	Conservation Status of Fish Species	✓/ ?
GES 3: Commercial species	% stocks within safe biological limits	X
GES 4: Food webs	Large fish indicator	X
GES 6: Benthic processes	% not trawled	?

4.6.1. Descriptor 1: Biodiversity

The interpretation of this indicator is difficult. The positive trend in CSFb score suggests GES is being attained but in the latest year of the time series, 2009, the CSFa score (average IUCN threat rating) is above the target level of 1. However, the reference period on which the CSFb score is based is relatively recent (1985-8 for the longest survey) meaning the improvement is likely from an already severely impacted state. Also these results are averaged across different surveys in five spatially explicit areas and when viewed independently there is much variation in their performance.

4.6.2. Descriptor 3: Commercial Species

Only 45% of assessed stocks fell within safe biological limits in the NWW region. Although only seven stocks qualified for inclusion in the indicator (representing less than 10% of landings) this percentage was relatively unchanged even if other wide ranging, pelagic stocks were included in the analyses (upping representation to 70-75%). Fishing compromises GES for this descriptor in the NWW; however the trend of this indicator has been positive over the last decade.

4.6.3. Descriptor 4: Food Webs

The average LFI for the latest year in the time series, 2009, was below the target level, whether pelagic species were included or not. However, as with descriptor one, when the five surveys were analysed independently the results were varied. The question now becomes should GES be based on an average score when multiple surveys are involved or should GES be met for all surveys? Given that GES is not met for 2/5 of the surveys it is probably most appropriate to view the entire NWW region as not achieving GES for this descriptor.

4.6.4. Descriptor 6: Benthic Processes

In the case of this descriptor an assessment of the impact of fishing on GES is not currently possible. Here there are two related stumbling blocks. Firstly the indicator is a pressure indicator rather than a state indicator, thus the indicator does not directly provide information on the environmental status of the sea-floor processes. Using a pressure indicator to inform on status can only be achieved when the link between pressure and state is well known; at present the link between pressure by mobile bottom gears and the state sea-floor functioning is not strongly developed only limited conclusions can be drawn about the impact of fishing on GES with respect to sea-floor processes. The second related stumbling block is that no reference limit has been identified by which to assess current status in relation to objective for GES. However no reference limit can be expected to be developed until the link between pressure and state has been better established.

5.1. Introduction

5.1.1. Drivers of Change in European Fisheries Management

The Green Paper on the Reform of the Common Fisheries Policy (i) identified the need for EBFM taking account of the ecological, social and economic pillars of sustainability, (ii) stated an intention to move towards a longer term approach to fisheries management, and (iii) made commitments to greater stakeholder involvement in management. The Marine Strategy Framework Directive (MSFD) defines environmental objectives for European seas, based on sustainable utilisation of healthy marine ecosystems in support of sustainable development. The Integrated Maritime Policy specifies that individual sectors (e.g. fisheries) need to support MSFD objectives. These commitments have shaped the development of the MEFEPO Fisheries Ecosystem Plans (FEPs).

5.1.2. Developing the regional case studies

'Descriptors' for the ecological, social and economic status of the fisheries were developed to enable simultaneous consideration of the potential impacts of different management strategies on the three pillars of sustainability (Piet et al. 2011; Fig. 5.1.2.1). Stakeholders supported the MEFEPO "three pillar" approach to explore potential impacts of different management strategies on multiple objectives for the marine environment.

Ecological descriptors, drawn directly from the MSFD, were selected at a MEFEPO stakeholder workshop as those most impacted by fishing activities (biodiversity, commercial fish, food-webs and seafloor integrity). Social and economic descriptors were defined to monitor the main aspects of fishing contributing to the economic and social wellbeing of society, in particular coastal communities. Economic descriptors focus on fishers' ability to maximise economic efficiency of fishing operations (efficiency) and minimising fluctuations in harvesting possibilities over time (stability). Social descriptors monitor employment opportunities within the catching sector (community viability) and securing catch potential for human consumption (food security).

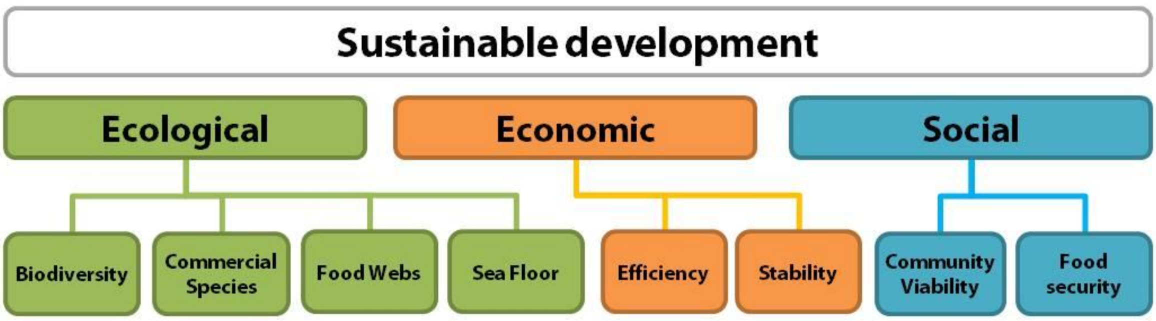


Fig. 5.1.2.1 Descriptors chosen to reflect the three pillars of sustainability (see Annex A for further details)

Preliminary case studies of selected fisheries have been developed to demonstrate practical application of the management strategies matrix approach. In each case, the potential performance of a limited number of management strategies (consisting of the application of multiple management tools) was evaluated. The efficacy of the management strategies was considered in the context of high level management objectives for European fisheries. The predicted change in the descriptor status associated with implementation of each management strategy was assessed.

Expected improvement in the status of the descriptor | Stable (i.e. no change in the status of the descriptor) | Expected deterioration in the status of the descriptor | Outcome unknown

The suite of management strategies comprised of "business as usual" (BAU) and alternative strategies applying different management tools, to explore how the objectives of EBFM may be most effectively achieved. Given that it may possible to deliver the same set of objectives in more than one way or it may be impossible to fully achieve all objectives simultaneously, consideration of alternatives management strategies allowed the trade-offs associated with different management approaches to be examined.

The results of this review are reported using a common format, a management strategies matrix, developed in consultation with MEFEPO stakeholders (see Van Hoof *et al.* 2011). Management strategy matrices were completed based on the best available evidence (modelled, empirical and expert judgment) under the following assumptions:

- Time frame: in keeping with the principles of the ecosystem based fisheries management (EBFM), the management strategies matrix was populated based on expected medium to long-term (5-10 year) outcomes. This means that other effects may take place in the short term.
- Partial assessment: we have examined changes in one (or a few) selected management tools and assume all other measures used in the fishery are kept constant.
- Constant external environment: we have assumed that all exogenous conditions (e.g. market price on fish, fuel prices, water temperature, fish food availability, etc.) are constant.

Information on the application and success of management tools from earlier project work (Aanesen et al. 2010), scientific literature and expert opinion was used to inform the choice of management tools in the development of the management strategies. Examining the performance of management strategies was more complex for the mixed-species fisheries case studies as it may not be possible to achieve MSY for more than one species at the same time. Thus management strategies explored possible trade-offs in terms of prioritising stocks.

Ultimately the decision on which management strategy should be adopted will be based on overarching management objectives (ecological, social and environmental). The aim of this process was to demonstrate the application of the management strategy matrix approach to present the information to help decision-makers to take appropriate decisions, rather than to pass comment on the "best" management strategy. However, information on stakeholder preferences for particular management tools (e.g. from EFEP) is used to provide commentary on which strategies might receive better stakeholder support. Gaps in knowledge (ecological, social and economic), which may limit our ability to successfully implement EBFM, were identified and likely consequences of management strategy application are discussed.

5.2. Case study: *Nephrops* fishery

5.2.1. Introduction to the fishery

Nephrops require a muddy seafloor habitat in which to burrow and the distribution of suitable sediment defines the species distribution. Fishing effort is highly concentrated around these areas, which are known as functional units (FU). The scientific advice has advocated "Functional unit" management for many years because the *Nephrops* populations and fisheries on different mud patches have different productivities and dynamics and should, where possible, be managed separately. Trawling for *Nephrops* results in by-catch and discards of other species, including cod, haddock, and whiting. 80 mm is the predominant mesh size used in *Nephrops* fisheries and the resulting discarding of fish can be high. Initiatives are in place to reduce the discard problem with respect to small fish. These include increases in access to the fishery (e.g. effort allowance) for vessels incorporating devices to reduce bycatch, such as square mesh panels or Swedish grids.

The high mud content and soft nature of *Nephrops* grounds means that trawling readily marks the seabed, with trawl marks remaining visible for some time (two months to a year depending on depth, exposure and fishing intensity). Despite the high intensity of fishing (some areas are impacted >7 times/year), burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is resilience to trawling (ICES, 2010). The communities on some of the more dynamic mud patches such as the Irish Sea are probably already adapted to high levels of disturbance but it is equally likely that some benthic communities have been fundamentally changed by decades of fishing.

5.2.2. State of the stock

The assessment and advice for Nephrops stocks in Division VIa and certain FUs in VII is primarily based on abundance estimates from underwater TV (UWTV) surveys together with fishery landings data and estimates of quantities of discards. Additional indicators of changes in stocks are derived from trends in length compositions and sex ratio in the fishery catches for the remaining FUs. There are no precautionary reference points defined for Nephrops. Owing to the way Nephrops are assessed, it is not possible to estimate FMSY directly and hence proxies for FMSY have been determined. No precautionary limits exist (ICES, 2010).

Functional Units in VI (11-13) (see Fig. 5.2.2.1)

According to the latest advice, two out of the three FUs in VI were fished above FMSY in 2009. For 2011 an EU TAC of 13,681 tonnes applies in area VI, roughly a 15% reduction on 2010.

Functional Units in VII (14-22)

The latest advice is varied. FUs 14 and 15 in the Irish Sea were fished above FMSY in 2009 and the harvest ratio should be reduced. FU 16, the Porcupine Bank, had falling catch and abundance so catches should be reduced to lowest possible level. FU 18, Aran, was fished below FMSY. For FUs 19-22, FMSY is unknown but LPUEs were stable and the advice called for reduced landings. For 2011 an EU TAC of 21,759 tonnes applies in area VII, roughly a 3% reduction on 2010.

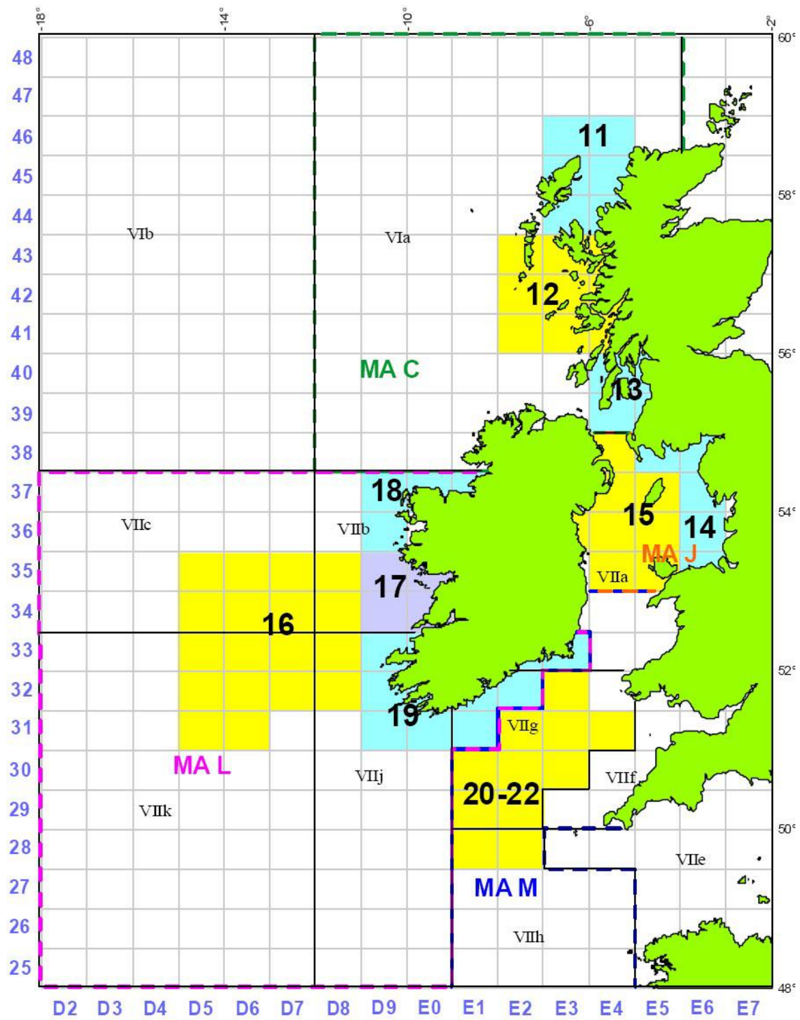


Fig. 5.2.2.1 Functional Units of *Nephrops* in NWW.

5.2.3. Main interactions with ecosystem components

Nephrops are primarily fished using bottom otter trawls and the direct effect of such fishing gear on the benthic habitat is related to physical disturbance by contact with the seafloor. These effects include marking of the seabed, removal of large physical features, reduction in structural biota and a reduction in complexity of habitat structure (leading to increased homogeneity). Indirect effects on the seabed include the disturbance of benthic trophic relationships by discards and the re-suspension of sediments resulting in phytoplankton blooms and release of previously sequestered contaminants.

The majority of the invertebrates that are killed by demersal trawling die as a result of contact with the fishing gear as it passes over the seafloor and not as a result of being caught in the net itself. However, a large proportion of the catch in the *Nephrops* fishery in NWW is made up of non-target, invertebrate, by-catch species of which only some are marketable; non-marketable by-catch is discarded at sea. Commercial (and non-commercial) fish species are also caught as by-catch;

marketable fish tend to be landed (if quota allows), undersized or over-quota fish are discarded. Thus the *Nephrops* fishery impacts upon other commercial stocks and food-webs, in areas where fishing and discarding occurs.

5.2.4. Current management (Business as usual)

The following tools are currently being employed for *Nephrops* management in NWW:

- Total allowable catch
- Effort (days at sea)
- Minimum landing size
- Mesh size restrictions (reduction of by-catch)
- Seasonal closures

5.2.4.1. Total Allowable Catch

For 2011 an EU TAC of 13,681 tonnes applies in area VI and Vb, and 21,759 tonnes in area VII (of which no more than 5.75% may be taken in FU 16, the Porcupine Bank). However ICES notes that the TAC and stock assessment areas do not match.

5.2.4.2. Effort (days at sea)

Effort controls also apply to the main *Nephrops* catching fleet (TR2; bottom trawls with mesh sizes between 70 and 99mm) under the Cod Long Term Management Plan (Cod LTMP) in west of Scotland and the Irish Sea (areas VIa and VIIa). Maximum allowable fishing effort for TR2 in 2011 is 479,043 kW days in VIa and Vb, and 584,047 kW days in VII.

5.2.4.3. Minimum Landing Size (MLS)

VII and VIb: 85mm Total length, 25mm Carapace length, 46mm Tail length.

VIa and VIIa: 70mm Total length, 20mm Carapace length, 37mm Tail length.

5.2.4.4. Mesh Size Restrictions (reduction of by-catch)

Area VII and VI outside restricted area in VIa: Vessels targeting *Nephrops* using towed gears in having at least 35% by weight of this species on board will require 70 mm diamond mesh plus an 80 mm square mesh panel as a minimum or having at least 30% by weight of Nephrops on board will require 80 mm diamond mesh.

Inside Cod LTMP area in VIa: In 2009 minimum mesh size went up from 70 mm to 80 mm.

5.2.4.5. Seasonal Closures

Porcupine Bank closed to all *Nephrops* fishing from 1st May to 31st July each year since 2010. Also closures due to Cod Long Term Management Plan in VIa and VIIa (EC Reg.1342/2008).

5.2.5. Key Management Issues\BAU performance

Due to the low efficiency of the gear and the direct relationship between effort and catch, effort controls are effective at limiting catch in *Nephrops* fisheries. However, the effort limits and temporary closures in VIa and VIIa are primarily aimed at Cod stock recovery and do not impact greatly on *Nephrops* fishing. TACs have been successful in reducing the overall landings but, due to being set at ICES area level, they allow the redistribution of fishing effort among FUs within the area which may negatively impact stocks in more vulnerable FUs. This issue has partially been addressed with the "of which" clause for the VII TAC in the Porcupine Bank. In NWW, France and Spain have not had full up-take of their quota, which allows the other nations leeway.

Discards form a relatively constant proportion of the catch from *Nephrops* trawls. This fixed component of the catch means that, although TACs are implemented to control landings, in this fishery the TAC also goes some way to controlling the catch. Minimum landing size is not an important aspect of the management of the NWW *Nephrops* fishery. Selectivity of the gear is poor but few undersize animals are caught and the market is the main driver for size selection (small *Nephrops* are discarded).

Although the *Nephrops* fishery in NWW has altered the biological communities in the mud patches targeted within each functional unit (FU) significantly, the most significant changes are likely to have occurred when the fishery commenced and in the initial years of exploitation. Landings and abundance in many FUs have been stable for a number of years and many FUs have levels of fishing mortality approaching MSY.

Under a BAU strategy, with slowly decreasing TACs and occasional closures in certain areas, most assessed FUs in NWW should eventually achieve stable populations with balanced sex ratios. However, this strategy leaves the descriptors in the ecological pillar (and the objectives of the MSFD) in their current, impacted, state and may also result in reduced efficiency in the economic pillar.

5.2.6. Other potential management tools

Potential management tools for the *Nephrops* fishery (NSRAC 2011) include:

- Marine Protected Areas (real time, seasonal or permanent)
- Management of effort/TAC at the Functional Unit level
- Larger mesh sizes, square mesh panels or other escapes panels or selection grids
- Fisheries closures to protect spawning grounds or aggregations of juvenile fish
- Restricted gear use or areas (e.g. creel only)

5.2.6.1. Marine Protected Areas

Marine protected areas (MPAs) are a commitment under international agreements such as the OSPAR Convention and the Convention on Biological diversity (CBD), which aims for an 'ecologically coherent network of Marine Protected Areas' by 2012. As such MPAs are considered a key component of all management strategies in all case studies. Numerous European directives and national bills and acts have already established a network of MPAs (with varying levels of protection) across the NWW. These include:

- Natura 2000. Special Areas of Conservation under the EC Habitats Directive and Special Protection Areas under the Birds Directive.
- RAMSAR. Convention of Wetlands of International Importance
- Scottish Marine and Coastal Access Act and Marine (Scotland) Act
- Northern Ireland Marine Bill
- Marine Conservation Zones (MCZs)

The recommendations for the most recent additions to the UK MPA network in NWW, Marine Conservation Zones, have recently been published (August 2011) by the Finding Sanctuary, Balanced Seas and Irish Sea Conservation Zone Projects. These recommended MCZs were developed in close contact with stakeholders and are due to be established in 2012. MCZs are not complete closures however; rather designated areas where the need to regulate certain fishing practices or gear types is acknowledged. For example, in the majority of the recommended MCZs in the Irish Sea "benthic and dredge fishing at their current levels would require additional management" whereas "pelagic fishing … at their current levels would not require additional management." As such, MCZs are due to affect demersal fishing to a far greater extent than pelagic fishing. The MCZs to be introduced in the Irish Sea are estimated to represent 3% of the total area and 13% of the *Nephrops* functional unit 22 in the Celtic Sea ("The Smalls") is also due to be protected from trawls.

5.2.6.2. Management at Functional Unit level

The overriding management consideration for these stocks is that management should be at the Functional Unit rather than the ICES Subarea/Division level. Management at the Functional Unit level should provide the controls to ensure that catch opportunities and effort are compatible and in line with the scale of the resources in each of the stocks defined by the Functional Units. Current management of *Nephrops* in Subarea VI (both in terms of TACs and effort) does not provide adequate safeguards to ensure that local effort is sufficiently limited to avoid depletion of resources in *Nephrops* NW of Ireland and West of Scotland Functional Units. In the current situation vessels are free to move between grounds, allowing effort to develop on some grounds in a largely uncontrolled way and this has historically resulted in inappropriate harvest rates from some parts. ICES (2010) has advised management of *Nephrops* at FU level in NWW, a view that is supported by the NSRAC (2011), therefore this approach has been considered as an integral and key component of each of the following potential management strategies.

5.2.7. Management strategy matrix evaluation

5.2.7.1. Overview of management strategies

Management Strategy A. Increase Closed Fishery Areas (above that required under CBD)

Currently 75% of one *Nephrops* Functional Unit (the Porcupine Bank) is temporarily closed to fishing for three months (May-June) each year. This tool is effective for reducing effort in the FU during the time of year when the highest proportion of females would be caught. However, effort has been focussed on the remaining 25% of the grounds and this imbalance of effort has the potential to negatively impact on stocks in the areas that remain open to *Nephrops* fishing. Under this strategy seasonal closures would apply to 100% of the FU. As per the North Sea RAC proposed *Nephrops* LTMP (Anon., 2011), this strategy could also include year-round closures in the most vulnerable FUs and continued real-time closures in areas where juvenile fish aggregate.

Management Strategy B. Minimise By-catch

The recently published paper on the Reform of the Common Fisheries Policy (July 2011) proposes elimination of discards through landing obligations (EC COM(2011) 417 final). The aim of this strategy is therefore to decrease the by-catch of juvenile *Nephrops* and other species in *Nephrops* trawls. Instruments for reducing by-catch include: larger mesh size in the main part of the net; square mesh or other escape panels and selection grids (NSRAC 2011). The tools proposed in this strategy are an increase in the minimum mesh size for *Nephrops* trawls from 70mm to 90mm (inside mesh) and the use of "Swedish Grid" separators, to reduce discards, to be mandatory in all Functional Units. Simply increasing the mesh size could reduce the catch rate of *Nephrops* by 34% in the Irish Sea (Briggs *et al*., 1999, based on an increase in inside mesh from 70mm to 80mm).

Article 11 of EC Reg.1342/2008 makes provision for a group of vessels to be exempt from effort controls in VIa and VIIa provided they can demonstrate that they consistently catch less than 1.5% cod. At present the only successful application for exclusion from the LTMP effort restrictions under Article 11 has been a fishery that uses "Swedish grids". These grids essentially eliminate the majority of round fish (cod, haddock and whiting) from the catch while maintaining catch rates of *Nephrops*. In NWW the most likely fisheries that could be exempted under article 11 include directed *Nephrops* fisheries using the "Swedish grid" or other highly selective trawls.

Management Strategy C. Increase Creels, Decrease Trawls

Selectivity in *Nephrops* trawls is generally considered to be low despite the discard reduction measures currently in place. The major impacts on the ecological descriptors in the *Nephrops* BAU strategy are related to the contact of the mobile bottom gear with the benthos (Ball and Munday, 2000) and most of the discards are small, non-marketable, benthic invertebrates (Bergman, 2000). Static traps, or creels, almost eliminate the impact on the seafloor and greatly reduce by-catch. According to the description of the MSC certified Torridon Loch Creel fishery: creel fishing is selective, and discards can be released alive by fishers. Bycatch, which comprises crustaceans, whelks and finfish, is reduced by the use of escape panels. Impacts of creels on sensitive species (e.g. the sea pen *Funiculina quadrangularis*) are considered to be low. This fishery was the first to achieve Marine Stewardship Council (MSC) certification.

Currently in Scottish waters Nephrops trawling is confined to weekdays and the weekend is reserved for creel fishing. According to the latest ICES advice, creel fishing takes place mainly in Scottish sea-loch areas, but has recently extended to areas further offshore. Overall effort in creel numbers is not known and measures to regulate the fishery are not in place. Under this strategy the use of trawls would be greatly reduced (over a number of years) and areas of each FU would be open to creel fisheries only (in inshore and offshore FUs).

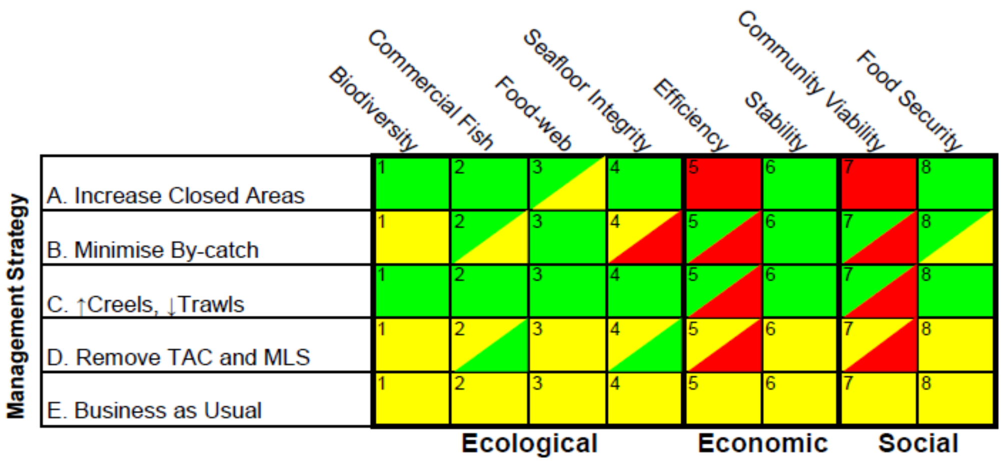
Management Strategy D. Removal of TAC and MLS

MLS is not an important aspect of the current *Nephrops* management strategy. The market for larger *Nephrops* incentivises the landing of bigger prawns and mesh size restrictions curb the by-catch of undersize individuals (although due to *Nephrops* anatomy a certain amount of small prawns are caught no matter what the mesh size). There is a strong, positive correlation between effort and catch in *Nephrops* trawl fisheries. Coupled with the fact that the rate of by-catch is fairly consistent, this means that the current TAC and quota system goes some way to controlling the actual *Nephrops* catch (rather than just landings) and also the fishing effort. However, this suggests that the current management strategy could be simplified and streamlined.

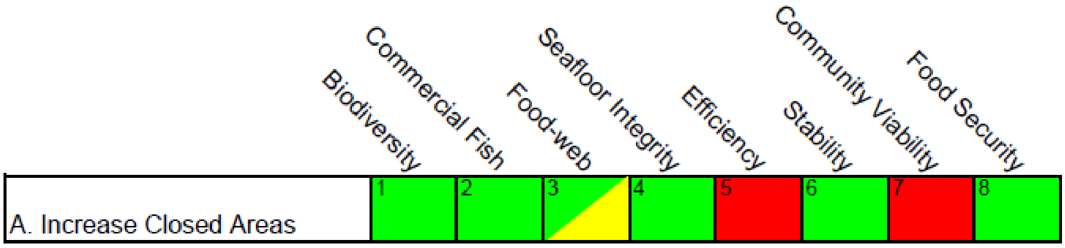
Under this strategy restrictions on the landing size of prawns are to be removed and the current TAC and quota system is to be replaced by days-at sea effort restrictions. All other aspect of the BAU strategy will remain in place.

5.2.7.2. Management strategies matrix

The matrix below compares the expected medium-term (5-10 year) outcomes from the three management strategies described above for *Nephrops* to the “business as usual” management strategy. Evaluation was in consultation with an expert (external to MEFEPO) and supported by relevant literature, and narrative for each of the management strategies is included below.



Management strategy A. Increase closed fishery areas



Assumptions
The management tools in the BAU strategy remain in place. The number, size and location of closed areas have been selected based on best available scientific data and in consultation with stakeholders.
Closed (fisheries) areas were one of the management measures found to be supported by fishers (EFEP REF). Furthermore, they are more simple to enforce that some technical measures (e.g. MMS), particularly in offshore areas, due to the Vessel Monitoring System (VMS) capabilities. Compliance with this management strategy is thus assumed to be high.

Ecological descriptors

Nephrops trawling has been demonstrated to reduce benthic biodiversity, particularly of fragile species (Ball and Munday 2000), due to the high proportion of non-target invertebrates in trawls (Bergman *et al*., 2002). Closed areas would facilitate replenishment of site-attached vulnerable organisms (A1) but improvement will depend on recovery periods and may be limited as the proposed closures are only seasonal.

Closed areas are considered to be effective at increasing the SSB of *Nephrops* (Droineau *et al*. 2005), density of the stock and reproductive output, and return sex ratios to natural levels and thus are expected to provide improvements in the commercial fish descriptor (A2).

Improvements in terms of food-webs (A3) are dependent on the local food-web structure. Benthic/sedentary species have the greatest chance of improvement following closure implementation; evidence of closure benefits for larger, mobile species is more limited (REF).

Seafloor integrity is predicted to improve in response to the removal of *Nephrops* trawling activity (A4), which has been demonstrated to increase the homogeneity of the seafloor (Collie *et al*. 2000; Kaiser *et al*. 2002). (Permanently) closed areas would facilitate a return to GES of the local benthos.

Economic descriptors

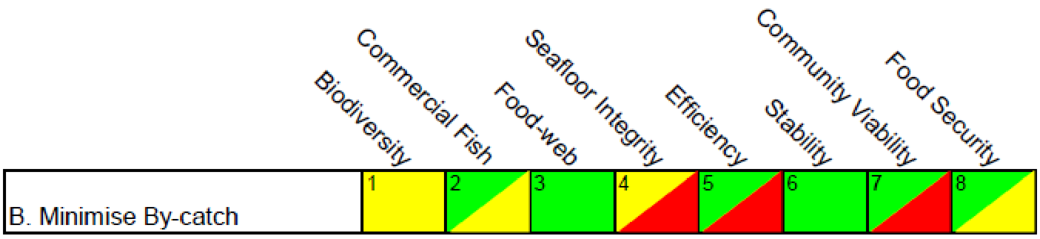
Closed areas have the potential to restrict fishers' ability to choose where to fish. Given the assumption that fishers operate to maximize profit from the harvesting activity, increased closures of existing fishing grounds will *ex ante* reduce the profitability, and thus reduce efficiency at the individual fisher level (A5). Closures in the absence of controls on fishing effort will result in greater fishing pressure outside of the closed area which may reduce profitability.

Area closures are commonly applied to restore commercial stocks and are thus more robust against exogenous pressures, closures are therefore expected improve the stability of catches (A6) and thus provide a more stable operating environment for fishers in line with the commercial fish descriptor (A4).

Social descriptors

Community viability (A7) is likely to deteriorate as some fishers may be excluded from the fishery, due to displacement from traditional fishing grounds and inability to switch their effort to non-protected (potentially more distant) areas (see Kaiser 2005 and references therein). This situation is likely to more readily affect smaller vessels which are more limited in their operating distances (REF). Closures in the absence of stricter fishing effort controls will lead to an increase in effort in areas effort outside the closure (displacement; Hilborn *et al*., 2004) and may affect efficiency and profitability (see A5). Improvements in the commercial fish (A2) descriptor would be expected to provide greater food security (A8).

Management strategy B. Minimise by-catch



Assumptions
The management tools in the BAU strategy remain in place. The introduction of a phased or complete discards ban in the reformed CFP. All other management tools already in place remain constant. Enforcement of and compliance with new regulations is effective.

Ecological descriptors

Discarded fish and prawns from trawls have a low survival rate (e.g. 31% in prawns; Ulmestand *et al*., 1998); Swedish grid separators and an increase in minimum mesh size will reduce the by-catch of non-target, vulnerable and undersized species and thus reduce discarding. This will lead to improvements in terms of commercial fish stocks (B2) with by-catch of the most vulnerable fish stocks of cod, haddock and whiting in the Irish Sea and West of Scotland greatly reduced due to the application of Swedish grids separators (Valentinsson and Ulmestrand, 2008). In turn, this will provide improvement to local food-webs (B3). General biodiversity would remain stable as the trawls would still affect vulnerable benthic species such as sea pens (B1). Simulations on the Bay of Biscay mixed fishery suggest that an increase in mesh size would significantly increase the total *Nephrops* biomass (B3) in the long-term (Drouineau *et al*., 2006).

Separator grids and larger mesh sizes are not expected to change trawl impact on the seafloor (B4), and as such the impact of the trawl on the fragile benthic species will also remain unchanged (B1). However, this management strategy may lead to deterioration of seafloor integrity as the area trawled may have to increase to produce the same landed weight of *Nephrops* to counter the reduced catch rate (Briggs *et al*. 1999).

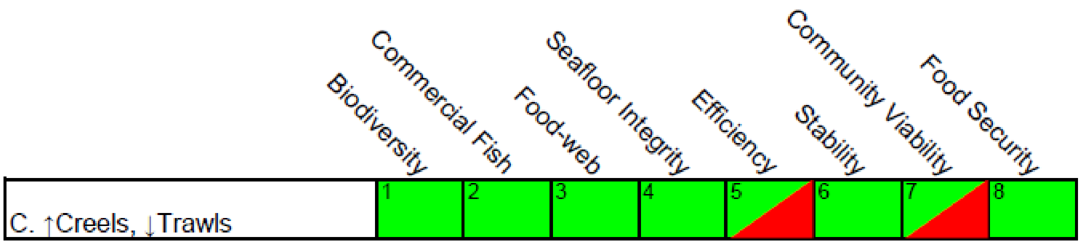
Economic descriptors

By-catch is considered to be an external effect (an unintended effect on an activity) and forcing fishers to take action to reduce by-catch implies reduced externalities and thus increased societal efficiency (B5), although there may be reduced profitability for individual fishers in the short term. Despite predicted increases in the total *Nephrops* biomass (B2) it is difficult to predict whether or not profit will be affected due to differences in the density and size of *Nephrops* across FUs. Commercial stocks are predicted to be more robust against exogenous pressure, due to stock improvements (B2), and thus stability will improve (B6).

Social descriptors

The introduction of additional management measures has the potential to impact upon the fishing community e.g. fishers will be required to modify/purchase new gear. Greater restrictions on *Nephrops* fishing may lead to declines in the fishing community which will negatively affect community viability (B7), "if it results in still more restrictions on fishing there will be no fishing community" (extract from North Sea RAC Draft LTMP for *Nephrops*; Anon., 2011). However, a bio-economical model for the Bay of Biscay suggests that increasing the mesh size would mean "rent could be even higher if selectivity was increased, and this would not necessarily require a decrease in global effort" (Macher and Boncoeur, 2010) (B7, see also B4). Improvements in the commercial fish descriptor will improve food security (B8).

Management strategy C. Increase Creels, Decrease Trawls



Assumptions

The management tools in the BAU strategy remain in place. Appropriate management and monitoring plans installed to prevent excessive concentration of effort.

Ecological descriptors

Creels are static gear and as such are considered to have little impact on the seafloor habitat and associated communities, even vulnerable species such as sea pens have been observed to survive smothering and uprooting after being in contact with creels (Eno *et al.*, 2001). Therefore improvements in biodiversity (C1) and seafloor integrity (C4) are predicted. Creels will significantly reduced by-catch of commercially important fish species and increase survival of undersized *Nephrops* compared to trawls (Ridgway *et al.*, 2006), with associated benefits for commercial fish (C2) and food-webs (C3)

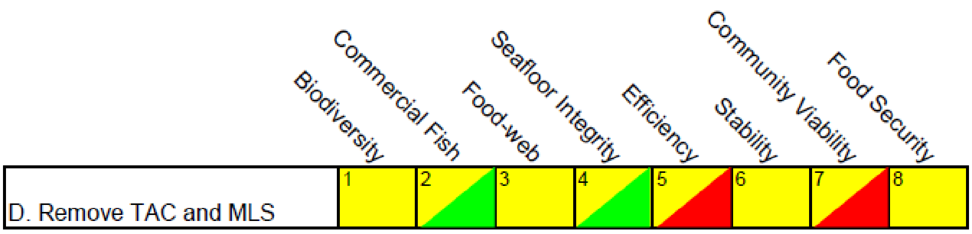
Economic descriptors

Given that creels demonstrate lower by-catch and catches of undersized *Nephrops* externalities (unintended effect of an activity) will be reduced and, in turn this will believe improvement in societal efficiency (C5), although it may reduce profitability of some individual fishers and there are economic costs associated with the switch from trawls to creels for *Nephrops* (see C7) Lower mortality of by-catch species and undersized *Nephrops* will lead to improvement in commercial fish (C2), making stocks more robust to exogenous pressure and thus increasing stability (C6).

Social descriptors

Although societal efficiency is expected to show improvement (see C5), this strategy requires a structural change in the fishing fleet. Modification or purchase of new gear has significant (negative) economic implications for fishing communities; fishers unable to switch from trawling to creels may be excluded from the fishery which will reduce community viability (C7). However, there will be improvement in community viability (C7) for those who remain in the fishery due to improvements in commercial stocks (C2); which will also contribute to improved stability (C6) and improved food security (C8).

Management Strategy D: Removal of TAC and MLS



Assumptions

Yearly sampling programs and stock assessments still carried out by relevant bodies. Total allowable effort (TAE) to be set based on such advice. Appropriate and timely reductions in TAE to account for technological improvements (gear, boats, *etc*.).

Ecological

As the MLS is largely redundant in this fishery, its removal should have little or no effect on the ecological descriptors (D1-4). A change from TAC to TAE should not alter the impacts of trawling on other organisms from those stated in the BAU strategy and as such the biodiversity, other commercial species and food-web descriptors should remain stable (D1-3). If the introduced TAE was a significant reduction from the effort currently expended to take the TAC, an improvement in the Nephrops stocks and seafloor integrity would be expected (D2 and 4).

Economic

Efficiency is expected to remain at the current level as the proposed changes do not change the input costs for trawl gears or the price attained for landed prawns. However, it should be noted that unless appropriate measures are also put in place to allocate the effort allowance, the introduction of a TAE system could lead to a "race to fish" for the largest and therefore most valuable prawns, thus reducing societal efficiency (D5). Societal efficiency could actually be improved in the long-term by introducing a system of Individual Transferable Effort. Stability is expected to remain stable due to the yearly assessments (D6)

Social

If the introduced TAE was a significant reduction from the effort currently expended to take the TAC, total employment in the Nephrops trawling sector would fall (D7).

5.2.8. Discussion

Under a BAU strategy, with slowly decreasing TACs and occasional closures in certain areas, it is considered that the assessed FUs in NWW should eventually achieve stable populations with balanced sex ratios. However, it is predicted that this strategy will fail to address the "poor" condition of the ecological descriptors and hence fail to meet the objectives of the MSFD. It may also reduce economic efficiency.

Review of the alternative management strategies indicates that it is possible to modify management in the *Nephrops* fishery to provide improvement in the ecological descriptors without significant deterioration in social and economic descriptors. However there is variation in performance among management strategies.

5.2.9. Management guidance

If the overarching management objective is to work towards GES in the context of the MSFD, then strategy C is considered to be the most appropriate given that a reduction in trawling and replacement by creels is predicted to provide improvement across all four ecological descriptors (biodiversity, commercial fish, food webs and seafloor integrity). This strategy is also predicted to provide improvement in terms of stability of catches and food security due to improvement in commercial stocks. However, strategy C may have negative effects on some parts of the *Nephrops* fleet where individuals are unable to afford the switch between gears (community viability) or where catches are reduced (efficiency).

If the overarching management objective is employment, strategy A is considered to be least appropriate, given that closed fishery areas are considered to negatively impact upon fishers by limiting choice on where they can fish, the potential for increased effort in areas where fishing is not restricted and potentially limiting access to areas of high profitability. Furthermore, depending on the location of the closures, and the scale of the fleet operating in their proximity, additional fisheries closures may exclude some fishers due to their inability to switch effort to different (non-protected) areas.

Finally, none of the strategies considered would significantly improve efficiency as they do not control fishing effort at the individual level, meaning that boats would continue to fish until their costs are equal to revenues. It may be possible to improve efficiency through introduction of a rights based management (RBM) system, to ensure that fishing rights end up with the most efficient fishers (those with the lowest harvesting costs) and this could be used in conjunction with the strategies considered. However, acceptability of the various forms of RBM differs among stakeholders and further investigated is required to examine application in this fishery (see Section 5.3: Scallop fishery for more detail on RBM).

5.3. Case study: Scallop fishery

5.3.1. *Introduction*

The scallop is an important commercially exploited bivalve in northern Europe; its distribution extends from southern Norway to Spain. In NWW, the fishery for scallops occurs mainly in inshore waters off the south east coast of Ireland, in the south Irish Sea and in the western approaches to the UK and France. There are also important fisheries around the Isle of Man and off the west coast of Scotland. Fleets from the UK, Ireland and France exploit stocks both within and outside of national 12nm territorial limits. In 2009 an estimated 51,900 tonnes of scallop were landed from the NWW area (FAO FishStat+). The scallop is a high value species and these fisheries are economically important to local coastal communities. There is also extensive and intensive scallop aquaculture in northern Europe.

Scallops are most abundant on gravel, sand/shell or stony substrates at depths of 15-75 meters. The main gear used to catch scallops is a toothed spring loaded "Newhaven" scallop dredge (Beukers-Stewart and Beukers-Stewart 2009). The Irish fleet generally utilise a dredge approximately 0.8m wide, with a bag that is constructed of 75mm internal diameter metal rings. The length and shape of the teeth, which penetrate the seabed, vary in size and design between vessels. Up to 34 of these dredges are held in series on two beams, which are fished on each side of the vessel (Tully et al., 2006).

Scallop stocks do not come under the remit of the Common Fisheries Policy (CFP) and ICES does not provide assessment or advice for the management of the fisheries. Management of the scallop fisheries in NWW is nationally based and lack of coordination between various governments may limit improvement of this fishery.

5.3.2. *State of the stock*

Regional stock surveys and limited assessment may be conducted e.g. Marine Scotland undertakes both fishery and fishery-independent research as the basis for stock assessments but does not set quotas. No formal stock assessments or quotas appear to occur for this species in England, Wales or Northern Ireland. However, according to Seafish (2008), UK stock status is variable with many considered to be fully or overexploited. The Isle of Man stock status is assessed by annual surveys and most stocks are considered to be fully or overexploited, with fisheries dependent on recruitment of young scallops (Seafish 2008). The Irish Government introduced improved data collection for fisheries management purposes in the southern Irish Sea scallop fishery, including fishery independent surveys and habitat mapping in 2005. Formal stock assessment or quota management have not yet been implemented but Seafish (2008) indicates stable stock, with low exploitation rates and stable age structures. In the French scallop fishery, stocks are assessed by annual surveys, and all are considered to be fully or overexploited with fisheries more or less solely dependent on recruitment of young scallops (Seafish 2008). In Scotland the outputs from virtual population analyses indicate that spawning stock biomass (SSB) in the West of Kintyre and the North West management areas has declined to low levels, when compared to historical values.

5.3.3. Main interactions with ecosystem components

Scallop fisheries are known to have significant effects on both target species and the wider marine environment. Towed fishing gears have been demonstrated to affect juvenile and adult scallops that have been encountered but not captured, in terms of growth and survival (Jenkins et al. 2001; Beukers-Stewart et al. 2005). Scallop dredges are considered to be among the most damaging of fishing gears to benthic communities and habitats (Kaiser et al. 2006), with significant effects on benthic communities recorded (e.g. Bradshaw et al. 2001). The severity and longevity of effects on the seabed is dependent on the resilience of the substrate and associated communities, and natural levels of disturbance. Disturbance of the seabed has been demonstrated to cause homogenization of sediments and topography (Collie et al. 2000; Kaiser et al. 2002) and in areas of soft sediment may cause re-suspension of sediment, with the potential for smothering of benthic organisms, including scallops (Brand 2006), and re-suspension of toxins or nutrients. Scallop fishing may also directly impact on macro-algae and protected habitats (e.g. maerl; Hall-Spencer and Moore 2000), and indirect effects include those on phytoplankton and zooplankton through food-web modification.

5.3.4. Current management (Business as usual)

The following tools are currently being employed for scallop management at the EU level:

- Minimum landing size
- Effort (days at sea)

Scallop fisheries are mainly managed at the national level and, as such, a plethora of management tools are used inside each Member State's territorial waters (12nm) but relatively few are employed in offshore areas. Management measures are generally designed to influence sustainability of the target species rather than on an ecosystem level. Different assessment methods and management measures applied by Member States to scallop fisheries include:

France: Three levels of regulation apply (1) a minimum landing size (MLS) as well as fishing access permits; (2) national summer closure from 15 May – 1 October, minimum belly ring size of 92mm, no shucking at sea; and (3) local complex series of regulations including licensing, effort, catch and gear restrictions. In Bay of Brest, areas are enhanced with hatchery-produced spat and fished in rotation.

UK: EU and local regulations. Permitted fish by-catch 5% and shucking at sea banned. Restrictive licensing since 1999 for vessels >10m. Local gear and fishing time restrictions apply in many areas. Regulations to control gear selectivity: internal belly ring diameter (≥ 75mm), top net mesh size (≥ 100mm), tooth number (<10) and tooth spacing ≥75 mm). Restrictions on the number of dredges permitted (e.g. Inshore Fisheries and Conservation Authority Byelaws, England; Scottish Executive; Welsh Assembly Government see Howell et al., 2006). Seasonal closures in the Irish Sea and within 6nm of Sussex, Devon and Welsh coastlines to protect scallops during breeding and larval settlement periods. There are also some restrictions (e.g. Northern Ireland and Devon inshore areas) on the time of day in which scallop fishing can take place.

Isle of Man: Annual seasonal closure from 1 June-31 October. Strict effort control in IoM three and 12-mile zones with regulations controlling boat size, fishing hours, and various technical measures governing the gear. A small closed area spawning refuge has been enforced since 1989.

Ireland: Fleet capacity is limited by the number of bi-valve and polyvalent licenses. From 2004 effort in ICES area VII, for vessels over 15 m in length, which included all of the fleet operating off the south east coast, was limited to a maximum of 525,012 kilowatt days at sea (Council Regulation 2004/1415). Furthermore, to fully comply with this regulation, the effort by all scallop vessels over 10m was limited to 109,395 kilowatt days in the biologically sensitive area (BSA) defined in Council Regulation 1954/2003.

The EU level regulations applicable to all fleets in NWW are as follows:

MLS

The minimum landing size for scallops is 110mm SL in the western English Channel and Irish Sea, and 100mm SL elsewhere in NWW.

Effort

From 2004 effort in ICES area VII, for vessels over 15m in length was limited to a maximum of 525,012 kilowatt days at sea (Council Regulation 2004/1415).

5.3.5. Key management issues/BAU Performance

Current landings of scallops in NWW countries are mostly stable (with the exception of certain Scottish stocks), however this may represent a sequence of depletions where fishers are continuously finding previously unfished areas (Beukers-Stewart and Beukers-Stewart 2009). Problems with the market for scallops also exist. The processing costs are high and scallop producers cannot compete with cheaper imports from outside the EU. The effort of the Irish fleet, for example, may be restricted by this market, with cheaper imported scallops making many fishing trips unprofitable. Although there is a cap on fishing effort, it is the market that is really controlling the amount of scallop dredging.

All of these conditions are liable to change and there is scope for improvement in the management of scallop in NWW.

Scallop dredges can severely damage sessile benthic organisms and therefore negatively affect seafloor integrity and biodiversity in sensitive areas but the main fishery occurs in areas of sand and gravel where much of the structural epifauna has already been removed. Due to the inefficiency of the Newhaven dredge, a maximum of ~30% of the catch is kept (Beukers-Stewart et al. 2001). The damaged by-catch (of non-target and under-size target species) and indirect fishing mortality attracts predators and scavengers to recently dredged areas (Kaiser and Spencer 1994), which has the potential to further alter local food-webs. Scallop dredging leads to incidental mortality of some other commercial species, such as crab, in some areas.

5.3.6. *Other potential management tools*

Potential management tools for the NWW scallop fishery include:

- MPAs (permanent or rotated closed areas)
- Gear restrictions (more environmentally sensitive dredges)
- Rights based management
- Total Allowable Catch

MPAs as required by the CBD are included in all management strategies (see section 4.2.4).

5.3.7. *Management strategies matrix evaluations*

5.3.7.1. Overview of management strategies

Management strategy A. Rotation of Closed areas

A 14-year study examined impacts of closed areas on the scallop fishery in the Isle of Man. Scallop densities were very low when the closed area was initially implemented but increased, at an accelerating rate, over the period inside of the closed area compared to adjacent fished areas. There was also a shift towards much older and larger scallops in the closed area as a result of reduced total mortality. The patterns of scallop density, age and size structure resulted in the exploitable biomass (adductor muscle and gonad) of scallops being nearly 11 times higher in the closed area than in the fished area by 2003 (after 14 years). The build up of high densities of large individual scallops enhanced local reproductive potential (as fertilization rate of scallop is strongly density dependent) and therefore the likelihood of export of larvae to the surrounding fishing grounds. Fisheries for relatively sedentary and long-lived species such as scallops appear to be particularly suitable for this type of management (Beukers-Stewart, et al. 2005).

However, issues surround the placement of permanently closed areas, such as smaller, more local fishing enterprises being disproportionally inconvenienced and overall effort simply being displaced. Myers et al. (2000) describe a rotational harvest strategy that could have substantial benefits for the management of fisheries of sessile species with high indirect fishing mortality. Under this strategy a certain percentage of the fishing area would be closed to scallop dredging and the “fallow” area rotated every four to six years. In this way the benefits of closed areas described above would be gained and some of the downfalls would be avoided. This strategy is mainly aimed at the offshore fishing areas but could be extended to inshore areas if required.

Management strategy B. Use of Fishing Technology and Increased Rights Based Management

The efficiency of scallop dredges is very low and the scallop fishery is therefore a costly operation with an environmental impact higher than it could be. Scallops are most abundant on gravel (e.g. off the South East coast of Ireland) so by increasing the resolution of available seabed maps the efficiency could be greatly improved (Tully et al., 2006). More environmentally friendly gear is also becoming available (for example dredges whose tines are individually sprung), which would reduce the large percentage of indirect fishing mortality (20-30% in the Irish Sea, Shephard et al. 2009) associated with the current dredges. Using such tools in isolation would increase fishing efficiency but would eventually lead to an unsustainable level of fishing mortality unless measures were put in place to limit that mortality. This strategy therefore utilises two management tools: fishing technology to improve efficiency, and rights based management to control effort.

This strategy calls for the use of improved fishing technology (such as high resolution seabed maps and innovative gear designs) coupled with rights based management to limit the amount of fishing effort. A property rights based system is a way of assigning an individual the property right to either the inputs into the fishery (i.e. how much effort can be put in, for instance number of days at sea), or the outputs from the fishery (i.e. how much catch is taken, for instance in individual quota share). It is then up to the individual fisher how (within present regulations) and when (usually within a calendar year) and where (within geographic limits) they will catch the fish. The fisher will then decide the most efficient (profitable) way to harvest the fish they are assigned, within the given regulations, and thus efficiency is achieved at an individual (fisher) level. If the rights are transferable, then efficiency is ensured also at the societal level. This is the case since, if fisher A can harvest more efficiently (at lower costs) than fisher B, fisher A can offer B a price for the right, which makes B indifferent between using the right or not. By this mechanism the rights end up with the most efficient fishers, i.e. fishers that have the lowest harvesting costs, ensuring societal efficiency. A big issue in the debate on transferable property rights in fisheries is whether the rights should have an infinite term, be valid for some years or only be valid for one year. Eternal rights, given that the control mechanisms for the quota system are effective and the fishing mortality for the stocks can be controlled, give the highest stability, whereas annual quotas give the lowest ex ante stability. However, with a well-functioning market for rights, longevity of the rights is not necessarily an issue.

Rights based management (RBM) systems can be scored and ranked according to four characteristics: exclusivity, validity, security and transferability. The RBM systems that tend to score most highly in terms of these characteristics are Individual Transferable Quotas (ITQ) and Individual Transferable Effort (ITE) systems, which score highly on transferability, and Territorial Use Rights in Fisheries (TURFs), which tend to score highly on the other characteristics but low on transferability. Under this strategy, RBM applied to scallop in NWW countries would move from their current systems (i.e. vessel quotas in Ireland, individual quotas and some TURFs in the UK, and limited licensing and community quotas in France) to systems ranked higher by the MRAG consortium report on RBM in European Waters (MRAG et al. 2009), such as ITQ/E or TURFs.

Management strategy C. Use of Fishing Technology and Catch Control

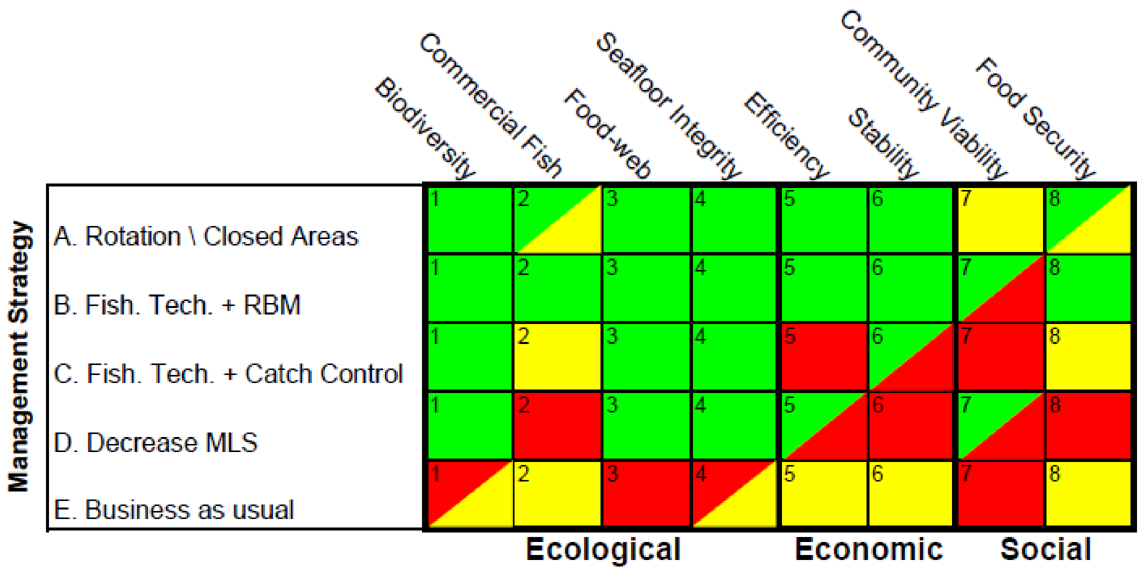
This strategy involves the use of improved fishing technology identical to the one above. In this case however, the tool used to limit target species mortality in order to compensate for the increased fishing efficiency is a total allowable catch (TAC). Catch would be limited using a TAC for each ICES division in which commercially viable offshore scallop populations exist (e.g. VIa, VIIa and VIIg). This would of course require an assessment of the stocks outside 12nm and the associated yearly advice and legislation from ICES, STECF and EC.

Management strategy D. Reduce Minimum Landing Size

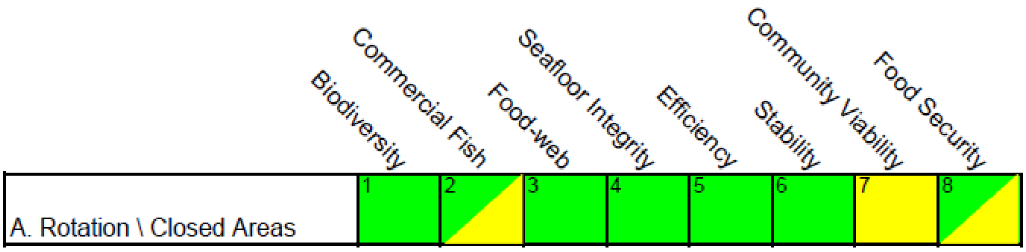
One of the few management tools applied across the whole NWW is MLS. Undersized scallop, particularly between 90mm and 100mm or 110mm, can account for up to 70% of the catch in some areas of the Irish Sea (Beukers-Stewart et al. 2003). The low selectivity of the gear requires a large area to be dredged. Reducing the MLS would increase the proportion of legal catch in each haul and decrease the effort required to fill the hold. Currently, MLS is 110mm in the English Channel and Irish Sea, and 100mm elsewhere; this is due to the fact that growth rates of scallop in NWW are spatially variable. Under this strategy MLS would be reduced by 10mm in both areas.

5.3.7.2. Management strategies matrix

The matrix below presents the expected medium-term (5-10 year) outcomes from the four scallop management strategies described above and the "business as usual" management strategy. Evaluation was in consultation with an expert (external to MEFEPO) and supported by relevant literature, and narrative for each of the management strategies is included below.



Management strategy A. Rotation \ Closed Areas



Assumptions

All other management tools already in place remain constant. The optimum number, size and location of each closed area is chosen according to best available scientific data during each period and agreed with all stakeholders. Enforcement of and compliance with the regulations of the closed areas are at levels such that the closed areas are truly closed. Closed areas are effective and increase the SSB and density of the scallop stock (see references above), increasing reproductive output. Spill-over and recruitment of larvae to adjacent non-protected areas occurs.

Ecological

By excluding the use of scallop dredges in closed areas for long periods of time, the deleterious effects on benthic organisms and seafloor processes (and therefore the food-web) can be reversed (A1,3 and 4; as described in the strategy explanation above). For the reasons outlined above, the commercial fish descriptor for scallop would improve under this strategy. As scallop dredging outside of the closed areas still incurs some by-catch of other commercial fish (e.g. edible crab), part of this descriptor remains stable (A2). Closed areas provide a spawning refuge where population density, and therefore fertilization rate, increases. In this way other areas should benefit from the spill over of larvae (Beukers-Stewart et al., 2004) (A2).

Economic

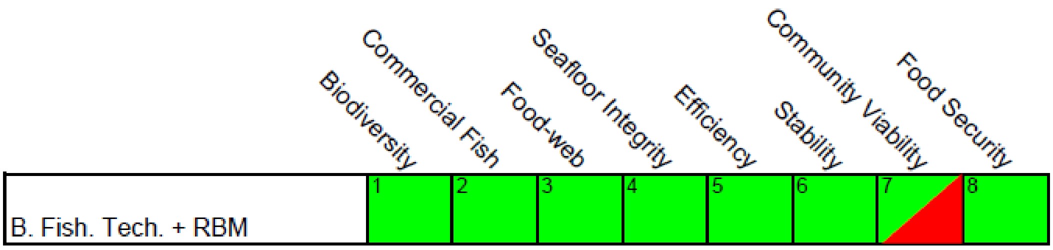
This measure restricts the fishers' freedom to choose where to fish. The fishers would usually choose areas in order to maximize profit from the harvesting activity. Hence, when not taking into consideration externalities, such a restriction will *ex ante* reduce the profitability, and thus efficiency for the individual fisher. Given externalities, e.g. large share of undersized fish in the catch, the measure will increase societal efficiency. In the long run closing an area may, depending on spill-over effects, result in commercial (and other) stocks also outside the area increasing, which will reduce the costs of harvesting these stocks, and also increase the benefits. The reduction in harvesting costs due to larger stocks may be lower, equal to or greater than the increase in harvesting costs due to not being able to choose freely where to fish. In the short term one may also expect greater fishing pressure outside the closed area, with the resultant environmental and economic consequences.

A population model of a similar scallop species in the North-West Atlantic (U.S. George's Bank) indicates that yield and spawning biomass per recruit would increase under such a management regime (Myers et al., 2000) (A5). Closure of areas is usually applied in order to restore (commercial) stocks such that they reach a higher level and are more robust against exogenous pressure and thus more stable over time. This measure will increase recruitment both outside and inside the protected areas and should therefore provide increased stability in landings (A6).

Social

As yield and spawning biomass per recruit are expected to increase under this strategy, landings per unit effort should also increase, making the fishery more attractive. Community viability should therefore remain relatively stable (A7). An improvement in the target commercial stock (see A2) and stability (see A6) would lead to improved food security (A8).

Management strategy B. Fishing Technology and Increased RBM



Assumptions

All other management tools already in place remain constant. The RBM system introduced is sufficiently acceptable to the majority of stakeholders and compliance is ensured.

Ecological

By increasing the efficiency of the scallop gear, this strategy reduces the total dredging effort required to land the same quantity of the target species. Effort will become more focussed on gravel areas where dredging has a lower impact on the seafloor integrity and other species (B1, 3 and 4). Increased selectivity will reduce the mortality of by-catch species and undersized fish of the commercial stocks. In turn this will contribute to increase the stocks of these species (B2).

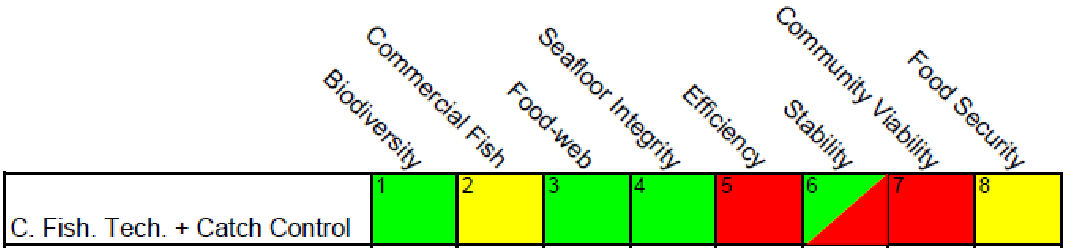
Economic

The correct system of RBM will increase societal efficiency (B5) and a long term right would lead to improved stability (B6). See arguments in strategy description above.

Social

Commercial stocks and profitability are expected to improve under this strategy (B2 and 5), which should lead to a sustainable fishery and a conservation of employment opportunities (B7). However, the acceptability of different RBM systems varies; for example, in its response to the green paper on the reform of the CFP, Ireland strongly opposed the introduction of individual transferable quotas (ITQ). Yield and stability under this strategy are expected to improve (B2 and 6), which would ensure future food security (B8).

Management strategy C. Fishing Technology and Catch Control



Assumptions

Effective introduction of yearly population surveys and stock assessments used to set TAC.

Ecological

As for management strategy B (above).

Economic

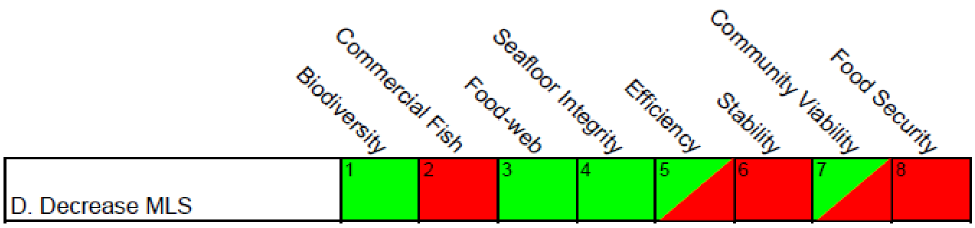
Setting a total quota without assigning individual property rights to shares of the TAC results in a "race for fish", which subsequently dissipates all resource rent, i.e. any super-profits emanating from the "free" input of fish. As long as expected income exceeds harvest costs, new vessels will enter the fishery, usually resulting in overcapacity. This race is a highly inefficient way to harvest a given amount of fish (C5). However, if the TAC ensures that fish attain a larger average individual size when caught, this may lead to increased price per unit catch. Costs are however not directly affected.

A TAC aims at restricting the fishing mortality of a stock, which in turn stabilizes or even increases the stock. A large, stable stock gives rise to a stable TAC over time (C6). The problem may arise at the individual fisher level, where the race for fish, a consequence of no property rights, may imply highly variable catches for one and the same fisher over years, even if the TAC remains constant (C6).

Social

As for management strategy B (above).

Management strategy D. Decrease Minimum Landing Size



Assumptions

All other management tools already in place remain constant.

Ecological

As with the above strategies, a reduction in the effort required to fill the hold would lead to a reduction in the total amount of dredging and consequently a reduction in the pressure on seafloor integrity, food-web structure and biodiversity (D1, 3 and 4). However, capturing smaller individuals further reduces the size spectrum and population density, and therefore reduces total spawning potential (D2).

Economic

Efficiency would initially improve under this scenario as the proportion of legal sized scallops in each haul would be greater (D5), however this descriptor would eventually deteriorate due to the reduction of reproductive potential (see D2). Decreased selectivity will increase the mortality of undersized scallop, which will in turn decrease the stocks. Lower stocks are less robust against exogenous pressure, and thus are less stable over time (D6).

Social

Increased landings per unit effort would make this a more attractive fishery and the consistent supply of scallop to processing plants may lead to a reduction in their costs. However, in the longer term community viability (D7) and food security (D8) would deteriorate with the declining stocks.

5.3.8. Discussion

Clearly the predicted outcomes of the fishing technology \ RBM strategy are dependent on the exact details of the RBM system to be introduced. To truly assess the impact of such a strategy, the finer details of the four characteristics need to be outlined: transferability, exclusivity, validity and security. How long are the rights valid for, yearly or eternal? How transferable and divisible are the rights and how is their market regulated? Is concentration of rights allowed? *etc*. On top of these questions the acceptability of the proposed system to all stakeholders needs to be assessed. For example Irish fishers associations are concerned that the introduction of ITQs would lead to a concentration of fishing rights in the hands of a few large companies and privatisation of a national resource. All of these questions would need to be addressed before introducing more RBM to this fishery. But to do so would require the development of a detailed management plan for scallop in NWW, which is outside the scope of this report. However the overall strategy of increasing the use of efficient gear technology and RBM systems can still be examined.

5.3.9. Management Guidance

If the overarching management strategy is to improve the ecological descriptors and achieve GES for the MSFD then management strategies A (rotational spatial closures) and B (fishing tech. and RBM) are the most appropriate. Closed areas would lead to definite improvements in those specific areas and probable improvements in unprotected areas whereas improving fishing technology and introducing RBM would likely lead to improvements in the entire region. Overall more descriptors are expected to improve under strategy B. Both strategies are expected to lead to an improvement in the stability descriptor, though it should be noted that the rotation/closed area strategy should produce a greater improvement than RBM. Closed areas greatly increase the density, and therefore spawning potential, of scallop whereas dredged areas, even under reduced effort, still have damaged adults and juveniles and reduced habitat complexity, which can impair scallop recruitment.

If the objective is to maximise long-term profit then strategy B is the best option as it will improve the commercial stocks and efficiency. However, as outlined above, the acceptability of RBM varies greatly between member states. Strategy A also provides advantages to commercial stocks and efficiency and closed areas may be a more universally acceptable management tool than RBM. Having said that, the proposed reform of the CFP includes plans for the introduction of individual fishing quotas for assessed stocks.

5.4. Case study : Northern Hake fishery

5.4.1. Introduction

European hake (*Merluccius merluccius*) is widely distributed over the northeast Atlantic shelf, from Norway to Mauritania, with a larger density from the west of Ireland to the south of Spain and in the Mediterranean and Black Sea (CEFAS 2009). European hake in the northeast Atlantic is split into two different stock units, commonly referred to as northern and southern stocks. With the NWW region, fishers target the northern stock in Sub-areas II, IV, VI and VII, and Divisions IIIa and VIIIa,b,d (CEFAS 2009).

Hake is an important resource for many demersal fisheries in the NWW region and is landed as targeted or incidental catch by a wide variety of gears including bottom trawls, gillnets, and long-lines (CEFAS 2009; ICES 2010). They are mostly found at depths between 70 and 370m (CEFAS 2009). They are usually found close to the bottom during the day and move vertically in the water column during the night. Hake is commonly caught in mixed fisheries, along with cod, haddock and whiting. Other species within the hake fishery include megrim, anglerfish, *Nephrops*, sole, seabass, ling, blue ling, greater forkbeard, tusk, blue whiting, *Trachurus* spp, conger, pout, cephalopods (octopus, *Loligidae, Ommastrephidae*, and cuttlefish), and rays. The relative importance of these species in the hake fishery varies between years depending on gears, sea areas, and biological conditions.

The overall fishery prosecuting the northern stock of hake has been categorised into 7 fleets (STECF 2008), 4 of which use trawl gears, whereas the remaining three use gillnet, longline and a combination of several gears. Spain, France, the UK and Ireland fish hake in NWW with the vast majority of landings being shipped to and processed in Spain.

5.4.2. State of the stock

The 2008 ICES assessment indicated that the estimates of SSB and fishing mortality showed the northern hake stock at full reproductive capacity and as being harvested sustainably. SSB was estimated to be about at the desired level (Bpa) in 2008, and F had been around the desired level (Fpa) since 2001. However, tagging of hake gave evidence of substantial growth underestimation (de Pontual et al. 2006). A subsequent ICES workshop (WKAEK, ICES, 2010) confirmed that the previous internationally agreed ageing method was neither accurate nor precise and provided overestimation of age. A replacement ageing method with sufficient precision and accuracy was not available and consequently a new stock assessment was required. The new method uses a length-based approach which allows direct incorporation of the quarterly length composition data and explicit modelling of a retention process that partitions total catch into discarded and retained portions. Initial results show that this approach is more flexible than the previous method and yields more reliable management advice.

According to the 2011 ICES advice, which is based on the new assessment method, the northern hake stock was fished above F_{MSY} in 2010:

“The spawning biomass has been increasing since 1998 and is estimated to be record high in 2011. Fishing mortality has been decreasing in recent years, but is still above F_{MSY}. Recruitment fluctuations appear to be without substantial trend over the whole series. After several high recruitments in 2006 to 2008, the last two recruitments are estimated to be low.”

ICES advises on the basis of the transition to the MSY approach that landings in 2012 should be no more than 51 900 t.

5.4.3. Main interactions with ecosystem components

Impacts of the hake fishery depend on the fishing gear; the predominant gear utilised is the demersal trawl. Demersal trawling has been demonstrated to have significant interaction with the seabed; severity and longevity of effects is dependent on the resilience of the substrate and associated communities, and natural levels of disturbance. Disturbance of the seabed may cause re-suspension of sediment and there is the potential for smothering of benthic organisms and re-suspension of toxins or nutrients. The hake fishery also has significant interaction with other target and non-target fish species (e.g. cod, whiting etc.), mammals, seabirds and macro-algae.

Indirect effects of the hake fishery include those on plankton and other fish species through food-web modification. Significant discards associated with this fishery may also modify food-web interactions (Groenewold and Fonds 2000); excessive discarding may lead to anaerobic conditions and a reduction in biodiversity (Hill and Wassenberg 1990).

5.4.4. Current management (Business as usual)

The following tools are currently being employed for hake management in NWW:

- Total allowable catch
- Minimum landing size
- Gear specifications (mesh size restriction and square mesh panel)
- Effort restriction (in biologically sensitive area)

5.4.4.1. Total allowable catch

The hake recovery plan (EC Reg. No. 811/2004) came into operation in 2004. This included TAC rules for hake, such that:

- a TAC shall not result in a decrease in spawning stock biomass
- a TAC shall not result in mortality rates exceeding the set value (0.25)
- within these constraints, TACs will not be 15 per cent less or greater than that of the preceding year (except for 2004 i.e. December 2003 TAC decisions) (IEEP 2004).

This is aimed at increasing the quantities of mature fish to values equal to or greater than 140 000t. This is to be achieved by limiting fishing mortality to 0.25. The TAC for northern hake in 2010 was 51,500 tonnes.

Following the emergency plan in 2001 and subsequent recovery plan in 2004, a long-term management plan was proposed in 2009 (COM 122/2009) after the northern hake stock exceeded its recovery target for two consecutive years. This management plan is yet to come into operation.

5.4.4.2. Minimum landing size

The minimum legal size for fish caught in Sub areas IV, VI, VII and VIII is set at 27 cm total length (30cm in Division IIIa) (Council Reg. no 850/98).

5.4.4.3. Minimum mesh size

An Emergency Plan (Council Regulations N°1162/2001, 2602/2001 and 494/2002) was implemented in June 2001 for the recovery of the northern hake stock (Division IIIa, Subareas IV, VI, and VII, and Divisions VIIIa,b,d). This consisted of a 100 mm minimum mesh size for otter-trawlers when hake comprised more than 20% of the total amount of marine organisms retained onboard however there was exclusion for vessels less than 12m in length, or to those that returned to port within 24 hours of their most recent departure. In 2002, a 100 mm minimum mesh size was introduced for all otter-trawlers, regardless of the amount of hake caught, operating in Subarea VII (SW of Ireland) and Subarea VIII (Bay of Biscay), 'hake boxes' (EC Reg. 494/2002).

5.4.4.4. Fishing effort

Measures to limit fishing effort in a 'biologically sensitive area' in Subareas VIIb, VIIj, VIIg and VIIh were introduced in 2003 (EC Reg. 1954/2003). However, overall there is no effort limitation within the hake recovery plan (EC Reg. No. 811/2004; IEEP 2004)

5.4.4.5. Square mesh panel

In the French *Nephrops* fishery in the Bay of Biscay, the use of a squared mesh panel to reduce discarding of undersized hake has been enforced since 2006.

5.4.5. Key management issues/ BAU Performance

ICES advice (2011) indicates a growing northern hake stock under the current management with SSB at a record high. In 2010 the Irish fleet landed large volumes of hake, coupled with the imported hake from outside the EU the price of hake collapsed and efficiency, in terms of income, went down. In this way a large increase in hake biomass can have a negative impact on efficiency. Such a decrease in profitability could lead to reduced employment opportunities in the long-term.

Changes in TAC are currently constrained to +/- 15% year-on-year. No large changes in TAC means that the pressure on the seafloor from hake trawls should remain stable. The food-web is expected to improve under BAU, however a large increase in biomass of the highly predatory hake could have unknown consequences for the rest of the food-web. There is no change in biodiversity expected as the hake stock grows.

There is concern that the TAC is not actually constraining the catch in the northern hake fishery. In 2010 a total of 73,100 t of hake were landed, well above the 2010 TAC of 55,100 t (WGHMM 2011).

So compliance with existing and future regulations needs to be addressed. Also, despite being called a total allowable catch, current management is more akin to a total allowable landing. The northern hake fishery would benefit from a truly catch based control system.

5.4.6. Other potential management tools

Potential management tools for the northern hake fishery include:

- Redistribution of quotas
- Increase trawl selectivity
- Marine Protected Areas (CBD required)

MPAs as required by the CBD are included in all management strategies (see section 4.2.4).

5.4.7. Management strategy matrix evaluation

5.4.8.

5.4.8.1. Overview of management strategies

Management Strategy A: Redistribution of quotas from trawls to the rest of the fleet

ICES advice for the northern hake stock 2011 states:

"Discards of juvenile hake can be substantial in some areas and fleets. The spawning biomass and the long-term yield can be substantially improved by reducing mortality of small fish. This could be achieved by measures that reduce unwanted bycatch through shifting the selection pattern towards larger fish."

The 2011 report from the WGHMM for the hake northern stock (Division IIIa, Subareas IV, VI and VII and Divisions VIIIa,b,d) provides details of the selectivity of various gears for hake (Fig. 5.4.7.1.1). Long-lines and gill-nets select for larger fish and therefore reduce the catch of hake under the MLS of 27cm.

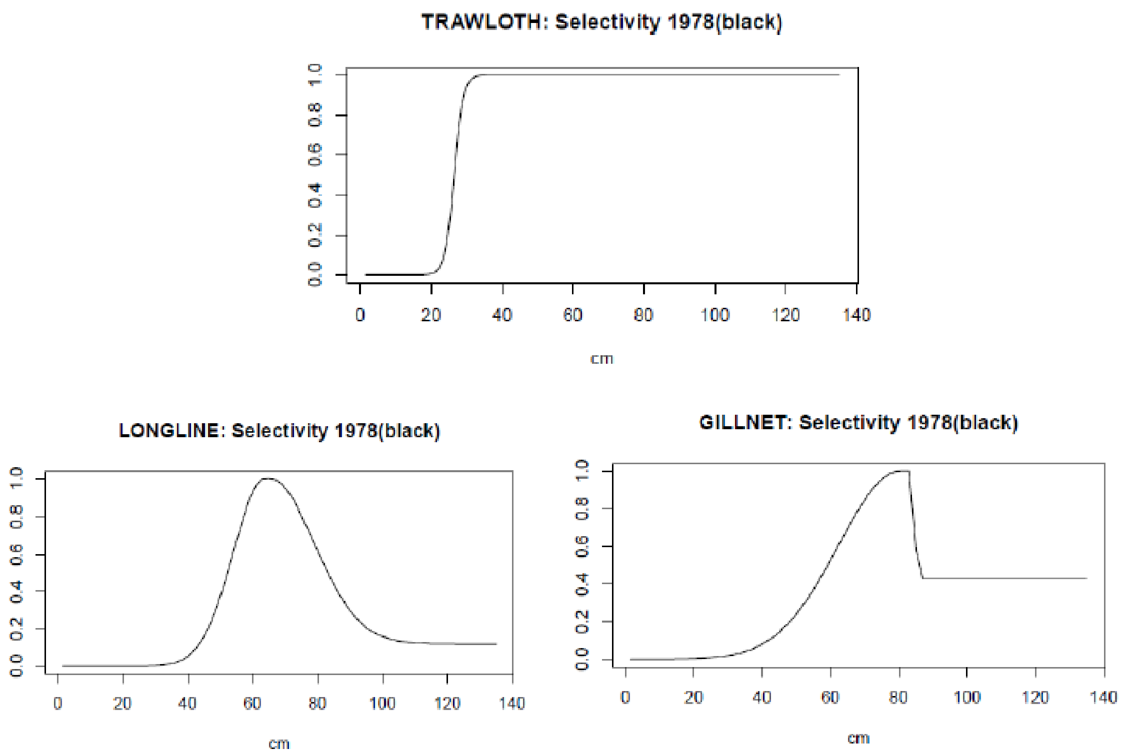


Fig. 5.4.7.1.1. Hake selection patterns at length by gear type (ICES WGHMM 2011)

Prior to the proposed long-term management plan for hake (COM 2009/122), STECF produced a report on the economic impacts of such a plan (STECF 2008) at the request of the commission. In its assessment, STECF utilised a simple model for a multi fleet fishery to calculate catches and spawning stock biomass for different selection patterns, by gear, induced by changes in quotas. The findings were:

"…that a redistribution of quotas from trawls to the rest of the fleet generates a higher Fmsy, more stable biomass and higher catch compared to fishing with the actual selection patterns. Both results are related to the changes that more selective gear will induce on the age distribution of the stock. Increasing the quotas of more selective gears raises the number of spawners and the average weight of the individual fish in the landings increases. In the long run, higher SSB and Yield are compatible with the present levels of fishing effort."

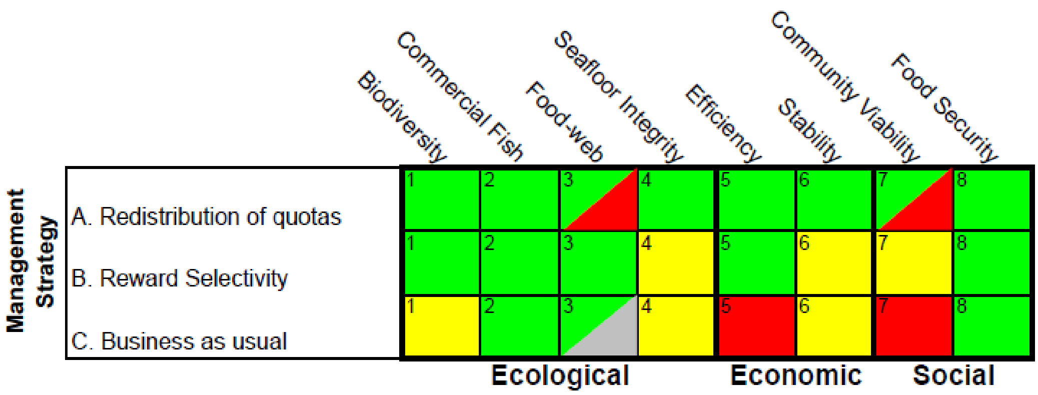
This strategy proposes a more selective exploitation of the resource by allocating the quota of member states fishing for hake in NWW preferentially to more selective gears, such as long-lines and, to a lesser extent, gill-nets. The exact quota redistribution is beyond the scope of this report but should significantly reduce the catch of size 26-35cm hake in trawls.

Management Strategy B. Rewarding Selectivity

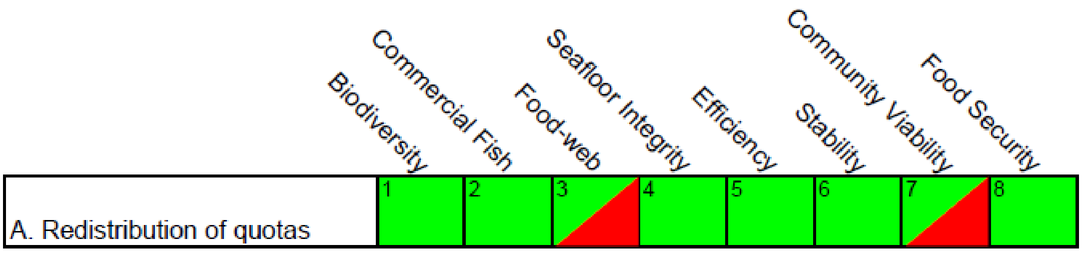
The reasoning behind this strategy is identical: there is a problem with the exploitation pattern associated with trawling, which is illustrated by the 52% discard rate in the Irish otter-trawl fleet (Irish discard Atlas, Marine Institute, in press). In this strategy however the tool used to address this problem is slightly different. Rather than a redistribution of quotas between gear types (e.g. trawls to gill-nets) this strategy proposes the use of a quota preference within the trawl group for more selective trawls. Rewarding those enterprises utilising selective trawls with increased quotas should encourage the uptake of more selective gear designs. Selectivity could be increased through the use of square-meshed panels, separator panels or sorting grids for example but the onus would be on the individual to demonstrate the improvements.

5.4.8.2. Management strategies matrix

Below is a matrix evaluating the expected medium-term (5-10 year) outcomes from the possible hake management strategies described above and the outcomes of the BAU strategy. Evaluation was in consultation with an expert (external to MEFEPO) and supported by relevant literature, and narrative for each of the management strategies is included below.



Management strategy A: Redistribution of Quota



Assumption

The strategy leads to an improvement in the selection pattern of the hake fishery but does not result in an overexpansion of the fishing mortality on the older, larger and more fecund portion of the population.

Ecological

Gill-nets and long-lines have little contact with the seafloor so redistributing effort from trawls to these gear types should lead to an improvement in seafloor integrity (A4). Similarly, gears that do not impact benthic species should lead to an improvement in biodiversity overall (A1). Although it should be noted that gill-netting and long-lining also have ecological concerns, such as ghost-fishing, and shark and cetacean by-catch. Increased selectivity should also improve the food-web descriptor, however taking more of the larger, more fecund hake from the population could result in a violation of the assumption of this strategy i.e. an overexpansion of the fishing mortality on the older fish (A3).

According to the model implemented by STECF (2008) "a reduction in discards or other losses of small fish might have an impact on the number of fish surviving to sexual maturity and might also therefore have an impact on the size of the fishable stock" (A2).

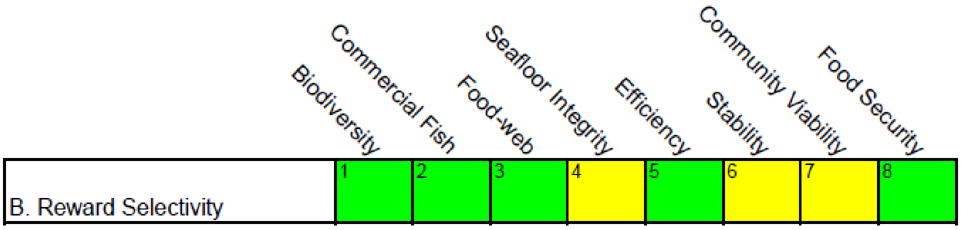
Economic

The outlook for efficiency under this strategy is broadly positive. The unit cost for gill-netting is substantially lower than for trawling (and this lower input cost also reduces the carbon footprint) (A5**).** According to the STECF (2008) model "a redistribution of quotas from trawls to the rest of the fleet generates a … more stable biomass… compared to fishing with the actual selection patterns" (A6).

Social

"As the use of more selective gear usually also implies the use of a technology more intensive in labour and less dependent on fuel consumption, it is possible that a redistribution of quotas between gears will increase employment (and) reduce (fuel) consumption" (STECF 2008). However, communities/enterprises reliant on trawling will be forced to adapt to lower hake quotas (A7). A larger SSB (A.2) and improved stability (A.6) should lead to better food security from this stock (A8).

Management strategy B. Reward Selectivity



Assumptions

All other management tools remain in place.

Ecological

More selective trawl gears should lead to an improvement in biodiversity due to reduced discards (B1). Overall effort of mobile bottom gears expected to remain stable, hence no change expected in seafloor integrity (B4). The commercial fish (B2) and food-web (B3) descriptors have the same arguments as strategy A (see A2 and A3 above).

Economic

In the short term LPUE would be expected to decrease due to the change in gear but in the long term an improving stock should improve efficiency (B5). Changes in TAC are currently constrained to +/- 15% year-on-year and under this strategy all current management tools remain in place. Stability should remain unaffected (B6).

Social

The number of jobs should remain stable under this strategy unless it removes supply to an important market for juvenile hake **(**B7). Food security should improve (B8) with improving commercial stocks (see B2).

5.4.9. Discussion

Redistributing quotas from trawls to gill-nets and long-lines does present some problems and tradeoffs. For example, when presented with reduced hake quota will trawling operations switch gears to catch hake or will they discard? Even under a BAU strategy it should be noted that a possible discard problem could arise if TAC is not in line with the growing hake stock biomass. Ecosystem issues also arise with increased gill-netting and long-lining, such as ghost fishing and shark and cetacean by-catch. Gill nets have been banned in the some areas due to impacts on other species.

5.4.10. Management Guidance

If the management objective is to improve the northern hake stock (to achieve MSY) any of the three strategies presented could be chosen because they all lead to improvements in the commercial fish descriptor. The choice therefore depends on other descriptors, which are discussed below.

There is no clear choice for the best strategy to adopt if the objective is to work towards GES in the ecological descriptors. Strategies A and B perform well but both have weaknesses in at least one ecological aspect. Strategy A has the highest number of green cells but there is an important concern that increasing effort in gill-nets and long-lines could lead to increased by-catch of sharks and marine mammals. Strategy B would be a more risk adverse choice but it would not improve stability or community viability.

If the overarching objective is to maximise profits in the long-term the choice is between redistributing quotas and rewarding selectivity. Under both strategies (A and B) efficiency is expected to improve. The deployment costs of long-lines and gillnets are substantially lower than trawls so it is considered that strategy A would be more efficient than B. However strategy A requires a major shift in how hake are caught whereas strategy B requires relatively straightforward trawl modifications and therefore would be easier to introduce.

The current management tools employed in this fishery could be streamlined by introducing strategy B. By rewarding selectivity in trawl gear across the entire region the need for enforcing the use of square mesh panels in the Bay of Biscay would be replaced and the onus would be on fisher organisations to demonstrate improved selectivity. Other than that small simplification all current management tools are considered to be required, provided they can be effectively enforced.

5.5. Case study: Mackerel fishery

5.5.1. Introduction

The mackerel fishery is one of the largest (by weight of landings) and most profitable fisheries in the Northeast Atlantic. Mackerel is mainly exploited in a directed fishery for human consumption using purse seines and mid-water trawls; however an industrial fishery started to develop and has increased since 2007. Small hand-line fisheries also operate in localised regions, such as north of Cornwall.

Mackerel is a widespread, and integral and important part of the pelagic ecosystem in the North Atlantic (Overholtz et al., 1991). Mackerel are distributed and fished in ICES Subareas and Divisions Iia, IIIa, IV, V, VI, VII, VIII, and Ixa and spawning areas are found in areas VI, VII, VIIIa,b,d,e. VIIIc, Ixa. IV, IIIa. For practical reasons all mackerel in the Northeast Atlantic are considered to comprise a single stock, which is divided into three area components: the Western Spawning Component, the North Sea Spawning Component, and the Southern Spawning Component. The Western Component is defined as mackerel spawning in the western area (ICES Divisions and Subareas VI, VII and VIII a,b,d,e). This component currently accounts for 76% of the entire Northeast Atlantic stock.

The fisheries target shoals of mackerel with echo-sounding equipment, so they are generally clean and efficient fisheries that result in low by-catch. However, shoals may consist of mixed species (most notable of herring and horse mackerel), which could result in non-target species being discarded (ICES, 2008). In addition to discarding of non-target species, low value small or poor quality mackerel can also be discarded or 'slipped' (released from the nets before being brought on deck) (Borges et al., 2008). High-grading, discarding and slipping of mackerel has been partially driven by the increasing price of large mackerel in Asian markets. Since January 2010 high-grading, discarding, and slipping from pelagic fisheries targeting mackerel, horse mackerel, and herring has been banned.

The widespread mackerel stock has previously been managed under international agreements between the EU, Norway, and the Faroe Islands. Recently the distribution of the spawning and feeding areas have shifted westward away from the 'traditional' feeding grounds off Norway towards Iceland. Although the mackerel population has been expanding over the last 5 years, catches have been declining off Norway and new fishing opportunities have opened in Icelandic waters (Fig. 5.5.1.1). The changing mackerel distribution has lead to a breakdown in the previously agreed international quota allocations arrangements as Iceland and the Faroe Islands have allocated themselves unilaterally determined quotas. Since 2007 catches have been considerably in excess of ICES advice and the current lack of effective international management is of concern.

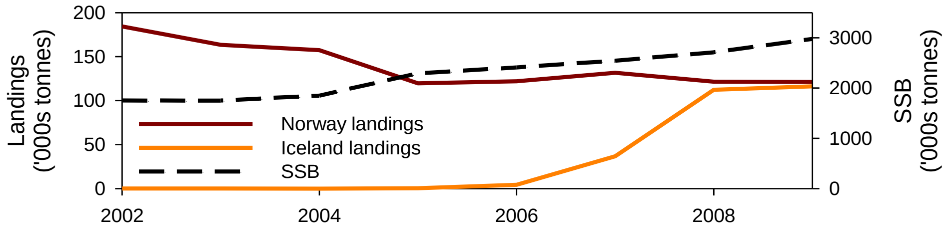


Fig. 5.5.1.1 Mackerel landings

5.5.2. *State of the stock*

Catches since 2007 have been considerably in excess of the ICES advice which was based on the management plan agreed October 2008 by EU, Norway and Faroes. This situation is expected to continue until effective international management agreements are re-established. The absence of effective international agreements between all nations involved in the fishery is a cause of continued concern and prevents control of the exploitation rate. The total estimated catch in 2010 resulted in an estimated fishing mortality of 0.31, which is well above the long-term FMSY target of 0.22, and transitional Fpa target of 0.23, stipulated in the management plan although the stock SSB remains above MSY SSB trigger level (ICES, 2010).

The spawning stock biomass (SSB) has increased from a low of 1.8 million t in 2002 to around 2.5 million t in 2008, a level similar to that seen in the 1990s. Available information indicates that the distribution of the spawning area and feeding areas of mackerel have expanded in recent years. Mackerel has been commercially fished in areas where it was previously not fished, particularly in the Icelandic EEZ (Fig. 4.4). In 2008 and 2009, catches in this area constituted approximately 18% of the total catch (ICES, 2010). This illustrates the inter-annual dynamics of a fast moving species. The distribution pattern coincided with considerably warmer surface waters in 2009 than in earlier years in both the western part of the Norwegian Sea and in the northern part of the Icelandic zone. Together with temperature, feeding opportunities seem to affect the distribution of the mackerel stock.

5.5.3. *Main interactions with ecosystem components*

NEA Mackerel is a relatively clean fishery with considerably less by-catch of non-target fish species compared to the mixed bottom trawl fisheries. Occasional by-catch of cetaceans and seals occurs in pelagic trawl fleets although these incidents are considered to be limited (Ross & Isaac, 2004; ICES, 2006; Couperus, 2008). Mackerel shoals may consist of mixed species (most notably of herring, horse mackerel and blue whiting), which can result in non-target species being caught and landed or discarded (van Helmond and van Overzee, 2007). The status of these by-catch species is varied. Herring to the north west of Ireland (Divisions Via South & VIIb,c) is depleted and needs to be rebuilt. Blue Whiting SSB was just above Bpa in 2009, although the estimated fishing mortality was well above Fpa.

Typically the gears used in pelagic fisheries do not make contact with the seafloor and so do not directly affect the benthos. However large discards or slippage of the catch may cause considerable localised impact to the benthos in terms of organic enrichment and disturbance to the benthic community (ICES, 2006).

Mackerel is an integral and important part of the pelagic ecosystem in the North Atlantic (Overholtz et al., 1991). Juvenile and adult mackerel are an important food source for demersal fish and larger pelagic predators, including sharks and marine mammals. Mackerel are also eaten by a variety of sea birds. In general marine mammals are opportunistic feeders capable of switching diets to reflect local abundance and are therefore robust to the effects of prey removal by the mackerel fishery. It is considered that the mackerel fleet has no significant impact at the population level (ICES, 2006).

Similarly, few seabirds are entirely dependent upon a particular species and show prey switching behaviour. On the other hand, pelagic fisheries generally tend to produce low levels of discards and are not thought to cause notable food subsidy for seabirds (ICES, 2006).

5.5.4. Current management

The following tools are currently being employed for mackerel management in NWW:

- Total allowable catch
- Minimum landing size
- Mesh size restrictions and catch composition (reduction of by-catch)
- Closed fisheries areas
- High-grading, discard and slippage ban

5.5.4.1. Total Allowable Catch

TAC of 646,000 tonnes set for 2011 for sub-areas VI, VII, VIIIa, VIIIb, VIIId and VIIIe; EU and international waters of Vb; international waters of IIa, XII and XIV between Norway and EU. No internationally agreed TAC for 2011 as Iceland and Faroes set unilateral TACs for themselves.

5.5.4.2. Minimum Landing Size (MLS)

The minimum legal size for fish caught is set at 20cm in all sub-areas except IV (North Sea), which is 30cm.

5.5.4.3. Mesh Size and Catch Composition

Pelagic Gear: Mesh Size 32-54mm and catch must consist of 90% of two or more of the target species (Mackerel, Herring, Scad, Boarfish).

Fixed Gear: Minimum mesh size of 50mm and catch composition of 70% of the target species (Mackerel, Herring, Scad).

5.5.4.4. Closed Areas

No directed fishing for mackerel except with gillnets or handlines in sub-area VIIf and parts of VIIe and g.

5.5.4.5. Ban on high grading, discards and slipping

In June 2009, an agreement was concluded between contracting parties to the Coastal States on mackerel banning high-grading, discarding, and slipping from pelagic fisheries targeting mackerel, horse mackerel, and herring beginning in January 2010.

5.5.5. Key management issues/ BAU Performance

The lack of effective international management has lead to catches being considerably above recommended levels with attendant risks for stock status. The lack of international management is the most urgent issue currently facing the mackerel fishery.

Until the recent shift in mackerel distribution effective management structures were in place. Fishing mortality had been brought under control and the stock biomass was rebuilding. The shift in distribution has lead to a reduction in fishing opportunities in some traditional grounds, and new opportunities have opened up in areas previously without mackerel. This has lead to a breakdown in the existing international management structures as the 'traditional' fishers lay claims on what they see as their historic resource, while fishers in the developing areas see it as a legitimate target resource within their waters.

5.5.6. Other potential management tools

The mackerel fishery is an example of a relatively clean, efficient and directed single species fishery that has limited wider interactions with the marine ecosystem. This means there are fewer challenges to successfully managing the mackerel fishery than a mixed stock demersal fishery, and the fishery can be effectively managed on a single species TAC basis. Therefore the alternative management scenarios did not consider alternative technical management measures. For the same reasons the soon to be introduced MCZs should also not affect the NWW mackerel fishery (see section 4.2.4).

5.5.6.1. Overview of management strategies

Before the breakdown in the international management agreements covering NE Atlantic mackerel stocks management had been operating effectively. Fishing mortality had been reduced to close to the MSY target level and SSB was above the MSY trigger level (Fig. 4.5). As a relatively clean single species targeted fishery a TAC based management system can be effectively applied. Currently the main concern facing the mackerel fishery is re-establishing an effective international management system.

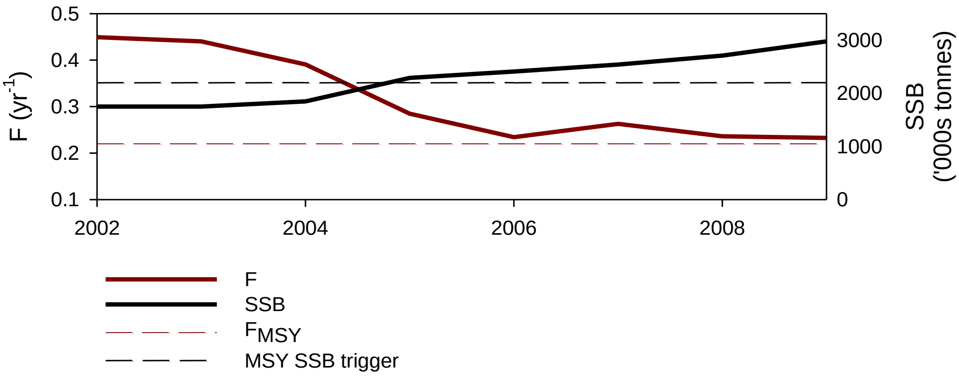


Figure 4.5. Mackerel fishing mortality (F) and spawning stock biomass (SSB).

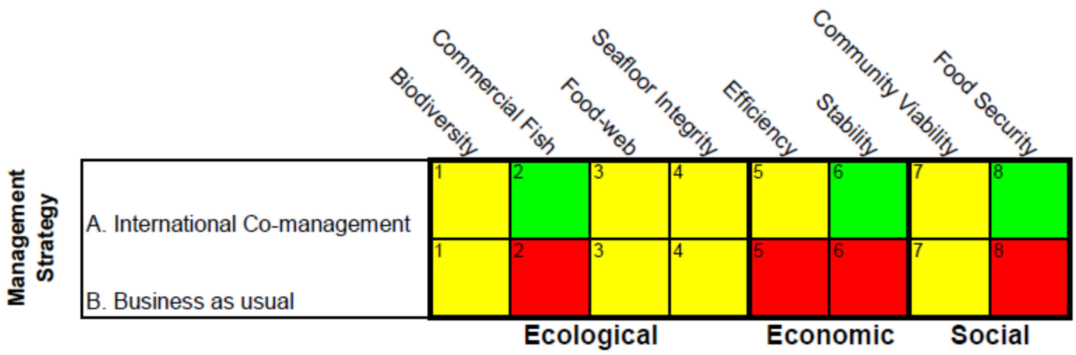
Management Strategy A: International co-management

The apparent change in the distribution of mackerel has reduced the proportion of the stock present in Norwegian waters, increased the proportion in Faroese waters and created new opportunities in Icelandic waters. Under the current system a total TAC was determined following ICES advice, and the TAC was apportioned to the EU, Norway and the Faroe Islands according to an agreed scheme. Since the change in the mackerel distribution Iceland and the Faroes have unilaterally self-appointed quotas, with no compensatory decrease in the TAC apportioned to other states, which can lead to harvesting well above advised levels.

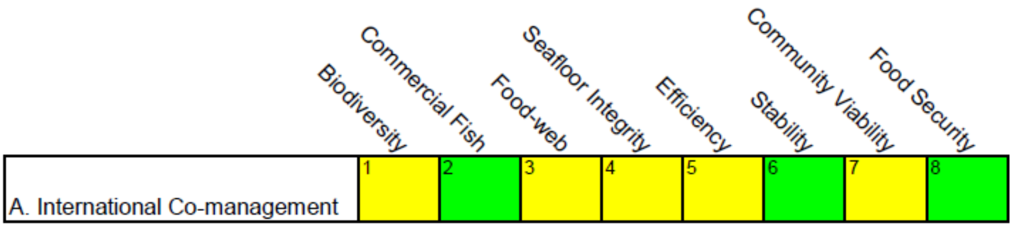
Under the international co-management strategy issues relating to the international quota sharing are resolved and total mortality is reduced to advised levels.

5.5.7. Management strategies matrix evaluation

Below is a matrix evaluating the expected medium-term (5-10 year) outcomes from the possible mackerel management strategies and the predicted outcomes of the BAU management strategy. Evaluation was in consultation with an expert (external to MEFEPO) and supported by relevant literature, and narrative for each of the management strategies is included below.



Management Strategy A: International co-management



Assumptions

Under the international co-management scenario it is assumed that fishing is conducted in accordance with scientific advice and that high stock sizes and landings are maintained over the medium term.

Ecological

It is considered that the mackerel fishery does not currently cause a significant impact on biodiversity; this would not change under the international co-management strategy **(**A1). Under an effectively implemented international co-management strategy the mackerel stock would be managed to comply with MSY targets (A2). The fishery has very little interaction with the seafloor (A4) and does not currently cause a significant impact on the food web (A3); this would not change under the international co-management strategy.

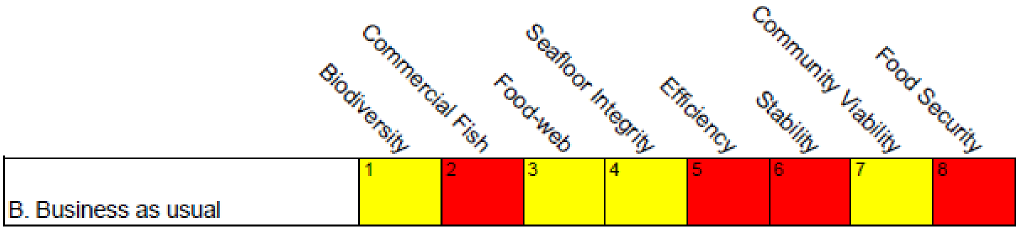
Economic

Efficiency would not be significantly affected as the fishery currently targets dense shoals of mackerel (A5). Maintaining a high stock biomass would support stability in the quota setting (A6).

Social

The mackerel fishery is predominantly a high capital, low employment fishery. Community viability would not be significantly affected under the international co-management strategy (A7). Food security would be improved by effectively managing the fishery to MSY targets (A8).

Business as usual



Assumptions

For the management strategy evaluation it is assumed that under the business as usual scenario the international disputes on quota sharing are not resolved and fishing continues at levels significantly above the advised TAC leading to a decline in to stock size and landings over the medium term.

Ecological

It is considered that the fishery does not currently cause a significant impact on biodiversity; this would remain the case under the business as usual strategy (B1). Without effective international agreements on TAC sharing landings will remain significantly above ICES recommendations and the stock could fall below target levels (B2). The mackerel fishery does not currently cause a significant impact on the food web; this would not change under the business as usual strategy unless massive stock depletion occurs (B3). The fishery has very little interaction with the seafloor; this would remain the case under the business as usual strategy (B4).

Economic

As the stock reduces the fleet may have to spend longer searching for shoals, increasing vessel time at sea and fuel costs (B5). At lower SSB levels the stocks will be more susceptible to environmental fluctuations, and more corrective restrictions on quotas may have to be applied. Both of these factors would reduce inter-annual quota levels (B6).

Social

The mackerel fishery is predominantly a high capital, low employment fishery. Community viability would not be significantly affected under the business as usual strategy (B7). Food security would decline if the stock was not effectively managed to MSY targets (B8).

5.5.8. Discussion

The most urgent issue facing the mackerel fishery is the lack of an effective international co-management framework. Therefore the management strategy evaluation considered alternative governance models for the NE Atlantic mackerel stock; management with and without effective international cooperation.

5.5.9. Management Guidance

If the overall management objective is to maximise long-term profit, international cooperation is considered the most effective choice of management strategy. Added benefits of this strategy are improved commercial stocks and food security. However, in order to achieve cooperation the international negotiations must be successful, which means the EU may have to reduce its overall mackerel TAC to reach a compromise with the Icelandic and Faroese.

If the overarching management objective is to work towards GES in the context of the MSFD then management strategy A is again considered to be the most appropriate as fishing mortality on the mackerel stock could be reduced to F_{MSY} improving the commercial fish descriptor. Although the mackerel fishery is relatively clean, with little impact on the seafloor, food-web or biodiversity, so continuing with business as usual would result in three out of four ecological descriptors remaining stable as well.

Again, if the objective is to improve stability in landings and food security international cooperation is considered the most appropriate management strategy.

Finding a satisfactory resolution to changing stock locations ultimately requires a process of political negotiation. As shifting stocks may become a more common feature under climate change it is desirable to develop a robust framework for addressing resource allocation rights for geographically shifting stocks; the example of the mackerel stock may form a test case for the development of such a framework.

The MEFEPO project has demonstrated the application of a management strategy evaluation matrix approach to the development of regional Fisheries Ecosystem Plans (FEPs) to help decision-makers to simultaneously consider ecological, social and economic implications of decisions, and to inform the development of ecosystem based fisheries management (EBFM) for European fisheries. We have identified 5 key steps to developing such an integrated ecosystem based fisheries management regime (Box 6.1) and have illustrated our approach using a number of case study fisheries. The case study fisheries examined should be seen as heuristic examples and not definitive assessments of the potential effects of different management strategies.

Box 6.1 Key steps to make ecosystem based fisheries management a reality for European fisheries

- Develop long-term management plans (LTMPs) for each of the region's fisheries considering the ecological, economic and social implications for ecosystem components. LTMPS should be integrated into regional FEPs.
- Develop closer integration among stakeholders, fisheries scientists, ecologists, social scientists and economists to develop effective management advice for LTMPs. Social and economic descriptors, and appropriate (region specific) indicators, require further scrutiny and development.
- Develop qualitative assessments and expert judgement to supplement analytical modelling to meet the increased data requirements of LTMP development and make them operational in the short term.
- Ensure that the management framework is adaptive and able to respond to new information and understanding to allow decisions based on the best available evidence.
- Implement appropriate governance mechanisms that facilitate true stakeholder engagement to generate credibility in the management process and foster stakeholder support, this includes both definition of objectives and indicators as well as the development and evaluation of LTMPs.

The transition from single species management to EBFM will have significant implications for the knowledge base required to underpin management. Long term management plans (LTMPs) should be developed for each of the region's fisheries that include consideration of the wider ecosystem (ecological, social and economic) interactions. Implementation of the management strategy evaluation matrix (hereafter the matrix) approach developed by the MEFEPO project will allow the broad range and quantity of information on potential impacts of different management strategies to be summarised in a concise manner, accessible to all stakeholders and so support the production of robust, evidence based and inclusive Long Term Management Plans.

Whilst the matrix approach is conceptually simple, a considerable amount of information is required to support its application. Much of this information, while routinely collected, is 'new' to a formal fisheries advisory process. It is also clear that it is not possible to meet all the additional data requirements using the data that are currently collected. For example, the ecological descriptors utilised were drawn directly from the Marine Strategy Framework Directive (MSFD), and were selected as those most likely to be impacted by fishing activities (biodiversity, commercial fish, food-webs and seafloor integrity). Social and economic descriptors were defined to monitor some of the main aspects of fishing contributing to the economic and social wellbeing of coastal communities but the choice was constrained by available data. Concerns therefore remain over the choice and application of all the descriptors utilised, and the definition of social and economic descriptors and appropriate indicators requires further scrutiny and development before this approach is applied within a formal advisory framework. However, these concerns need not be a barrier to implementation of EBFM due to the adaptive and consultative management process within the new management regime (Fig. 6.1), and we recommend a process of collaborative (Member State, scientists, and industry) to ensure that descriptors and indicators for all pillars are fit-for-purpose.

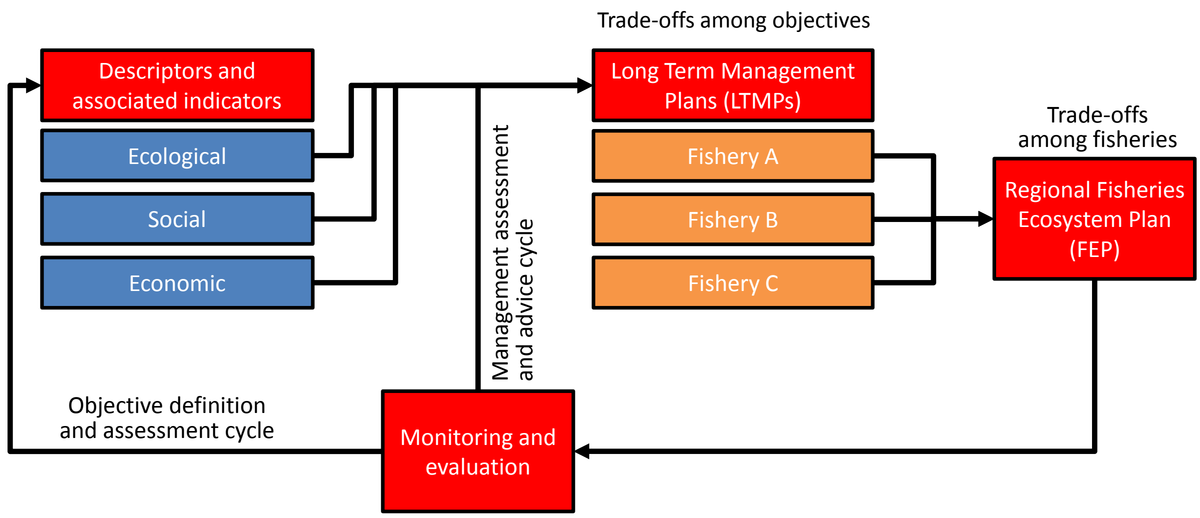


Fig. 6.1 Adaptive management framework proposed by the MEFEPO project for the development of Fisheries Ecosystem Plans to support ecosystem based fisheries management in European fisheries.

The institutional framework developed by MEFEPO (Section 2) would enhance stakeholders' participation in management at the regional scale, and facilitate stakeholders' involvement in the development of management objectives and appropriate descriptors for all three pillars, and in the evaluation of management strategies to give credibility to the processes and foster stakeholder support. If effectively implemented, this governance structure should serve to increase the legitimacy of the CFP and associated instruments among stakeholders (which presently is low) and reduce conflict between administrators and industry.

The absence of data must not be allowed to prevent decisions from being made and management advice should be formulated based on the best available evidence (be it modelled, empirical or expert opinion), consistent with the FAO Code of Conduct for Responsible Fisheries (FAO 2005) and the precautionary principle. Development of matrices for the case study fisheries demonstrated that qualitative assessments and expert judgement are needed to supplement analytical modelling, particularly with respect to social and economic pillars, if EBFM is to be made operational. Effort should be expended on developing approaches to incorporate qualitative data, expert judgment and data from outside of the traditional scientific fisheries advice domain (e.g. from industry, environmental scientists) to ensure that management decisions are appropriately informed.

LTMPs developed based on best available evidence must be implemented within an adaptive management regime, responsive to changes in environmental conditions, and new knowledge and understanding on the marine environment. Furthermore, the regime should be able to respond to advances in technology and associated changes in fishers' behavior to ensure that the long term sustainability is not compromised. Monitoring should be implemented to report on progress in meeting management objectives, with action taken where objectives are not being met (Fig. 6.1).

Ultimately management decisions will be made by politicians or managers (at EU and MS level), on the basis of overarching objectives. However, the joint development and evaluation of management strategies in the format described here has the potential to develop common understanding of the long-term implications of management decisions, and build communication and trust between industry and managers. Trade-offs are required among the pillars of sustainability in the development of LTMPs, and among fisheries when integrating LTMPs into regional FEPs; managers and stakeholder must work together to address priorities. Due to the nature of the trade-offs, it may not be possible to satisfy all stakeholder groups simultaneously (e.g. high level objectives call for EU fisheries to be exploited at MSY, however it may not be possible to achieve this for all fisheries simultaneously). Resolution of these trade-offs is not a technical scientific decision, however development of decision support frameworks such as the management strategy evaluation matrices can aid managers in making appropriate decisions on the basis of the best available information.

Over the past decade the use of Long Term Management Plans in the North Western Waters area has increased, and have been implemented or are under discussion for a range of fisheries including the Western Channel sole, Northern hake and the mixed demersal fisheries in the Celtic Sea. However, these LTMP have predominantly taken a single stock perspective and a rather limited scope on the related fishing fleets, and management plans are generally based on a biological assessment and wider ecosystem considerations are lacking. Furthermore, in the majority of cases, economic data is only included after the biological assessment has been implemented if at all. A firm bio-economic feedback loop is generally lacking, and social considerations of reliance and resilience of fishing communities are not included (Symes & Phillipson 2009).

In response to the Western Channel sole LTMP consultation, the NWW RAC has expressed support for the desirable objectives of achieving long-term, sustainable exploitation and management within safe biological limits, acknowledging that a move towards multi-annual multi-species management plans may help in achieving these objectives AND provide stability and predictability for associated fisheries (NWW RAC 2011). However, there are still concerns about the availability of data required to support long-term planning including appropriate biological data to minimise uncertainty in stock assessments, and economic and social data to understand the wider impacts of management decisions. In order to curb this trend an effort should be made to devise analytical tools that do enable an integrated assessment of ecological, economic and societal impact of LTMP. Building upon the work presented here, this requires a considerable effort in making available relevant economic and social indicator data, equivalent to the ecological data. RACs have already started working with ICES and other bodies to help identify gaps in knowledge and it is important that there is greater collaboration to identify and utilise ALL data sources and help address these short-comings.

Pivotal in the analysis of a LTMP is the evaluation of measures at the geographical ecosystem level. This will require a regional scope in the analysis and thus an integration of data sets on ecological, economic and societal aspects from different nations, both EU MS and third countries. Also it will call for cooperation between MS, EC and stakeholders at the regional level. Currently this regional level has no formal position in the EU treaty.

Central to this analysis will be appropriate governance mechanisms that facilitate true stakeholder engagement to generate credibility in the management process and foster stakeholder support. The

North Sea RAC is, according to its members, partly living up to this expectation. However, the policy development cycle is currently geared towards a traditional science-policy interface, with a linear process form science to policy. In the evaluation of LTMP it is recommended to acknowledge that traditional science is not fit to meet the challenges of many policy questions of today, but that these questions require (1) new, trans-disciplinary approaches, (2) an awareness of how values are embedded in the framing of policy questions and the choices of scientific methods and (3) that uncertainty be addressed more adequately.

These challenges are not specific to the North Western Waters RAC region, and in fact within the NWW already data availability and cooperation are advancing. Yet in order to fuel a participatory regional ecosystem evaluation of fisheries plans more and other data are required as well as the development of tools that facilitate a participatory science-policy interface servicing the needs of all parties involved in the policy evaluation cycle.

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9.1. ANNEX A: Descriptors and related indicators

For these descriptors/indicators is indicated how they were considered within the case study fisheries' management strategies matrices (Table A1). One descriptor for the social pillar, job attractiveness, was dropped in this exercise as it was severely criticised in a previous stakeholder workshop and was believed to be very difficult (if not impossible) to determine the effect of management measures on this descriptor.

Table A1 Descriptors, related indicators used in MEFEPO, and their consideration within the case study fisheries' management strategies matrices.

Pillar	Descriptor	Indicator(s) used in MEFEPO*	Consideration
Ecological	Biodiversity	Conservation Status of Fish	Related to fishing pressure (mortality) applied to fish. Measures of genetic diversity are not taken into account. The existence of "sub-species and populations where they need to be assessed separately" is included. It may also be related to more specific known impacts (particular gears impacting particular vulnerable species) that may be mitigated by specific spatial or technical regulations.
	Commercial fish	Proportion of stocks within safe biological limits (SBL) with regard to SSB and fishing mortality (F)	Related to the state of the case study fishery stock and other commercial stocks that interact with the case study fishery.
	Food-webs	Large fish indicator (LFI)	Related to fishing pressure on the fish community (especially larger longer lived fish). Indirectly, it may also be related to effects of discards on local food webs.
	Seafloor integrity	Proportion of area not impacted by mobile bottom gears	Pressure indicator of the extent of trawling impacts, related to the effort applied by mobile bottom gears and to the areal coverage of bottom trawling.
Economic	Efficiency[1]	Fishers' ability to take a given harvest at the lowest possible cost	Related to benefits and costs: social, economic (e.g. input) and ecosystem (externalities e.g. costs of by-catch and discarding).
	Stability	Minimising fluctuations in harvesting possibilities over time	Related to stability in fishing opportunities (e.g. fluctuations in TAC). If stock above SBL it is more likely that it will be more robust to short term environmental 'noise', therefore less need for regular changes to quotas to respond to changes in recruitment/environmental noise. Note that this is only true for stocks with strong stock-recruit linkages.
Social	Community viability	Employment linked with fisheries	Related to employment (e.g. catching, amount and type of employment, processing, administration, science,…) As this is a social descriptor, including cultural values, it is not only linked to "efficiency". .
	Food security	Securing a sustainable and sufficient supply of marine protein as food	Related to marine protein caught from the sea, hence this is related to yield, but not exclusively to commercial fish stock status.

* Earlier in the MEFEPO project, more than one indicator per descriptor had been suggested.

[1] NS beam trawl: Net revenues were the prime consideration.