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Report of the Working Group on Evaluation of Closed Areas

STECF SGMOS-07-02

Scientific, Technical and Economic Committee for Fisheries

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This report will be evaluated by the Scientific, Technical and Economic Committee for Fisheries (STECF) in its plenary session of 18-22 June 2007

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1. TERMS OF REFERENCE

The group is requested to:

- Prepare an inventory of MPAs within the EU EEZ. The MPAs to be included are marine areas where some limitations are introduced regarding fishing activities.

- Prepare an overview of existing information and evaluations regarding the MPAs in the inventory

- To identify a process and the data requirements for an evaluation of the MPAs in the inventory, considering maximum use of existing evaluations and information

2. BACKGROUND OF THE MEETING

The Commission is in the process of revising the technical measures used under the Common Fisheries Policy. As a part of this, an evaluation of closed areas is required. A considerable body of material and evaluations has been compiled through a number of research projects and study groups. A two-step approach is therefore required: first an overview is made of the existing MPA's within the EU EEZ and of the existing material and evaluations. Then meetings will be set up to evaluate specific sets of MPAs using the existing material supplemented with calls for data as required.

This meeting is the first step in this process and it is expected that the outcome will be an inventory of MPAs, an overview of existing information and evaluations relating to these and an identification of data requirements to produce supplementary evaluations as required.

3. INVENTORY OF MPA'S WITHIN THE EUROPEAN EEZ

3.1. Introduction and scope

An initial inventory of marine protected areas (where some limitations are introduced regarding fishing activities) was carried out on a regional basis, i.e. Baltic, North Sea and NE Atlantic, Macronesia and Biscay and the Mediterranean.
The draft inventory included fisheries closures under the Common Fisheries Policy (CFP), NATURA 2000 sites requiring fisheries management measures under the EU Habitat's Directive and national and other closures.

Given that the rationale for this work is support for review of technical conservation measures under the CFP, the principal inventories list only areas where fishing restrictions are applied under CFP (Appendix1a) and where regulation of fisheries may be required to support management of NATURA 2000 sites in waters beyond territorial sea jurisdiction (Appendix 1b).

The study group notes the existence of numerous inshore NATURA 2000 and other marine protected areas and includes an inventory of those found in the Mediterranean, in Appendix 1c. While not of direct relevance to the TOR, for completeness, a short note on the situtation in the Mediterranean follows.

3.1.1 Comments on the Mediterranean inventory of closed areas

The EU countries in the Mediterranean Sea and the Black Sea have a high number and variety of areas where there are restrictions to fishery activities.
The fishery management is under the responsibility of the General Fishery Commission for the Mediterranean (GFCM), which covers also the Marmara Sea and the Black Sea, where all coastal countries including the EC are members, as well as countries having fleets fishing in these areas (like Japan). International closed areas for fisheries are now firstly agreed and adopted by GFCM, which became a Commission, with a legislative binding power, only three years ago.
In addition to that, the International Commission for the Conservation of Atlantic Tuna has the responsibility to manage the fishery of tuna and tuna-like species, including other species usually affected by the same fishery concerned (all the large pelagics). Its competence covers the Atlantic Ocean, the Mediterranean Sea, the Marmara Sea and the Black Sea. Its members are all the coastal States having interest in the large pelagic fishery, including the EC, as well as other States having their fleets fishing for the same species in the convention area (like Japan, China, Korea, etc.). The ICCAT has a legislative binding power for all Member states, but some Mediterranean and Black Sea countries are not ICCAT members.
Due to the lack of EEZs in most of the Mediterranean and Black Sea marine areas, then the EU and national legislations apply only on national waters (usually within 12 miles, except for the gulfs, or areas where there are specific rules or agreements, including the Spanish fishery protection area eastern from the Balearic islands).
According to the increasing sensitivity for the protection of marine environment, many types of protected areas have been created so far, including several areas closed to some fishing gears or where the fishery is banned.

It s quite difficult to assess the difference between each type of protected area, because some times it appears more a question of a different terminology used in each country, but here following there is a first attempt to make a list, including their main characteristics.

Most of Mediterranean MPAs are small (surface between 1 and 100 square Km), coastal and has been established by National or regional legislation. Main objectives are conservation and restocking but often are combined with tourism and educational functions. Some large areas already exist, including those where only a fishing gear is regulated or banned, but usually these do not imply any significant reduction of the fishing effort or fishing mortality existing before the implementation. However, they may prevent a future increasing of the fishing effort and ensure an acceptable level of protection to the target species or habitats.

3.2. An Introduction to Marine Protected Areas

3.2.1. What Are MPAs?

Closing areas of ocean and seas to specific activities or for certain periods of time is a tool commonly used for nature conservation all over the world. These areas are generally called ‘marine protected areas’ (MPAs).

MPAs were developed as tools for the conservation of biological diversity through spatial protection from human interference of species and habitats, focussing on the ecosystem as such. Given the current debate on spatial measures for fish stock protection and recovery, it is appropriate to clearly distinguish marine protected areas with a "conservation objective" from those with a fisheries management objective such as stock recovery. The latter are called "Fisheries MPAs".

Closures for fisheries management have a long history. For example in the EU, fisheries management measures may apply in defined closed areas called ‘fisheries boxes’. The plaice box was set up in 1989 to protect juvenile plaice by restricting beam trawling in 38,000 sq km of the North Sea. Studies indicate that the box reduces mortality of younger fish.

The case for Fisheries MPAs has been championed by targeting protection for sedentary species living on tropical reefs and it is in the warmer zones of the world that the concept has come most successfully to fruition. However, it is important to note that Fisheries MPAs do not only benefit sedentary species – mobile finfish stocks such as cod, mackerel or plaice, will also benefit where hydrodynamic or topographic isolation effectively increase larval return and reduces adult emigration, or where strong management significantly reduces fishing mortality.

On the Georges Bank Fisheries MPA off the US east coast, after 6 years of closure, the spawning stock biomass of yellowtail flounder, haddock and cod had increased by 800%, 400% and 50% respectively. Furthermore, recent tagging research has shown that migratory species display considerable intra-species differences in movement behaviour – a proportion of the population may remain in a relatively small area, while others undertake significant migrations. This enables the resident population to build up and local aggregations to occur within MPAs.

3.2.2. Marine Protected Areas (MPAs) Types

The term Marine Protected Area (MPA) is a broad umbrella term that encompasses a wide, and sometimes surprising, variety of area-based approaches to marine conservation (Figure 1).

Over the years many terms have been applied to the concept of managing and protecting marine areas, leaving us with a dense jungle of terms to choose from: *Marine park, reserve, nature reserve, habitat reserve, protected area, national seashore, marine wildlife reserve, wilderness area, maritime park, sanctuary, life refuge, conservation area, no-take area, fisheries closure, fish box, closed area, Special Areas of Conservation (SAC's), multiple-use area, national park, species-specific harvest refugia, full reserve, refugium, gear or behavioural restrictions, seasonal restrictions, etc. (Sorensen, 2006).*

One definition for MPAs is that they are areas designated to protect marine ecosystems, processes, habitats and species including the essentials of marine biodiversity and which can contribute to the restoration and replenishment of resources for social, economic, and cultural enrichment. Areas such as catchments and islands enclosed within MPAs may well influence and be necessary for the management of the area, and may be counted for identifiable and explicit reasons.

3.2.2.1 Nature Conservation MPAs

Marine Nature conservation MPAs are spatial areas identified for biodiversity protection, whose primary objectives relate to the conservation and recovery of marine biodiversity and ecosystems processes. They are usually permanent to allow the recovery and maintenance of biodiversity, and have different management strategies ranging from multi or managed use to strict protection of Highly Protected Marine Reserves (HPMRs). In the UK, and Europe, nature conservation MPA management has focused on multi-use. Nature conservation MPAs are an important part of the marine nature conservation tool kit, but in order to address wider issues, (such as pollution, shipping and fisheries) nature conservation MPAs need to be set in a broader marine nature conservation policy and wider environmental management framework, i.e. part of an overarching marine spatial plan.

3.2.2.2 Fisheries MPAs

Fisheries MPAs are spatially defined areas of the sea or an estuary where natural populations of commercial species (finfish and/or shellfish) are protected either in part or completely from exploitation and/or other detrimental human activities. Fisheries MPAS are a fisheries management tool e.g. for stock management and/or fish stock recovery. Fisheries MPAs can be permanent/non-permanent, gear type specific, fish species specific, vessel type/size specific, etc. There are two main sub-types of fisheries MPAs: closed areas and no take zones.

3.2.2.2.1 Closed Areas (aka 'Fisheries Boxes')

A closed area is a fisheries management tool which relates to a sea area closed (either permanently or seasonally) to either a certain fishing gear (or vessel size), or for a certain target species usually for fish stock management/ recovery purposes. Since fishing is not totally prohibited, these boxes are not true no-take zones.

Several 'fisheries boxes' are already in use in Europe, such as the Norway pout, mackerel and plaice boxes or boxes that protect spawning herring.

3.2.2.2.2 No Take Zone (NTZs)

An area of sea that has been temporarily or permanently closed to all (not just some gear types) fishing to protect fish stocks and/or natural habitats. NTZ's can enable the ecosystem within the area to recover (at least partially) from the effects of fishing.

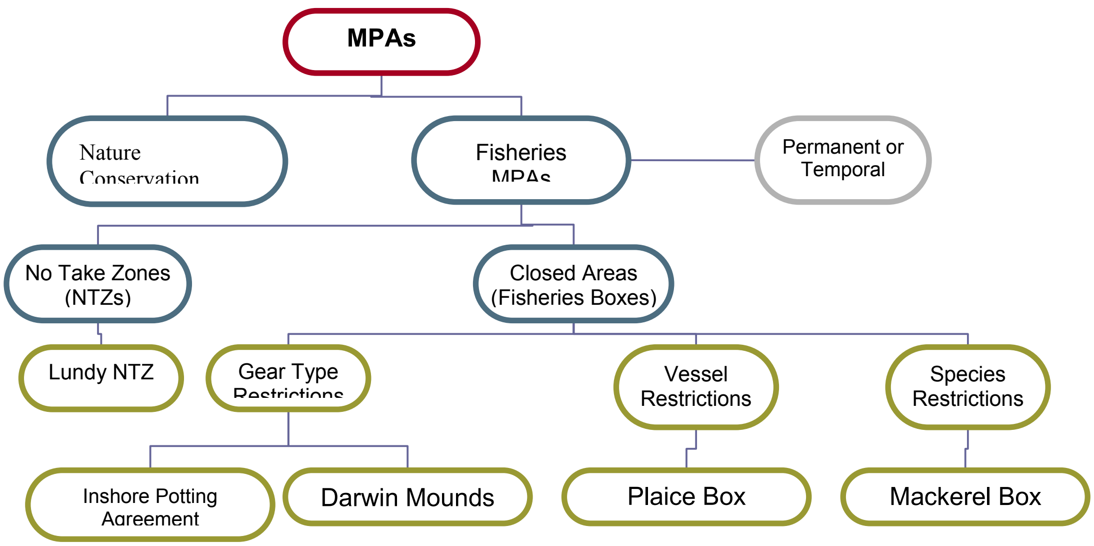

Figure 1. The Relationship between the different types of MPAs with focus on fisheries MPAs

3.2.3. Are fisheries closures MPAs?

The legal basis

The basic CFP Regulation *provides for* the establishment of 'zones and/or periods in which fishing activities are prohibited or restricted including for the protection of spawning and nursery areas' as well as specific measures to reduce environmental impacts of fishing. It does not require the EU or Member States to develop MPAs, but rather puts in place a legal framework through which they could be established, accepting that fisheries closures represent MPAs. Indeed, as fisheries is a policy area of 'exclusive competence' of the EU, the management of fisheries beyond inshore waters, including spatial management, should be done through the CFP at an EU level (Lutchman, 2006), therefore any MPAs beyond inshore waters will *require* fisheries closures. It is therefore illogical to distinguish between fisheries closures designed for MPA protection and those designed for fish stock conservation, given that fish stocks are an element of marine ecosystems. It would also be contrary to the concepts of ‘integration’ and the ‘ecosystem approach’ to distinguish between fisheries closures and MPAs.

The EU Habitats Directive (92/43/EEC) requires Member States to designate Special Areas of Conservation (SACs) to protect some of the most threatened habitats and species across Europe. SACs are an integral part of the Directive and required the first listing of proposed Sites of Community Importance (pSCIs) by June 1998. Member States were then given six years, until June 2004, to designate sites as SACs. Under the EU birds Directive (79/409/EEC), Member States are required to designate Special Protection Areas (SPAs) for the conservation of a specific list of bird species. The sites designated under both Directives will together form an EU-wide network of protected sites known as ‘Natura 2000’.

A large area of EU waters can be considered as “Fisheries MPA”, whereby fishing is restricted spatially and/or seasonally for fisheries management purposes. Such spatial and seasonal controls are more common place in inshore waters where management is better developed and there is more control of local vessels. These fisheries MPAs are broad and shallow however. They are developed primarily for fisheries purposes (often single stock), apply only to certain gear/vessel categories and are often temporary. The restriction of fisheries on a spatial basis for environmental purposes is not common, although it may be increasing. Even these however lack permanency, in some cases, and rarely applies to all forms of fishing (Lutchman,2006).

Progress on “nature conservation MPAs” is driven by the obligatory nature of EU legislation for the development of the Natura 2000 network. To date, most progress on the implementation of MPAs for nature conservation is being made inshore and very little offshore. MPAs for nature conservation are more permanent than fisheries MPAs. The Natura 2000 network tends not to be highly restrictive however, being concerned essentially with sustainable use rather than non-use (Lutchman, 2006).

The IUCN Protected Area Management Classification Scheme provides a good basis for drawing discussions on this question together (Table 1). Using the protected area categories that can be readily applied to the marine environment, the different levels of protection that can be provided for through the CFP can be related to different categories of MPA, so different levels of fisheries closure can be considered as MPAs. It is, however, important to recognise that an MPA network that does not include Category 1 fisheries closures is arguably not an effective network. Certainly, it would not be consistent with recommendation 5.22 of the IUCN’s World Congress on Protected Areas, which calls “on the international community as a whole to…. establish by 2012 a global system of effectively managed, representative networks of marine and coastal protected areas… that should be extensive and include strictly protected areas that amount to at least 20-30% of each habitat”. Nor would it be consistent with the growing number of calls for ‘no-take’ MPAs to contribute to marine ecosystem restoration and a precautionary approach to fisheries management .

Key to the discussion on revision of the CFP technical conservation measures is recognition that many of the areas closed on a seasonal basis or to certain gears under the CFP are not considered as MPAs pers se by the Commission (DG Fish pers. comm.).

Table 1. IUCN Categories of Protection matched to CFP requirements

IUCN Categories (marine)	Description	Explanation	CFP-related measures	Scale	Examples
Ia	Strict nature reserve/wilderness protection area managed mainly for science or wilderness protection	An area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring	Complete closure to all fishing gear (as well as all other extractive and disturbing activities regulated by other bodies) to provide for ecosystem restoration or where applicable maintaining naturalness	Reserve has to be large and complete overlap with fishing closure required	
II	National park: protected area managed mainly for ecosystem protection and recreation	Natural area of land and/or sea designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.	Restriction of certain fishing activities not compatible with the management objectives of the national park	National Parks are large, and zoned into areas where different levels of protection/fisheries management regimes apply	
V	Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation or recreation	Area of land, with coast or sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.	Provision for human uses which are in equilibrium with the natural environment, i.e. low impact, traditional and artisanal fishing methods		
VI	Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural resources	Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while also providing a sustainable flow of natural products and services to meet community needs.	Accepting that no marine areas are unmodified, natural systems,		

3.2.4. Do we need Fisheries MPAs?

In the past there were always places that could not be fished because they were too deep, too dangerous, too hard to get to, or the bottom was too rough. Modern technology gives us access to these areas and the amount of sea that is not fished has dwindled. Unfished areas once played a critical role in supporting fisheries. Fisheries MPAs reinstate some of these vital refuges for fish breeding stocks.

3.2.5. How will Fisheries MPAs work?

The successful design and implementation of Fisheries MPAs relies on setting clearly defined objectives and encouraging stakeholder participation in the planning, design and implementation process.

Fisheries MPAs are proposed as a management tool to help in the management of fish stocks for exploitation or possibly as a restoration tool for a fishery that has been over-exploited. They will never, however, be the sole tool for fish stock and fisheries management. Fisheries MPAs (including temporal closures) can also be introduced as a way to manage fishing mortality.

Protected areas are considered to be able to increase the sustainability and stability in a fishery through:

Helping to maintain a predicted and secure level of yield from a fishery
Providing for spillover or larval export that can be considered to be securely linked to natural or broad scale environmental changes but uncoupled from fishery-induced impacts
Providing for unfished reference sites where important parameters for the fishery may be estimated, free from the effects of fishing
Acting as reference sites where benchmark environmental conditions can be established so that the impacts of external factors affecting the fishery and local habitats can be assessed and predicted
Providing a form of insurance against the effects of unexpected problems that may arise from the existing system of stock management.

3.2.6. Can fisheries and conservation MPAs be combined?

In Europe the political commitment to MPAs with nature conservation objectives is fairly well developed with every country in Western Europe having either designated some nature conservation MPAs or developed a process by which nature conservation MPAs will be designated. The majority of governments have not only committed to designating nature conservation MPAs, but have committed to designating *fully representative and effective networks* of nature conservation MPAs and are taking steps towards achieving this. Political commitment to fisheries MPAs is not so well developed despite them being recognised as a tool for fisheries management.

In some cases, nature conservation MPAs *will* provide benefits for fish stocks and for fisheries management such as the protection of nursery and spawning grounds, and decreased fishing mortality, which in turn can lead to spillover effects into the surrounding areas where resources can be fished. Similarly fisheries MPAs have the potential to provide benefits for conservation – healthier stocks which not only support the fishing industry but also the wider ecosystem. In some cases it may be possible to combine objectives for both nature conservation and fish stock management within one site (Figure 2).

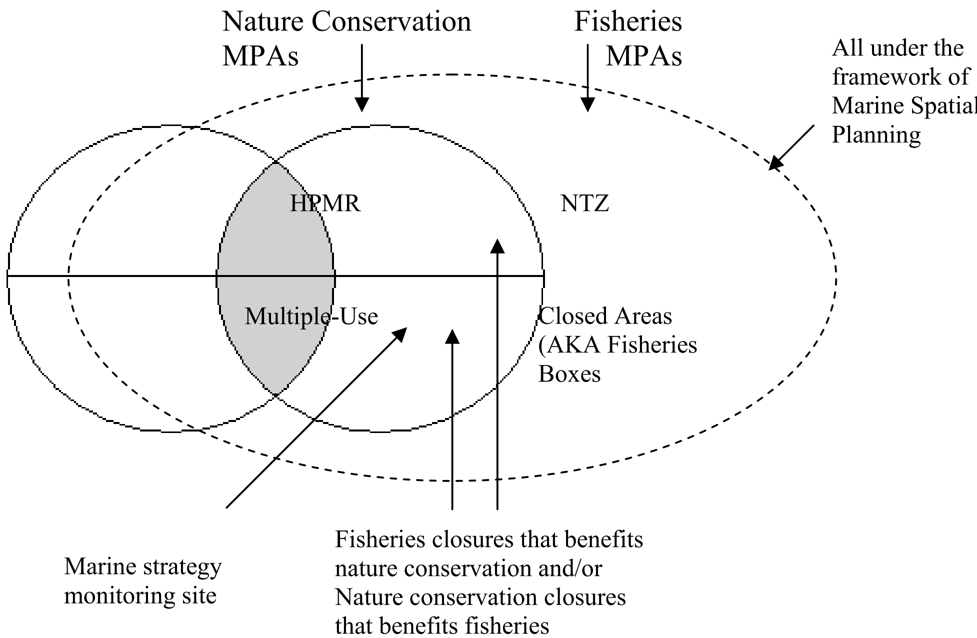

Figure 2. The potential to combine MPAs with different objectives.

3.2.7. Is there an optimal size for MPAs?

The optimal size of marine reserves will depend on conservation needs and goals, quality and amount of critical habitat, efficacy of other management tools, and the particular characteristics of species or biological communities (Gerber et al. 2003). Within a fisheries context the optimal size will be that which brings egg production up to the level that results in adequate stock recruitment. When discussing the optimal size for a fishery MPA, NOAA (1990) suggested that it "should include critical adult habitat and should be sufficiently large to support breeding populations with a stable age structure. Juvenile habitat should be included for species that utilise different habitats as juveniles, especially when juveniles are vulnerable to fishing mortality".

Modelling studies based on the transfer rate between open and closed areas, indicate MPAs ranging in size between 50% and 75% of stock area are necessary to optimise yields (Guénette and Pitcher 1999) and as a hedge against uncertainty (Lauck et al. 1998). Botsford et al. (2001) suggested that persistence of some species requires closing as much as 35% of the species range. The value of 35% is the fraction of lifetime reproduction required for sustainability, as determined in analyses of overfishing.

For highly migratory species, MPAs may not be very effective unless extensive proportions of their range can be closed to fishing (Lauck et al. 1998; Murawski et al. 2000). Less mobile species such as plaice and sole, are more likely to increase in size

and abundance in an MPA than cod or herring, which tend to be twice as mobile (Daan 1993). For sessile or more sedentary species, even small areas are likely to increase survivorship, abundance and mean size. For example within the very small ($3.3km^2$) MPA at Lundy the UK's first statutory no-take zone, after 18 months of closure the numbers of lobsters increased threefold. Lobsters were also on average 6 mm bigger within the MPA when compared to control sites around the island and reference sites in Pembrokeshire (Hoskin et al. 2004). Similarly, $2km^2$ off the southwest coast of the Isle of Man (Irish Sea) has been closed to commercial fishing with mobile gear since 1989. Both the number and size of scallops have increased inside the MPA. The number of individuals above minimum landing size increased to 7 times that of pre-closure levels. There is also indirect evidence for both spillover and larval export from the MPA (Beukers-Stewart 2004).
Almost all existing MPAs are small. Worldwide the median size of MPAs is ~16000ha (Figure 3).

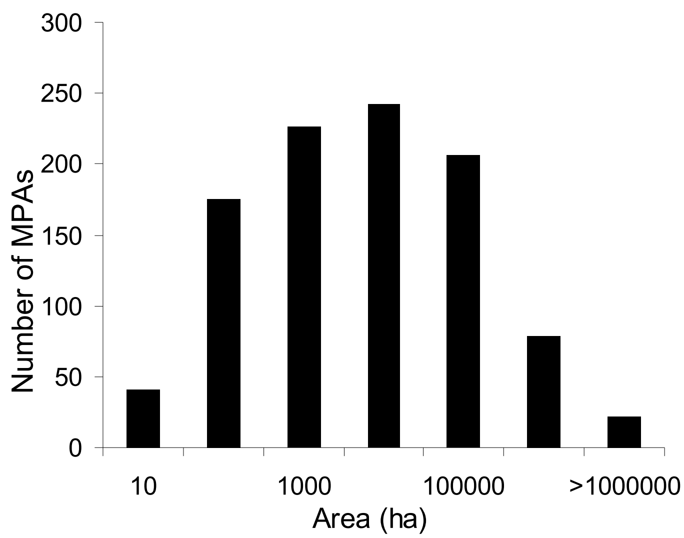

Figure 3. Size distribution of 991 MPAs around the world for which area is known (After Kelleher *et al*. 1995)

3.2.8. The need for No-Take Zones

Along the ecological succession, ecosystems change their productivity and net production. These reach their maximum at intermediate and relatively early successional stages. When ecosystems reach equilibrium with the natural environmental conditions, i.e. successional climax, productivity and net production tends to be very low, as most of the production of the system is reused by the system.

In this framework, the objectives of protection for conservation are related to reach attainment of climax and restoring the natural equilibrium between the various components of the ecosystem. This is characterized by high biodiversity, complex networks and trophic webs, and low productivity.

The objectives of fisheries management, on the otherhand try to enhance productivity to maximum sustainable catch rates. Depending on the life cycle, trophic level and ecological strategy (r vs. K) of the target species, increasing their productivity and abundance would involve keeping the system at a relatively young succession stage. The objective of fishing regulations in fishing closure areas is to maximize the net production of the system therefore preventing the system from reaching climax.

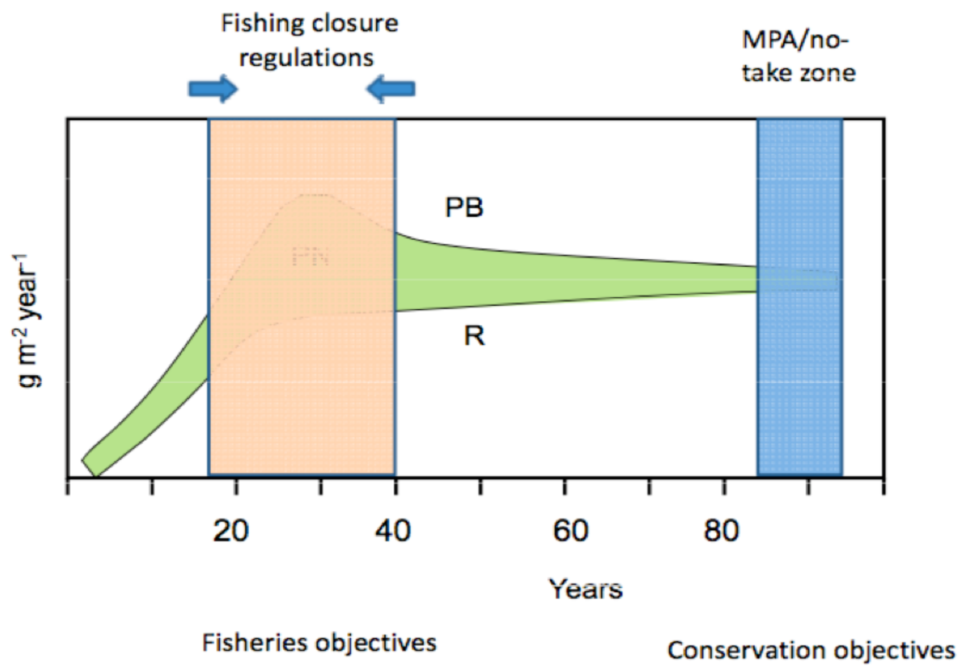

Fig 4. Productivity and net production as a function of successional state demonstrating how fisheries and conservation management regimes favour different points in the successional paradigm.

When the system is overexploited with in this situation the productivity decreases. This is also the outcome if regulatory measures move the system towards climax.

Because of this, ecological as well as fishing indicators are needed to evaluate the effectiveness of fishing restrictions.

The following points illustrate the importance of maintaining no-take areas in

MPAs:

- They are needed as reference points to evaluate the evolution of fishing closures with respect to successional state in a given set of environmental conditions.
- They permit, as controls, the differentiation between natural variability of the system and the effects of regulations.
- They maintain a natural size and age structure in the population and maximize the potential fecundity.
- Finally they maintain the genetic diversity and structure in the populations (Pérez-Ruzafa et al., 2006) that permits natural selection to operate.

The latter two points improve the homeostatic mechanisms of the system and ensure a quicker recovery of the system when it is overexploited.

3.3. Inventories

A preliminary list of areas where fishing restrictions are applied under CFP is listed under Appendix 1a (also available as an excel file - SGECA-07-02_Appendix_1a). These areas are described under the following headings:

Management Area (ICES/Other)
Closure Name
Management Regime
Earliest Legislation
Recent Legislation
Status of closure
Fishing restrictions
Purpose
Measure
First established
Size (km2)

NATURA 2000 sites where regulation of fisheries may require CFP technical measures, i.e. when they occur in waters beyond territorial sea jurisdiction is contained in Appendix (1b) (available as an excel file - SGECA-07-02_Appendix_1b).

An inventory of Mediterranean marine protected areas is contained in Appendix (1c) (available as an excel file - SGECA-07-02_Appendix_1c).

3.3.1 The need for a central GIS linked database

The need for a central database for this type of information has been identified. NATURA 2000 site information is managed by an European Topic Centre who are currently developing GIS tools for easy access to map information (Aguilar, pers.comm. cf. Appendix 2). CEFAS have begun a pilot project to produce a UK database (Large, pers. comm.) that makes use of hyperlinks to provide much of the information contained in our excel database. The Maritime Task Force are also in the process of preparing GIS based maps displaying fishing closures and Natura 2000 sites among others (John Sheppard, pers.comm.).

The provision of accurate GIS shapefiles of closure boundaries would provide opportunities to address overlaps with other fisheries closures and with NATURA 2000 and other conservation iniatives. This would facilitate a more streamlined approach to the use of fishing closures in some areas.

4. OVERVIEW OF EXISTING INFORMATION AND EVALUATIONS

4.1. Introduction

The material overviewed in this section comes primarily from the work done under the aegis of the FP6 Specific Targeted Research Project: *MPAs as a Tool for Ecosystem Conservation and Fisheries Management (*Project No. SSP8-CT-2004-513670). The reviews of the North Sea Plaice Box, the North Sea Cod Box, the Shetland Box, the Norway Pout Box, the Sprat Closed Area Box and Baltic cod fishery closures are drawn from (Sørensen, 2006; Suuronen, 2006; Wright, 2006 in the *PROTECT (2006) Review of MPAs).* The overview of the Irish Cod closure is derived from Kelly et al. 2006.

4.2. Lessons Learned and Recommendations

The detailed reviews are contained in Appendix 3. A summary of lessons learnt and recommendations (where available) is given in Table 2.

Table 2. Summary of closed area effectiveness and recommendations for improvement

Closure	Why established	Lessons Learnt	Recommendations
North Sea Plaice Box	Reduce discards of undersized plaice and sole in nursery grounds	There is no direct evidence that the Plaice box has had a positive effect on recruitment. Since the Plaice box was established in 1989 recruitment has shown a negative trend for the southern North Sea, i.e. SSB (spawning stock biomass) and yields are down by 60%. The effects of discard reduction may have been offset by ecosystem changes in the North Sea ecosystem around the time of the establishment of the Plaice box. A shift in the distribution of juvenile plaice has also been suggested as an explanation. There is no single parameter from which the ecological effect of the box can be measured. The Plaice box management measure was not set up as experimental design, with a control area, that would have allowed statistically sound comparisons and conclusions. Effects of MPA on size structure have been shown, but closure effects are in this case impossible to separate from natural changes. The Plaice box is only a partially closed area: there are still beam trawlers ≤ 300hp, a *Crangon* (shrimp) fleet and otter trawls operating. Data is lacking in many cases on the spatial distribution of fleets. Projected gains in recruitment from the closure where based on unrealistic expectations.	Prohibit all demersal trawling in the area, regardless of gear and engine power. Closure of the whole box to all vessels on a year-round basis would provide greater fisheries benefits (landings and SSB would increase by 24 and 29% respectively) particularly linked to cessation of discarding from allowed fisheries that result in mortalities of many young plaice and sole. Relevant, measurable criteria should be considered/ developed. A research programme should be established to monitor effects over a predetermined time scale. The Plaice box should be established in an experimental setup, which allows for the separation of autonomous developments and the closure (with or without fishing) effects, for example a control area which differs from the treatment area only in terms of fishing intensity.
North Sea Cod Box	Enhancing spawning of cod in the period mid-February to end April 2001 as part of a general cod recovery plan	Closure need not meet objectives. Inappropriate timing and positioning of the area resulted in that no positive effects of the closure were achieved. There was no overall effort reduction during closure, only displacement of fishing effort. The Cod closure was rather poorly designed, did not consider side effects on the level of discarding in demersal stocks, and did not consider the wider ecosystem implications.	

Closure	Why established	Lessons Learnt	Recommendations
Irish Sea Cod Box	The closed area in the Irish Sea was part of a general cod recovery plan	The initial recovery plan, included closed areas to ‘‘allow as many cod as possible to spawn’’ as part of the plan to rebuild the stock. However the relationship between reproductive potential and recruitment is far from assured. Even the link between reproductive potential and SSB is subject to interannual fluctuation through egg viability. The forward link to recruitment is additionally thought to be subject to factors influencing the survival and growth of larvae and juveniles, including temperature, primary production, and predation. Given the complexity of this relationship, protecting spawning offers only a tentative probability of increased recruitment. Even if the closed areas did effect 100% protection of spawning cod, the benefit to the stock in terms of recovery would be subject to the prevailing environmental and ecological conditions (and, of course, the exploitation rate). Such a measure to protect spawning to increase recruitment would therefore seem at best passive, and at worst ineffective. Even closed nursery areas have been hard to evaluate, and results are not unequivocally positive. Even with complete exclusion of all fishing fleets, a closed area alone may not be enough to reduce exploitation of a population if there is significant movement of the fish stock between the closed area and the fishery. The lack of an appreciation of risk associated with a management strategy has contributed to further difficulties with the cod recovery plan. These difficulties were manifested in the frustration of fishers and managers at how long the recovery process was going to take. Other contributors to this frustration were poor communication of the inherent uncertainty and likely probability of success, and the lack of clarity in the purpose of the recovery plan. These frustrations were amplified when the stock did not appear to ‘‘follow the plan’’ as originally envisaged, or worse still, it could not be shown if the plan was working.	Cod are capable of moving large distances so it is unlikely that a closed area on its own will be sufficient to protect the stock, and any recovery plan would need to include further effort or TAC restrictions as well. Clear purpose which effectively communicates that the instrument of recovery is the reduction in exploitation, and how this is to be achieved. Clear understanding that this will require a reduction in fishing opportunities, and a consideration of the fleet-specific reduction in revenue of such reduced exploitation. Clear means as to how this reduction will be adhered to. A multi-species harvest plan to manage the stock when (or if) recovery is achieved. Clear, measurable performance targets, underpinned by sufficient data collection to assess performance of recovery, and an understanding of the inherent uncertainty involved.

Closure	Why established	Lessons Learnt	Recommendations
Shetland Box	To protect "species of special importance…which are biologically sensitive by reason of their exploitation characteristics	It seems unlikely that the management regime for the box has ever effectively restricted the level of fishing effort. There is no evidence of unsatisfied demand for licences or for access to the Box. Vast majority of vessels are too small to require a license in any case. Value of the Shetland Box to Shetland itself is largely, if not entirely, symbolic. Not to say that it is not an important area in biological conservation terms or as a potential conservation tool (NAFC 2004). Key interviewed informants of the Shetland Islands can be said to have the following points of view, among others: diminished capacity of the centre to exert control; marginalisation of local knowledge/views; inadequate penalising of rule breakers No system was ever established to monitor the Shetland Box or to collect the data that would be needed to demonstrate its effectiveness.	
Norway Pout Box	Reduce levels of fishing mortality on juvenile gadoids such as haddock and whiting in the Norway pout fishery, and hence increase the recruitment of these species to the stock biomass for sustainability and for future fisheries	Since the establishment of the Norway pout box no studies have been carried out on either the effects of more selective fisheries technology and changed fleet behaviour, or does the data exist that enables an evaluation of the Box and an analysis of the consequences of a partial or total reopening of the Box.	
Sprat Closed Area Box	Reduce mortality of juvenile (0-group) herring (*Clupea harengus*). Establishment of Sprat Box was expected to lead to a significant decrease in the levels of by-catch of juvenile (especially 0-group) herring in the entire ICES IVb-area.	In order to study the effects of the Box, we need more knowledge on the distribution of juvenile herring in the North Sea as well as better analyses of the composition of catches in industrial fisheries.	

Closure	Why established	Lessons Learnt	Recommendations
Baltic Sea Cod Closure	Part of a multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks.	The poor status of the cod stock suggests that the present management regime is incapable of facilitating stock recovery. There is a need for more effective management tools, closures (or MPAs) being one obvious candidate. Studies have shown that the closed area for fishing in the Bornholm Basin during main spawning periods 1995-2003 did not necessarily ensure undisturbed spawning in all years although the position of the closure in the centre of the basin was adequate. Closure of the area in May might in some cases be too late, as pre-spawning concentrations of cod will gather earlier, increasing the catchability of cod in spring months in both the targeting fishery and as by-catch in the pelagic fishery.	To be effective in reducing the overall fishing mortality on cod, closure(s) should be designed taking into account the distribution and migration patterns of cod as well as the adaptive responses of fishing fleets. Baltic cod use separate locations and habitats for spawning, larval development, juvenile and adult feeding. Such complex life history requires a successful temporal and spatial linkage between these locations to integrate the whole life-cycle and produce abundant generations.

4.2.1 Lessons Learnt

A summary of some of the salient lessons learnt are given in Table 2 for each closure.

In all cases, it is difficult to ascertain the true effectiveness of the closed area due to, inter alia:

i) Poor MPA design based on flawed or over simplistic assumptions (i.e. stochastic variability in fish behaviour and environmental forcing) resulting in inappropriate timing and positioning of closures.
ii) MPAs were not designed to facilitate monitoring and collection of the data that would be needed to demonstrate effectiveness of the closure. This resulted in a lack of clear road map to recovery leading to frustration for stakeholders.
iii) Derogations for some fishing gears did not take into account discarding effects and wider ecosystem implications.
iv) Socio-economic interests were allowed to weaken conservation policy so that closures had little chance of success, and in some cases, restrictions were not properly enforced.
v) Necessary social-flanking measures to discourage displacement of fishing effort following restrictions were not implemented.

4.2.2. Recommendations for improving the current situation

Improved management and monitoring of fisheries closures requires, inter alia (Kelly et al,. 2006):

i) The development of clear, measurable performance targets, underpinned by sufficient data collection to assess performance of recovery, and an understanding of the inherent uncertainty involved.
ii) Clear statement of purpose that effectively communicates that the instrument of recovery is the reduction in exploitation, and how this is to be achieved.
iii) Clear understanding that there will be a reduction in fishing opportunities, and that fleet-specific reduction in revenue of such reduced exploitation most be addressed.
iv) For mobile species, closure(s) should be designed taking into account the distribution and migration patterns of the fish as well as the adaptive responses of fishing fleets.
v) Closures are only one tool for fisheries management, therefore, particularly for mobile species, additional effort control or TAC restrictions will be required.
vi) The choice of one large closed area is not always the best solution. A network of smaller closures may protect fish over more of their range. Closed areas must also be small enough to facilitate spill-over.
vii) A multi-species harvest plan to manage the stock when (or if) recovery is achieved.

4.2.3. Recommendations for improved assessment of the effectiveness of closures

Current knowledge regarding MPA management is rapidly evolving (cf. PROTECT, EMPAFISH and EMPAS projects; presentations and discussion at the 2007 European Symposium on Marine Protected Areas in Murcia, for example). The move towards an ecosystem approach to fisheries within the Common Fisheries Policy together with the revision of technical conservation measures suggests that this is an optimum time to modernize our approach to the utilization of fisheries closures in fisheries management particularly in design, management and monitoring.

Therefore we would suggest that serious consideration be given to suppressing existing fisheries closures that have been established without clear monitoring protocols to evaluate their effectiveness. We would recommend that they are replaced with new regulations that incorporate carefully designed closures applying the recommendations listed above particularly with regards to the monitoring of carefully choosen performance indicators to facilitate review and future adaptive management.

4.2.4. Global considerations

WWF advocates, among others, the establishment of a comprehensive network of fisheries MPAs in the Northeast Atlantic. Such networks should include Fisheries MPAs encompassing restrictions that can be permanent/non-permanent, gear type specific, fish species specific, vessel type/size specific and in some cases will overlap with a network of MPAs with nature conservation objectives. In Australia, the government recently declared a network of no-fishing zones in the Great Barrier Reef National Park.

Evidence suggests that benefits to mobile fish species is more likely to be associated with MPAs in areas associated with critical life stages, such as nursery areas, recruitment grounds or spawning grounds. Further work is required to identify the potential benefits of MPAs for commercial fisheries. Some work has been carried out in the Mediterranean (see 5.1.1.4 below) while WWF-UK is commissioning a study on this topic that should report in Spring 2008.

5. DATA REQUIREMENTS TO PRODUCE NEW/SUPPLEMENTARY EVALUATIONS

5.1. Baseline and monitoring requirements

5.1.1. Data Collection issues

5.1.1.1. Fisheries management requirements for German Natura 2000 sites

In May 2004, Germany nominated ten Natura 2000 sites in its Exclusive Economical Zones (EEZ) of the North Sea and the Baltic Sea to the EU Commission. Germany is the first EU Member State with a comprehensive set of marine Natura 2000 nominations, accounting for approx. 31% of its EEZ (Krause *et al.*, 2006). Including current nominations within its territorial seas, approx. 38% of Germany's total marine area is covered by Natura 2000 sites. Two SPAs, one in the North Sea and one in the Baltic Sea achieved in September 2005 the national legal status of a nature reserve, IUCN category IV (von Nordheim *et al*., 2006).

In February 2006 a research and development project *Environmentally Sound Fishery Management in Protected Areas* [EMPAS] was initiated by ICES and the Federal Agency for Nature Conservation (BfN). The EMPAS project aimed at developing fisheries management plans for each of ten Natura 2000 sites (MPAs) designated in the German EEZ of the North Sea and Baltic Sea. EMPAS is designed to serve as a pilot project and to provide guidance on developing the necessary management plans for fishing activities in all Natura 2000 sites designated under the Birds and Habitat Directive (ICES, 2006; ICES, 2007).

By analysing all fishing activities of all the fleets operating in (and adjacent to) Natura 2000 sites, the EMPAS project will provide guidance on lack of data about fishing activities in order to assess the potential destructive effects on species and habitats. After analyses and assessments of fisheries activities in and around Natura 2000 sites, a concept for managing fisheries in marine protected areas will be developed.
The main tasks of the project are:

- Documentation of the fine-scale spatial and temporal distribution of current and recent past fishing activities in and around the German Natura 2000 sites;
- Investigation of the effects of fishing activities on habitats and species;
- Identification of possible conflicts between fisheries and nature conservation targets;
- Development of fisheries management plans for each Natura 2000 site.

The first workshop in the project, Workshop on Fisheries Management in Marine Protected Areas (WKFMMPA), was held in 3-5 April 2006 (ICES, 2006). The workshop identified the need for detailed information about fishing activities in and around the ten designated Natura 2000 sites in the German EEZ, with fishing fleets and fishery described for each country individually. Answers should be given to questions such as:

- In which parts of the protected areas do the vessels fish?
- Which vessel types are deployed (e.g. size)?
- What gear types are used by the vessels?
- How big is the fishing effort?
- When does the fishery take place (e.g. monthly distribution of fishing effort over the year)?
- Which species and how much is caught by the fleets?
- What is the consistency in fishery over years/interannual variation?
- What are the bycatch rates of marine mammals and seabirds?

The available data and information must be obtained from fishing ministries/research institutes and the fishing industry/fishers. To manage the fisheries according to the nature conservation objectives information at a finer resolution than the present data aggregated at ICES rectangle levels is needed. More detailed information on fishing efforts and impacts needs to be collected in cooperation with the national research institutions, fisheries organizations, and the fishers. Logbook data together with the so called VMS data are the most appropriate existing data for the investigation of potential conflicts between fisheries and nature conservation objectives. Currently, to access these data for purposes other than the ones originally intended (monitoring, control, and surveillance), some countries require written permission from each individual fisher before the data are released for analysis by the EMPAS project.
The year of the EMPAS project has shown that it is difficult and a slow process to get access to the needed spatial and temporal detailed data and information about the fisheries in the designated Natura 2000 sites. Even though detailed fisheries data and information exists (VMS, logbooks, and national fisheries observer/research/sampling programs) this data and information are in a number Members States not available for national research scientist and the EMPAS project. Access to fine-scale spatial fisheries

data for scientific projects like the EMPAS project should be supported by the EC data policy. The anonymity of fishers should be secured; however, it should be possible to perform an analysis of fine-scale spatial fisheries data without restrictions and in cooperation with the fishers (fishers' representatives).

5.1.1.2. Evaluation of the deep-water closures of the Faraday, Hekate, Antialtair, Altair seamounts and the area on the Southern Reykjanes Ridge.

On 1 January 2005 NEAFC created the first high seas fisheries closures in the Atlantic Ocean, prohibiting bottom trawling and the use of static gear (including bottom gillnets and longlines) fishing on part of Reykjanes Ridge and on mid-Atlantic seamounts called Hecate, Faraday, Altair and Antialtair in response to a proposal from the Norwegian Government (NEAFC, 2004). This measure is in force until 31st December 2007 to protect vulnerable deep-sea habitats.

In 2005, the NEAFC Commission requested ICES to evaluate these closures. Two ICES groups provided expert input to this evaluation: Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP) and Working Group on Deep-water Ecology (WGDEC).

In 2006, WGDEEP only received catch and effort data at a spatial scale of ICES Sub-areas and Divisions and this was of insufficient spatial resolution to evaluate the effects of these area closures. The MAR-ECO project (www.mar-eco.no) visited some of the locations selected for closure, but this was in 2004 before the areas were closed. The sampling effort was also too limited in each site to be useful as a reference and for monitoring.

WGDEC in 2006, although provided with VMS data, was also unable to carry out a useful evaluation because the VMS data were not accompanied by information on what type of vessels visited the areas and what gears were used. Also, the data available did not indicate the type of vessel activity (steaming or fishing) associated with each record.

Marchal *et al*. (2006), using filters to detect fishing activity from VMS records of vessel speed and changes in vessel direction, were able to map fishing activity by demersal trawlers in and around the NEAFC closed areas on the Mid-Atlantic Ridge. The results indicated that fishing activity within the closed areas was low before and after the closures in 2005. However, these results should be interpreted with caution because less than 50% of VMS records was accompanied by information on the fishing gear used and of these trawlers represented 70%. Methods to detect fishing activity from VMS records have not yet been developed for vessels deploying static gear, so fishing activity by longliners and netters could not be evaluated.

WGDEC in 2007 plotted fishing activity on these closed areas for 2004 and 2005 using the same data available to Marchal *et al*. (2006) and therefore with the same limitations (Figure 5). VMS data were filtered to show only fishing vessels moving at bottom trawling speed (1.5 – 4.5 knots, subsequently called 'fishing effort'). Note that this category may include vessels travelling at these speeds, but not bottom trawling. In 2004, fishing effort was recorded to a small extent in the areas on Reyjanes Ridge, Faraday, and Antialtair, more frequently above Hekate and not at all above Altair seamount (Figure 5). When the closures came into effect in 2005, no bottom fishing effort was observed during the entire year over the closed area at Reykjanes and Hekate seamount. However, fishing effort apparently increased at Faraday and Antialtair seamounts, showing a clear targeting of the two seamounts. While no fishing took place at Altair in 2004, after the closure in 2005 fishing effort could be observed above one of the protected seamounts.

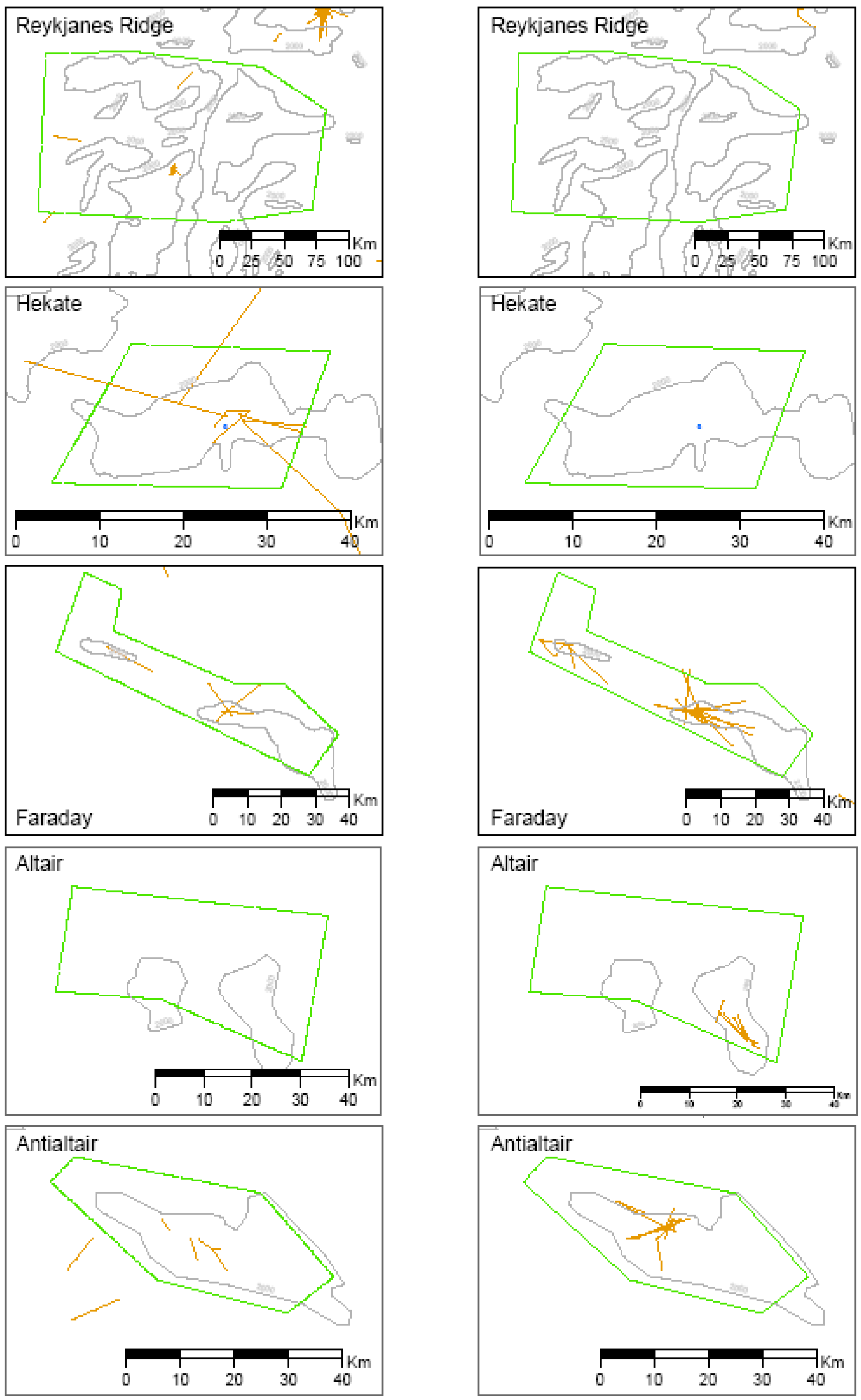

Figure 5. Fishing activity calculated using VMS data from 2004 (left) and 2005 (right) for the NEAFC high seas closures that came into place 1 January 2005.
5.1.1.3. Mediterranean Spillover Studies

According to the information available at the meeting, there are a few studies concerning the spillover effects of closed areas and MPAs in the Mediterranean and the Black Sea. In particular there has been a EU collaborative project directed to assessing biomass export of littoral species from six Western Mediterranean MPAs (Banyuls, Carry, Medes, Tabarca, Cabrera and Cabo de Palos) (BIOMEX Final Report: www.univ_perpig.fr/biomex). This study assessed gradients of biomass, experimental catches and commercial fishery catch and efforts around these MPAs and results indicate increased abundance and mean size of target species inside MPAs and decreasing gradients of density and yields from MPA boundaries for commercial fish species of reduced to moderate mobility (e.g. Sparids, Mullids) and spiny lobster (Palinrus elephas). The study also showed commercial effort concentration along MPA boundaries. The geographic scale of export effects was of 800 to 2500 m depending on the species. Spillover of P. elephas was also assessed from commercial fishery and tag-recapture data in the Columbretes Islands MPA demonstrating spillover effects extending up to 1500 m from the MPA boundary (Goni et al., 2006). Anecdotic information concerns mostly the higher presence of groupers (*Epinephelus marginatus*) in the area nearest to some protected sites (Lavezzi, Islas Medas, etc.), where the presence of this species was reported to be increasing.

A recent and still incomplete on-going study is carried out in five Italian MPAs to assess a possible spillover. According to the preliminary results (Molinari, Bava & Tunesi, 2005) from the MPA in Portofino (Ligurian Sea), it appears evident a spill-over concerning at least some species of Sparidae and the grouper. According to this preliminary report, the fishery yields for these species are higher within the MPA and in some surroundings areas, compared to other nearest area where the fishing activity on this species was not regulated like inside the MPA. This is almost expected in most of the coastal MPAs in the Mediterranean, where a no-take zone is enforced and whenever a regulated fishing activity is adopted within the MPA. Nectonic species, and particularly those having a short range distribution, might logically take advantage of well-enforced and patrolled MPAs, and this is specially true when other fishery management measures exists even outside the MPA. It is quite difficult to assess the combined effects of MPAs, other fishery management regulation, natural cycles and the natural ecosystem dynamics and how one single component (a MPA or a closed area) can affect the fishery yields. Another recent study (Bava *et al*., 2006) is available for the same MPA of Portofino, but the results concerning the fishing activity within the MPA and in the nearest coastal areas do not show any visible or remarkable effect on fish yields. At the same time, this report mention an undefined increasing of fishing activity (that we suspect is mostly related to recreational fishermen and small scale fishermen) within the zone covered by the MPA.

In conclusion, experience in the Mediterranean shows that when effective enforcement exists (i.e. control activities, clear rules and boundaries, etc.), together with specific monitoring studies, then it is possible to observe benefits for restocking and conservation. It is important to note that comprehensive investigations have been carried out only in a limited number of places where fisheries are strictly regulated or banned. There are, nevertheless, many studies that demonstrate an increase of biomass or abundance of conserved species.

5.1.1.4. Identification of essential fish habitat

A first attempt to define and locate essential fish habitats in the Mediterranean was done by an STECF working group in 2006 (STECF/SGMED-06-01). Most of the report deals with fish species and areas which are important in some basic biological life-stages, namely areas where juveniles are usually present or where spawning happens. This preliminary work can be used to define more precise strategies for a better management of some fish stocks within the CFP and in agreement with the GFCM.

5.1.2. Recommendations for Data Collection

5.1.2.1. Integrating fisheries/ecosystem data collection for evaluations

Fisheries closure evaluations should include indicators of ecosystem well being as well as fish and fisheries indicators. This is consistent with the EU's legal requirement under the new CFP to implement the ecosystem-based approach to fisheries.

The type of ecosystem indicator to employ will depend on the specific sites and therefore will have to be identified on a case-by-case basis.

The PROTECT project in it's review (Pinnegar & Bell in PROTECT, 2006) pointed to the need to identify measurable indicators and success criteria (cf. 5.1.2.2. below) to allow evaluation of the performance of closures including the adoption of Before–After Control-Impact (BACI) montoring strategies.

5.1.2.2. Developing Success Criteria for Monitoring

This section draws on the PROTECT review (Pinnegar & Bell, 2006) contained in full in Appendix 4.

Some of the key questions that should be addressed through monitoring include: (1) Does the MPA regime meet its goals and why or why not? (2) Have there been unanticipated consequences? (3) Are the size and location of closed areas optimal?

To achieve these goals, specific and measurable objectives must be defined in terms of what outputs and outcomes are being sought. This in-turn requires that well-defined management plans be developed, <u>measures of MPA success be identified and defined in advance</u>, impacts of management actions be monitored and evaluated, and that the results of these activities be fed back into the planning process to revise objectives, plans and outcomes (Pomeroy et al. 2004), i.e. 'adaptive management'.

The process of goal setting is closely linked to stakeholder expectations, MPA design, and the establishment of criteria to evaluate the progress made in meeting those objectives (Agardy, 2000). If goals are not well articulated, it is difficult to define criteria to measure progress or to identify and quantify the indicators of progress (Kay & Alder, 1999). A useful way to clearly organise monitoring requirements is through the development of GOIS (Goals, Objectives, Indicators and Success Criteria) tables where:

A ‘goal’ is a broad statement of what the MPA is ultimately trying to achieve, i.e. why was the MPA created and what are the main aspirations

An ‘objective’ is a more specific measurable statement of what must be accomplished by management to attain the related goal.

An ‘indicator’ is a quantifiable attribute of the system in question that is simple etc

The 'success criteria’ is the threshold above which an indicator value demonstrates positive status for the system attribute being measured.

An example of the development of GOIS table to access generic management requirements for cold-water corals is given in Appendix 5. This approach could be adopted by SGMOS-07-03. For each closed area under evaluation a hypothetical monitoring programme with appropriate indicators and thresholds could be devised using the GOIS table approach. The GOIS table could then be used to benchmark the availability and suitability of monitoring data for each closure and to identify gaps where new data collection is required for effective closure evaluation.

In identifying indicators to access the effect of the implementation of an MPA on species (including fish), habitats and ecosystems the following should be borne in mind:

i) Direct and indirect effect of fisheries on species, habitats and ecosystem to be protected; direct effects could be catch or habitat destruction, while indirect effects could be changes in genetic diversity of the target species by selective fishing and changes in the food web by targeting specific predator or prey species,

ii) Passive and active exchanges processes between protected and unprotected areas, not only of species and their life stages to be protected or targeted by the fishery, but important predator and prey species as well, and

iii) Variability in dynamics of species, habitats and ecosystems to be protected caused by natural and other anthropogenic disturbances; this includes the effect of climate change, habitat destruction through construction activity, eutrophication and contamination.

iv) Understanding scale effects is essential. The need to understand the relationship between the area over which a population is operating compared with the size of the MPA is paramount. Understanding stochastic variability both in environmental forcing and fish behaviour is important when comparing observed changes in indicator values.

However, the analysis of the effects of any MPA is likely to require certain fundamental knowledge of fisheries and ecosystems independent of the specific case.

An indicator measures the success of a management action, such as the specific design of an MPA. It is a unit of information measured over time that will make it possible to document changes in specific attributes of the MPA (Pomeroy et al. 2004). General considerations in selecting or designing an indicator include:

• Measurable - able to be recorded and analyzed in quantitative or qualitative terms.
• Precise - clear meaning, with any differences in meaning well understood or measured the same way by different people.
• Consistent - not changing over time, but always measuring the same thing.
• Sensitive - changing proportionately in response to actual changes in the variables measured, and not sensitive to other variables.
• Simple - rather than complex.
• Independence defined - correlation with other indicators examined.

In selecting indicators, a monitoring and evaluation plan for an MPA or portion of the MPA network should (Pomeroy et al. 2004):

- Define and provide a brief description of the indicator;
- Explain the purpose and rationale for measuring the indicator;
- Consider difficulty and utility—that is, how difficult it is to measure and the relative usefulness of information provided by the indicator;
- Evaluate the required resources including people, equipment, and funding;
- Chose cost effective indicators;
- Specify the method and approach to collecting, analyzing, and presenting information on the indicator, including sample size, and spatial and temporal variation;
- Identify reference points or benchmarks against which results will be measured and timelines within which changes are expected;
- Explain how results from measuring the indicator can be used to better understand and adaptively manage the MPA;
- Provide references on methods and previous uses of the indicator.

Prior knowledge of the variability in the indicators selected should be incorporated into the monitoring and evaluation design where possible. If no prior knowledge exists variation in indicators must be identified within the monitoring and evaluation program. Multiple independent indicators are required for complex systems such as in the marine environment. Consideration should also be given to the timescale within which changes in an indicator might reasonably be expected. For instance, recovery of populations of long-lived species, such as some rockfishes, may require many years; performance measures or other types of benchmarks for such indicators should reflect this longer timescale.

A useful general MPA evaluation tool is the IUCN self-assessment checklist for building networks of MPAs. It is based on best practice and is designed to enable those engaged in designing or managing MPA networks to determine progress towards effective MPA networks. A copy of the checklist is contained in Appendix 6 and can be downloaded at http://www.iucn.org/themes/wcpa/biome/marine/checklist.html).

5.2. Other considerations

5.2.1. Indirect trophic effects

Fishing may have both direct and indirect effects on benthic community structure (Jennings & Kaiser 1998). The initiation of fishing or harvesting in an unfished system leads to serious reductions in the abundance of target stocks, however indirect effects of fishing can be even more consequential because many fishing gears lead to direct degradation of benthic habitats by physically removing emergent sessile organisms that provide a critical structural habitat, important in recruitment and prey protection (Jennings & Kaiser 1998). Fishery removals may have indirect trophic (food web) implications. Several authors have attempted to review 'trophic cascades' in marine ecosystems, and the possible indirect consequences of designating marine protected areas (MPAs) (e.g. Pinnegar et al. 2000).

Most evidence for indirect trophic effects comes from coral reef and hard-bottom systems (including those in the Mediterranean), however strong evidence exists also for 'trophic cascade' effects associated with fisheries in kelp forests. There is comparatively little empirical evidence for trophic cascade effects among soft bottom communities. Fishery-target fish populations may recover in terms of numerical abundance and biomass after a cessation of fishing activities (Saeger 1981; Yamasaki & Kuwahara 1989; Pipitone *et al*. 2000), but there has been little regard for potential indirect effects on prey species. Caging experiments in soft bottom communities have showed that the exclusion of predators generally results in large increases in density and diversity of infaunal species (Virnstein 1977). However, because trawls and dredges may inflict considerable physical damage on infauna populations (Kaiser & Spencer 1996; Kaiser & Spencer 1996b; Prena *et al*. 1999), the effects of predation and thus observation of any potential trophic cascades may be obscured (see review by Jennings & Kaiser 1998); populations may even show increases in numerical abundance and biomass after cessation of trawling, despite increases in their predators.

Some of the strongest circumstantial evidence for trophic cascades in the western-north Atlantic, exists for the Gulf of Maine (e.g. Steneck 1997). In the 1930s, otter trawls and other technological improvements allowed for the efficient harvesting of coastal spawning stocks, and by the end of the 1940s, inshore groundfish stocks were already becoming heavily depleted (Steneck 1997). This rapid decline in stocks (as evinced by changes in the aereal extent of fishing grounds, cod landings and substantial reduction in the average size of fish caught) continued throughout the remainder of the century, such that today, large predatory finfish are functionally absent from regions of the Gulf of Maine (Steneck 1997). This loss of the top trophic level is thought to have fundamentally altered food webs and the fish assemblage (and consequently the catch) is now dominated by small-bodied and commercially less important species such as sculpins, dogfish and skate. Such changes are also thought to have been responsible for significant changes in the abundance of benthic invertebrates in coastal zones, with lobsters, crabs and sea urchins all becoming more abundant (Steneck 1997).

In the North-east Atlantic there has been much discussion about consumer species which may have become dominant (or more abundant) as a result of removal of predators and/or competitors. Attention has focussed on grey gurnards *Eutrigla gurnadus* and lesser spotted dogfish, both of which are species that have increased in abundance.

Neither species are a major target species for any fishery, and both survive being caught and discarded. In addition, it is thought that these species may benefit by feeding on benthos damaged by trawl gears or dead animals, discarded from fishing boats. Several authors (e.g. Pinnegar et al 2003; Farina et al. 1997) have noted an increase in the relative and absolute abundance of non-commercial vs. commercial species in the north-east Atlantic. There is also evidence that small fish have increased in abundance in real-terms, whereas traditional fishery larger target species have become more scarce (Blanchard et al 2005; Trenkel et al 2004).

Multispecies modelling in the North Sea has highlighted the inter-connectedness of many commercial species and that it may be impossible to 'recover' all species (or maintain them at MSY) simultaneously. For example, recent analyses have shown that a recovery of cod populations in the North Sea may imply a long-term decline in sandeel and Norway Pout populations in the future, since these species are a major prey items for cod. Thus the designation of an MPA in EU waters may result in unintended consequences for other components of the ecosystem, which are often very difficult to predict beforehand.

Many populations of scavenging animals are thought to have been maintained at artificially high levels because of current fishing and discarding practices. Consequently any changes in fishing, such as the imposition of an MPA or an ending of all discarding, will likely have implications for other components of the ecosystem. In the North Sea there has been a marked increase in the abundance of certain seabird species since the 1950s, in particular species such as Fulmar and Great Skua which are known to feed heavily on fishery discards. Fulamar were virtually absent from the North Sea before 1940, but now there are in excess of 300,000 breeding individuals. Any change in fishery discarding practices is likely to impact fulmar population numbers, and these are considered as an indicator of ecosystem health (EcoQO) under the OSPAR direvective. Recent changes in discarding practices around the Shetland Isles is thought to have resulted in Great Skua, changing their feeding habits to predate on seabird (in particular Kittewake) chicks, thereby having wide-scale impacts on the whole seabird community.

Work concerning possible trophic cascades in the Mediterranean has a relatively short history, but comprises some of the most comprehensive data of any littoral system. It has been suggested that the increased prevalence of barrens of bare substrate and coralline algae in many parts of the western Mediterranean may be one symptom of this long-standing intensive use of the littoral (Sala 1998a). Many studies in the Mediterranean rocky littoral have demonstrated that large piscivorous and invertebrate-feeding fish are more abundant within MPAs compared to sites outside (e.g. Bell 1983; Francour 1994; Harmelin *et al.* 1995) and this is often particularly so for the sparid fishes *Diplodus sargus* and *D. vulgaris* (Bell 1983; Harmelin *et al.* 1995). These *Diplodus* species have been implicated (Sala 1997b) as major predators of adult sea urchins (particularly *Paracentrotus lividus*). When at high densities, such as is the case outside MPAs, sea urchins have been shown to remove large erect algae and induce the formation of coralline barrens (Lawrence 1975; Verlaque 1987). Transition form coralline barrens back to erect algal assemblages is possible when sea urchins are eliminated or their populations are strongly reduced as has been shown by both experimental and natural removal (e.g. Kempf 1962; Nédélec 1982). Mediterranean rocky-sublittoral assemblages have been considered to exist in one of two states, namely (1) an overgrazed community with high abundance of sea urchins and low algal biomass and (2) a 'developed' community with an abundance of fish and dominance by fleshy algae (McClanahan & Sala 1997).

Other circumstantial evidence for fish-mediated trophic cascade effects in the Mediterranean rocky littoral includes the work of Boudouresque *et al*. (1992) in Corsica. Conspiciously lower abundance and species richness of macrozoobenthos (mostly echinoderms and molluscs) were observed within the Scandola MPA (Boudouresque *et al*. 1992), compared to sites outside, where the abundance, biomass and diversity of predatory fishes were greatly reduced (Francour 1994). Similarly, within the integral (core) zone of the Ustica MPA (Italy), it was noted (Badalamenti *et al*. 1999; Chemello *et al*. 1999, Milazzo *et al.* in press) that during the spring, abundance and species richness of polychaetes (at 1-15m depth) and gastropods (1-15m depth) were significantly higher than at sites where fishing was allowed. This coincided with an observed decrease in the abundance of the small-sized microcarnivorous fish species (e.g. blenniids, gobiids, tripterygiids and juveniles of several taxonomic groups) and in the same area, an increase of piscivorous and macrocarnivorous fish abundance (e.g. groupers) (Vacchi *et al*. 1998, LaMesa & Vacchi 1999). Macpherson (1994) also observed fewer species and much lower abundances of blenniids inside the Medes Marine Reserve (Spain) compared to sites outside, where potential predators were less abundant.

5.2.2. Comments on the Non-Paper addressing replacement of EC Regulation 850/98

Fisheries closed areas should consider a wider range of goals than simply the protection of juvenile concentrations or spawning areas. The maintenance of ecological processes or habitats is also important to ensure that carrying capacity is not also diminished.

It is important to establish baseline studies for each closed area considering the particular and the general goals of the protection intended by the regulations. Furthermore when a regulation is complex with derogations for certain gears, differentiating the effect of the closure could be difficult. Targetted experiments may be required to improve evaluations.

Most of the areas considered are large with a wide range of depths. In many cases, National and Regional governments could have difficulties to carry out necessary monitoring. It may be necessary to consider a Community approach to ensure adequate infrastructure and funding is available to perform baseline and monitoring. As more than one closure can have the same goals, there should be scope to standardize some of the baseline and evaluation studies methodologies thus promoting inter-calibrations and comparisons between areas.

5.2.3. Integration of fisheries closures and conservation objectives

5.2.3.1. Examples of conservation boxes in CFP
With the approval of the revised Common Fisheries Policy of the European Union (Council Regulation 2371/2002), EC fishing vessels shall have equal access to waters and resources in all Community waters other than those waters up to 12 nautical miles from baselines under countries jurisdiction (territorial waters). This means that any EC vessel can fish within the 200 nm exclusion economic zone (EEZ) of a specific country, with the exception of the territorial waters.

For the protection of the sensitive biological situation of the waters around the Azores, Madeira and the Canary Islands and the preservation of the local economy of these islands, the EC adopted some protective measures, mainly by establishing a protection box of 100nm miles around these islands (Council Regulation 1954/2003). Further to this regulation the EC agreed that highly sensitive deepwater habitats host important and highly diverse biological communities and are considered to require priority protection. Examples of these sensitive habitats are deep-water coral reefs that have recently been included in a list of endangered habitats in the framework of the Convention for the Protection of the Marine Environment of the North-East Atlantic ('OSPAR Convention'). The protection of these areas from the adverse impact of fishing is entirely consistent with, and required, under the UN Fish Stocks Agreement, in particular the provisions requiring the application of the precautionary approach and the protection of biodiversity in the marine environment. The EC found appropriate to prohibit the use of fishing gear likely to cause damage to habitats in areas where these are still in a favourable conservation status and thus published the Council Regulation 1568/2005 where vessels shall be prohibited from using any gillnet, entangling net or trammel net at depths greater than 200 metres and any bottom trawl or similar towed nets operating in contact with the bottom of the sea in a box around the Azores, and in another box around Madeira and Canary Islands.

These two recent regulations created different boxes aimed at the conservation of sensitive habitats: the 100 nm miles boxes and the no-trawling boxes around the archipelagos of Azores, Madeira and Canarias.

Another example of a conservation box under the CFP is the Sandeel box intended as a temporary measure to provide food for kittiwake seagulls (Council Regulation 51/2006). This measure is clearly aimed at the conservation of a non-commercially important species and not the whole ecosystem.

5.2.3.2. Examples of conservation boxes under the EU Habitat's Directive

One example of a NATURA 2000 conservation box is the Formigas bank in the Azores EEZ. Due to its remoteness and conservation background, the bank is still one of the best examples in the Azores representing a set of species, habitats and ecological processes in Macaronesia. However, some easily available resources such as limpets are currently overexploited and are in need of restoration measures. The same probably applies to some commercial demersal fish although no monitoring data are available. In this case the precautionary approach was applied and the MPA is expected to prevent the potential depletion of fish stocks. This area is not yet a full no take zone but there is a proposal to consider is as such.

5.2.3.3. Examples of other conservation boxes - OSPAR

A good example of an OSPAR conservation box is the Menez Gwen hydrothermal vent field in the Azores EEZ. This conservation box was created to prevent degradation of and damage to species, habitats and ecological processes following the precautionary approach; and also to protect and conserve areas that best represent the range of species, habitats and ecological processes in the OSPAR area. The Menez Gwen area was discovered during the French cruise DIVA1. The main volcanic feature is a circular volcano at the central part of the segment. This volcano is 700 meters high, with a diameter of 17 km. Chimneys are essentially composed of white anhydrite, formed by the mixing of seawater and hydrothermal fluid. Around these small chimneys, some mounds with hot water diffusing through all surfaces are found (Fouquet et al., 1995). Hydrothermal vents do not present high species diversity, but high productivity with a low number of species but very specialized. Compared with non-vent deep-sea environment, the productivity is huge, despite the diversity on the non-vent deep-sea environment be very high.

5.2.3.4. Examples of fishing closures in CFP

North and Irish Sea cod closures (cf. Appendix 3).

5.2.3.5. Differences between fishing closures and conservation boxes

Several spatial management measures have been implemented in Europe. They have been designated as fisheries closures or conservation boxes (the same as MPAs). Usually fisheries closures are proposed under the CFP of national legislations while conservation boxes have been proposed under CFP, NATURA 2000, OSPAR, or national governments. It is apparent that the main difference between fishing closures and conservation boxes lies in their objectives and time scaling. Fishing closures clearly aim to manage a single specific objective usually a species or stock with commercial value, while the conservation boxes are, in general, aiming the management of the whole ecosystem. However, conservation boxes can also have specific objectives such as protecting charismatic species but they act at an ecosystem level. In terms of time scaling fisheries closures are assumed to be temporary (or short-term), i.e. until the recovery of the stock, while conservation boxes are seen to be permanent (long-term). Sizes are also different with fisheries closures usually much larger than conservation boxes. There are, however, exceptions. Management measures are usually the same and include no-fishing zones, gear control, effort control, among many others.

It is apparent that conservation boxes should always be fisheries closures but the opposite is not always true. When fisheries closures consider ecosystem or secondary objectives and time scale is broader then FC will become conservation boxes. The confusion comes because of this overlap between the two and not only because of the terminology. The bottom line is that we need better integration between fisheries and conservation objectives (this was the main topic of the 4th World Fisheries Congress).

5.2.4. Standardisation of fisheries measures supporting NATURA 2000 site management

A small number of Member States have notified the Commission of their intention to designate offshore Special Areas of Conservations (e.g. coral SACs off the west coast of Ireland). To ensure the ecological integrity of the protected coral reef habitats in this area, the Irish authorities have requested that fishing practices in the area be regulated by appropriate Technical Conservation Measures under the Common Fisheries Policy to ensure they apply to all Member States fleets as these SACs are located in areas of open access. The Commission requested advice from ICES on what measures are required. This advice is contained AGWIN report, ICES (2007).

As of October the Commission has adopted a proposal from the Irish authorities for measures to protect coral reefs. This involves a ban on fishing with both active and passive gears in four areas off the Atlantic coast of Ireland which have been identified by scientists as hosting extensive cold water coral reefs. On the basis of the scientific evidence, the Commission considers that there is a good case for taking all necessary steps to prevent further damage to these ecosystems before permanent protection measures can be put in place. To this end, the Commission has proposed provisional measures immediately prohibiting all fishing in those areas under the Common Fisheries Policy.

Given that other Member States will designate offshore SACs consideration should be given to standardising the type of fisheries measures required in similar circumstances rather than dealing with requests on an ad hoc basis. The EMPAS project is coordinating ICES work addressing similar issues. The ICES Workshop on Fisheries Management in Marine Protected Areas was held in April 10 to 12, 2007 on the subject (cf. ICES WKFMMPA Report 2007).

5.2.5. Enforcement-compliance issues

Control measures play a key role in ensuring the success of technical conservation measures. The use of Vessel Monitoring System (VMS) data to monitor activities around or in fisheries closures is increasingly seen as a cost effective means to ensure compliance (see 5.1.1.2 above). This suggests that Technical Conservation Measures should accommodate efficient use of VMS as an integral part of the regulation. Derogrations that allow some fisheries to continue to operate in areas closed to other fisheries, as well as potential negative impacts due to discards on target species and benthos, also reduces the power of VMS to ensure compliance without regular inspections of fishing activity in the closure. Optimal use of VMS requires that no vessels enter a fisheries closure except those transiting (with speed over ground of > 8 knots) (Cmd. Mark Mellett, Irish Naval Service, pers.comm.).

5.2.6 Socio-economic considerations: closure impacts on fisheries

Evaluation of the economic implications for fishers livelihoods forbidden from fishing in closures requires information about fishing vessel characteristics, fisheries statistics and fishing behaviour. In general, the provision of fisheries statistical information relating to catch and effort at the level of ICES sub-rectangles is too coarse to be used in assessment of changes in fishing behaviour induced by small area closures. Consideration of finer scale data collection for this purpose should be made in the Data Collection Regulation.

6. SUMMARY AND RECOMMENDATIONS.

MPA Inventory

Inventories were established for areas where fishing restrictions are applied under CFP (Appendix1a); where regulation of fisheries may be required to support management of NATURA 2000 sites in waters beyond territorial sea jurisdiction (Appendix 1b); and for the Mediterranean, in Appendix 1c.

Recommendations

1) There is a need to establish an interrogational, dynamic GIS linked to a relational database displaying all closures, to identify where measures overlap and to increase ease of access to legislation and follow up evaluations. Shape files of all closures should be publicly available.

2) While the TOR was specific to the Atlantic and North Sea, in the future Baltic and Mediterranean closures should be evaluated.

Overview of existing information and evaluations

A number of existing closures were reviewed, namely the North Sea Plaice Box, the North Sea Cod Box, the Shetland Box, the Norway Pout Box, the Sprat Closed Area Box, Baltic cod fishery closures and the Irish Cod closure.

Most of the MPAs have not meet their objectives due to, inter alia:

- Poor MPA design based on flawed or over simplistic assumptions (i.e. stochastic variability in fish behaviour and environmental forcing) resulting in inappropriate timing and positioning of closures.
- MPAs were not designed to facilitate monitoring and collection of the data that would be needed to demonstrate effectiveness of the closure. This resulted in a lack of clear road map to recovery leading to frustration for stakeholders.
- Derogations for some fishing gears did not take into account discarding effects and wider ecosystem implications.
- Socio-economic interests were allowed to weaken conservation policy so that closures had little chance of success, and in some cases, restrictions were not properly enforced.
- Non implementation of necessary social-flanking measures to mitigate the effects of displacement of fishing effort.

Recommendations

3) MPAs must have clear, measurable performance targets, underpinned by sufficient data collection to assess performance, while understanding the inherent uncertainty involved.

4) A clear statement of the purpose of the MPA must be effectively communicated to stakeholders so that they fully understand that the instrument of recovery is the reduction in exploitation, and how this is to be achieved.
5) Clear understanding that there will be a reduction in fishing opportunities, and that fleet-specific reduction in revenue of such reduced exploitation most be addressed.

6) For mobile species, closure(s) should be designed taking into account the distribution and migration patterns of the fish as well as the adaptive responses of fishing fleets.

7) Closures are only one tool for fisheries management, therefore, particularly for mobile species, additional effort control or TAC restrictions will be required.

8) The choice of one large closed area is not always the best solution. A network of smaller closures may protect fish over more of their range. Closed areas must also be small enough to facilitate spill-over.

9) A multi-species harvest plan should be instigated to manage the stock when (or if) recovery is achieved.

10) Direct and indirect effects of fisheries on species, habitats and ecosystem need to be monitored. These include the direct effects of catch or habitat destruction, and indirect effects such as changes in genetic diversity of the target species by selective fishing or changes in the food web by targeting specific predator or prey species.

11) Passive and active exchanges processes between protected and unprotected areas should be considered, not only of target species and their life stages but important predator and prey species as well.

12) Natural variability in the dynamics of species, habitats and ecosystems has to be understood before the effectiveness of closures can be evaluated. This variability is compounded by climate change effects and possible non-fishing anthropogenic impacts.

13) Understanding scale effects is essential. In particular, the relationship between the range of a population compared with the size of the MPA.

14) Choice of monitoring indicators is highly important. These should describe both fisheries and environmental components of the whole ecosystem. This is consistent with the EU's legal requirement under the new CFP to implement the ecosystem-based approach in fisheries management. If no prior knowledge exists variation in indicators must be identified within the monitoring and evaluation program.

15) Consideration should be given to the timescale within which changes in an indicator might reasonably be expected. For instance, recovery of populations of long-lived species, such as some rockfishes, may require many years; performance measures or other types of benchmarks for such indicators should reflect this longer timescale.

Integrating fisheries and conservation MPAs

Some opportunities will arise to integrate both fisheries and conservation MPAs in the more formal marine spatial planning environment likely under the Maritime Policy. While conservation boxes should always be fisheries closures the opposite is not always true because each management regime favours different points on the ecosystem succession paradigm. Because of this, ecological as well as fishing indicators are needed to evaluate the effectiveness of fishing restrictions.

Recommendations

16) No take areas are should be included as part of MPA zoning to: act reference points to evaluate the evolution of fishing closures with respect to successional state in a given set of environmental conditions; act as controls, to facilitate differentiation between natural variability of the system and the effects of regulations; maintain a natural size and age structure in the population and maximize the potential fecundity and maintain the genetic diversity and structure in the populations creating greater resilience in the face of overexploitation.

17) Better integration between fisheries and conservation goals is required. The time scale of some fisheries closures could be revised in order to incorporate long-term conservation perspectives in management.

18) Lack of success of closures to achieve their fisheries conservation objectives should not necessarily be regarded as a basis for repealing the closure regulation if there is an important secondary habitat protection function.

19) Within the Marine Strategy, there is potential within an overarching marine spatial plan to chose (pristine) sites as reference areas for comparison during fisheries and conservation monitoring.

Methods and data required for evaluations of the MPAs in the inventory

Available data and information must be obtained from fisheries ministries/research institutes and the fishing industry/fishers. It is currently a difficult and slow process to gain access to detailed spatial and temporal detailed data and information about the fisheries in MPAs. Even though detailed fisheries data and information exists (VMS, logbooks, and national fisheries observer/research/sampling programs) this data is not available to national research scientists in a number of Member States. When VMS data is required for purposes other than the ones originally intended (monitoring, control, and surveillance), written permission from each individual fisher involved is needed before the data can be released. In addition, the provision of fisheries statistical information relating to catch and effort at the level of ICES sub-rectangles is too coarse to be used in assessment of changes in fishing behaviour induced by small area closures.

Recommendations

20) Access to fine-scale spatial fisheries data for scientific projects should be supported by the EC Data Collection Regulation. The anonymity of fishers and thus their

intellectual property rights, should be ensured; however, it should be possible to perform an analysis of fine-scale spatial fisheries data without restrictions and in cooperation with the fishers (fishers' representatives).

21) Monitoring fisheries activities around discrete spatial areas requires finer resolution data collection than the present data aggregated at ICES rectangle. There is a major need to improve spatial resolution of data collection (e.g. catch statistics) to support monitoring of closed areas. More detailed information on fishing efforts and impacts should be collected in cooperation with the national research institutions, fisheries organizations, and the fishers.

22) Evaluation of the socio-economic implications for fishers livelihoods prevented from fishing in closures also requires information about fishing vessel characteristics, fisheries statistics and fishing behaviour (as seen by VMS).

23) There needs to be improved support for individual Member States data collection in offshore areas through Community supported initiatives.

Further discussions on the availability of suitable fisheries data for assessment on MPA effectiveness are contained in the report of the ICES Workshop on Fisheries Management in Marine Protected Areas (ICES WKFMMPA Report 2007).

Recommendations for improved assessment of the effectiveness of closures

The move towards an ecosystem approach for fisheries management within the Common Fisheries Policy together with the revision of technical conservation measures suggests that this is an optimum time to modernize our approach to the utilization of fisheries closures particularly in terms of design, management and monitoring. Serious consideration should now be given to suppressing all existing fisheries closures that have been established without clear monitoring protocols to evaluate their effectiveness.

Recommendations

24) We recommend that outmoded closures are replaced in new regulations with closures that are designed with well defined management plans that include careful choice of performance indicators to facilitate review and future adaptive management.

25) A useful way to clearly organise monitoring requirements is through the development of GOIS (Goals, Objectives, Indicators and Success Criteria) tables. This approach could be adopted by SGMOS-07-03. For each closed area under evaluation a hypothetical monitoring programme with appropriate indicators and thresholds could be devised using the GOIS table approach. The GOIS table could then be used to benchmark the availability and suitability of monitoring data for each closure and to identify gaps where new data collection is required for effective closure evaluation.

26) A useful general MPA evaluation tool is the IUCN self-assessment checklist for building networks of MPAs. It is based on best practice and is designed to enable those engaged in designing or managing MPA networks to determine progress towards effective MPA networks.

Other Considerations

Standardisation of fisheries measures supporting NATURA 2000 site management

Given that a number of Member States are now in the process of designating offshore SACs, consideration should be given to standardising the type of fisheries measures required to support similar conservation goals rather than dealing with requests on an ad hoc basis.

Recommendation

27) There is a potential to standardise the design and evaluation of MPAs established for the same goal taking into account regional differences.

Enforcement/Compliance

Control measures play a key role in ensuring the success of technical conservation measures. The use of Vessel Monitoring System (VMS) data to monitor activities around or in fisheries closures is increasingly seen as a cost effective means to ensure compliance particularly offshore. However, derogations that allow some fisheries to continue to operate in areas closed to other fisheries, as well as potential negative impacts due to discards on target species and benthos, also reduces the power of VMS to ensure compliance without regular inspections of fishing activity in the closure. This also has increased cost implications for the enforcing Member State. Situations may arise, particularly offshore, were the enforcement burden may need to be shared amongst neighbouring Member States.

Recommendations

28) Technical Conservation Measures regulations should accommodate efficient use of VMS as a control tool particularly in offshore waters.

29) Further work is required to maximise the usefulness of VMS to monitor vessels deploying static gears.

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7. APPENDICES

Appendix 1a	Inventory of areas with fishing restrictions under the CFP
Appendix 1b	Inventory of NATURA 2000 sites likely to require fishing restrictions under the CFP
Appendix 1c	Inventory of Mediterranean closed areas
Appendix 2	Presentation on the current status of NATURA 2000 implementation
Appendix 3	Reviews of existing closed area effectiveness
Appendix 4	How do we judge whether an MPA has been 'successful' or not?
Appendix 5	GOIS Tables for the management of cold-water coral MPAs
Appendix 6	IUCN self-assessment checklist for building networks of MPAs
Appendix 7	List of participants

APPENDIX 1A

Management Area (ICES/Other)	Closure Name	Management Regime	Earliest legislation	Recent legislation	Status of closure	Fishing restrictions	Purpose	Measure	First established	Size (km2)
	Baltic (TS, GK, APS)									
SD 25-32	Eastern Baltic summer ban	IBSFC/CFP	IBSFC resolution from 1994	EEC 52/2006, COM(2006) 411 final	Seasonal	Some (trawl)	Reduce F on cod pre-spawning and spawning concentrations	Prohibit targeted cod fisheries	1995	
SD 22-24	Western Baltic summer ban	IBSFC/CFP	IBSFC resolution from 2004	EEC 52/2006, COM(2006) 411 final	Seasonal	Some (trawl)	Reduce F on cod pre-spawning and spawning concentrations	Prohibit targeted cod fisheries	2005	
SD 25	Bornholm Spawning closure	IBSFC/CFP	IBSFC resolution from 1994	EEC 52/2006, COM(2006) 411 final	Permanent in 2005 Currently seasonal	All active gears	Ensure undisturbed cod spawning	Prohibit all active gears	1995	
SD 25, 26, 28	Spawning closures in the Central Baltic	IBSFC/CFP	IBSC resolution from 2004	EEC 52/2006, COM(2006) 411 final	Permanent in 2005 Currently seasonal	All active gears	Ensure undisturbed cod spawning	Prohibit all active gears	2005	
	North Sea/Scotland (MT, JP, PL)									
	Plaice Box	CFP	EEC 4193/88, EEC 3094/86	EEC 850/98/29/1b	Permanent	>8m demersal trawl & Danish seine (&similar towed gears)	Protect plaice nursery grounds			
	Norway Pout Box	CFP (boundaries ?)	EEC 3094/86	EEC 850/98/27/1	Permanent	Any towed gear	Reduce bycatch mortality on gadoids			
	Sandeel Box	CFP		EEC 41/2006/III/5	Permanent	Sandeel vessels	Protect food resources for dependent predators			
	Shetland/Northern Isles Box	CFP +	EEC 2371/2002	EEC 2371/2002	Permanent	Large demersal vessels >26m [licence] (but not those targeting Norway Pout or Blue whiting),	To protect heavilly dependent local fishing communities			
	Cod (temporary) closure	CFP +	EEC 259/2001	EEC 259/2001	Temporary Seasonal	All gears except pelagic and sandeel	Emergency measure to protect cod stock during spawning season.			
	Herring Box (Danish coast)	CFP	EEC 850/1998/	EEC 850/1998/	Permanent Seasonal (1 July-31 Oct)	Some (targetting herring or sprat)	Protect herring nursery grounds			
	Inshore plaice closure	CFP	EEC 850/98/29/1a	EEC 850/98/29/1a + 850/98/29/4biii	Permanent	(Vessels >8m)	Protect inshore plaice nursery areas			
	East Herring Box (NE England)	CFP	EEC 850/1998/20, 1e	EEC 850/1998/20, 1e	Permanent Seasonal (15 Aug - 30 Sept)	Some (targetting herring or sprat)	Protect herring nursery grounds			
	Sprat Box (NE England)	CFP	EEC 850/1998/21, 1a	EEC 850/1998/21, 1a	Permanent Seasonal (1 Jan-31 March + 1 Oct-31 Dec)	Some (targetting sprat)	Protect herring nursery grounds			
	Sprat Box (Firth of Forth/Moray Firth)	CFP	EEC 850/1998/21, 1b	EEC 850/1998/21, 1b	Permanent Seasonal (1 Jan-31 March + 1 Oct-31 Dec)	Some (targetting sprat)	Protect herring nursery grounds			
	NW Scotland cod box	CFP	EEC 27/2005, 12a	EEC 41/2006/III/7.1	Temporary (until 31 Dec 2007), seasonal	Some (reduction in effort)	Managemeny of cod stocks			
	Darwin Mounds	CFP		EEC 603/2004/1	Permanent	All bottom gears	Protection of deepwater coral reefs			
	Herring Box (Hebrides)	CFP		EEC 850/1998/20,1,d	Permanent, seasonal (15 Aug-30 Sep)	Some (targetting herring or sprat)	Protect herring nursery grounds			
	W Scotland herring box	CFP		EEC 850/1998/21,1c	Permanent, seasonal (15 Aug-15 Sep)	Some (targetting herring or sprat)	Protect herring nursery grounds			
	NE England Herring box	CFP		EEC 850/1998/20,1c	Permanent, seasonal (15 Aug - 15 Sep)	Some (targetting sprat)	Protect herring nursery grounds			
	Clyde Herring box	CFP		EEC 850/1998/20,1a	Permanent, seasonal (1 Jan - 30 April)	Some (targetting sprat)	Protect herring nursery grounds			
	North Jutland Plaice box	CFP		EEC 850/1998/29/1c	Permanent	Some (>8m towed)	Protect inshore plaice nursery areas			
	Northern North Sea (4a & 4b)	CFP		EEC 850/1998/30/2a	Permanent	Beam trawlers	Restricting access to beam trawls			
	Faroes & 6a	CFP		EEC 850/1998/30/2b	Permanent	Beam trawlers	Restricting access to beam trawls			
	12-nautical mile zone around UK and Ireland (from baseline)	CFP +		EEC 850/98/34	Permanent	Large beam trawlers (>221kW)	Restricting access to beam trawls			
	Rockall Haddock box	CFP + NEAFC		EEC 41/2006/III/6	Permanent	Some (trawl gears)	Protect juvenile haddock			
	Orange roughy protection area (VIa)	CFP +		EEC 2270/2004/7	Permanent	All gears	Protect orange roughy stocks			
	NW Rockall	CFP +		EEC 41/2006,13	Permanent	All bottom gears	Vulnerable deep sea habitats			
	W Rockall Mound	CFP +		EEC 41/2006,13	Permanent	All bottom gears	Vulnerable deep sea habitats			
	Logachev Mounds	CFP +		EEC 41/2006,13	Permanent	All bottom gears	Vulnerable deep sea habitats			
	Hatton Bank	CFP +		EEC 41/2006,13	Permanent	All bottom gears	Vulnerable deep sea habitats			

	West of Ireland (SC, AG, PJ)								
ICES VII	Irish hake recovery box	CFP		EEC 494/2002/5/1a	Permanent	All towed gears except beam trawls	Recovery hake stock in ICES areas	55-99mm beam trawls only	
ICES VII	Herring box	CFP		EEC 850/98/21,1J	Seasonal	Herring fishing	Temporary ban on fishing for herring	In 1997 and every third year thereafter from the first Friday in January for a period of sixteen consecutive days	
ICES VII	Herring box	CFP		ECC 850/98/20,1k	Interannual/seasonal	Herring fishing	Temporary ban on fishing for herring	In 1998 and every third year thereafter from the first Friday in November for a period of sixteen consecutive days	
ICES VII	Herring box	CFP		EEC 850/98/20,1i	Seasonal	Herring fishing	Temporary ban on fishing for herring	In 1997 and every third year thereafter from the second Friday in January for a period of sixteen consecutive days	
ICES VII f & g	Celtic Sea 'Trevose' cod box	CFP		EEC 41/2006/III/7.2	Seasonal (rolling annual)	All gears	Cod recovery - Celtic Sea	01 Feb to 31 Mar 2007, with derogations for potting, <55mm nets for herring, mackerel, pilchard/sardines, sardinelles, horse mackerel, sprat, blue whiting & argentines; does not apply inside 6nm	
ICES VII e, f & g	SW Approaches Mackerel box	CFP		EEC 850/98/22,1	Permanent	Mackerel gears	Mackerel conservation	Ban on mackerel fishing except where mackerel <15% of total catch	
ICES VIIa	Irish Sea Cod Box	CFP		EEC 41/2006/III/8	Seasonal (rolling annual)	Most demersal	Ban on all static & towed demersal gears except otter and separator trawling in sub-areas	14 Feb to 30 April 2007	
ICES VIIa	Herring box	CFP		EEC 850/98/20,1,fii	Seasonal	Herring fishing	Restrictions on fishing for herring	21 Sept to 31 Dec	
ICES VIIa	Herring box	CFP		EEC 850/98/20,1,fi	Seasonal	Herring fishing	Restrictions on fishing for herring	21 Sept to 15 Nov	
ICES VIIa	Herring box	CFP		EEC 850/98/20,1,g	Permanent	Herring fishing	Restrictions on fishing for herring	Throughout the year	
	Altair seamount closure	CFP		EEC 41/2006/III/13	Permanent	All bottom gears	Conservation of vulnerable habitat	Prohibited to conduct bottom trawling and fishing with static gear, including bottom set gill-nets and longlines,	
	Antialtair seamount closure	CFP		EEC 41/2006/III/13	Permanent	All bottom gears	Conservation of vulnerable habitat	Prohibited to conduct bottom trawling and fishing with static gear, including bottom set gill-nets and longlines,	
	Faraday seamount closure	CFP		EEC 41/2006/III/13	Permanent	All bottom gears	Conservation of vulnerable habitat	Prohibited to conduct bottom trawling and fishing with static gear, including bottom set gill-nets and longlines,	
	Hectate seamount closure	CFP		EEC 41/2006/III/13	Permanent	All bottom gears	Conservation of vulnerable habitat	Prohibited to conduct bottom trawling and fishing with static gear, including bottom set gill-nets and longlines,	
	Part of the Reykjanes Ridge	CFP		EEC 41/2006/III/13	Permanent	All bottom gears	Conservation of vulnerable habitat	Prohibited to conduct bottom trawling and fishing with static gear, including bottom set gill-nets and longlines,	
ICES VII	Orange roughy box	CFP +	EEC 2270/2004/7	EEC 2015/2006/7	Permanent	All gears	Protect orange roughy stocks	Fishing for orange roughy prohibited within box	2005

Macronesia and Biscay (APR, IL, TM)								
Azores No trawl Zone	CFP	EEC 858/98	EEC 1568/2005	Permanent	Ban on bottom trawl	To protect highly sensitive habitats like cold water corals		
Algarve Restrictions for fishing for hake area	CFP	EEC 850/98/28/1b			?			
No trawl Zone -Madeira and Canaries	CFP	EEC 858/98	EEC 1568/2005	Permanent	Ban on bottom trawl	To protect highly sensitive habitats		
Bay of Biscay-Recovery of stock of hake in ICES area	CFP	EEC 494/2002/5/1b		Permanent				
Cantabric Sea Resstrictions for fishing on anchovy area	CFP	EEC 850/98/23/1		Permanent				
Galicia-Restrictions on fishing for hake area	CFP	EEC 850/98/28/1a		Permanent				
Mediterranean (JLS, RG, GP, ADiN)								
	CFP		CFP (2001), ICCAT (2003), GFCM (2004)	Permanent	The use of surface driftnets for swordfish tuna and tuna-like species are prohibited in the of whole Mediterranean Sea and Black Sea.	Conservation of marine biodiversity, Restocking	Broad areas where the use of specific gear is prohibited	2004
	CFP		(CFP) EC MED REG	Seasonal	The use of aggregating fishing devices (FAD) for *Coryphaena hippurus* from 1 January to 14 August are are prohibited in the of whole Mediterranean Sea and Black Sea.	Restocking	Broad areas where the use of specific gear is prohibited	2007
	CFP		(CFP) EC MED REG	Permanent	Bottom trawls are prohibited in coastal areas within 3 miles from the shore or having a depth less than 50 m, but never closer than 0.7 miles in 2007 ($)	Conservation of marine biodiversity	Broad areas where the use of specific gear is prohibited	2007
	CFP		(CFP) EC MED REG	Permanent	Encircling gears for small pelagics are prohibited in coastal areas within 300 m from the shore or having a depth less than 50 m, with a depth >70% of the drop ???	Conservation of marine biodiversity	Broad areas where the use of specific gear is prohibited	2007
	CFP		(CFP) EC MED REG	Permanent	Boat dredges and hydraulic dredges are prohibited in coastal areas within 0.3 miles from the shore	Conservation of marine biodiversity	Broad areas where the use of specific gear is prohibited	2007
	CFP		(CFP) EC MED REG	Permanent	Sponge dredges are probibited in coastal areas within 0.5 miles from the shore or having a depth less than 50 m	Conservation of marine biodiversity	Broad areas where the use of specific gear is prohibited	2007

Legend
Management Regime

CFP	Common Fisheries Policy
FCZG	
IBSFC	International Baltic Sea Fishery Commission
NEAFC	North East Atlantic Fisheries Commission

APPENDIX 1B

Management Area (ICES/Other)	Closure Name	Management Regime	Status of closure	All gears/some	Earliest legislation	Recent Legislation	Purpose	Measure	First established	Fisheries Jurisdiction e.g <12nm (CFP) or < 12nm (national)	Size (km2)
ICES VII	Belgica Mounds Special Area of Conservation	Habitats Directive	Proposed	All demersal gears *	Habitats Directive (92/43/EEC)		Protect cold-water corals	Geographic fencing	2006	>12nm (CFP)	411
ICES VII	Hovland Mounds Special Area of Conservation	Habitats Directive	Proposed	All demersal gears	Habitats Directive (92/43/EEC)		Protect cold-water corals	Geographic fencing	2006	>12nm (CFP)	1,086
ICES VII	SW Porcupine Bank Special Area of Conservation	Habitats Directive	Proposed	All demersal gears	Habitats Directive (92/43/EEC)		Protect cold-water corals	Geographic fencing	2006	>12nm (CFP)	329
ICES VII	NW Porcupine Bank Special Area of Conservation	Habitats Directive	Proposed	All demersal gears	Habitats Directive (92/43/EEC)		Protect cold-water corals	Geographic fencing	2006	>12nm (CFP)	716
				* cf. ICES AGWINS 2007							
	Baltic (TS, GK, APS)										
Western Baltic Sea	Fehmarn Belt	Habitats Directive	Proposed	Under development	Habitats Directive (92/43/EEC)	EEC {SEC (2006) 607}	Protect habitats and species	Geographic fencing			
Western Baltic Sea	Kadet Trench	Habitats Directive	Proposed	Under development	Habitats Directive (92/43/EEC)	EEC {SEC (2006) 607}	Protect habitats and species	Geographic fencing			
Western Baltic Sea	Western Rønne Bank	Habitats Directive	Proposed	Under development	Habitats Directive (92/43/EEC)	EEC {SEC (2006) 607}	Protect habitats and species	Geographic fencing			
Western Baltic Sea	Adler Ground	Habitats Directive	Proposed	Under development	Habitats Directive (92/43/EEC)	EEC {SEC (2006) 607}	Protect habitats and species	Geographic fencing			
Western Baltic Sea	Pommeranian Bay with Odra Bank	Habitats Directive	Proposed	Under development	Habitats Directive (92/43/EEC)	EEC {SEC (2006) 607}	Protect habitats and species	Geographic fencing			
Western Baltic Sea	Pommeranian Bay SPA	Birds Directive	Permanent	Under development	Birds Directive (79/409/EEC)	EEC {SEC (2006) 607}	Protect seabirds species	Geographic fencing			
ICES rectangle 4057	Øresund (The Sound)	Bi-national	Permanent	All active gears	National legislation from 1932	Swedish-Danish National legislation	Maritime safety	prohibit all active gears	1932		
	North Sea/Scotland (MT, JP, PL)										
	Dogger Bank (German sector)	Habitats Directive	Permanent	No closure (yet)		DE 1003-301	Protect shallow porpoise, common seal & shallow sandbank habitat				1700
	Borkum-Riffgrund	Habitats Directive	Permanent	No closure (yet)		DE 2104-301	Protect sandbanks and reefs.				625
	Sylter Außenriff	Habitats Directive	Permanent	No closure (yet)		DE 1209-301	Protect sandbank, reef and porpoises.				5314
	Östliche Deutsche Bucht	Birds Directive	Permanent	No closure (yet)		DE 1011-401	Protect bird populations				3135
	Braemar Pockmarks	Habitats Directive	Proposed	No closure (yet)		UK0030357	Protect structure caused by leaking gas				
	Dogger Bank (UK sector)	Habitats Directive	Proposed	No closure (yet)		UK0030352	Protect sandbank habitat				
	Haig Fras	Habitats Directive	Proposed	No closure (yet)		UK0030353	Protect rocky reef habitat				
	North Norfolk Sandbanks and Saturn Reef	Habitats Directive	Proposed	No closure (yet)		UK0030358	Protect shallow sandbank & reef habitat				
	Scanner Pockmark	Habitats Directive	Proposed	No closure (yet)		UK0030354	Structure caused by leaking gas				
	Stanton Banks	Habitats Directive	Proposed	No closure (yet)		UK0030359	Protect reef habitat				
	Wyville Thomson Ridge	Habitats Directive	Proposed	No closure (yet)		UK0030355	Protect reef habitat				
	Danish (southern) North Sea	Birds Directive	????	No closure (yet)		DK	Protect bird populations				2463
	Dogger Bank (Netherlands sector)	Habitats/Birds Directive	Possible (proposed SAC)	No closure (yet)			Protection of sandbank habitat				
	Cleaverbank	Habitats/Birds Directive	Possible (proposed SAC)	No closure (yet)			Protection of gravel 'reef' habitat				
	Frisian Front	Habitats/Birds Directive	Possible (proposed SAC)	No closure (yet)			Protection of seabirds (and benthic habitats)				
	Netherlands coastal sea	Habitats/Birds Directive	Possible (proposed SAC)	No closure (yet)			Protection of seabirds (and sandbank habitat)				

APPENDIX 1C

Name	Category	Permanent /seasonal /temporary	All gears /some	Earliest legislation	Recent Legislation	Management area	Purpose	Size Km^2	First established
BULGARIA									
Srébarna	NR	P		National Legislation		GFCM 29	C	0.01	2004
CYPRUS									
Lara	NR	S	ALL GEAR	National Legislation		GFCM 26	C	5.50	1989
FRANCE									
Port-Cros (*)	NP	P	SOME	National Legislation		GFCM 7	C,R,E,T	13.00	1963
Lavezzi (now included in the ZEP of Bouches de Bonifacio)	NR	P	SOME	Regional Legislation		GFCM 7	C, R, T, E	50.80	1982
Cerbère-Banyuls	NR	P	SOME	National Legislation		GFCM 7	C,R,	6.50	1974
Scandola	NR	P	SOME	Regional Legislation		GFCM 8	C,R,	10.00	1975
Bastia	FR	P	SOME	Regional Legislation		GFCM 8	R	7.91	1977
Saint-Florent	FR	P	SOME	Regional Legislation		GFCM 8	R	24.40	1977
Ile Rousse	FR	P	SOME	Regional Legislation		GFCM 8	R	8.80	1977
Calvi	FR	P	SOME	Regional Legislation		GFCM 8	R	10.74	1978
Piana & Porto	FR	P	SOME	Regional Legislation		GFCM 8	R	5.76	1978
Propiano	FR	P	SOME	Regional Legislation		GFCM 8	R	5.89	1978
Ile et Iles Bruzzi at Ilets aux Moines	APB	P	SOME	Regional Legislation		GFCM 8	C		1992
Golfe Juan	FR	P	SOME			GFCM 7	R	0.50	1981
Beaulieu-sur-Mer	FR	P	SOME			GFCM 7	R	0.50	1982
Rochebrune-Cap Martin	FR	P	SOME			GFCM 7	R	0.50	1983
Carry-le-Rouet (MP Cote Blue)	MPZ	P	ALL GEAR			GFCM 7	R	0.85	1987
Cap Couronne (MP Cote Blue)	MPZ	P	ALL GEAR			GFCM 7	R,E	2.15	1996
Bouches de Bonifacio	ZEP	P	SOME	Regional Legislation	National Legislation 2003	GFCM 7	C,R,E,T	800.00	1999
GREECE									
North Sporades Isles Zone A	NP	P	ALL GEAR	1992		GFCM 22	C,T,E	2265.00	1992
North Sporades Isles Zone B	NP	P	SOME	1992		GFCM 22	C,T,E		1999
Zakintos, Laganas Gulf	NP	P	SOME	1999		GFCM 20	C,T,E	89.20	
Thermaikos Gulf, inner part	FCZG	P	SOME	P.D. 189/78		GFCM 22	C, R		
Thermaikos Gulf, outer part	FCZG	P	SOME	P.D. 189/78		GFCM 22	C, R		
Pagassitikos Gulf	FCZG	P	SOME			GFCM 22	C, R		
Amvrakikos Gulf	FCZG	P	SOME			GFCM 20	C, R		
Saronikos Gulf, inner part	FCZG	P	SOME			GFCM 22	C, R		
Saronikos Gulf, outer part	FCZG	P	SOME			GFCM 22	C, R		
Korinthiakos Gulf, Itea	FCZG	P	SOME			GFCM 22	C, R		
Limnos Island, Gulf of Moudros	FCZG	P	SOME	R.D. 917/66		GFCM 22	C, R		
Kerkyra Island, Alexandros Gulf	FCZG	P	SOME	R.D. 917/67		GFCM 20	C, R		
Maliakos Gulf	FCZG	P	ALL GEAR	P.D. 144/86		GFCM 22	C, R		
Vistonikos Gulf	FCZG	P	ALL GEAR			GFCM 22	C, R		
Lesvos Island, Kalloni Gulf	FCZG	P	SOME			GFCM 22	C, R		
ITALY									
Archipelago Toscano	NP	P	SOME	National Legislation	National Legislation (L 394 - 6/12/91)	GFCM 9	C,R,T	614.74	1989
Arcipelago di La Maddalena	NP	P	SOME	National Legislation	National Legislation (L 394 - 6/12/91)	GFCM 11	C,R,T,E	150.46	1994
Isole dell'Asinara	NP	P	SOME	National Legislation (L 394 - 6/12/91)	National Legislation 2002	GFCM 11	C,R,E	107.32	1997
Cinque Terre	MPA/NP	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1997	GFCM 9	C,R,T,E	27.26	1997
Miramare-Golfo di Triestre	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1986	GFCM 17	C,E	0.30	1997
Isola di Ustica	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1986	GFCM 10	C,R,T,E	159.51	1986
Isole Tremiti	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1989	GFCM 17	C,R,T	14.66	1989
Capo Rizzuto	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 2002	GFCM 19	C,R,T	147.21	1991
Isole Ciclopi	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1996	GFCM 19	C,R,T,E	6.23	1989
Isole Egadi	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1996	GFCM 18	C,R,T	539.92	1991
Torre Guaceto	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1991	GFCM 16	C,R,T	22.27	1991
Secche di Tor Paterno	MPA	P	SOME	National Legislation (L 394 - 6/12/91)		GFCM 9	C,T,E	13.87	2000
Parco sommerso di Baia	MPA	P	SOME	National Legislation 2002		GFCM 10	C,R,E	1.77	2002
Parco sommerso di Gaiola	MPA	P	SOME	National Legislation 2002		GFCM 10	C,T,E	0.42	2002
Isole di Ventotene-S. Stefano	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1997	GFCM 9	C,R,T	27.99	1997
Porto Cesareo	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1997	GFCM 17	C,R,T,E	166.54	1997
Punta Campanella	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 2000	GFCM 10	C,R	15.39	1997
Tavolara-Punta Coda Cavallo	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 2002	GFCM 11	C,R,T,E	153.57	1997

Capo Carbonara	MPA	P	SOME	National Legislation (L 394 - 6/12/91)	National Legislation 1999	GFCM 11	C,R,T	85.98	1998
Golfo di Portofino	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 1999	GFCM 9	C,R,T,E	3.46	1998
Peninsola del Sinis - Is. Mal di Ventre	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 2003	GFCM 11	C,R,T,E	329.00	1998
Capo Caccia – Isola Piana	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 2002	GFCM 11	C,R,T	26.31	2002
Isole Pelagie	MPA	P	SOME	National Legislation (L 979 - 31/12/82)	National Legislation 2002	GFCM 13	C,R,T,E	43.67	2002
Capo Gallo – Isola delle Femmine	MPA	P	SOME	National Legislation (L 394 - 6/12/91)	National Legislation 2002	GFCM 10	C,R,T,E	21.73	2002
Plemmirio	MPA	P	SOME	National Legislation (L 93 - 23/3/01)		GFCM 19	C,T,E	25.00	2004
Area Miramare	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 17	R	15.00	1998
Area Tenue	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 17	R	160.00	1998
Area fuori Ravenna	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 17	R	240.00	1998
Area Barbare	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 17	R	160.00	1998
Zona D - Fossa di Pomo	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 17	R	2226.00	1998
Area Tremiti	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 17	R	115.00	1998
Zona C – al largo della Puglia	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 18	R	2226.00	1998
Area Penisola Sorrentina	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 10	R	60.00	1998
Zona B – al largo del Lazio	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 10	R	125.00	1998
Zona A – al largo dell'Argentario	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 9	R	50.00	1998
Area prospiciente Amantea	BPZ	P	SOME (bottom and pelagic trawl)	National Legislation DMPA 16/6/98		GFCM 10	R	75.00	1998
Golfo di Catania	FCZG	P	SOME	Regional Legislation		GFCM 19	R		1974
Golfo di Patti	FCZG	P	SOME	Regional Legislation		GFCM 10	R		1981
Golfo di Castellammare	FCZG	P	SOME	Regional Legislation		GFCM 10	R	200.00	1990
Oasi Blu di Gianola	MR	P	SOME	National Legislation		GFCM 10	C,T,E	0.05	1988
Oasi Blu degli Scogli di Isca	MR	P	SOME	National Legislation		GFCM 10	C,T,E	0.06	1991
Oasi Blu di Monte Orlando	MR	P	SOME	National Legislation		GFCM 10	C,T,E	0.03	1995
Oasi Blu della Villa di Tiberio	MR	P	SOME	National Legislation		GFCM 10	C,T,E	0.11	1995
Stagnone di Marsala	NR	P	SOME	Regional Legislation	National Legislation (L 394 - 6/12/91)	GFCM 16	C,T,E	20.12	1984
Isola Bella	NR	P	SOME	Regional Legislation		GFCM 19	C,T,E	0.10	1998
MALTA									
Filfla Island	NR	P	ALL GEAR	National Legislation		GFCM 15	C	0.02	1988
Fungus Rock	NR	P		National Legislation		GFCM 15	C		1992
Malta Fisheries Management Zone	FMZ	P	SOME (FADs)	National Legislation	CFP	GFCM 15	R	10700.00	2004
Rdum Majjiesa/Ras is Raheb	MPA	P	SOME	National Legislation		GFCM 15	C,T	0.10	2005
ROMANIA									
Delta of the Danube River	BR	P	SOME	National Legislation		GFCM 29	C	5900.00	1990
Vama Veche	NR	P	SOME	National Legislation		GFCM 29	C,T,E		2006
SLOVENIA									
Debeli Rtic	NM	P				GFCM 17	C,T,E	0.16	1991
Cape Madona	NM	P				GFCM 17	C,T,E	0.13	1990
Strunjan	NR	P				GFCM 17	C,T,E	0.90	1990
SPAIN									
Islas Chafarinas	HR	P	SOME	National Legislation		GFCM 3	C		1983
Tabarca	MR	P	SOME	National & Regional Legislation		GFCM 6	R,C,T,E	14.00	1986
Maro-Cerro Gordo	FCZ	P	NONE	Regional Legislation		GFCM 1	C	9.00	1989

Islas Columbretes (*)	MR	P	SOME	National Legislation		GFCM 6	R,C,T	44.00	1990
Islas Medas (*)	MPA	P	SOME	Regional Legislation		GFCM 6	C,T	5.50	1983
Isla de Cabrera	NP	P	SOME	National Legislation		GFCM 5	C,E	81.64	1991
Ses Negres-Cap Begur	MPA	P	ALL GEAR	Regional Legislation		GFCM 6	E	0.80	1993
Cabo de San Antonio	MR	P	ALL GEAR	Regional Legislation		GFCM 6	R,C,T	0.85	1993
Cabo de Gata-Nijar (*)	MR	P	SOME	National & Regional Legislation		GFCM 1	R,C,T,E	122.00	1995
Cabo de Palos-Islas Hormigas (*)	MR	P	SOME	National Legislation		GFCM 6	R,C,T	18.98	1995
Freus d'Eivissa i Formentera	MR	P	SOME	Regional Legislation		GFCM 5	R,C,T	136.17	1995
Isla de Alborán (*)	MR	P	SOME	National Legislation		GFCM 2	R,C	494.44	1997
Cabo de Creus	MPA	P	SOME	Regional Legislation		GFCM 6	C,T,E	20.00	1998
Bahía de Palma	MR	P	SOME	Regional Legislation		GFCM 5	R,C	23.94	1982
Norte de Menorca	MR	P	SOME	Regional Legislation		GFCM 5	R,C,T,E	51.19	1999
Masía Blanca	MR	P	ALL GEAR	Regional Legislation		GFCM 6	R,C	3.22	1999
Tamarit-Punta de la Mora	MR	P	SOME	Regional Legislation		GFCM 6	R,C,E	1.00	2001
Migjorn de Mallorca	MR	P	SOME	Regional Legislation		GFCM 5	C,R,T,E	223.32	2002
Isla del Toro	MR	P	ALL GEAR	Regional Legislation		GFCM 5	R	1.36	2004
Isles Malgrats	MR	P	ALL GEAR	Regional Legislation		GFCM 5	R	0.89	2004
Serra Gelada	NR	P	SOME	Regional Legislation		GFCM 6	C,T	49.20	2005
UNITED KINGDOM (GIBRALTAR)									
Gibraltar	MPA	P	ALL GEAR	National Legislation		GFCM 1	C	nda	1996
MULTI-NATIONAL									
Pelagos Marine mammal Santuary (*)	MS	P	None	Multi-national agreement (FR-IT-MO)	2001	GFCM 9	C	8750.00	1999
Lophelia reef off Capo Santa Maria di Leuca	FCZ	P	SOME		OJEU 20-1-2007 L15/11	GFCM 19	C		2007
The Eratosthemes Seamount	FCZ	P	SOME		OJEU 20-1-2007 L15/11	GFCM 26	C		2007
The Nile Delta area cold hydrocarbon steeps	FCZ	P	SOME		OJEU 20-1-2007 L15/11	GFCM 26	C		2007
BROAD AREAS HAVING SPECIAL PROTECTION OR MANAGEMENT REGIME									
Off-shore areas having a depth over 1,000 m	FCZG	P	SOME (bottom trawls)	GFCM Regulation	CFP	GFCM	C		2006
Posidonia oceanica meadows	FCZG	P	SOME (bottom trawls, bottom towed gear, bottom-set longlines, dredges)	Natura 2000	CFP	GFCM	C		2001
Maerl bottoms	FCZG	P	SOME (bottom trawls)	CFP		GFCM	C		2006
Coralligenous	FCZG	P	SOME (bottom trawls)	CFP		GFCM	C		2006
BROAD AREAS WHERE THE USE OF SPECIFIC GEAR IS PROHIBITED									
The whole Mediterranean Sea and Black Sea, as concerns the use of surface driftnets for swordfish tuna and tuna-like species	FCZG	P	SOME (driftnets)	CFP (2001)	ICCAT (2003), GFCM (2004)	GFCM	C,R		2004
The whole Mediterranean Sea and Black Sea, where the use of aggregating fishing devices (FAD) is banned for *Coryphaena hippurus* from 1 January to 14 August.	FCZG	S	SOME (FADs)	GFCM Regulation	(CFP) EC MED REG	GFCM	R		2007
The whole Mediterranean Sea, where the use of purse-seine and pelagic longlines for *Thunnus thynnus* is banned from 1 August to 31 December.	FCZG	S	SOME (tuna purse-seines, tuna pelagic longlines)	ICCAT Regulation (2006)	(CFP) EC MED REG (2007)	GFCM	R		2007
The whole Mediterranean Sea, where the use of aereal spotting for *Thunnus thynnus* is banned.	FCZG	P	SOME (tuna areal spotting)	ICCAT Regulation (2006)	(CFP) EC MED REG (2007)	GFCM	R		2007
Bottom trawl in coastal areas within 3 miles far from the shore or having a depth less than 50 m, but never closer than 0.7 miles in 2007 ($)	FCZG	P	SOME	(CFP) EC MED REG			C		2007
Encircling gears for small pelagics in coastal areas within 300 m far from the shore or having a depth less than 50 m, with a depth >70% of the drop	FCZG	P	SOME	(CFP) EC MED REG			C		2007
Boat dredges and hydraulic dredges in coastal areas within 0.3 miles far from the shore	FCZG	P	SOME	(CFP) EC MED REG			C		2007
Sponge dredges in coastal areas within 0.5 miles far from the shore or having a depth less than 50 m	FCZG	P	SOME	(CFP) EC MED REG			C		2007

Legend.
Type of protection: **FCZ**: fisheries closed zone; **FCZG**: fisheries closed area for some gear; **FMZ:** Fisheries Management Zone; **FR**: Fishery Reserve; **HR**: hunting refuge; **MPA**: marine protected area; **MPZ**: marine protected zone (France); **MR**: marine reserve; **MNR**: marine natural reserve; **MaNR**: Managed Natural Reserve; **BPZ**: biological protection zone; **BR**: Biosphere Reserve; **MS**: marine sanctuary; **NMR**: Natural Marine Reserve; **NP**: National Park; **NM**: Natural Monument, **NR**: Natural Reserve;**APB**: Area for the protection of biotopes; **ZPE**: Zone for ecological protection; (*) besides the national type of protection, these areas have been included among **SPAM**I: specially protected areas of Mediterranean importance, according to the Barcelona Convention (2001); ($) more restrictive national regulations already exist.
Type of main objective: **C**: Conservation of the marine biodiversity; **E**: education; **R**: restocking; **T**: tourism/recreation.

Appendix 3

Review of Existing MPAs

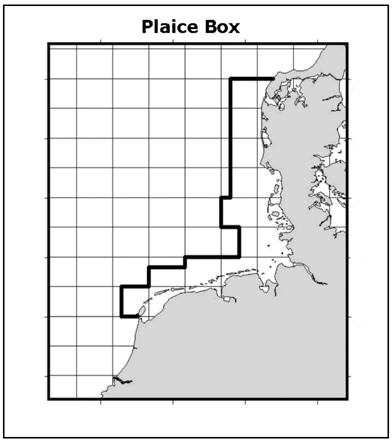
1. North Sea Plaice Box
2. North Sea Cod Box
3. Irish Sea Cod Box
4. Shetland Box
5. Norway Pout Box
6. Sprat Closed Area Box
7. Baltic Sea Cod Closure

Introduction

The reviews of the North Sea Plaice Box, the North Sea Cod Box, the Shetland Box, the Norway Pout Box, the Sprat Closed Area Box, Baltic cod fishery closures, Firth of Forth and Shetland Sandeel fisheries are drawn from (Sørensen, 2006; Suuronen, 2006; Mosegaard, 2006; Wright, 2006) in the *PROTECT (2006) Review of MPAs as a Tool for Ecosystem Conservation and Fisheries Management* (a Deliverable of EU 6th Framework Programme, Specific Targeted Research Project No. SSP8-CT-2004-513670) and the Irish Cod closure from Kelly et al. 2006.

1. North Sea Plaice Box

Map



Approximately 30 nm wide extension of the 12 nm zone stretching from Den Helder in the Netherlands to Hanstholm in Denmark.
Map Source: http://europa.eu.int/comm/fisheries/news_corner/press/inf05_46_en.htm

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Purpose of establishment

North Sea Plaice is mainly taken in a mixed flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Minimum mesh size of 80 mm results in much discard (ICES 1987). In addition, the survival of discarded plaice is very poor (unpublished RIVO report 1985 in ICES 1987).

The Plaice box was established to reduce discards of undersized plaice and sole in their main nursery grounds (FSBI 2001; Marchal et al. 2002).

The scientific basis of the current closure is the notion that by a reduction in fishing effort in areas with a high abundance of undersized plaice, discard mortality rates will be reduced so a larger proportion of each cohort of 0-group fish will recruit to the fisheries and to the adult population (Rijnsdorp 1998). Scientific basis developed in 1987 by ICES North Sea Flatfish Working Group (ICES 1987). ICES (1987) advised closure to reduce discard rate.

- A similar proposal was discussed in 1912 by the ICES Plaice Committee. The Plaice Committee agreed that the plaice stock in the North Sea had suffered a decrease in larger-sized fish since the advent of the steam trawling fishery. It agreed that closing nursery grounds would preserve smaller plaice for capture after they grew to a more valuable size, but recognised the political difficulties of such a measure internationally (Rozwadowski 2002).

Selection methodology and design

North Sea Beam trawlers mainly target sole and plaice. Undersized juveniles of these species mainly reside in shallow coastal waters along the continental coast (Piet et al. 1998).

Distribution maps showed that discarding was concentrated on age group 2 and 3 in rectangles along the Frisian Islands, German Bight and up along the Danish coast (ICES 1987). It was expected that a closure of the areas with the highest densities of young plaice would have the highest impact (ICES 1987).

The Plaice box is not part of a designed network of closed areas (ICES 2004a).

Implementation process and legal aspects

The Plaice box is based on EEC Council Regulation No 4193/88 (FSBI 2001).

At first Dutch trawling in the Plaice box area was restricted to small vessels harvesting according to gear and catch restrictions (Piet et al. 1998; Piet and Rijnsdorp 1998) to directly and indirectly reduce numbers of juvenile plaice and sole caught and increase predicted plaice recruitment by 25% (ICES 1994) and sole recruitment by 11% (Rijnsdorp et al. 1998). Failure to meet predicted recruitment levels, possibly due to increased legal fishing within the box (Pastoors et al. 2000) led to regulations being extended to the fourth quarter in 1994 and from 1995 the whole year. In summary, the Dutch trawling effort in the Plaice box was reduced in several phases:

At first the area was closed only during 2nd and 3rd quarters, but in 1994 the closure was extended to 4th quarter. Since 1995 the Plaice box has been closed for all but the exemption fleet all year (Piet et al. 1998; Marchal et al 2002).

<table>
<tr><th>Period</th><th>Regulation</th><th>Period</th></tr>
<tr><td>-1989</td><td>No specific regulation</td><td></td></tr>
<tr><td>1989-1993</td><td rowspan="3">No fishing within the box by bottom trawlers with vessels larger than 300hp.
(Not applicable to exemption fleets)</td><td>2nd and 3rd Quarters</td></tr>
<tr><td>1994</td><td>2nd, 3rd and 4th Quarters</td></tr>
<tr><td>1995-present</td><td>Year round</td></tr>
</table>

No fishing is allowed inside the Plaice box within 12 nm of the coast by vessels exceeding 8m overall using beam and otter trawls (Council regulation (EEC) No. 3094/86) (Piet & Rijnsdorp 1998).

Inside the Plaice box (beyond 12 nm from the coast), no fishing is allowed by beam trawlers and otter trawlers exceeding 24 meters and 300 Hp (“Eurocutters”). Fishing by other vessels (exemption fleet) is permitted provided that they are (Piet & Rijnsdorp 1998):

- on an authorised list and that vessel length is less than 24 m and engine power does not exceed 300 Hp, even if fishing with beam trawls
- not on a list but fishing for shrimp (incl. beam trawl)
- not on a list but fishing with other trawls using 100mm mesh, even if engine power exceeds 300 Hp, provided that at least 5% of the catch is sole, and no more than 10% of the catch is composed of cod, haddock and saithe.

Ecosystem effects

Effects of the Plaice box were predicted based on estimated changes in yield per recruit and spawning stock biomass (SSB) per recruit under various fishing patterns (ICES 1987). Using quarterly data on distribution of age groups and distribution of undersized plaice per ICES rectangle, expected gain in recruitment to the fishery was calculated for various scenarios, under the following assumptions (ICES 1987):

- quarterly spatial distribution of each age group was fixed and not affected by changes in fishing patterns or growth
- a constant growth rate, independent of density
- all effort was expelled from the box

Predicted effects of the Plaice box (ICES 1987):

- For a cohort of plaice, proportion surviving could increase by ca. 25% if box closed for all discarding fleets in 2nd and 3rd quarters; and almost ca. 35% if closed all year.
- General enhancement of sole predicted, but to a lesser extent than plaice, due to generally lower discards in sole (Rijnsdorp and van Beek 1991).

To measure the effects of the Plaice box according to its objectives, the question that must be asked is: Has the cumulative discard mortality until the time when the cohort reaches the minimal landing size decreased? (ICES 1999)

Actual effects: According to various references, the reduction in Dutch beam trawl effort to around 6% (e.g. Pastoors et al. 2000) of the original level led to:

- Reduction in overall juvenile discard (Pastoors et al. 2000).
- No real signs of improvement (ICES 1999).
- No change in species composition (Piet and Rijnsdorp 1998).
- Increase in abundance of commercial fish species within marketable size range (Piet and Rijnsdorp 1998).
- Positive effects (in 1994) were probably reduced by low growth rate, exemption fishing fleet and increased fishery in 4th quarter (ICES 1994 in ICES 1999).
- Increase in species richness due to influx of southerly species and decrease in relative abundance of plaice, within and outside Plaice box (FSBI 2001).
- SSB (spawning stock biomass) and yield have decreased since initial claims of increase (Pastoors et al. 2000).
- If the Plaice box were removed, long term standing landings and SSB would decline 8 and 9% respectively (Horwood 2000).
- Beam trawl discards remain very high inside and outside of the Box. Discard is higher inside the Box than outside, usually made up of mostly age 2 plaice (18-27 cm). Shrimp fisheries also appear to have high discards (ICES 1999).

Overall, it is not possible to determine the extent to which the Plaice box has contributed to the apparent increase in the fishing efficiency of some of the exemption fleets fishing on the grounds where management has been implemented (Marchal et al. 2002).

Documented effects of the Plaice box on invertebrate fauna:

- Data of by-catch of benthic invertebrates of two beam trawl surveys showed significant effects of closure. Closing the box in 2nd and 3rd quarter caused an increase in abundance of several benthic invertebrate species followed by a decline when the Plaice box was closed year-round. Perhaps the most abundant were scavengers and predators for which the deleterious effect of additional mortality is overruled by a decreased competition for food and risk of predation.

- Same shift to opportunistic species (mainly polychaetes) adapted to disturbed habitats has been observed in Dogger Bank, Wadden Sea and German Bight (Kröncke 1990, 1995 in ICES 1999).

In addition, the Plaice box is important for breeding Sandwich tern populations and for red and black throated divers, red-necked grebe, common scoter, little gull and common gull (Skov et al. 1995).

Effects on fisheries effort/ benefits

Larger beam trawlers (>300Hp) continued to fish in the Box especially in 4th quarter in the period 1989-1994 (Marchal et al. 2002). Surplus effort was probably intensified outside box (Piet et al. 1998). 1993-1996 confirms heavy exploitation just outside the Plaice box by large vessels as well as inside the Plaice box during open months (Rijnsdorp et al. 1998).

The Dutch beam trawl effort was reduced to 40% between 1989 and 1993 (Pastoors et al. 2000). After 1994-1995, beam trawl effort decreased to 6% of original levels (Pastoors et al. 2000). Thus, the year-round closure resulted in a 94% reduction in effort of large Dutch beam trawlers. Most of the effort, however, was displaced to areas just outside the Plaice box (ICES 2004a).

The Plaice box has been an effective measure to exclude large beam trawlers (Pastoors et al. 2000). Reduction in beam trawl effort implies that discard mortality rate is decreased.

Fishing with small vessels continued in the Plaice box, in fact the exemption fleet increased in capacity (Pastoors et al. 2000). Fishing effort of *exemption* beam trawlers (max. 24 m and 300 Hp) increasedby 90% between 1989 and 1994 (Grift et al. 2004). For instance, the main effort build up of the Dutch shrimpers from 1989 to 1993 took place inside the Box, caused by an increase in small roundfish vessels switching to fishing for *Crangon* (brown shrimp) (ICES 1994). It decreased again by 45% between 1994 and 1998 (Grift et al. 2004). Simultaneously, stricter enforcement of engine power limitations in the German area brought effort down as well as reduced catch rates. An increase in Danish gillnet fishing efforts took place between 1989 and 1994 (Grift et al. 2004).

Landings per unit effort for Plaice decreased by more than 50% in the Box, but percentage of Plaice discards (% of numbers caught) in the beam trawl fishery increased from 77% between 1976 and 1990 to 87% between 1999 and 2003, both in terms of numbers and in biomass (Grift et al. 2004).

Socio-economic effects on fisheries and other stakeholders

German otter trawlers found that the Plaice box measures were too restrictive (Dahm et al. 1996). Among most interviewed fishers (Venema 2001) there is much incongruence in the perception of the Plaice box and its effects. The perception of fishers is naturally dependent on whether or not and/or how their fisheries are affected by the establishment of the closure. Thus, the Plaice box has a varying degree of support from fishers, ranging from “waste of time”/”big mistake” to “undivided support” (Venema 2001).

- "There is generally a lack of communication between authorities, biologists and the fishers. No one has attempted to communicate with fishers" (quote from a fisherman in Venema 2001).
- A fisherman with a vessel greater than 300 hp states in Venema (2001): "There is no control over number of Eurocutters (≤ 300hp) fishing in the Box. Their numbers are increasing within the Plaice box. A high number of Eurocutters of 300hp are just as destructive as beam trawlers greater than 300 hp. A trend among dutch fishers is to sell larger vessels and buy Eurocutters. Eurocutters are exempt of logbooks, but shouldn't be."

Registered engine power cannot in general be considered totally reliable (COM 2001). According to an interviewed fisher, new engines of e.g. 2000 hp can have a much greater power than an old engine of 2500 hp (Venema 2001).

"…there is a perception by the local industry that the Box provides some socio-economic benefit even if there is little evidence for this" (Anon 2005).

Lessons learned

There is no direct evidence that the Plaice box has had a positive effect on recruitment. Since the Plaice box was established in 1989 recruitment has shown a negative trend for the southern North Sea, i.e. SSB (spawning stock biomass) and yield are down by 60% (Grift et al. 2004).

The effects of discard reduction may have been offset by ecosystem changes in the North Sea ecosystem around the time of the establishment of the Plaice box (Rijnsdorp 1998; Pastoors et al. 2000) (changes in species abundance and composition in southern NS and reduced growth rates for plaice (ICES 1999; Pastoors et al 2000; Jennings & Kaiser 1998)) and/or relatively low number of pre-recruit plaice in early 1990's (Pastoors et al. 2000).

A shift in the distribution of juvenile plaice has also been suggested as an explanation (Rijnsdorp 1998). For instance, juvenile plaice usually avoided deeper waters because of predation by cod. As cod stocks are lower now than in previous times, there is less reason for juvenile plaice to avoid predation, i.e. they may leave the Plaice box and swim into deeper waters. Alternatively, a decrease in the abundance of older plaice may have led to less competition for food in deeper areas, i.e. smaller plaice may swim into deeper waters to forage (Rijnsdorp 1998).

The expulsion of Dutch beam trawlers has been blamed for the drop in ecosystem productivity. However, the literature shows (e.g. Schratzberger & Jennings 2002; Schratzberger et al. 2002) no positive effects of bottom trawling on ecosystem productivity.

There is no single parameter from which the ecological effect of the box can be measured. The Plaice box management measure was not set up as experimental design, with a control area, that would have allowed statistically sound comparisons and conclusions (Grift et al. 2004). Effects of MPA on size structure have been shown, but closure effects are in this case impossible to separate from natural changes (ICES 1999; FSBI 2001).

The Plaice box is not a closed area: There are still beam trawlers ≤ 300hp, a *Crangon* (shrimp) fleet and otter trawls operating in the Plaice box. In 2003, still *7%* (6.695 tonnes) of the total plaice landings from North Sea came from the Plaice box (Grift et al. 2004).

Data is lacking in many cases on the spatial distribution of fleets. Data shows that there is still a substantial amount of trawlers exceeding 300hp fishing in the 12 nm zone and in the Plaice box after its full implementation in 1995 (Marchal et al. 2002).

Expected gains were reduced by the increasing amount of effort exerted by small vessels and larger trawlers in the 4th quarter within the Plaice box since its closure in 1989 (ICES 1994).

Using quarterly data on distribution of age groups and distribution of the proportion of undersized plaice per ICES rectangle, expected gain in recruitment to the fishery due to the establishment of the Plaice box was calculated for various scenarios, under the following assumptions (ICES 1987; Pastoors et al. 2000), both of which are quite unrealistic (Ed.):

- quarterly spatial distribution of each age group was fixed and not affected by changes in fishing patterns or growth
- constant growth rate, independent of density

The best way to make the Box effective would be to prohibit all demersal trawling in the area, regardless of gear and engine power (Anon 2005). Closure of the whole box to all vessels on a year-round basis would provide greater fisheries benefits (landings and SSB would increase by 24 and 29% respectively (Horwood 2000). Many young plaice die when discarded from e.g. permitted *Crangon*-shrimpers. Total closure would potentially also lead to increased recruitment rates in sole, which also suffer high discard levels (ICES 1999).

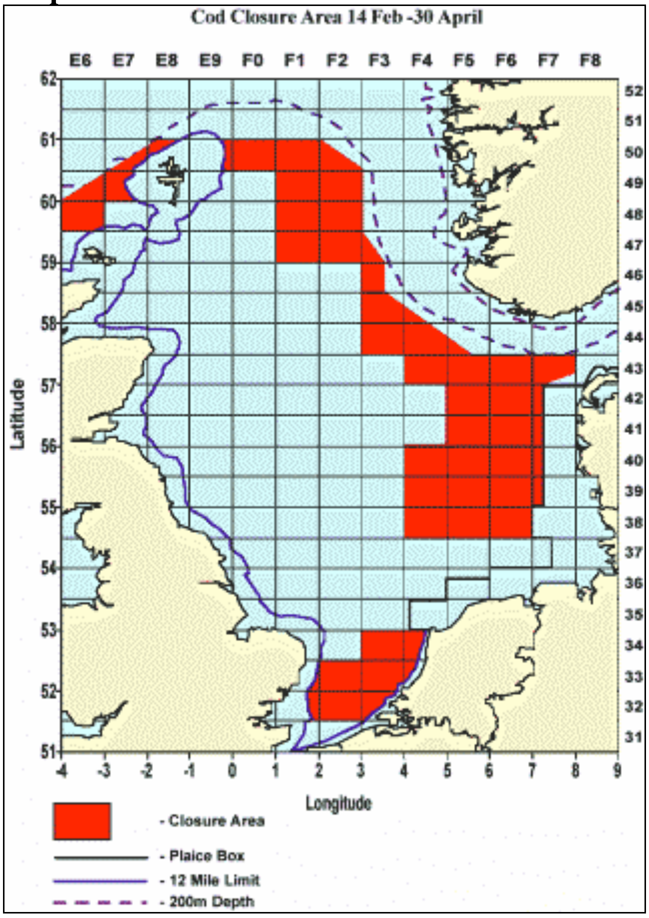
Additional recommendations regarding the Plaice box (Grift et al. 2004):

- Specific aims and objectives of the closure should be considered and well defined
- Relevant, measurable criteria should be considered/developed
- A research programme should be established to monitor effects over a predetermined time scale
- The Plaice box should be established in an experimental setup, which allows for the separation of autonomous developments and the closure (with or without fishing) effects, for example a control area which differs from the treatment area only in terms of fishing intensity.

According to the European Parliament (1999), “a recurrent theme in the EU has been the weakening of conservation policy for particular national social and economic interests, and the Plaice box is a good example of this”.

2. North Sea Cod Box

Map



Map source: www.cefas.co.uk/fsmi/roundfish.htm

Area of more than 40.000 square miles, almost a fifth of the North Sea, that in 2001 was closed to fisheries likely to catch cod for 75 days (Dinmore et al. 2003).

Purpose of establishment

The cod stock in the North Sea was considered by ICES to be outside of safe biological limits and at serious risk of collapse (ICES 2001; Cook et al. 1997).

The immediate requirement was to allow as many cod to spawn in the period mid-February to end April 2001 (ICES 2004a).

EU Council asked the Commission of the European Communities to establish a plan to protect the cod stock during spawning season and to stop misreporting and discarding of cod in all fisheries. This plan was called the Cod Recovery Plan and included:

- Closed areas
- Technical measures
- Comprehensive proposals for longer-term measures

The North Sea beam trawl fishery doesn't primarily target cod, but cod are taken as a significant and valuable by-catch and vessels fish in many cod spawning areas.

In 1993 the EU had investigated possible effects of closing cod areas. It was concluded that, due to a limited understanding of fish movements and fleet behaviour, a closure would do very little for cod, even if they were very large areas. (Horwood 2000).

Selection methodology and design

The closed area was part of the Cod Recovery Plan and was not designed as part of a larger network of closed areas (ICES 2004a).

Implementation process and legal aspects

In November 2000, ICES indicate that cod stock in North Sea area IV is in serious risk of collapse (ICES 2004a). The Council meets in December 2000, where the Commission and Council note an urgent requirement to establish a recovery plan for the North Sea cod stock, termed the "North Sea cod recovery plan" (ICES 2004a). An Agreed Record was signed January 24 2001 by EU and Norway, indicating the management measures which should take place (ICES 2004a).

It was decided that it was urgent that a closed area be established. However, the North Sea Cod box took months to implement (ICES 2004a).

Commission Regulation (EC)No 259/2001 of 7 February 2001 establishes measures for the recovery of the stock of cod in the North Sea (ICES sub-area IV) and associated conditions for the control of activities of fishing vessels.

- However, fishing for sand eel and pelagic species were allowed in the Cod box. It was decided that observers should be placed on board vessels fishing for these species.

Ecosystem effects

The closure probably had a negative impact on the rate of discarding of vulnerable components of the ecosystem (e.g. elasmobranchs or long-lived benthic species) due to an increase in trawling activities in areas that are not normally fished (ICES 2004a).

No data exists that allows an evaluation of changes outside the closure (ICES 2004a; Rijnsdorp et al. 2001). The closure may even have been counter-effective for cod, commercial species and benthic ecosystems (Rijnsdorp et al. 2001).

In addition to overfishing, the North Sea cod stock is threatened by a decline in the production of young cod that has paralleled warming of the North Sea over the past ten years. Possible persistence of adverse warm conditions combined with a diminished stock endangers the long-term sustainability of cod in the North Sea. To decrease risk of collapse, fishing pressure must be reduced (O'Brien et al. 2000).

Effects on fisheries effort/benefits

Fishing activities were monitored using Vessel Monitoring Systems (VMS) and the biota (demersal fish and benthos) during several bottom surveys (ICES 2004a). VMS was very effective in enforcement. During the period target effort was reduced by (probably) 100% within the Cod box (ICES 2004a).

Beam trawl fisheries were affected. Beam trawlers in the area target sole, plaice, dab, turbot and brill, but they also catch roundfish such as cod as by-catch (Rijnsdorp et al. 2001).

Eurocutters (beam trawlers up to 300 hp) were not directly affected by the area closure, since they may fish in the 12 nm-zone. These smaller vessels may even have benefited from reduced catches in the Cod box, since sole within the closure migrate to shallow coastal areas within the 12nm-zone to spawn in spring (Rijnsdorp et al. 2001).

Discard information shows that plaice discards were about 78% in the box area (ICES 2004a). Adjacent to the box area the discards were 31% before closure but 74% in the period 1999-2000 for focal species. For commercial species there was a minor increase in discards from 12% to 19% (ICES 2004a).

Displaced beam trawlers continued fishing throughout the closure, but in other fishing grounds (Rijnsdorp et al. 2001). Beam trawl effort mainly moved to the area "Open North". Some of the beam trawling effort was displaced to areas that had never been beam trawled before (Rijnsdorp et al. 2001; ICES 2004a), and recovery of benthic communities in these areas was expected to take more than 10 years (ICES 2003). Environmental effects of trawling on diversity, biomass and production of benthic communities are expected to be greater in these previously untrawled and infrequently trawled areas than in the normal fishing grounds (ICES 2003; Frid et al. 2005).

No data exists that allows an evaluation of changes outside the Cod box (ICES 2004a). However, no beneficial effects of the closure on cod are registered (Rijnsdorp et al. 2001; ICES 2004a).

Catches of commercial species within the Cod box were higher after re-opening but returned to normal after 2-3 weeks (ICES 2004a).

Socio-economic effects on fisheries and other stakeholders

- no data

Lessons learned

INSIDE the Cod box: Closed areas only partially overlapped with known spawning grounds (Rijnsdorp et al. 2001; ICES 2004a). In the southern grounds, peak spawning takes place from weeks 4-7 and probably somewhat later further north. The Cod box was closed weeks 8-17 so it probably only protected the second part of the spawning season (ICES 2004a; Rijnsdorp et al. 2001).

The aim of the emergency closure was to reduce fishing mortality on spawning cod, but the wider consequences of this closure were not considered at the outset (Frid et al. 2005)

Closure did not meet objectives. Inappropriate timing and positioning of the area resulted in that no positive effects of the closure were achieved (ICES 2004a).

There was no overall effort reduction during closure, only displacement of fishing effort (Rijnsdorp et al. 2001).

The Cod closure was rather poorly designed, did not consider side effects on the level of discarding in demersal stocks, and did not consider the wider ecosystem implications (Rijnsdorp et al. 2001).

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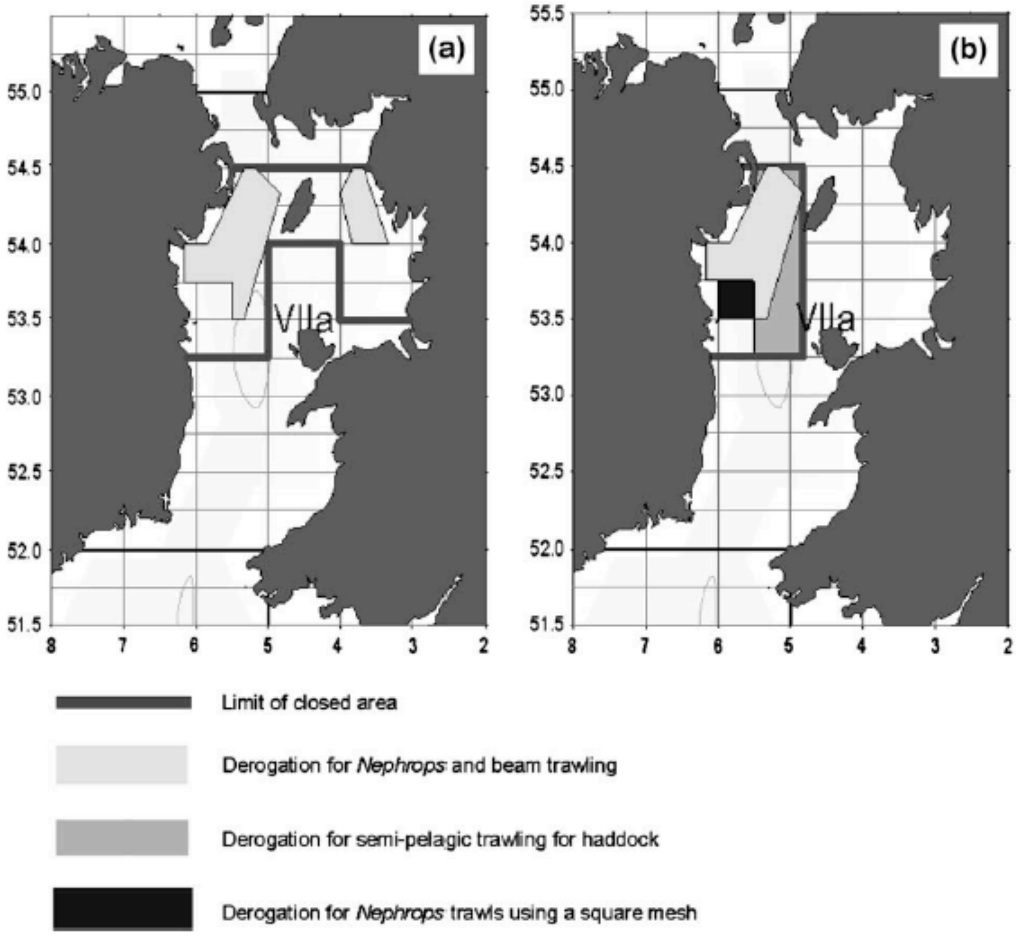
3. Irish Sea Cod Box

Map



Location of the closed areas in the Irish Sea (Area VIIa) cod recovery plan for the period 2000-2004. (a) The area closed in 2000 under regulation EC No. 304/2000 from 14 February to 30 April (thick black line); (b) closed areas amended under regulation EC No. 300/2001. The light grey polygons indicate areas where a derogation was in place for *Nephrops* and beam trawling, the dark grey rectangle where a derogation was in place for haddock fishing with semi-pelagic trawl nets, and the black box where a derogation was made for *Nephrops* vessels using a square-mesh panel (Kelly et al., 2006).

Purpose of establishment

Historically, cod has been one of the most important fish stocks in the North Atlantic. Recent stock collapses have been attributed to overfishing, and in February 2000 the European Commission established a closed area in the Irish Sea as part of a general recovery plan. The recovery plan was further revised and implemented between 2001 and 2005 (Kelly et al., 2006).

Selection methodology and design

The closed area was part of the Cod Recovery Plan and was not designed as part of a larger network of closed areas (ICES 2004a).

Implementation process and legal aspects

Irish Sea cod stocks have experienced a continuous decline in spawning-stock biomass (SSB) over the past 20 years. The biomass was estimated to be so low in 1999 that ICES (the International Council for the Exploration of the Sea) advised that the stock was in danger of collapse, and recommended that a recovery plan be put in place (ICES, 2001). In February 2000, the European Commission established measures to aid recovery (Anon., 2000a). These measures initially included two closed areas in the eastern and western Irish Sea to provide the maximum possible protection during the spawning season and to maximize egg production of the existing stock. The closed areas were based on the putative spawning grounds at peak spawning time (14 Februarye30 April; ICES, 2003b). The closures applied to all fishing activities, excepting derogations for Norway lobster (Nephrops norvegicus) trawls and beam trawlers, which were permitted to fish in defined ‘‘boxes’’ within the closed areas (Figure 1a). Because of the initial restrictions, some sections of the fleet felt unfairly constrained, and many fishing representative groups lobbied for mitigating measures that would not reduce the opportunity of fishing for other species. Additional measures were adopted in November 2000 (Anon., 2000b), banning various technical specifications of towed nets. The regulation stated in its preamble ‘‘The closure to protect cod should, therefore, be established in such a way that fisheries for Norway lobster, shrimps and flatfish, should not be significantly diminished while minimizing risk to cod.’’ The extent of the closed area and derogations for fishing within the area were amended in February 2001 (Anon., 2001a), limiting the closure to the eastern Irish Sea and permitting two types of fishing within the reduced closed area through derogation (Figure 1b). This was again further amended in July 2001 (Anon., 2001b), permitting the use of double twine no greater than 4 mm in the construction of the codend of the trawls. The recovery plan was further specified in 2004 (Anon.,2004), setting a target biomass for the stock of Bpa 1/4 10 000 t and establishing procedures for the setting of the total allowable catch (TAC). These procedures were designed to ensure a 30% annual increase in SSB (relative to the most recent assessment estimates of stock size) and to limit TAC changes to 15%. During that time there were consultations with fishers, but there were no compensation packages for those disadvantaged by the scheme, as in the case of the Canadian Northwest Atlantic cod fishery plan. As such, the Irish Sea cod recovery plan relied for its success on the reduction of quotas, the closure of spawning grounds, and technical gear regulations (ICES, 2003a).

Ecosystem effects

Although bycatch limits were specified in the recovery plan (Anon., 2001a), discard data were unavailable across all fleets (ICES, 2003b, 2004b). This lack of data prevents a complete analysis of the impact of the derogated fisheries. However, it is likely that the potential of the closed areas in reducing exploitation was eroded somewhat by creating derogations for other fishing enterprises, whose impact could not be evaluated fully. This highlights the lack of another important aspect in the Irish Sea cod recovery plan: namely, that sufficient data be collected to allow evaluation of the impact of the plan on the stock.

Effects on fisheries effort/benefits

The result of the recovery plan in terms of landings was an initial decrease, followed by increased landings and unreported catches. In terms of SSB, the ‘‘recovery’’ did not yield the expected gain, and some six years on, the stock is still well below Bpa (10 000 t), and is likely also to be below Blim (6000 t).

The latest stock assessment for Irish Sea cod (ICES, 2005b) is highly uncertain owing to problems with unreliable data, but SSB is thought to be still well below Blim 1/4 6000 t, and the stock is classed as being ''at reduced reproductive capacity and being harvested unsustainably'' and as ''overexploited''. From 1999 to 2004, the SSB of the stock is thought to have been below Blim every year, while the average F2_4 over the same period was approximately 1.3. In fact, the Irish Sea cod stock at the end of 2004 seemed to be in a state similar to that in 1999, so the recovery plan seems to have had little effect.

Socio-economic effects on fisheries and other stakeholders

There were consultations with fishers during implementation, but there were no compensation packages offered.

Lessons learned

The initial recovery plan, included closed areas to ''allow as many cod as possible to spawn'' as part of the plan to rebuild the stock. This strategy implies a relationship between reproductive potential and recruitment. However, such a relationship is far from assured. Even the obvious link between reproductive potential and SSB is subject to interannual fluctuation through egg viability. The forward link to recruitment is additionally thought to be subject to factors influencing the survival and growth of larvae and juveniles, including temperature, primary production, and predation. Given the complexity of this relationship, protecting spawning offers only a tentative probability of increased recruitment. Even if the closed areas did effect 100% protection of spawning cod, the benefit to the stock in terms of recovery would be subject to the prevailing environmental and ecological conditions (and, of course, the exploitation rate). Such a measure to protect spawning to increase recruitment would therefore seem at best passive, and at worst ineffective. Horwood et al. (1998) discuss how use of a closed area to protect the spawning stock may actually be counterproductive, because fishing mortality can be displaced onto juvenile fish outside the spawning grounds. They suggest that better use of a closed area would be permanently to close the nursery areas of the stock, so reducing discards of juvenile fish. However, even closed nursery areas have been hard to evaluate, and results are not unequivocally positive (Pastoors et al., 2000). Even with complete exclusion of all fishing fleets, a closed area alone may not be enough to reduce exploitation of a population. If there is significant movement of the fish stock between the closed area and the fishery, then the closed area is unlikely to be effective (Horwood et al., 1998). Cod are capable of moving large distances (Robichaud and Rose, 2004) so it is unlikely that a closed area on its own will be sufficient to protect the stock, and any recovery plan would need to include further effort or TAC restrictions as well. The lack of an appreciation of risk associated with a management strategy has contributed to further difficulties with the cod recovery plan. These difficulties were manifested in the frustration of fishers and managers at how long the recovery process was going to take. Other contributors to this frustration were poor communication of the inherent uncertainty and likely probability of success, and the lack of clarity in the purpose of the recovery plan. These frustrations were amplified when the stock did not appear to ''follow the plan'' as originally envisaged, or worse still, it could not be shown if the plan was working. This highlights the need for scientists to communicate to both managers and fishers the uncertainty and inherent levels of risk in a strategy, and for targets to be based on measurable improvements in the stock associated with this risk.

A better approach to the development of a recovery plan for Irish Sea cod would include the following:

(i) Clear purpose which effectively communicates that the instrument of recovery is the reduction in exploitation, and how this is to be achieved.

(ii) Clear understanding that this will require a reduction in fishing opportunities, and a consideration of the
fleet-specific reduction in revenue of such reduced exploitation.
(iii) Clear means as to how this reduction will be adhered to.
(iv) Clear, measurable performance targets, underpinned by sufficient data collection to assess performance of
recovery, and an understanding of the inherent uncertainty involved.
(v) A multispecies harvest plan to manage the stock when (or if) recovery is achieved.

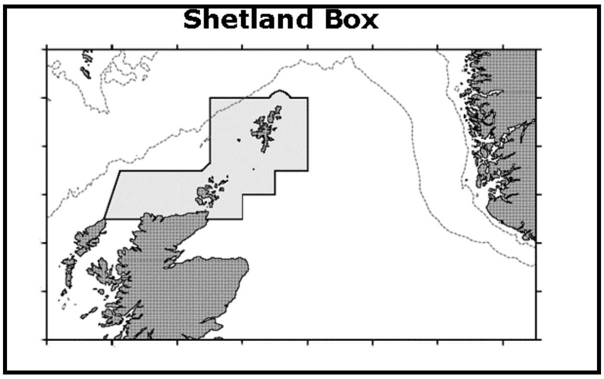
Even so, there is no guarantee that these measures if rigidly applied will lead to recovery of the stock, and this possibility should be discussed openly. However, such suggestions should allow for clear evaluation of the state of the stock in relation to both management actions and objectives.

References

Kelly CJ, Codling EA, Rogan E (2006) The Irish Sea cod recovery plan: some lessons learned. ICES J Mar Sci 63:600-610 (and papers therein)

4. Shetland Box

Map and description



Map Source: http://europa.eu.int/comm/fisheries/news_corner/press/inf05_46_en.htm

Area around the north of Scotland, Orkney and Shetland. Commercially important demersal species in the Box area are: cod, haddock, whiting, saithe, and anglerfish (Kunzlik 2001).

The purpose of establishment

Established in 1983 to protect "species of special importance…which are biologically sensitive by reason of their exploitation characteristics." (NAFC 2004)

The Shetland box played an important role in attempts to achieve a balance between the different fleets and fishing communities.

Selection methodology and design

In principle the main criterion was to grant preference to local fishing vessels (Crean & Wisher 2000).

Implementation process and legal aspects

The legal basis of the Shetland box is Council Regulation (EC) No. 2371/2002 of December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy (CFP). The number and nationality of large demersal vessels fishing at any one time is restricted by a CFP licensing scheme (Council Regulation (EC) No. 2371/2002) (NAFC 2004).

Vessels more than 26 m fishing for other than blue whiting and Norway pout are only allowed inside with a license from the European Commission. Allocations (below) are based on track records prior to partial closure (North Atlantic Fisheries College. Vessels without licenses may only enter if less than 26 m, unless they fish only for blue whiting and Norway Pout. There are 128 licenses: 62 to UK, 52 to France, 12 to Germany, 2 to Belgium (NAFC 2004).

The exemption of Blue whiting and Norway pout is to clarify what is covered by "fishing for demersal species". This is because these species are usually caught using different techniques closer to those used in pelagic fisheries, and the species are covered by other regulations, among others the Norway Pout Box (COM 2002).

Ecosystem effects

On the basis of fisheries sensitivity maps (Coull et al. 1998 in NAFC 2004) the Shetland Box is suggested to have relatively important, disproportionate concentrations of spawning and nursery grounds for 9 of 13 species for which maps were available. There appears to be a case for retaining (or strengthening) current management arrangements (NAFC 2004).

Shetland box contains a disproportionate concentration of mature haddock and whiting, young anglerfish and, to a lesser extent, young haddock than neighbouring waters. It indicates that the area is important in the distribution of these fish at a time when the abundance of the principal gadoid fish stocks is known to be generally reduced (Kunzlik 2001).

However, the vulnerability of stocks and importance of areas rely on a qualitative view of data. They reflect differing impacts on species, which also vary in age. Nevertheless, taken together, they support the argument that the region of the Shetland Box is of conservation importance to the species concerned (Kunzlik 2001).

Effects on fisheries effort/ benefits

For light trawlers, annual Landings Per Unit Effort (LPUE) when fishing in the Shetland Box are consistently higher than when fishing outside the box (Anon 2005).

Demersal fish stocks of importance to the region are shown to have declined generally in abundance since initial EEC Regulation was adopted in 1983, especially for cod, whiting and haddock (Kunzlik 2001).

Spawning Stock Biomass (SSB) estimates for 1999 are substantially below that of 1983 for cod, haddock, and whiting, and close to its 1983 value for saithe. *Cod*= continuous decline. *Whiting*=stability throughout 80's then continuous decline. *Haddock and saithe*=current stock estimates indicate upturn following lowest observations in 1990's (ICES 2001).

Socio-economic effects on fisheries and other stakeholders

There is a heavy economic dependency of the area's local communities on fishing. They are still dependent on fishing In 1998 33% of Shetland economic turnover was from fishery and appr. 20% of active population is employed in the fishing industry (DEFRA 2002). The Box is a statement of the importance of fishing to the islands (Crean 2000).

Some say that Shetland Box was established to protect northern Scottish fishing communities (NAFC 2004). Some say that the Shetland Box has nothing to do with fisheries, but rather is a compensation to the UK for accepting conservation elements of the Common Fisheries Policy (Holden 1994). The general view among interviewed fishers (NAFC 2004) is that the retention of the Shetland Box could be acceptable if a sufficiently compelling case was made for its conservation benefits.

Discussions from representatives of fishing communities from Member States with and without access revealed support for *non-discriminatory* measures to conserve fish stocks. They were, however, unconvinced of the positive effects of the Shetland Box. They say it must be proven better AND be non-discriminatory (NAFC 2004).

Interviewed Shetlands fishers: The Box, as it is constructed, is viewed as relatively unimportant with regard to excluding outsiders and, therefore, its potential to lessen exploitation pressure upon fisheries resources (Crean 2000; Crean and Wisher 2000).

A strong majority of Shetland fishermen believe that local fishermen do not have enough say in management of coastal fisheries resources and that fishermen’s knowledge was not used to help formulate fisheries management regulations (Crean & Wisher 2000). In addition, they believe that fisheries regulations in force do not suit local conditions.

Lessons learned

It seems unlikely that the management regime for the box has ever effectively restricted the level of fishing effort. There is no evidence of unsatisfied demand for licences or for access to the Box. Vast majority of vessels are too small to require a license in any case (NAFC 2004).

To keep the Box, it must be based on future potential and not the past record (NAFC 2004).

If the Box is renewed it will be necessary to develop new management regime that is not overtly discriminatory. (NAFC 2004).

Value of the Shetland Box to Shetland itself is largely, if not entirely, symbolic. Not to say that it is not an important area in biological conservation terms or as a potential conservation tool (NAFC 2004).

Key interviewed informants of the Shetland Islands can be said to have the following points of view, among others (Crean & Wisher 2000):

- diminished capacity of the centre to exert control
- marginalisation of local knowledge/views
- inadequate penalising of rule breakers

No system was ever established to monitor the Shetland Box or to collect the data that would be needed to demonstrate its effectiveness (NAFC 2004).

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5. Norway Pout Box

Map

Norway pout box was introduced in 1986. Its size is 95.000 km^2 or appr. 30.000 square nautical miles and it overlaps with the Shetland (or North of Scotland) Box.

Purpose of establishment

According to EC Regulation No 3094/86, the purpose of the Norway pout box is to reduce levels of fishing mortality on juvenile gadoids such as haddock and whiting in the Norway pout fishery, and hence increase the recruitment of these species to the stock biomass for sustainability and for future fisheries (Anon 1986).

Selection methodology and design

The Norway pout box was designed by an expert committee.

EC Regulation No 3094/86 defines the boundaries of the Norway pout box (Anon. 1986).

Implementation process and legal aspects

Norway Pout is regulated by minimum mesh size, the Norway pout box and by-catch regulations to protect other species (ICES 2004).

UK Government ratifies statutory instrument setting up area closure of the Norway Pout fishery in Feb 1977.

Dates	Extent of Box			
	Northern Boundary	Eastern Boundary	Southern Boundary	Western Boundary
21 Feb – Mar 77	60°N	0°	56°N	4°W
1 Apr – 31 Aug 77	None	None	None	None
1 Sept – 15 Oct 77	60°N	0°	56°N	4°W
16 Oct 77–30 Sept 78	60°N	0°	56°N	4°W
1 Oct 78 – present	60°N	2°E median	56°N	4°W

(Table: Modified from ICES 1979)

Restrictions on fishing for Norway pout with small meshed trawls to protect other roundfish: The Norway pout box is a defined area in the Northern North Sea, east of Shetland. Retention of Norway Pout on board a vessel inside the Box (exceeding a 5% by-catch level) is considered to be an offence. This regulation is to prevent the capture of juvenile haddock (which are abundant within the Box) by vessels that use 16mm nets, which are allowed for Norway Pout elsewhere (European Parliament 1999).

In 2005 the fishery was closed, and there has been no directed effort for Norway pout in the first two quarters of 2005, except for a very small Danish trial fishery in the 2nd quarter of the year in the North Sea (ICES in press).

Ecosystem effects

Since the establishment of the Norway pout box no studies have been carried out on neither the effects of more selective fisheries technology and changed fleet behaviour, nor does the data exist that enables an evaluation of the Box and an analysis of the consequences of a partial or total reopening of the Box (Anon 1987).

Analyses of catch and bycatch data in the Danish Norway pout fishery inside and outside the Box 1975-1986:

- The conclusion was that bycatch of each age group of whiting, haddock and herring depends on location, quarter, year class strength and year within the study period (Anon 1987).

Bycatch of whiting and haddock dominated in the Norway Pout fishery. Bycatch was shown to be correlated with introduced technical measures, including the Norway pout box and the introduction of the Common Fisheries Policy in 1983. However, changes in bycatch were shown to be linked to differences in yearly and seasonal distribution of Norway pout. Thus, it is difficult to separate area and seasonal effects. In addition, technological development in the industrial fisheries in this decade was not evaluated (Anon 1987).

A monitoring programme has been established in 2005.

Effects on fisheries effort/ benefits

Fishing began in Northern North Sea using light high headline demersal trawl in the late 50's. In the mid 70's the maximum catch was 736.000 tons in 1974. Rapid increases in catch of Norway pout led to ICES establishing a work group on Norway Pout and sand eel in the North Sea. At meetings in 1977 and 1978 the ICES Advisory Committee found no clear need for any regulations on the exploitation of Norway pout (ICES 1979).

Norway pout is caught (for fish meal and fish oil) in small meshed trawls (16-31mm) in a mixed fishery with blue whiting. The blue whiting component in the catches has been relatively low in recent years, and the Norway pout fishery has become cleaner.

In addition to the directed Norway pout fishery, the species is also taken as by-catch in the blue whiting fishery.

The Norway pout TAC in the North Sea shared between Norway and EU (mainly Denmark). Official landings of Norway pout in ICES area Via (northern North Sea) has fluctuated between 2.000 and 14.000 tonnes for the last 10 years with an average of 7.700 tones (SWG 2005). In 2004 the proportion of the official landings of Norway pout landed by Norway in the North Sea was approximately 40%, while the EU (mainly Denmark) landed the remaining

60% (SWG 2005).

In 2005 the fishery was closed, and there has been no directed effort for Norway pout in the first two quarters of 2005, except for a very small Danish trial fishery in the 2nd quarter of the year in the North Sea (ICES in press).

The effects of the Norway pout box are unknown and not yet thoroughly evaluated. Earlier attempts have proven it impossible to differentiate the effects of the box from the effects of e.g. technological advances and selectivity of gear (Anon. 1987). The scientific basis for an evaluation of the effect of the box and the consequences of reopening the box does not exist (Hoffmann et al. 2004; Anon. 1987).

Since the establishment of the box there have been great changes in the industrial fisheries and stocks in the North Sea, i.e. a general reduction in by-catch of roundfish, including the Norway pout fishery. Reduction in bycatch exceeds decline in stock sizes of roundfish. This is partly due to altered behaviour of the fishery, which is related to higher levels of control and enforcement (DIFRES 2001).

Historically relevant studies relating to evaluations of the Norway pout Box include the EU Project "The consequences of increased North Sea herring, haddock and whiting abundances for the fishery for Norway pout in the North Sea" (Anon 1987).

Socio-economic effects on fisheries and other stakeholders

According to Raakjær Nielsen and Mathiesen (2002), Norway pout fishery was accused of having large by-catches of whiting and haddock. Danish fishers say this is more a question of political dispute over territorial fishing rights and not a measure to protect fish.

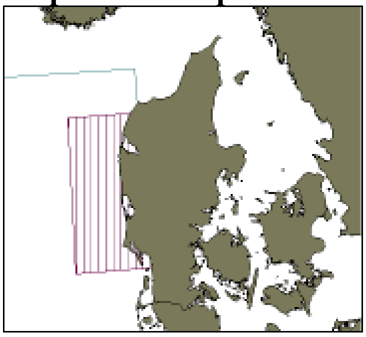
According to Raakjær Nielsen and Mathiesen (2002), the Spanish minister of fisheries in the debate on the reform of the Common Fisheries Policy proposed by the EC accused the Danish industrial fisheries of being unsustainable, all knowing that the hidden agenda was to get focus away from a huge reduction of the capacity of the Spanish fleet and for Spain to get access to the North Sea.

Lessons learned

Since the establishment of the Norway pout box no studies have been carried out on neither the effects of more selective fisheries technology and changed fleet behaviour, nor does the data exist that enables an evaluation of the Box and an analysis of the consequences of a partial or total reopening of the Box (Anon 1987).

6. Sprat Closed Area Box

Map and description



Map Source: Hoffmann et al. 2004.

Purpose of establishment

Although it is called the Sprat Closed Area, it was actually established to reduce mortality of juvenile (0-group) herring (*Clupea harengus*). Establishment of Sprat Box was expected to lead to a significant decrease in the levels of by-catch of juvenile (especially 0-group) herring in the entire ICES IVb-area (Hoffmann et al. 2004).

Selection methodology and design

Much sprat fishery in the box area led to a very large by-catch of juvenile herring. Random sampling showed that 90% of the herring by-catch took place within the current Sprat Box (Hoffmann et al. 2004).

Implementation process and legal aspects

Annual closure to industrial fishery from 1st July to 31st October (Hoffmann et al. 2004).

COUNCIL REGULATION (EC) No 850/98 of 30 March 1998 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms

Article 21 Restrictions on fishing for sprat to protect herring

1. The retention on board of sprat which are caught within the geographical areas and during the periods mentioned below shall be prohibited:

…

(c) from 1 July to 31 October, within the geographical area bounded by the following coordinates:

- the west coast of Denmark at latitude 55° 30' N,
- latitude 55° 30' N, longitude 7° 00' E,
- latitude 57° 00' N, longitude 7° 00' E,
- the west coast of Denmark at latitude 57° 00' N.

2. However, vessels may retain on board quantities of sprat from any of the areas described, provided they do not exceed 5 % of the total live weight of the marine organisms on board which have been caught in each separate area during any of the periods specified. (Anon. 1998)

Ecosystem effects

Why the increase in 0-group herring by-catch in the 1990’s after a drastic decrease in 1984?

Hoffmann et al. (2004) present several hypotheses that have been discussed in various ICES working groups:

- Large cohorts of herring with more widespread distribution outside Box. However there is no consistent connection between *recruitment strength* and fisheries mortality of 0-group herring.
- Overall conclusion: No clear connection between establishment of Box and fisheries mortality of 0-group herring from the Box's establishment to 1996.

From 1996 there has been a reduction of by-catch. This coincides with the introduction of a limitation of herring by-catch in industrial fisheries.

Effects on fisheries effort/ benefits

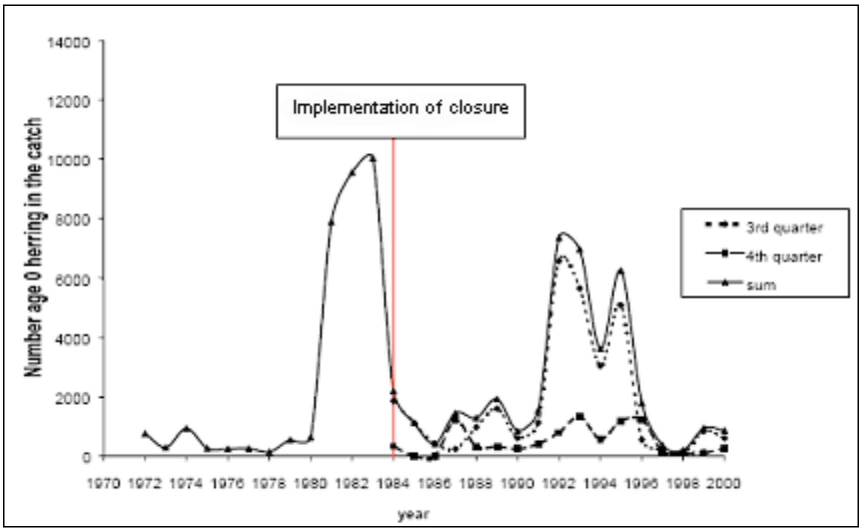


Figure modified from Hoffmann et al. 2004.

The figure clearly indicates that the expected decrease in 0-group herring by-catch could be detected directly after the establishment of the box in 1984. However, in the 1990's the by-catch of 0- group herring in the industrial fishery increases, especially in the 3rd quarter. In 1996 0-group herring by-catch decreases once again and continues to do so (Hoffmann et al. 2004).

Socio-economic effects on fisheries and other stakeholders

- no data

Lessons learned

In order to study the effects of the Box, we need more knowledge on the distribution of juvenile herring in the North Sea as well as better analyses of the composition of catches in industrial fisheries (Hoffmann et al. 2004).

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7. Baltic Sea Cod Closure (Bornholm Basin)

Map and description

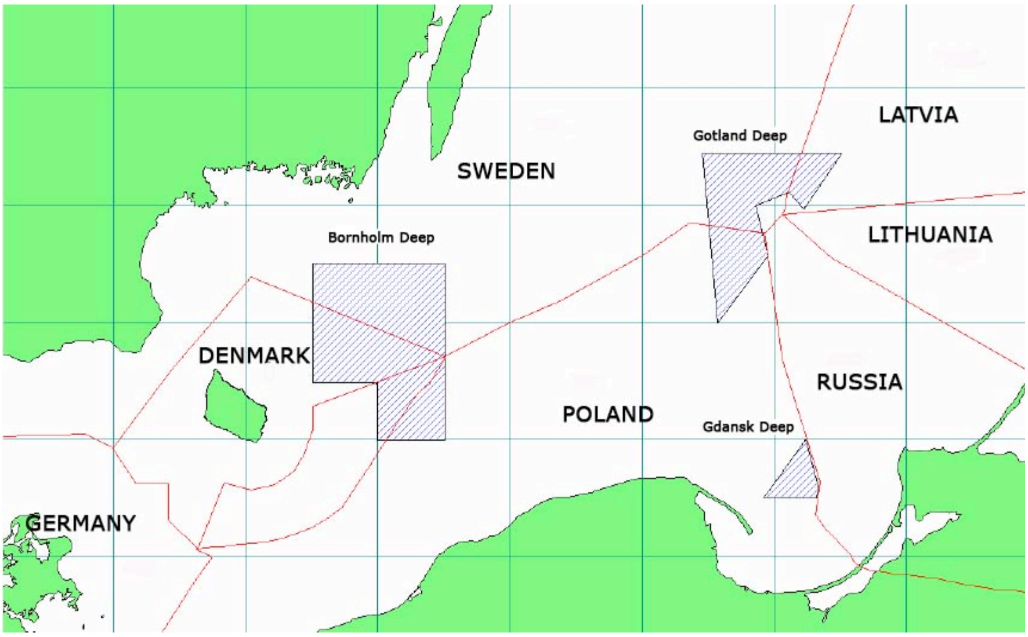


Figure 1. Three current closed areas (Borholm, Gdansk and Gotland Deeps) for targeted cod fisheries from 2005 (EU fleet). Map modified from Fiskeridirektoratet, www.fd.dk.

Legal aspects

Proposal for a Council Regulation establishing a multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks. COM(2006) 411 final. 2006/0134 (CNS).

Closures non-binding for Russia.

Purpose of establishment

- Drastic decline of the eastern Baltic cod stock in the recent two decades has largely been caused by a combination of high fishing pressure and environmentally driven recruitment failure (e.g. MacKenzie et al. 2000; Köster et al. 2003). Decreased predation pressure by the cod stock, in combination with high reproductive success and relatively low fishing mortality, resulted in the second half of the 1990s in a drastically enlarged sprat stock in the Central Baltic Sea. Sprat predation is an important source of egg mortality for Baltic cod, eventually influencing its recruitment (Köster and Möllmann 2000). Moreover, the present sprat-dominated regime has had major ‘negative’ implications on lower trophic levels (e.g. Möllmann and Köster 2002). The reduced availability of meso- and macrozooplankton has negatively affected the condition, growth and potential recruitment of Central Baltic herring (e.g. Cardinale and Arrhenius 2000; Möllmann et al. 2003).

- The re-establishment of a more abundant cod stock in the Central Baltic could lead to a more stable ecosystem structure and more sustainable as well as economically sound fisheries.

Selection methodology and design

There is no published information on selection criteria, methodology and design principles of these closures.

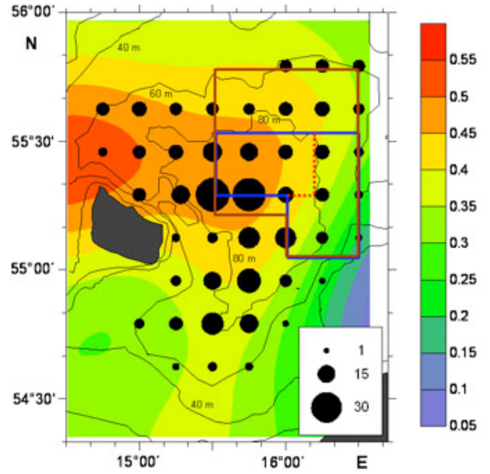
Closures enforced in mid 1990s ("historical closures")

In view of a rapid decline of the eastern Baltic cod stock in early 1990's, two types of "Closures" were enforced in mid 1990s by the International Baltic Sea Fishery Commission (IBSFC) to preserve this stock. These closures were:

- A summer ban on targeted cod fishing was introduced in 1995 and is presently enforced from 15th April to 31st August (*note that the ban was shorter when established in 1995; since then the dates have had some variation*).

- A "spawning closure" for all fisheries from 15th May to 31st August in a relatively small area east of the island of Bornholm (in the Bornholm Basin).

ICES Baltic Fisheries Assessment Working Group (ICES 1999) assessed the effects of these closures and concluded that the introduction of the summer ban had no significant positive impacts on the Baltic cod stock; this is mainly because the main cod catches in the Baltic Sea are taken from September to April, with in particular the trawl fishery exploiting pre-spawning concentrations of cod in late winter and spring. Similarly, the Working Group concluded that the relatively little "spawning" closure area east of Bornholm to protect the spawning stock has had little effect on stock (ICES 1999).



Evolution of Bornholm Basin cod spawning closure. Red dotted line enforced May-August 2003-2005; blue line enforced 15.5.-31.8.2004; brown line enforced year-round in 2005, 1.5.-31.10 from 2006. Background colour scale and dots represent mean egg survival probability (color scale) and mean egg distribution 1989 – 2003 (dots; n/m²) in relation to area closures (Modified from ICES 2004).

Clearly, a closure located in one small area is of limited use in enhancing spawning opportunities for a mobile fish such as cod because the reduction in catches is relatively easily compensated by increased catches in neighbouring areas and/or other seasons. It is noteworthy that in 2004 the ICES Study Group on Closed Spawning Areas of Eastern Baltic Cod (ICES 2004) stated that the closed area in the Bornholm Deep enforced in 1995-2003 was not large enough to ensure adequate coverage of potential areas with favourable hydrographic conditions. The Group also stated that the extension of the closed area in the Bornholm Deep in 2004 is not likely to significantly increase the egg production (i.e., eggs surviving) because the spatial extension covers mainly the eastern slopes where under normal circumstances the hydrographic conditions are not favourable for egg survival and egg density is not particularly high.

Stricter closures enforced in 2005

Due to the lack of recovery of Baltic cod stocks and due to serious risk of stock collapse, new closures were enforced from 1.1.2005 by the EU (these closures are not binding for Russia). These closures were enforced mainly to reduce the overall fishing mortality of Baltic cod but they also aimed to protect the spawning.

- Extended summer ban: Fishing for cod prohibited in Sub-divisions 25-32 (Central Baltic) from 1st May to 15th September.

- Spring ban (a new measure): Fishing for cod prohibited in Sub-divisions 22-24 (Western Baltic) from 1st March to 30th April.

- All cod fishing prohibited within three historical spawning areas in the Central Baltic (Fig. 1) for the entire year (EU fleet).

New regulations in 2006

New EU regulations relating to the three year-round closures (Fig. 1) were implemented on 1 January 2006. From the beginning of 2006 the areas are only closed during the spawning season of Baltic cod in the areas, i.e. from May 1 to October 31 2006.

In 2005 the three areas were totally closed to alle fisheries. In 2006, however, fishing for salmon with hooks or nets with mesh sizes larger than 157 mm is permitted year-round. In addition, vessels of lengths less than 12 meters using bottom nets with mesh sizes exceeding 110 mm are permitted to fish year-round, provided that bycatch of cod is less than 10% (www.danmarks-fiskeriforening.dk).

Effectiveness of the expanded closures

There is not much information of the efficiency and potential stock implications of the closures enforced from 1.1.2005. However, the assessment made by the ICES Study Group on Closed Spawning Areas of Eastern Baltic Cod (ICES 2004) helps us to predict some of the potential effects.

The ICES Study Group considered that an extended summer ban is an appropriate management measure in particular in the situation when there are improved spawning conditions. An appropriately timed fishery ban protects spawning without redirecting fishing effort towards juvenile cod. The Study Group, however, did not make any conclusions whether an extended summer ban would significantly help to recover the stock.

Regarding closed areas on the potential spawning areas, the Study Group states that the Bornholm Deep has been an important spawning area in all years whereas the Gdansk Deep and in particular the Gotland Deep have been important only in years where the salinity and oxygen conditions have allowed successful spawning, egg fertilisation and egg development, and when the spatial distribution of cod stock has included these areas (this has been the case in years with a large cod stock). Hence, a closure located in the deepwater areas of the Bornholm Deep may help to protect the spawning fish and ensure undisturbed spawning. On the other hand, closures located in the more eastern part of the Central Baltic, for instance in the Gdansk Deep and in particular in the Gotland Deep, may have only a limited protection value at the current stock and hydrographic situation.

The Study Groups concluded that any closed area implemented to secure undisturbed cod spawning should cover areas and times of high egg survival, and should be large enough to cover the natural spatial variability of hydrological conditions. The Group, however, also stressed that even favourable hydrographic conditions and high egg production do not guarantee successful reproduction. The reproductive success of Baltic cod depends on many other processes that are affecting early life stages, such as egg and fry predation by clupeids, food availability, cannibalism by adult cod (e.g. Tomkiewicz et al. 1998; Uzars and Plikshs 2000; Hinrichsen et al. 2002a, 2002b; Kraus et al. 2002).

The Study Group further stated that mature cod appear to concentrate in areas of favourable hydrographic conditions for spawning; this implies a spawning migration into the Bornholm Basin when hydrographic conditions are unfavourable in the eastern spawning areas. However, the extent and eventual driving forces of these migrations are not yet clear.

The main spawning time of cod in the Central Baltic is currently from June to August, i.e. in the summer months. The Study Group states that very recently there may have been a slight shift back towards spring spawning (spawning is starting in May). A further shift in spawning time to earlier months of the year would have substantial implications for the design requirements of a closure. Pre-spawning concentrations of cod would start to gather earlier, increasing the catchability of cod in spring months in both the targeted fishery as well in the pelagic fishery (as by-catch).

The fact that the three new closures are enforced year-around, and not only the spring and summer months, was not considered by the Study Group. Neither did the Study Group assess any potential fisheries impacts (socio-economic effects) of these closures. Wider ecosystem effects have not been assessed yet. No information exists about the level of enforcement.

Lessons learned

The poor status of the cod stock suggests that the present management regime is incapable of facilitating stock recovery. Thus, there is a need for more effective management tools, closures (or MPAs) being one obvious candidate.

Studies have shown that the closed area for fishing in the Bornholm Basin during main spawning periods 1995-2003 did not necessarily ensure undisturbed spawning in all years (e.g. Hinrichsen et al. *accepted*), although the position of the closure in the centre of the basin was adequate (ICES 2004)(see figure). In addition, closure of the area in May might in some cases be too late, as pre-spawning concentrations of cod will gather earlier, increasing the catchability of cod in spring months in both the targeting fishery and as by-catch in the pelagic fishery (ICES 2004).

To be effective in reducing the overall fishing mortality on cod, closure(s) should be designed by taking into account the distribution and migration patterns of cod as well as the adaptive responses of fishing fleets. Baltic cod use separate locations and habitats for spawning, larval development, juvenile and adult feeding. Such complex life history requires a successful temporal and spatial linkage between these locations to integrate the whole life-cycle and produce abundant generations.

APPENDIX 4

How do we judge whether an MPA has been ‘successful’ or not?

John K. Pinnegar & Ewen Bell
CEFAS

Of the 1,306 MPAs surveyed world-wide by Kelleher et al. (1995) only 31% were thought to be fully achieving their management objectives. How do we judge whether or not an MPA has been 'successful'? What do we need to know in order to assess MPA performance?

Marine protected areas are established for a wide range of purposes, including protecting marine species and habitats, conserving marine biodiversity, restoring fisheries stocks, managing tourism activities, and minimizing conflicts among resource users. To achieve these goals, specific and measurable objectives must be defined in terms of what outputs and outcomes are being sought. This in-turn requires that well-defined management plans be developed, <u>measures of MPA success be identified and defined in advance</u>, impacts of management actions be monitored and evaluated, and that the results of these activities be fed back into the planning process to revise objectives, plans and outcomes (Pomeroy et al. 2004), i.e. 'adaptive management'.

The process of goal setting is closely linked to stakeholder expectations, MPA design, and the establishment of criteria to evaluate the progress made in meeting those objectives (Agardy, 2000). If goals are not well articulated, it is difficult to define criteria to measure progress or to identify and quantify the indicators of progress (Kay & Alder, 1999).

A **'goal'** is a broad statement of what the MPA is ultimately trying to achieve, i.e. why was the MPA created and what are the main aspirations

An **'objective'** is a more specific measurable statement of what must be accomplished to attain the related goal. Attaining a goal is typically associated with the achievement of two or more corresponding objectives. A useful objective (Margolius & Salafsky, 1998) is one that is:

- specific and easily understood,
- written in terms of what will be accomplished, not how to go about it,
- realistically achievable,
- defined within a limited time period, and
- achieved by being measured and validated.

Monitoring is an integral component of marine area management; it provides the data required to evaluate changes in marine ecosystems as a result of the implementation process. These evaluations are essential for determining effectiveness, improving design, and providing progress reports to stakeholders (Houde *et al.* 2001).

Some of the key questions that should be addressed through monitoring include: (1) Does the MPA regime meet its goals and why or why not? (2) Have there been unanticipated consequences? (3) Are the size and location of reserves within the MPA optimal?
The management criteria and monitoring systems put in place for an MPA are case specific. However, analysis of the effects of any MPA is likely to require certain fundamental knowledge of fisheries and ecosystems independent of the specific case. Common data-types are likely to be a common feature (e.g. baseline information from before and after the MPA was established), and such data can be analysed using a standardized suite of methodologies.

Four categories of information may be included in a monitoring program: (1) structure of marine communities (abundance, age structure, species diversity, and spatial distribution); (2) habitat maintenance or recovery; (3) indicators of water quality or environmental degradation (e.g., pollutants, nutrient levels, siltation); and (4) socioeconomic attributes and impacts (Houde *et al.* 2001).

There are two approaches to analysing the impacts of MPAs on living resources (Houde *et al.* 2001). In the first approach, changes within the MPA are evaluated temporally such that conditions are documented before the implementation and then compared to conditions following implementation (**before vs. after**). A limitation of this approach is that environmental variation in the years before and after the establishment of the MPA may obscure trends resulting from protection. For instance, variable recruitment in a fishery due to a change in oceanic conditions may affect, either positively or negatively, the apparent recovery of a stock after closure of an area. In Kenyan reefs, a twofold increase in fish abundance was observed in surveys of both unprotected and protected sites (McClanahan, 1995); hence, the change was independent of the MPA. A further example is provided by the North Sea 'Plaice box' (see chapter on "past and present MPAs").

System 'carrying capacity' will vary with temperature (e.g. productivity) and habitat type, but is often thought of as the total biomass of all components within the 'virgin' ecosystem (see Jennings & Blanchard 2004). Knowledge about the 'virgin' state of an ecosystem is often poor. However, such information is often required in order to establish baselines against which current or future levels of impact can be compared (Steel & Schumacher 2000), without suffering the problem of 'shifting baseline syndrome', i.e. when a baseline is set with a short-term perspective and represents an increasingly exploited state over time (see Pauly 1995). Jennings & Blanchard (2004) point out that the unexploited biomass of a community (the 'carrying capacity') is not necessarily the same as the historically observed state, because climate has also changed over time. Indeed it is unlikely that ecosystems today would always revert to historic levels if fishing were stopped, either because phase-shifts have occurred or because the environment is fundamentally different from that existing prior to human exploitation.

In the second approach, changes in the MPA are evaluated spatially such that conditions inside the MPA are compared to conditions in a similar area outside (**inside vs. outside**). The limitation of this approach is that MPAs often encompass unique habitats and are set up because the area is distinctive or 'special' in the first place; hence, there are few situations in which comparison areas accurately represent the features found within the MPA. A further alternative would be to use a 'spectrum' of sites with different (quantified) levels of fishing pressure, to look for trends and correlations rather than a simple 'pairwise' comparison (inside vs. outside). This approach has been adopted in the North Sea, Fiji, and in the Seychelles by Jennings et al. (2001, 1995) and Jennings & Polunin (1996).

The ideal experimental design, to test conclusively whether MPAs have a particular ecological effect relative to their original goals, would involve monitoring regimes at multiple localities that include surveys before and after MPA establishment. Ideally, survey methods should be rigorous enough to detect a 10-25% change in biomass, density, or species numbers (Pomeroy et al. 2004). In many cases, however, such quantitative rigor is difficult to achieve.

A recent paper by Maxwell & Jennings (2005) set out to explore the power of a large-scale annual monitoring programme (the English North Sea bottom trawl survey) to detect decline and/or recovery of species that are vulnerable to fishing. Even though this survey was one of the largest and best resourced trawl surveys in the north-east Atlantic, the power to detect declines in abundance of vulnerable and rare species (elasmobranchs, cod etc.) on time scales of <10 years was low. Furthermore, the study showed that if conservation measures were effective, and vulnerable populations recovered at maximum potential rate, 5-10 years of monitoring would often be required to detect recovery.

Unfortunately, many surveys and monitoring schemes are established with no prior assessment of power, and others are used to study species that were not their original focus. This is increasingly the case given the recent focus on the integration of conservation concerns into fisheries management. Fisheries surveys are often the only source of time-series distribution and abundance data for species in offshore waters (Maxwell & Jennings 2005). Nicholson & Jennings (2004) tested the power of the North Sea International Bottom Trawl Survey (IBTS) to detect trends in six community metrics: (mean length, mean weight, mean maximum length, mean maximum, weight, slope of the biomass size spectrum, and mean trophic level). The authors demonstrated that the power of the trawl survey to detect trends at the community level is generally poor. While community metrics do provide good long-term indicators of changes in fish community structure, it is argued that they are unlikely to provide an appropriate tool to support short-term management decisions, for example to judge the success of MPAs. Similar concerns have been raised by Nicholson & Fryer (1992), Fryer & Nicholson (1993) and Gerrodette (1987).

It is important to note that different species will respond to protection in different ways, and at differing rates. Comparisons of 'before vs. after' and 'inside vs. outside', need to take such factors into account. Small species typically have higher growth rates, mature earlier, and have higher intrinsic rates of population increase (Jennings et al. 1999). Hence we would anticipate a more rapid response to protection in these species. Badalamenti et al. (2002) examined the response of three fish species following a trawl ban in the Gulf of Castellamare, Sicily. The largest and most sedentary of the three fish species (*Lophius budegassa*) exhibited the smallest numerical increase following the trawl ban. This species is known to mature later and at a greater size in comparison with *Mullus barbatus* and *Merluccius merluccius*, which exhibited remarkable numerical increases once protected from fishing (within 5 years).

Sometimes 'outside vs. inside' type comparisons do not yield significant differences because the species concerned are highly migratory and frequently cross the MPA boundaries. Differences are more likely to occur where species are less motile and site-attached (e.g Russ and Alcala 1998; Murawski et al. 2000).

The changing role of research and monitoring programmes

The most useful input of science in the planning phase of an MPA is to help define management issues, why there are problems, and how they should be addressed. The first task of natural scientists is to supply objective data to support or challenge perceptions of resource depletion/degradation or risk. A key role of science is to isolate the causes of the problem and help eradicate misconceptions and prejudices, so that management can then focus on real solutions. Baselines and monitoring of natural conditions should be in place before the implementation stage, so that an assessment can be made of whether the programme's objectives are being met or not. In theory, many technologies, e.g. GIS and remote sensing, are available at the planning phase, but their use is likely to be limited by a lack of time, money and data availability (Pomeroy et al. 2004).

As the MPA programme matures, the role of science evolves from identifying issues to developing the technologies needed to support management and to understanding the results of research, and monitoring. Reporting on success in management is very important; so is reporting on setbacks and failures. The results from monitoring should be used to adapt management, so that management actions have the intended effects in the long-term. Typically such work requires a long-term commitment to data collection, management and analysis. Ideally, monitoring and research should be supported by long-term funding as part of the core management of the MPA. Often a data set extending over many decades is needed to understand the significance of human impacts as compared to the natural impacts and processes which underpin the functioning of an ecosystem. In the interim, caution should be applied in interpreting results (Pomeroy et al. 2004).

It is important to continually update and refine the management programme on the basis of the results of monitoring. This step has been omitted or performed superficially in most MPAs. Yet, if MPAs are to be ecologically and socially sustainable, almost continuous evaluation and learning is essential. Evaluation must address two broad questions:

a) What has been accomplished by the MPA and learned from its successes and failures?
b) How has the context (e.g. environment, governance) changed since the programme was initiated?

A meaningful evaluation can be conducted only if the MPA objectives were stated in clear terms and if indicators for assessing progress were identified in the planning phase, and monitored afterwards. Baseline data are essential. Many evaluations yield ambiguous results because these preconditions for assessing performance do not exist. Natural and social scientists have important roles to play in evaluation. In particular, they should assess the relevance, reliability and cost-effectiveness of scientific information generated by research and monitoring, and advise on the suitability of control data (Pomeroy et al. 2004).

Few methods have been developed to evaluate the effectiveness of MPA management (Kelleher, Bleakley, & Wells, 1995; Alder, 1996; Hockey & Branch, 1997). Most of these studies investigated whether designated MPAs were transformed from "paper parks" to functional management systems. For example, Hockey and Branch (1997) proposed broad criteria to measure the scientific, practical, socioeconomic, and legal performance of MPAs against the management objectives. Some of their criteria are difficult to score because they included several factors such as education, recreation, tourism, and research in a single criterion (Alder et al 2002).

Choosing and using indicators

There are hundreds to thousands of potential indicators of ecosystem status that can be used for management. They range in complexity from single-species indicators to 'emergent properties' of ecosystem models (Rice 2003).

To be useful for management, indicators should be:

- Relatively easy to understand by non-scientists and other users;
- Sensitive to a manageable human activity;Relatively tightly linked in space and time to that activity;
- Easily and accurately measured, with a low error rate;
- Measurable over the area where they may be used,

• and based on existing time-series data to help set reference points In 2000 the IUCN together with the World Wide Fund for Nature, formed the *MPA Management Effectiveness Initiative (MPA-MEI)*. This programme had four main objectives:

1. to develop a set of natural and socio-economic indicators to evaluate MPA management effectiveness,
2. to develop a process for conducting an MPA evaluation – in the form of an easy-to-use guidebook,
3. to ground-truth and field-test the guidebook and indicator methods, and
4. to encourage uptake.

The MPA-MEI programme conducted a survey of MPA goals and objectives from around the world, and categorized these into three broad types: biophysical, socio-economic and governance. 130 'indicators' were investigated and mapped to relevant MPA goals and objectives. Operational descriptions and definitions were subsequently provided for 44 indicators as well as a detailed narrative of methods of measurement and guidance on analysis/interpretation of results (Pomeroy et al. 2004;
see www.effectivempa.noaa.gov/guidebook/guidebook.html).

Pomeroy et al. (2004) provide a useful tool which could be applied within PROTECT for devising hypothetical monitoring programmes under each of the three case-studies and matching indicators, to the aims and objectives of the MPAs concerned. Biophysical (natural) goals of MPAs are considered to fall into 5 broad and distinct categories. Those associated with maintaining/protecting resources and hence yields in the future, MPAs aimed at protecting individual species, MPAs aimed at maintaining/protecting vulnerable habitats and those established with the aim of restoring already degraded areas. The three case-studies being considered under PROTECT fall within this overall framework (one focuses on an MPA to protect/maintain seabirds, one focuses on an MPA to protect vulnerable deep sea habitats, on focuses on an MPA to potentially increase/restore fishery yields in the Baltic).

Not all indicators will be appropriate for use in every MPA and case-study. Some indicators require a higher level of skill, labour, financing and time to measure than others.

In PROTECT we are mainly concerned with biophysical indicators since these are the ones of primary interest to scientists. Regardless of their many social benefits, MPAs are ultimately a tool for conserving or restoring the biophysical conditions of oceans and coasts. In most cases the link between the biological state of the marine environment and the livelihoods, income and food security of the people who use and depend upon the resource is explicit. It then follows that beyond characterizing natural systems, the measurements of biophysical indicators can also be useful when viewed in the context of the socio-economic and governance conditions that operate in and around the MPA (Pomeroy et al. 2004).

On the other hand, experience shows that social, cultural, economic and political factors can shape the development, management and performance of MPAs more than biological or physical factors (Fiske 1992, Kelleher & Recchia 1998). Understanding the socio-economic context of stakeholders involved with and/or influenced by the MPA is essential for assessing, predicting and managing MPAs. The use of socio-economic indicators allows MPA managers to: (a) incorporate and monitor stakeholder group concerns and interests into the management process; (b) determine the impacts of management decisions on the stakeholders; and (c) demonstrate the value of the MPA to the public and decision-makers (Pomeroy et al. 2004).

Modelling approaches to judge the 'success' of MPAs

Monitoring and evaluation of MPA management performance is beginning to receive attention and several analytical approaches are emerging, from complex strategic comparisons of MPAs using multidimensional scaling (e.g. Alder et al 2002) to park-specific programs (e.g. Hockings, 2000).

A recent study by Alder et al. (2002) considered management effectiveness in 20 MPAs located in different regions of the World. This work was based on an ordination method known as 'Rapfish'. The development of the Rapfish approach is detailed in Pitcher et al. (1998), and it has now been used elsewhere to evaluate the sustainability of fisheries throughout the North Atlantic (Alder et al., 2000).

Rapfish uses a multidisciplinary appraisal technique based on a number of easy-to-score attributes (Pitcher & Preikshot, 2001). The attributes within five evaluation fields (ecological, economic, social, technological, and ethical) are chosen and defined to reflect the notion of sustainability. Rapfish was modified for MPA use based on the following considerations: Any measure of management effectiveness must be pragmatic so that policy and decision makers can readily understand what is being measured and apply its relevance in MPA management. Similarly, the cost of collecting and analyzing the information needed to evaluate management effectiveness must be small compared to the market and non-market value of the MPA and the cost of managing the area.

Twenty-two MPA managers and researchers tested the approach by scoring MPAs in which they were presently or recently working. These managers and researchers were considered experts in the areas they scored, and they based their scores on reports or studies with which they were familiar. The analysis provided an overall comparison of northern and southern hemisphere MPAs based on the average score in each evaluation field. In this particular case (Figure 1), northern hemisphere MPAs scored better for ecosystem management objectives compared to southern hemisphere MPAs. Southern hemisphere MPAs, however, scored better for meeting social objectives than northern hemisphere areas (Alder et al. 2002).

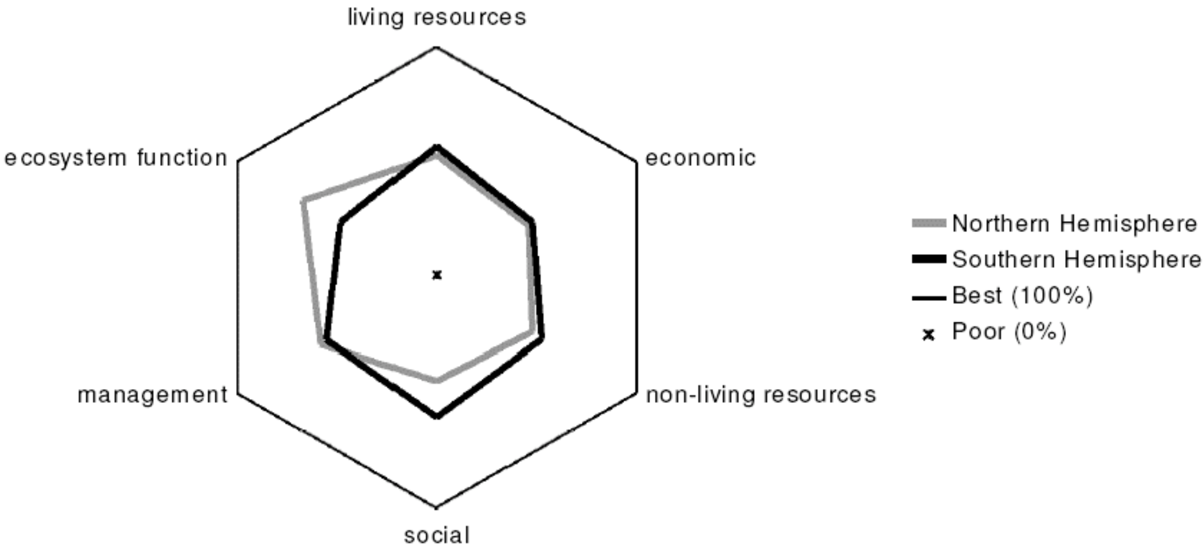


Figure 1. Composite kite diagram of the average scores in each evaluation field for all MPAs evaluated, grouped by northern and southern hemispheres (from Alder et al. 2002).

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Appendix 5

Example of GOIS Table for the Management of Cold Water Corals

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Managing Cold-Water Coral Protected Areas

MPA goals (primary, secondary and tertiary)	Specific objectives of the MPA	Indices to be measured (necessary to judge success)	Success (management) criteria
BIOPHYSICAL GOALS; NO TAKE			
Primary Goal (1) Ensure the structural integrity of cold water coral habitat	Prevent all activities which cause abrasion and physical damage	Biological: Statistical comparison of percentage cover using visual inspections of coral – before and after (BACI)	Coral percentage cover to remain within percentage cover values calculated for reference sites
		Fisheries: Frequency of vessel activity in MPA as shown by VMS	Vessel entry into area = 0
		Other Activities: Level of compliance with terms of scientific research permits issued for study in MPA	Compliance with terms of permit = 100 %
		Licensed granted for oil and gas exploration/exploitation	Licenses = 0
		Number of seafloor structures/platforms constructed including associated groundworks in coral fields	Seafloor construction /platforms = 0
		Number of instances of dumping/lost fishing gear	Instances = 0
		Number of instances of ship related pollution effects including wrecks/spills and intentional discharge	Instances = 0
Secondary Goal (1) Restore degraded habitat	Prevent all activities which cause abrasion and physical damage to permit recovery	Document presence of coral re-growth in impacted areas	Instances of re-growth > 0
	Cut down recovery time through possible interventions such as artificial reefs /transplantations with due regard to population genetic considerations	Document presence of coral re-growth in impacted areas	Instances of re-growth > 0

Managing Cold-Water Coral Protected Areas

MPA goals (primary, secondary and tertiary)	Specific objectives of the MPA	Indices to be measured (necessary to judge success)	Success (management) criteria
Primary Goal (2) Protect living populations of *Lophelia pertusa* and ensure contributions of local genetic diversity to *Lophelia* gene pool	Prevent all activities which cause unnatural mortality to *Lophelia* populations. Ensure contribution of local genetic diversity to *Lophelia* gene pool.	Calculate proportion of living to dead coral using video or photographic stills	Proportion of living to dead coral maintained at natural levels* for *Lophelia* as estimated** from multiple reference sites. *Natural levels defined in time and space to allow for natural shifts linked, for example, to climate change ** Reference limits not defined - methodology to be developed.
	Maintain environmental quality at levels sufficient to ensure natural viability of living coral polyps within reference limits	Measure relevant oceanographic variables including temporal variation of quantity and quality of suspended particulates in the locality of the reef	Environmental parameters remain at natural levels. Threshold not defined - research required
Primary Goal (3) Protect associated biodiversity and ecosystem function (including fish populations)	Losses to associated biodiversity and ecosystem function prevented, maintenance of trophic structure complexity ensured	Visually assess the structural integrity of reefs and diversity of associated mega-fauna along monitoring transects.	Structural integrity of reefs and associated mega-fauna above OSPAR EcoQO reference levels. Reference levels not established.
Secondary Goal (3) Restore degraded coral habitat areas to level sufficient to support natural associated faunal assemblages (including fish species) similar to those found in non-degraded habitat	Prevent all activities which cause abrasion and physical damage to permit recovery	Document presence of coral re-growth in impacted areas	Instances of re-growth > 0
	Cut down recovery time through possible interventions such as artificial reefs /transplantations with due regard to population genetic considerations	Document presence of coral re-growth in impacted areas	Instances of re-growth > 0

Managing Cold-Water Coral Protected Areas

MPA goals (primary, secondary and tertiary)	Specific objectives of the MPA	Indices to be measured (necessary to judge success)	Success (management) criteria
Socio-economic goals: No take			
Primary Goal (1) Livelihoods enhanced or maintained	Ensure the option value (reservoir) of coral habitat for potential biodiscovery	Visually assess the structural integrity of reefs and diversity of associated mega-fauna along monitoring transects.	Structural integrity of reefs and associated mega-fauna above OSPAR EcoQO reference levels. Reference levels not established.
	Maintain contribution of coral habitat supporting local populations of exploitable fish stocks (refuge and stock reservoir etc.)	Census exploitable fish stocks in locality of coral habitat.	Fish populations of commercial species maintained or enhanced
Primary Goal (2) State compliance with EU and international obligations and maintenance of international standing	Ensure that the State is compliant and not subject to EU penalties or private lawsuits. Economic imperative of not drawing down fines or engendering lawsuits.	Number of notified breaches of EU and international obligations with fiscal penalties	Number of breaches with fiscal penalties = 0
Primary Goal (3) Maintain as scientific reference area and increase scientific knowledge to ensure long-term dividend of research investment is realised	Scientific understanding increased through research and standardised monitoring approaches – future link with Marine Strategy objectives.	Instigate long-term sampling and monitoring programme with standardised sample design.	Long-term data-sets collected are robust and amenable to time series analysis.

Managing Cold-Water Coral Protected Areas

MPA goals (primary, secondary and tertiary)	Specific objectives of the MPA	Indices to be measured (necessary to judge success)	Success (management) criteria
Socio-economic goals: no take			
Secondary Goal (1) Increase understanding of climate change processes	Undertake paleo-climate studies	Develop appropriate coral skeletal isotopic proxies	Improved understanding of climate change
Primary Goal (4) Environmental awareness and knowledge enhanced	Level of scientific knowledge held by the public increased	Monitor public exposure to available new science related information through public questionaires	Questionaires reveal increase in public awareness and knowledge of coral reefs over time
Tertiary Goal (1) Ensure non-monetary benefits	Aesthetic value enhanced or maintained (education, tourism)	Visually assess the structural integrity of reefs and diversity of associated mega-fauna along monitoring transects.	Structural integrity of reefs and associated mega-fauna above OSPAR EcoQO reference levels. Reference levels not established.

APPENDIX 6

IUCN self-assessment checklist for building networks of MPAs

Public education, communication & awareness (Broader consideration #6) Best Practice examples		Your score	Your comments
Virtually the entire community (including the local communities and the wider public) are very familiar with the MPA network and the managing agency (or agencies)	3		
Most of the community has some awareness of the MPA network and the managing agency(-ies)	2		
Part of the community has some awareness of the MPA network, and the managing agency.	1		
The community has little or no awareness of the MPA network or the managing agency	0		
The community (including the local communities and the wider public) are familiar with the objectives of the MPA network.	Bonus 1		
Scientific & information management considerations (Best Practice #4 and 12# and Broader consideration #3) Best Practice examples		Your score	Your comments
All available scientific, social and economic information is used to support planning and management, and it is regularly updated and used for effective decision-making.	3		
There is some scientific, social and economic information to support planning and management, and whatever is available is used for decision-making.	2		
There is limited scientific, social or economic information to support planning and management, but it is rarely used for decision-making.	1		
There is little or no scientific, social or economic information base to support planning and management, or the available information is not used for decision-making.	0		
There is an ability to incorporate new information into subsequent planning or for ongoing management tasks	Bonus 1		
Size and shape (Ecological Design Criteria #7) Best Practice examples		Your score	Your comments
Specific consideration was given to the size and shape of your MPA network when it was designed and implemented in order to maximize the effectiveness of the network to achieve its ecological objectives.	3		
Some consideration was given to the size and/or shape of your MPA network when it was designed, but no consideration overall to achieving its ecological objectives.	1		
Little or no consideration was given to the size and/or shape of your MPA network when it was designed; NOR any consideration of the effectiveness of the network to achieve its ecological objectives.	0		
Consideration was given to minimise edge effects of your MPA network when it was designed	Bonus 1		

Resilience (Ecological Design Criteria #7) Best Practice examples		**Your score**	**Your comments**
Your MPA network has been specifically designed so 30% or more of the area* is free from extractive activities or habitat-altering activities, or other significant human-induced stresses.	**3**		
Between 10-30% or the area* is free from extractive activities or habitat-altering activities, or other significant human-induced stresses.	**2**		
Only a small part the area* (<10%) is free from extractive activities or habitat-altering activities, or other significant human-induced stresses.	**1**		
Virtually none, if any, of the area* is free from extractive activities or habitat-altering activities, or other significant human-induced stresses.	**0**		
Your MPA network has been specifically designed to maximize the resilience of the network in the face of long-term geophysical and/or biochemical changes.	**Bonus 1**		
Precautionary design (Ecological Design Criteria #4) Best Practice examples		**Your score**	**Your comments**
Your MPA network is configured to take into consideration all or most of the known threats occurring within the wider area*.	**3**		
Your MPA network considers several of the known threats occurring within the wider area*	**2**		
Your MPA network considers a couple of the known threats occurring within the wider area*.	**1**		
Your MPA network does not consider any of the known threats occurring within the wider area*	**0**		
Your MPA network has been effectively designed to cope with a lack of comprehensive data.	**Bonus 1**		
Stakeholder participation (Best Practice #3) Best Practice examples		**Your score**	**Your comments**
A wide range of stakeholders (including local and regional stakeholders) were directly involved in planning the network, and assist the managers by being involved in virtually all of the planning and management decisions for your MPA network	**3**		
Some stakeholders (ie local and/or regional) assist the managers by contributing either input and/or directly in most of the planning and management decisions for your MPA network	**2**		
Some stakeholders (local or regional) have some involvement, and assist the managers by having some input into some planning and management decisions for your MPA network	**1**		
No stakeholders (local or regional) had input into planning your MPA network, nor do they assist the managers to make any planning and management decisions for the network.	**0**		
A wide range of stakeholders (including local and regional stakeholders) are directly involved in decision making, e.g. through active participation in a formal capacity.	**Bonus 1**		
Political will & leadership (Broader consideration #5 and Best Practice #2) Best Practice examples		**Your score**	**Your comments**
There is clear and effective leadership, commitment and support at both the political and agency levels, with a shared vision and capacity to achieve success.	**3**		
There is clear or effective leadership at both the political and agency levels, but only some limited capacity to implement the necessary strategies.	**2**		

There is some leadership at either the political or agency levels, but an inadequate capacity to implement the necessary strategies.	1		
There is no clear and effective leadership or commitment at either the political or agency levels, and no shared vision or capacity for success.	0		
There is political support from all relevant levels of government for your MPA network, with politicians and/or legislators involved in the planning process and aware, and supportive, of the requirements for ongoing management.	Bonus 1		
Clearly defined objectives (Best Practice #1) Best Practice examples		**Your score**	**Your comments**
There is a range of clear, achievable and measurable objectives (including ecological, social and economic objectives) defined for the MPA network and derived from the legislation;	3		
There are various objectives for the MPA network which are clear, achievable and measurable; addressing at least two of the relevant aspects in the necessary range (ie. ecological, social or economic objectives);	2		
There are some objectives for the MPA network; but only one or two can be considered as clear, achievable and measurable; AND your objectives do not address the necessary range (ie. ecological, social and economic objectives).	1		
There are no clear objectives for your MPA network.	0		
These objectives were determined through an open, transparent and balanced process involving a wide range of stakeholders	Bonus 1		
Viability (Ecological Design Criteria #3) Best Practice examples		**Your score**	**Your comments**
Your MPA network includes many self-sustaining viable no-take areas, which are all geographically dispersed within the wider area* ensuring viability at all levels (ie at the ecosystem, species and genetic levels) irrespective of natural cycles of variation	3		
Your MPA network includes some no-take areas geographically dispersed within the wider area*, some of which are self-sustaining.	2		
Your MPA network includes a few no-take areas geographically dispersed within the wider area*.	1		
Your MPA network includes only a single no-take area, or does not include any no-take areas within the wider area*.	0		
Permanence (Ecological Design Criteria #5) Best Practice examples		**Your score**	**Your comments**
Your MPA network has the backing of an efficient combination of legislative instruments (eg statutes, laws, regulations) and administrative instruments (eg policies) at various levels (local/state/national), that collectively provide long-term protection for the MPA network and ensure its viability.	3		
Your MPA network has some legislative instruments (eg statutes, laws, regulations) and/or administrative instruments (eg policies), that collectively assist in protecting the MPA network.	2		
Your MPA network has some backing by way of legislative instruments (eg statutes, laws, regulations) or administrative instruments (eg policies), but some of these may be varied by governments and/or ignored by officials.	1		
Your MPA network has little or no backing by way of any legislative instruments or administrative instruments, and its viability may be affected by any adverse activities occurring either within, or adjacent to, the area.	0		
Your MPA network has the backing of an efficient combination of legislative instruments that can extend outside the spatial domain of the MPA network if external threats need to be addressed	Bonus 1		

Compliance & enforcement (Broader consideration #9) Best Practice examples		**Your score**	**Your comments**
A survey or other effective means indicates that over 75% of all your MPA users are aware of, understand, and comply with the regulations.	**3**		
Realistic estimates indicate that between 50-75% of all your MPA users are aware of, understand, and comply with the regulations.	**2**		
Realistic estimates indicate that between 25-50% of all your MPA users are aware of, understand, and comply with the regulations.	**1**		
Less than 25% of all your MPA users are aware of, understand, and comply with the regulations.	**0**		
Integrated management framework (Best Practice #5) Best Practice examples		**Your score**	**Your comments**
Your MPA network fits within a clear integrated and holistic framework, including both planning and management at differing scales (ranging from national planning frameworks, through to regional/local planning and site planning).	**3**		
Your MPA network has some integration of planning and management at differing scales.	**2**		
Your MPA network has some integration of planning and management activities; OR there is some coordination across relevant jurisdictions and agencies.	**1**		
Your MPA network does not have a clear integrated framework for either planning or management, or there is little or no coordination between relevant agencies.	**0**		
A high level of management coordination exists across all relevant jurisdictions and agencies (including across the land–water interface), as well as between users/sectors.	**Bonus 1**		
The airspace above, the seabed below and the adjoining terrestrial influences may all be considered either by effective planning and/or management regimes or legislative controls	**Additional Bonus 1**		

Adaptive management (Best Practice #6) Best Practice examples		Your score	Your comments
Your MPA network is readily able to incorporate changes such as new information becoming available (eg. from 'in-the-field' experience, or as a result of changing external circumstances).	3		
Your MPA network has some ability to incorporate some changes when new information becoming available (eg. 'in-the-field' experience, or as a result of changing external circumstances).	2		
Your MPA network does not have management systems nor any monitoring arrangements to determine system responses and provide a basis for adaptive management; NOR is it able to incorporate changes such as new information becoming available.	0		
Your MPA network has effective management systems that implement policies (ie specifying locally appropriate actions), as well as monitoring arrangements to determine system responses and provide a sound basis for adaptive management.	Bonus 1		
Economic & social considerations (Broader consideration #1) Best Practice examples		Your score	Your comments
The design and implementation of your MPA network continues to consider the economic and socio-cultural setting, as well as the real benefits and costs of the network (including both tangible and intangible benefits and costs);	3		
The design and implementation of your MPA network initially considered the economic and socio-cultural setting, as well as the real benefits and costs of the network (and may have included tangible and intangible benefits and/or costs).	2		
Some consideration was given to the economic and socio-cultural setting, or to the benefits or costs, when your MPA network was initially designed.	1		
No consideration was given to the economic or socio-cultural setting, or to the benefits or costs, when your MPA network was initially designed, and little/no consideration occurs during implementation.	0		
Your MPA network has addressed the need for structural adjustment or compensation for lost benefits from foregone economic opportunities.	Bonus 1		
Spatial & temporal considerations (Broader consideration #2) Best Practice examples		Your score	Your comments
The design of your MPA network considered a wide range of spatial and temporal considerations including ecological processes, connectivity and external influences; and managers continue to consider these as part of ongoing implementation.	3		
The design of your MPA network did consider some spatial and temporal issues; and managers continue to consider each of these issues as part of ongoing implementation.	2		
The design of your MPA network did consider one or more spatial or temporal issues; and some of these are still considered by managers in the ongoing implementation of the network.	1		
Spatial and temporal issues were not considered in the design or in the ongoing implementation of your MPA network.	0		
There is good historical baseline information (or historic data) to determine whether there are 'shifting baselines' for a range of issues.	Bonus 1		
Institutional & governance considerations (Broader consideration #4) Best Practice examples		Your score	Your comments

Your MPA network has well established mechanisms for the vertical integration between all levels of government (eg. national, state and local), and horizontal integration among agencies with different mandates, as well as involving local communities, Indigenous people and regional groups.	3		
Your MPA network has some mechanisms for the vertical integration between different levels of government, and horizontal integration among agencies with different mandates, as well as involving local communities, Indigenous peoples and regional groups.	2		
Your MPA network has some legislative and administrative arrangements, but these do not provide both effective vertical integration between different levels of government, and horizontal integration among agencies.	1		
Your MPA network has little or no mechanisms for the vertical integration between different levels of government, nor for any horizontal integration among agencies with different mandates.	0		
Your MPA network has an effective legislative and administrative framework, including a 'nested governance' structure operating simultaneously at multiple scales and levels (integrating local aspirations, national strategies and/or international obligations).	Bonus 1		
Replication (Ecological Design Criteria #2) Best Practice examples		**Your score**	**Your comments**
Your MPA network includes spatially-separated replicates of no-take areas within 80% or more of the ecoregions occurring within the wider area* (ie almost all known ecoregions within your network have replicates to spread any risk).	3		
Your MPA network includes spatially-separated replicates of no-take areas within 25 - 80% of the ecoregions occurring within the wider area*	2		
Your MPA network includes some spatially-separated replicates of no-take areas, but they occur in less that 25% or less of the ecoregions occurring within the wider area*	1		
Your MPA network does not have any spatially-separated replicates of no-take areas within any ecoregions	0		
Systematic replication occurring throughout every ecoregion in the networks, e.g. cross shelf and long-shore replication	Bonus 1		
Monitoring & assessment (Broader consideration #7) Best Practice examples		**Your score**	**Your comments**
A good monitoring and evaluation system exists, with progress against most if not all the objectives of the MPA network being monitored regularly and objectively, with the results being widely disseminated and used in adaptive management.	3		
There is an agreed and implemented monitoring program, and progress against some of the objectives of the MPA network is objectively monitored periodically, with the results publicly available and/or used in adaptive management.	2		
There is some ad hoc monitoring and progress against at least one of the objectives of the MPA network has been monitored and/or publicly reported.	1		
Progress against the objectives of the MPA network is rarely monitored AND no assessment of MPA effectiveness has ever occurred or been reported.	0		
Connectivity (Ecological Design Criteria #6) Best Practice examples		**Your score**	**Your comments**
Your MPA network has been purposefully designed to maximize all or most of the known ecological processes (spatial and/or temporal) known to occur in the area*	3		
Your MPA network was purposefully designed and does consider some of the known ecological processes (spatial and/or temporal) known to occur in the area*	2		

Your MPA network was purposefully designed and does consider a few (one or more) of the known ecological processes (spatial and/or temporal) known to occur in the area*	**1**		
The design of your MPA network took little or no account of any known ecological processes known to occur in the area*	**0**		
Your MPA network has been purposefully designed to maximize and enhance most of the linkages between individual MPAs in the network.	**Bonus 1**		
Sustainable financing (Broader consideration #8) [Best Practice examples]		**Your score**	**Your comments**
Your MPA network has a well-developed and periodically audited program of long-term funding (assessed, and if necessary, increased against a recognised financial index) in order to meet both core costs and emerging issues.	**3**		
Your MPA network has an adequate program of long-term funding for core costs and able to seek funding for emerging issues.	**2**		
Your MPA network has poor and spasmodic program of long-term funding to meet core costs, and is sometimes able to seek funding for emerging issues.	**1**		
Your MPA network doest not have a well-developed or periodically audited program of long-term funding.	**0**		
The budget in your MPA is well managed; and all staff understand the financial situation.	**Bonus 1**		
Representativeness (Ecological Design Criteria #1) [Best Practice examples]		**Your score**	**Your comments**
Your MPA network includes representative examples of 80-100% of known marine habitats and/or ecological processes within the wider area* (ie 80-100% of all known ecoregions are within your network).	**3**		
Your MPA network includes representative examples of between 30-80% of the habitats and/or ecological processes known in the area*.	**2**		
Your MPA network includes representative examples of 10 -30% of the known habitats and/or ecological processes known in the area*.	**1**		
Your MPA network comprises only one or two types of marine habitat known in the area* (eg. only coral reefs are protected in the network)	**0**		

Examples of Best Practice

Public education, communication & awareness

Virtually the entire community (including the local communities and the wider public) are very familiar with the MPA network and the managing agency (or agencies)
The community (including the local communities and the wider public) are familiar with the objectives of the MPA network.

Examples
Australia – Great Barrier Reef Local Marine Advisory Committees
USA – Channel Islands NMS Working Groups & Sanctuary Advisory Committees

Scientific & information management considerations

All available scientific, social and economic information is used to support planning and management, and it is regularly updated and used for effective decision-making.
There is an ability to incorporate new information into subsequent planning or for ongoing management tasks

Examples
Australia – Great Barrier Reef Science and Research Program and Research Priorities
Australia - CRC Reef Report Making a Difference

Size and shape

Specific consideration was given to the size and shape of your MPA network when it was designed and implemented in order to maximize the effectiveness of the network to achieve its ecological objectives.
Consideration was given to minimise edge effects of your MPA network when it was designed

Examples
Australia – Great Barrier Reef - Biophysical Operating Principles

Resilience

Your MPA network has been specifically designed so 30% or more of the area* is free from extractive activities or habitat-altering activities, or other significant human-induced stresses.
Your MPA network has been specifically designed to maximize the resilience of the network in the face of long-term geophysical and/or biochemical changes.

Examples
Australia – Great Barrier Reef - Biophysical Operating Principles

Precautionary design

Your MPA network is configured to take into consideration all or most of the known threats occurring within the wider area*.
Your MPA network has been effectively designed to cope with a lack of comprehensive data.

Examples
Australia – Great Barrier Reef - Threats

Stakeholder participation
A wide range of stakeholders (including local and regional stakeholders) were directly involved in planning the network, and assist the managers by being involved in virtually all of the planning and management decisions for your MPA network
A wide range of stakeholders (including local and regional stakeholders) are directly involved in decision making, e.g. through active participation in a formal capacity.

Examples
Australia – Great Barrier Reef - Public involvement in RAP

Political will & leadership
There is clear and effective leadership, commitment and support at both the political and agency levels, with a shared vision and capacity to achieve success.
There is political support from all relevant levels of government for your MPA network, with politicians and/or legislators involved in the planning process and aware, and supportive, of the requirements for ongoing management.

Examples

Clearly defined objectives
There is a range of clear, achievable and measurable objectives (including ecological, social and economic objectives) defined for the MPA network and derived from the legislation;
These objectives were determined through an open, transparent and balanced process involving a wide range of stakeholders.

Examples
Australia – Great Barrier Reef - Biophysical Operating Principles
Australia – Great Barrier Reef - Social –Economic Operating Principles
Australia – Great Barrier Reef - Evaluation of extent to which operating principles implemented

Viability

Your MPA network includes many self-sustaining viable no-take areas, which are all geographically dispersed within the wider area* ensuring viability at all levels (ie at the ecosystem, species and genetic levels) irrespective of natural cycles of variation

Examples

Australia – Great Barrier Reef - Zoning maps showing no-take (green) zones

Permanence

Your MPA network has the backing of an efficient combination of legislative instruments (eg statutes, laws, regulations) and administrative instruments (eg policies) at various levels (local/state/national), that collectively provide long-term protection for the MPA network and ensure its viability.

Your MPA network has the backing of an efficient combination of legislative instruments that can extend outside the spatial domain of the MPA network if external threats need to be addressed

Examples

Australia – Great Barrier Reef - Legislation and Regulations

Compliance & enforcement

A survey or other effective means indicates that over 75% of all your MPA users are aware of, understand, and comply with the regulations.

Examples

Australia – Great Barrier Reef - Day-to-day Management

Integrated management framework

Your MPA network fits within a clear integrated and holistic framework, including both planning and management at differing scales (ranging from national planning frameworks, through to regional/local planning and site planning).

A high level of management coordination exists across all relevant jurisdictions and agencies (including across the land–water interface), as well as between users/sectors.

The airspace above, the seabed below and the adjoining terrestrial influences may all be considered either by effective planning and/or management regimes or legislative controls.

Examples

Australia – Great Barrier Reef - How Federal and State agencies cooperate in managing the Great Barrier Reef

Adaptive management

Your MPA network is readily able to incorporate changes such as new information becoming available (eg. from 'in-the-field' experience, or as a result of changing external circumstances).
Your MPA network has effective management systems that implement policies (ie specifying locally appropriate actions), as well as monitoring arrangements to determine system responses and provide a sound basis for adaptive management.

Economic & social considerations

The design and implementation of your MPA network continues to consider the economic and socio-cultural setting, as well as the real benefits and costs of the network (including both tangible and intangible benefits and costs);
Your MPA network has addressed the need for structural adjustment or compensation for lost benefits from foregone economic opportunities.

Examples
Australia – Great Barrier Reef - Social- economic considerations in RAP
Australia – Great Barrier Reef - 'Measuring the Economic & Financial value of the GBRMP' (Report by Access Economics)

Spatial & temporal considerations

The design of your MPA network considered a wide range of spatial and temporal considerations including ecological processes, connectivity and external influences; and managers continue to consider these as part of ongoing implementation.
There is good historical baseline information (or historic data) to determine whether there are 'shifting baselines' for a range of issues.

Examples
Australia – Great Barrier Reef - Biophysical Operating Principles

Institutional & governance considerations

Your MPA network has well established mechanisms for the vertical integration between all levels of government (eg. national, state and local), and horizontal integration among agencies with different mandates, as well as involving local communities, Indigenous people and regional groups.
Your MPA network has an effective legislative and administrative framework, including a 'nested governance' structure operating simultaneously at multiple scales and levels (integrating local aspirations, national strategies and/or international obligations).

Examples
Australia – Great Barrier Reef - How Federal and State agencies cooperate in managing the Great Barrier Reef

Replication

Your MPA network includes spatially-separated replicates of no-take areas within 80% or more of the ecoregions occurring within the wider area* (ie almost all known ecoregions within your network have replicates to spread any risk).
Systematic replication occurring throughout every ecoregion in the networks, e.g. cross shelf and long-shore replication.

Examples
Australia – Great Barrier Reef - **Evaluation of extent to which operating principles implemented**

Monitoring & assessment

A good monitoring and evaluation system exists, with progress against most if not all the objectives of the MPA network being monitored regularly and objectively, with the results being widely disseminated and used in adaptive management.

Examples
Australia – Australian Institute of Marine Science – Environmental Change
Australia – Australian Institute of Marine Science – Status and Trends

Connectivity

Your MPA network has been purposefully designed to maximize all or most of the known ecological processes (spatial and/or temporal) known to occur in the area*
Your MPA network has been purposefully designed to maximize and enhance most of the linkages between individual MPAs in the network.

Examples
Australia – Great Barrier Reef - Connectivity 'The Blue Highway'
Australia – Great Barrier Reef - Biophysical Operating Principles

Sustainable financing

Your MPA network has a well-developed and periodically audited program of long-term funding (assessed, and if necessary, increased against a recognised financial index) in order to meet both core costs and emerging issues.
The budget in your MPA is well managed; and all staff understand the financial situation.

Examples

Representativeness

Your MPA network includes representative examples of 80-100% of known marine habitats and/or ecological processes within the wider area* (ie 80-100% of all known ecoregions are within your network).

Appendix 7

Working Group Participants

Participants

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