An Ecosystem Based Approach to the Common Fisheries Policy: Defining the Goals

John G Pope
David Symes

Summary

Introduction

1. The 2002 review of the Common Fisheries Policy (CFP) provides an opportunity to realign fisheries policy, shifting the emphasis from a narrow preoccupation with fish stock management to a more holistic or ***ecosystem based approach*** that includes sustainable use of both resources and the supporting marine ecosystems. Redefining the goals for fisheries management is an essential first step.

An ecosystem based approach to fisheries management

2. The concept of ecosystem based management, underpinned by the objective of systems integrity, originates from terrestrial and freshwater management in the USA. In 1998, the US Congress commissioned a report on the application of ecosystem based management for marine fisheries. It defined eight operating principles and outlined five basic elements for fisheries policy. These basic elements embody the precautionary principle, co-management and adaptive management. In a European context, the progression from defining the concept to its operational implementation is less advanced.

3. To date little has been done to manage the effects of fishing on the marine environment. Although progress has been made in identifying, understanding and quantifying some of these effects - notably through ICES - thus far fisheries science has focused attention largely on the target species of the commercial fisheries; the effects of fishing on most non-target species remain poorly understood. Direct effects in the form of fish and by-catch mortalities, though the most visible, may not be the most significant impacts of fishing on the marine ecosystem.

The reorientation of fisheries management

4. An ecosystem based approach to fisheries management will require the integration of a series of new management objectives with the established goals of maximising:

   (i) the sustainable yield of the fishery;
   (ii) economic returns; and
   (iii) social utility in terms of employment and income.

   These existing objectives will normally compete for prioritisation under conditions of under or fully exploited fisheries and trade-offs will occur. Under crisis management conditions, where resources are over exploited - as is the case with most commercial fisheries in European waters - the focus of management will be narrowed to an overriding concern for the sustainability of commercial fish stocks.

5. In its present form, the CFP is a flawed instrument for the effective management of commercial fisheries, and a wholly inadequate vehicle for delivering the broader goals of sustainable marine ecosystems and the conservation of endangered habitats and species. It is not yet fully integrated and compliant with several international conventions, nor with the terms of the Maastricht and Amsterdam Treaties, in respect of objectives for environmental protection and sustainable development. A revised CFP thus needs to be built around four basic objectives, namely:

- to ensure sustainable, sound and healthy ecosystems, maintaining their characteristic structure and function, productivity and diversity;
- to achieve sustainable exploitation of living resources;
- to ensure economically viable commercial fisheries;
- to enhance the social utility of marine fisheries and guarantee social equity in the allocation of access to the resources.

Defining the objectives for an ecosystem based approach

6. Development of an ecosystem based approach to fisheries management within the EU requires the clarification of objectives for protecting marine ecosystems which are scientifically sound, economically viable and administratively feasible. As the CFP is concerned principally with fishing in offshore waters (i.e beyond the 12 nm territorial limits) such objectives are more likely to be concerned with managing the direct and indirect effects of fishing rather than the protection of particular marine habitats or the conservation of specific endangered species.

Ten possible objectives are considered and described in the main text under the headings:

- Understanding the Consequences
- Ecological Indicators
- Essential Fish Habitat
- Rational Exploitation
- Ecosystem Limit Reference Points
- Maximum Economic Yield of the Ecosystem
- Ecosystem Target Reference Points
- Optimum Size Spectra
- Optimum Harvest of Trophic Levels
- Restoring the Integrity of the Ecosystem

These are grouped under four sub-headings, those which :

A build on current practice and require few changes to current management approach or projected levels of fishing intensity ;

B imply some protection to all species and which may therefore require some significant reductions in fishing intensity ;

C imply a level of optimisation for all parts of the ecosystem and substantial reductions in fishing intensity ;

D involve a switch from a species level to a whole system approach requiring some reductions in fishing intensity.

When the ten objectives are examined in relation to the scientific inputs, administrative feasibility and the likely response from the fishing industry, half may be discounted as being beyond what is likely to be feasible in the medium term.

7. The remainder should be viewed as a single integrated package rather than as a set of alternative objectives. They nest together quite effectively to describe a management system in which:

- scientists are required to provide ecosystem impact assessments alongside the advice on fisheries management options;

- scientists are required to establish limit reference points for all target and non-target species within the ecosystem and managers should determine best fishing practice to guarantee minimum levels of disturbance to the ecosystem;

- in the absence of precise scientific knowledge, estimates of habitat and species target levels are used as indicators of a healthy environment;

- particular action is required to protect essential fish habitats through a more widespread use of closed areas, developed on a permanent or seasonal basis, and the permanent exclusions of specific fishing gears; and

- fisheries managers are required to take all necessary actions to ensure that damage to the ecosystem (*viz*. excessive non-target species mortality and degradation of marine habitats) is not caused by intensities or forms of fishing activity beyond those required for rational and responsible exploitation of target species within commercial fisheries. In effect, this will require most - if not all - fishing effort to be reduced to levels commensurate with limit reference points.

The inclusion of such a package within a revised CFP will require integration with the more traditional objectives concerned with optimal yield of the fishery, economic viability and social sustainability.

Marine habitat and wildlife conservation

8. Finally, an ecosystem based approach is not only concerned with the moderation of current fishing practice. A more proactive agenda for the protection of vulnerable marine habitats and endangered marine wildlife will also be required through the implementation of Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora - the Habitats Directive. However, care will need to be taken to ensure that the value of such measures is optimised through carefully coordinated strategies for marine ecosystem sustainability, combining both revised objectives for fisheries management and specific actions for the protection of habitats and species.

Conclusions

9. The arguments presented above need to be repositioned in the particular consequences of the prolonged overexploitation of Europe's fisheries. The demands on the management system and the fishing industry created by the introduction of an ecosystem based approach may well be dwarfed by the changes implicit in solving the problems of existing overcapacity and excessive fishing effort. An opportunity exists to address both issues - the structural imbalances within the industry and the introduction of an ecosystem based approach to management - in a complementary fashion.

1. Introduction

In European waters, as elsewhere in the world, fisheries policies have largely failed to stem the problems of overfishing, reduction in the resource base and degradation of the marine ecosystem. Annual increases in world catches (FAO, 1998) - achieved largely as a result of increasing exploitation of stocks of lower commercial value - disguise the progressive decline of the more important foodfish stocks throughout many of the world's oceans. Such declines are especially marked in areas like the North Atlantic which have endured a long history of intensive exploitation. At the same time, there is growing awareness of the negative impacts of fishing activities on the diversity and integrity of marine ecosystems.

Many different explanations have been put forward to explain the apparent crisis in fisheries management (Symes, 1996). Likewise, several suggestions have been offered for the solution of the crisis. The momentum for a fundamental change in the approach to fisheries management, from the current narrow preoccupation with fish stock assessment to a 'whole system' approach which links the issue of sustainable fisheries to a much wider concern for the productivity, diversity and integrity of the marine ecosystem, is growing (Svelle *et al*., 1997). In turn, this changing emphasis implies a switch from short term reactive management, characteristic of modern systems, to a longer term strategic approach to fisheries development within a wider ecosystem context.

Although one should be careful not to overestimate the prospects for reform of the Common Fisheries Policy (CFP) in 2002, the ongoing review does provide an important opportunity to reassess the policy process with a view to bringing it more closely in line with recommendations of the Food and Agriculture Organisation's *Code of Conduct for Responsible Fisheries* (FAO, 1995) and with the European Union's obligations in relation to several international conventions concerning the marine environment.

In this, the first of two reports outlining an ecosystem based approach to fisheries management, we are concerned to identify new and more appropriate objectives for fisheries management in the EU. The report begins by outlining the broad characteristics of an ecosystem based approach to fisheries management and its recent appearance on the political agenda in the USA and Western Europe (Section 2), and indicating that its adoption would require a restructuring of the objectives of the Common Fisheries Policy, bringing it more into line with its external and internal treaty obligations (Section 3). While the objectives concerned with the sustainability of fish stocks, profitability of the industry and social equity are in general quite widely understood, those relating to the health of the marine ecosystem require more careful elaboration. Accordingly, in Section 4 - the main part of this first report - the intention is to set out a range of scientifically sound and administratively feasible objectives for an ecosystem based approach which could, without too much difficulty, be incorporated within a revised CFP. Section 5 briefly considers the need for complementary measures for the protection of vulnerable marine habitats and endangered species, and for a carefully integrated strategy to ensure the future development of commercial fisheries within a sustainable marine ecosystem. The measures to achieve these objectives will be explored in the second report - *Achieving the Objectives*.

2. An ecosystem based approach to fisheries management

2.1 The concept of ecosystem based management

Ecosystem based management of aquatic environments is a relatively new concept which is rapidly gaining wider recognition. A number of countries have already developed initiatives to consider ecosystem based management approaches for the marine environment. One useful definition of this new approach is provided by the *Assessment Report* of the Intermediate Ministerial Meeting of the North Sea Conference, on the Integration of Fisheries and Environmental Issues which states:

> '*An ecosystem approach involves considering all the physical, chemical and biological variables within an ecosystem. In the management of living resources this means that decisions are based on the best available scientific knowledge of the functions of the ecosystem, including the interdependence of species and the interaction between species (food chains) and the abiotic environment, as well as knowledge of the temporal development of the ecosystem. It could therefore imply a widening of the multispecies approach, currently used in fisheries, to encompass not only fish but also other organisms which directly or indirectly depend on fish or on which fish depend, as well as other significant biotic and abiotic environmental factors'* (Svelle *et al*; 1997: 8.3.2).

The ecosystem approach concept has its origins in the management of terrestrial and freshwater ecosystems, where it is usually presented in terms of maintaining the integrity of the ecosystem and the processes that sustain it. But there are several differences in the ways that terrestrial and marine ecosystems are organised, and how they are affected by human use.

Management of terrestrial ecosystems tends to place the emphasis on the maintenance of habitat rather than the conservation of individual species within the habitat. By contrast, fisheries management has tended to concentrate on achieving optimal harvesting rates for target species. This difference in approach partly reflects the different structuring of terrestrial and marine ecosystems. Terrestrial ecosystems are often dominated by comparatively large primary producers - trees, for example - which form key elements of the landscape and provide the habitats. These primary producers are often the subject of harvesting and other forms of direct disturbance. Herbivores and their predators will frequently be of similar sizes and food chains comparatively short: neither the herbivores nor the predators are necessarily the subject of direct harvesting. Not surprisingly, therefore, the management of landscape is often seen as the appropriate approach for species conservation.

This approach is reasonable in freshwater ecosystems since the majority of extinctions among freshwater fish and other aquatic animals have resulted from habitat modifications. Extinctions are far less common in marine ecosystems, though exploitation has reduced some stocks of marine mammals, reptiles and fish to historically low levels.

The open sea food chain starts from very small primary producers and passes through herbivorous and carnivorous zooplankton, few - if any - of which are harvested directly, before reaching the target species for the fishing industry. It is, therefore, quite logical to portray ecosystem problems as relating at least partly to the harvest of target species. However, it is important to remember that these target species both depend upon the wider ecosystem for their food and, at the same time, provide food for other parts of the ecosystem. Moreover, they

depend on the provision of appropriate habitats for at least part of their life cycle stages. As a result, their conservation cannot, and should not, be divorced from the conservation of the wider marine ecosystem.

Marine ecosystems are far less easily managed than their terrestrial counterparts. They tend to be larger, less easily divisible into viable sub-units and have shifting boundaries. In freshwater systems, management is focused on restoration of habitats, control of pollution and flooding. The management of 'essential fish habitat', as practised in freshwater systems in the USA, is closely related to the ecosystem management approach. This approach may also be appropriate for estuaries and for some marginal, shallow water, marine ecosystems. Chesapeake Bay in the USA provides an example of an ecosystem approach to the management of nearshore waters. Here, there is concern about excessive phytoplankton production and a reduction in the area of submerged aquatic vegetation and oyster beds, associated with nutrient run-off from surrounding land areas; strict controls have been implemented within the catchment area. It is also likely that fishing activity has directly contributed to the degradation of the ecosystem; however, controls on fishing are less advanced and less well coordinated (STAC, 1998).

In Europe, an ecosystem based approach to the management of fisheries is a new and so far underdeveloped concept, despite the fact that the basic regulation for the CFP (EC 3760/92) requires it:

> *'to protect and conserve available and accessible living marine resources, and to provide for rational and responsible exploitation on a sustainable basis, in appropriate economic and social conditions for the sector, taking account of the implications for the marine ecosystem, and in particular taking account of the needs of both producers and consumers'* (Article 2).

An ecosystem based approach was, however, strongly canvassed during the Intermediate Ministerial Meeting on the Integration of Fisheries and Environment Issues held in Bergen in March 1997. The resulting *Assessment Report* (Svelle *et al.*, 1997) contains the basis for a definition of an ecosystem approach but not an operational plan (Symes, 1998). Likewise, the *Summary of Conclusions* (1997) proposes that management of North Sea fisheries be guided by principles including, *inter alia:*

> *'further integration of fisheries and environmental protection, conservation and management measures, drawing upon the development and application of an ecosystem approach which, as far as the best available scientific understanding and information permit - is based on in particular:*
>
> - *the identification of processes in, and influences on, the ecosystems which are critical for maintaining their characteristic structure and functioning, productivity and biological diversity:*
>
> - *taking into account the interaction among the different components in the food-webs of the ecosystems (multi-species approach) and other important ecosystems interactions; and*
>
> - *providing for a chemical, physical and biological environment in these ecosystems consistent with a high level of protection of those critical ecosystems processes'*

(para 2.6)

But again, the *Summary of Conclusions* offers no real guidance on the means of implementing such an approach. The most recent communication from the European Commission (COM (1999) 363 final) indicates little material progress in the context of the Community's fisheries policy.

By contrast, in the United States, Congress has commissioned a report from the National Marine Fisheries Service on the application of an ecosystem based approach to marine fisheries management (NMFS, 1999). The report defines a series of principles, goals and policies (see Box 1) which can be used as a guide for evaluating current applications of ecosystem principles in fisheries research and management, and developing recommendations for further implementation of an ecosystem based approach. In the view of the National Marine Fisheries Service, the ecosystem based approach incorporates not only the precautionary principle (Policies 1 and 2) but also the concepts of co-management (Policy 4) and adaptive management (Policy 5). In addition, the report proposes that existing fisheries management plans (FMPs), drawn up by the regional management councils, should be modified to correspond with overarching fisheries ecosystem plans (FEPs), thus ensuring that in future fisheries management is compatible with the achievement of objectives for healthy and sustainable marine ecosystems. Similar considerations have been explored in Canada (FRCC, 1997), though on a less formal level.

It is important to recognise that institutional structures in the USA, resulting from the *Magnuson-Stevens Fisheries Conservation and Management Act* 1976 and recent amendments through the *Sustainable Fisheries Act* 1996, together with the setting up of Regional Fisheries Management Councils, may make the adoption of an ecosystem based approach to fisheries management very much easier than is the case in Europe. Nonetheless, the National Marine Fisheries Service's Report to Congress contains some important pointers for the development of the ecosystem based approach in Europe.

Box 1: Ecosystem principles, goals and policies
(Source National Marine Fisheries Services NMFS, 1999)

Principles

1. The ability to predict ecosystem behaviour is limited.
2. Ecosystems have real thresholds and limits which must not be exceeded.
3. Once thresholds and limits have been exceeded, changes can be irreversible.
4. Diversity is important to ecosystem functioning.
5. Multiple scales interact within and between ecosystems.
6. Components of ecosystems are strongly linked.
7. Ecosystem boundaries are open.
8. Ecosystems change with time.

Goals

1. Maintain ecosystem health and sustainability.

Policies

1. Change the burden of proof to protect ecosystems rather than fishermen.
2. Purchase 'insurance' against unforeseen, adverse ecosystem impacts.
3. Make local incentives compatible with global goals.
4. Promote participation, fairness and equity in policy and management.
5. Learn from management experiences.

2.2 Ecosystem effects of fishing activity

While so far little has been done to moderate the effects of fishing on the marine environment, over the last decade some significant progress has been made in understanding and quantifying them (see Jennings and Kaiser, 1998; Kaiser and De Groot, forthcoming). The ICES Working Group on the Ecosystem Effects of Fishing Activities has been an important focus for such work. Initiated in 1991 to provide inputs to the 1993 North Sea Quality Status Report (North Sea Task Force, 1993), it has continued to act as a major catalyst for research and policy discussion.

The effects of fishing on the marine environment were outlined by the ICES Study Group (ICES, 1992) as follows:

- it causes mortality on target fish species and incidentally on other biota;

- it makes food available to other species in the ecosystem by:

  (i) discarding unwanted catch of fish and benthos;
  (ii) discarding wastes; and
  (iii) by killing or damaging animals in the path of the gear during its deployment;

- it disturbs the seabed through the action of some fishing gears;

- it generates litter composed of lost or discarded gear as well as other, non-specific debris.

The Study Group also noted that these direct effects can in turn lead to indirect effects such as the modification of predator-prey relationships, thereby changing the flow of energy through parts of the system, and to the modification of habitats.

Until recently, applied fisheries science has been almost exclusively concerned with understanding the first of these effects - the mortality of target species which form the focus for commercial fisheries. Adequate quantification of this process alone, for the purposes of fisheries management, proves time consuming and expensive and is still subject to considerable error.

In general, the effect of fishing in killing non-target species remains comparatively poorly understood, and assessment of the impact on ecosystems is thus uncertain. A number of studies have been made on the mortality of non-target species in the track of towed gears, and of incidental capture in static gears, but these have rarely generalised their findings to assess the effects at population level. In a few cases, studies have allowed the estimation of mortality rates for particular non-target species. Examples include: skates and rays in the North Sea (ICES, 1998); common and striped dolphin in the Bay of Biscay (Antoine *et al*., 1997); harbour porpoise in the North Sea (ICES, 1998); and common dabs and grey gurnards in the North Sea (MacDonald *et al*., 1994). Methods for determining approximate exploitation levels and estimating levels of vulnerability to fishing have also been developed (MacDonald *et al*., 1994; ICES, 1994).

Some progress has also been made with quantifying the extent to which fisheries provide food to other species especially, with regard to the use of discarded fish and offal by seabirds (ICES, 1996a). Here, it would seem that sufficient food has been provided by fisheries to fuel the large expansion of scavenging seabirds noted this century in the North Sea.

By contrast, less is known about the effects of fishing activity in causing damage to marine habitats through the actions of certain fishing gears, or the generation of litter through lost or discarded gears. A recent review of the state of knowledge on these particular effects is provided in ICES (1998) and two large scale studies have recently been funded by the EU (Lindeboom & de Groot, 1998).

Studies designed to elucidate the interactions between fish species and fisheries have provided some information on the importance of fishing in modifying food chains and predator-prey relationships (ICES, 1996b). Again, these studies refer mainly to the effects on target species, but some progress has been made in quantifying the effects in respect to benthos (ICES, 1998). Predation mortality is an important variable, and one that is indirectly affected by fishing levels. Studies of size spectra (ie. the physical size range of species) also indicate that fishing can have a major influence on the structure of the harvested portions of marine food webs.

Thus, while fishing mortality and by-catch mortality generated by fishing are the most obvious ecosystem effects of fishing, they may not always be the most important. For the time being, however, these are the effects we know most about. Whereas other effects may exert positive effects for some populations, it is reasonable to assume that fishing and by-catch mortalities will have a negative effect on the impacted populations. Direct mortality thus constitutes the ecosystem effect of fishing which is most likely to require management in the immediate future. But this is not to deny the need to consider all other aspects of fishing activity in developing an ecosystem based approach to fisheries management.

3. A reorientation of fisheries management

3.1 The existing goals

An ecosystem based approach implies a reorientation of fisheries management. But rather than replace the old order, the new objectives will need to stand alongside those which have structured fisheries management over the past 40 years or so. What is intended is a 'quiet revolution': the challenge will lie in achieving a balanced integration of what have so far proved to be rather conflicting objectives. In most policy statements these objectives are inadequately defined and rarely prioritised in a systematic fashion. As a result, each objective will tend to be prioritised by a particular actor within the policy community, and will often favour a particular management tool.

(i) Maximisation of yield from fisheries

This was the original goal of fisheries management, dating from the time of relatively unstressed and unregulated fisheries, and is largely attributable to fisheries scientists. It seeks to maximise output from commercial fish stocks in a biologically sustainable way, in order to enhance supplies of quality proteins to a hungry world market, including both human food consumption and protein supplements for intensive livestock feeds.

It introduces the classical function of Maximum Sustainable Yield (MSY) - the maximum long term average yield which can be sustained for a stock under normal exploitation patterns - (see Fig.3.1), and is reliant on assumptions regarding behaviours of fish populations, a tendency towards equilibrium and fishing mortality as the only significant variable. Management mechanisms in support of MSY were based initially on technical measures (eg. mesh size) to prevent growth[1] and recruitment[2] overfishing. More recently the emphasis has been on TACs and quotas.

(ii) Maximisation of economic rent from fisheries

This goal is advocated primarily by economists, fleet operators and individual enterprises. When added to the maximisation of yield, it produces the Gordon-Schaefer 'bio-economic' model, where profit maximisation is expressed as Maximum Economic Yield (MEY) (Fig.3.1). It can be viewed
from two distinct perspectives: (a) the State, where 'profit' is the net social benefit less 'transaction costs', and (b) the individual firm.

Maximisation of profit for the firm is the function of several factors in addition to resource availability. These include scale of enterprise, technology, operating costs (fuel, labour) and market prices. Traditionally, the fishing industry has viewed quantity of output as the basis of profitability. However, with declining resource availability the harvesting and processing sectors

[1] Growth overfishing - occurs when most of the larger fish are removed so the optimum yield per fish is not achieved.

[2] Recruitment overfishing - occurs when fishing reduces the stock to a level where it can no longer replace itself.

are turning to quality and value added to the product as the more enlightened basis for profitability.

The current approach favours the neoliberal concept of individual transferable quotas (ITQs) (or the privatisation of use rights). The assumed benefits of ITQs include rationalisation of fleet structures, better planning of the use of the means of production (no longer focused on the 'race to fish'), more even flows of raw materials to markets, lower transaction costs, and a more fisheries conservation friendly approach to resource exploitation. Despite these assumptions, ITQs

Figure 3.1: Locating existing fisheries objectives on the yield curve

have only been introduced in a handful of countries. Part of the apparent reluctance to implement ITQs in other counties may relate to the potentially high social costs involved, especially in terms of employment.

(iii) Maximisation of employment (at sea and ashore)

This is a social goal associated with the problems of fisheries dependent regions (FDRs) and communities. In most cases, social objectives have not been specified other than in general terms, but they are generally linked to the notion of social equity in access to fishing rights. Social considerations are often taken into account only in the later stages of policy formulation as 'excuses' for not carrying through the scientific or economic agendas - this is because of the substantial 'hidden' social costs of job losses and threats to viability of coastal settlement structures in fisheries dependent regions.

It is difficult to locate on the yield curve (Fig. 3.1) but the tendency to support employment objectives through subsidies to the industry suggests that Maximum Social Yield (MSocY) will be found well to the right of MEY or MSY and close to zero yield (ZY) in the area characterised by overfishing.

Maximisation of employment will imply deliberately arresting the tendencies towards market-led rationalisation of the fishing industry, through preferential treatment of small-scale inshore fisheries in access to fishing areas and/or allocation of quotas.
This goal is generally antipathetic to ITQs because quota markets tend towards the elimination of smaller, marginal enterprises. Because quota systems generally disadvantage the small-scale inshore sector, the social goal will tend to favour systems of regulation based on territorial preference or strict regulation of access by vessel size, gear groups etc. and upon technical conservation measures (gear regulations, seasonal closures etc.);

Social goals are more likely to be prioritised in regional or local management systems than at national or supra-national levels. It is popularly argued that small-scale local enterprises exert less pressure on stocks and cause less damage to the marine ecosystem. If this is the case, social goals may be more easily integrated with an ecosystem approach. However, the premise that small-scale fisheries do indeed cause less problems than other fisheries can be disputed: while they may tend to use less intrusive gears, they also typically fish closer inshore in what may be considered more sensitive areas.

Crisis management

The above goals will compete for prioritisation under conditions of underexploited or fully exploited fisheries; trade-offs will inevitably occur. The present situation is different simply because management is having to cope with a situation which is *in extremis:* the only (or at least the prime) objective is the prevention of stock collapse. Crisis management therefore implies the acceptance of a ruthless management regime which allows little scope for trade-offs. Delays and compromises in management decisions add to the problem.

Under crisis management conditions, the tendency will be to narrow the focus of management on resource conservation while seeking to maintain a viable economic situation, but ignoring concern for social equity or ecosystem effects, except where the latter are unambiguously linked to resource conservation.

3.2 Revised goals for an integrated Common Fisheries Policy

It is clear that the CFP is both a flawed instrument for the effective management of commercial fisheries and a wholly inadequate vehicle for delivering the broader goals of the sustainability of marine ecosystems and conservation of endangered habitats and species. Despite Article 2 of Council Regulation 3760/92 which lays down the general objectives for the CFP, the Policy is, in practice, concerned almost exclusively with the conservation of fish stocks at levels which require minimal changes to existing patterns of fishing activity, and the creation of a common market for fish and fish products.

Yet the Policy is failing even in these limited objectives. Many of the commercially important fish stocks in European waters are being fished beyond target levels and not infrequently beyond reasonable limit reference points[3]. In other words, these fish stocks are currently overexploited. A comment frequently appended to ICES management advice is that the lack of explicit policy objectives is one reason why stocks cannot be considered to be managed according to a precautionary approach (ICES, 1997). Existing objectives are inadequate in that they are not

[3] Limit Reference Points - represent a measure that scientists and managers use to judge the state of exploitation of fish stocks.

being achieved: they are imprecisely framed, insufficiently prioritised and lacking a specific time frame. Management action is biased towards the realisation of short term objectives concerned with maintaining the *status quo* rather than a long term strategy for the recovery and sustainability of the fishery.

At present the CFP represents a highly centralised, technocratic approach to fisheries management, heavily dependent on scientific advice concerning the state of the fish stocks arrived at through mathematical modelling and recommendations for managing yields through adjustments to fishing mortality (F). Only very recently has the scientific advice been moderated by the application of a precautionary approach in an attempt to ensure that F is maintained at levels below those associated with the risk of spawning stocks falling below a critical level. However, such shifts from resource optimisation to risk minimisation involving the development of even more complex stochastic models, still occur within a management paradigm that continues to assume that future trends in fish stocks are predictable and that largely ignores the wider context of natural and man induced changes to the marine ecosystem (Degnebol, 1999). Moreover, these changes to the scientific advice are viewed with suspicion by the fishing industry, and therefore do little to improve the validity and legitimacy of the science in the eyes of the majority of the stakeholders.

If the CFP is to embrace an ecosystem based approach and so align itself fully with the terms of the several international conventions relating to the maintenance of the biodiversity of the marine ecosystem and the protection and conservation of endangered habitats and marine wildlife, (see Box 2) then it will be necessary to redefine its goals, principles and procedures. It is also likely that the Community's own Biodiversity Action Plans and any future amendments to the Community's Environmental Action Programme, including for example the addition of fisheries to the existing five main economic sectors (industry, transport, energy, agriculture and tourism) will set new requirements for the Community's fisheries policy.

Box 2: Examples of external and internal obligations of relevance to the CFP

- The Convention on Biological Diversity, the OSPAR Convention, the Bern Convention and the ASCOBANS Agreement;
- The FAO's *Code of Conduct for Responsible Fishing* (1995);
- The Statement of Conclusions from the Intermediate Ministerial Meeting of the Fifth International Conference on the Protection of the North Sea, Bergen, 1997;
- *The Maastricht Treaty*, Article 130(2) relating to the adoption of the precautionary principle and the integration of environmental protection requirements into the definition and implementation of other community policies;
- The provisions of the Habitats Directive (92/43/EEC); and
- The Amsterdam Treaty, which makes sustainable development an explicit objective of the European Union.

The goals for a more comprehensively defined fisheries policy can be stated as :

- to ensure sustainable, sound and healthy ecosystems, restoring and/or maintaining their characteristic structure and function, productivity and diversity;

- to achieve sustainable exploitation of living resources;

- to ensure economically viable fisheries;

- to enhance the social utility of marine fisheries and encourage social equity in the allocation of access to the resources.

There is little that is strictly new about these goals - they can be readily identified within the existing Common Fisheries Policy (Article 2). But what the process of re-orientation requires is that each of these broad goals be translated into specific, yet mutually reconcilable, objectives - a difficult task all round. Translating the ecosystem goal into clear and feasible objectives is likely to prove the hardest challenge, partly because of a lack of understanding of, and empathy for, the concept of an ecosystem based approach to fisheries management on the part of those within the public administration and the fishing industry with a responsibility for management.

The ecosystem based approach faces other difficulties including :

- a general lack of awareness or concern for the effects of fishing on the marine environment and the conservation needs of particular habitats, ecosystems and species, due principally to their relative 'invisibility'; and

- the difficulty in ascribing a monetary value (or price) to marine ecosystems and non-commercial species, so that they cannot easily be incorporated into economic models for the optimal development of fisheries.

These last two constraints will need to be faced at an early stage. But the immediate task is to identify and evaluate the range of objectives which underlie this approach.

4. Defining objectives for ecosystem based management

4.1 Assessing the alternatives

An essential first step in developing an ecosystem based approach to fisheries management is to establish a series of specific objectives for the wider marine ecosystem which are both scientifically sound and administratively feasible, and also capable of coordination with the economic and social objectives of fisheries policy. Some ecosystem objectives might seek to protect particular marine habitats, but since the CFP is predominantly involved with the management of fisheries beyond the 12 nm territorial limits, it is reasonable to assume that it will be more concerned to manage the direct - and, to a lesser extent, the indirect - effects of fishing on populations rather than habitats.

Ten possible objectives are considered below: they are grouped together under four sub-headings, indicative of the degree of difficulty in implementation. The ten objectives are not mutually exclusive. Some could work comfortably alongside each other, while others can be seen as achievable staging posts on the road to more exacting objectives. Initially, each objective is described briefly and some indication of the implications for current management practice is given; then each objective is assessed in terms of its scientific requirements and administrative feasibility, culminating in Table 1 setting out notional scores (the authors' best guess) for their operational feasibility. In assessing feasibility the financial cost of implementing each objective has not been separately considered; however, the cost will in part reflect the extent to which the formulation and implementation of the objective requires additional scientific and/or management inputs.

A Objectives which build on current practice and which might require little change to current management approaches or levels of fishing effort.

(1) 'Understanding the Consequences'

The simplest ecosystem objective would be a requirement for managers to be informed of the ecosystem consequences of particular fisheries management options. This would require that an ecosystem impact assessment be provided alongside fisheries management advice for the target species. The intention would be for managers to understand and give weight to those factors when deciding between management options. The requirement for a deeper understanding of effects on the ecosystem should also influence their research spending decisions. The aim of this objective is to ensure that managers do not adopt measures that damage the ecosystem simply out of ignorance, and also to ensure that adequate scientific knowledge is developed to support their decisions. 'Understanding the consequences' does not of itself require new management measures or a reduction in fishing mortality, but greater awareness of the ecosystem consequences could lead to both. It might also necessitate the wider education of managers and stakeholders in the ecosystem implications of different management policies.

Implications for science - It should be possible to adopt and service this objective with current levels of understanding. However, it is likely that the impact assessments will, in the early stages, serve to expose large gaps in our understanding.

Management feasibility - 'Understanding the consequences' should fit with current management systems. It would not necessarily involve specific reductions in fishing intensity, but the highlighting of ecosystem impacts could well generate pressure for future reductions. As such it would be a useful first step, paving the way for a more sophisticated ecosystem based approach.

Problems for implementation - Problems with implementing this objective would mostly result from uncertainties in our scientific understanding of the effects of fishing on the wider ecosystem, and our lack of understanding of how fishermen will react to specific measures. Scientific advice would therefore need to identify areas of uncertainty. Given current management approaches, advice will be mainly concerned with indicating the likely effects of the choice of different levels of TACs on the target species.

(2) 'Ecological indicators'

This objective follows an approach being developed in the Dutch part of the North Sea and particularly in the Wadden Sea, where an ecologically desirable balance of species and their population has been identified (see Fig 4.1). Species directly affected by human activities can be used as indicators of biodiversity and ecological processes. The intention is to achieve agreed target levels of population density for non-target species of particular interest. Where scientific knowledge is lacking a precautionary approach is applied and arbitrary targets are set. The objective could specify maximum levels for undesirable species (e.g. toxic algae) as well as minimum levels for desirable species (e.g. harbour porpoise). While it may not require an immediate reduction in fishing intensity - except for any specified commercial species - additional measures including curbs on the use of particular fishing gears may well be necessary to achieve the objective.

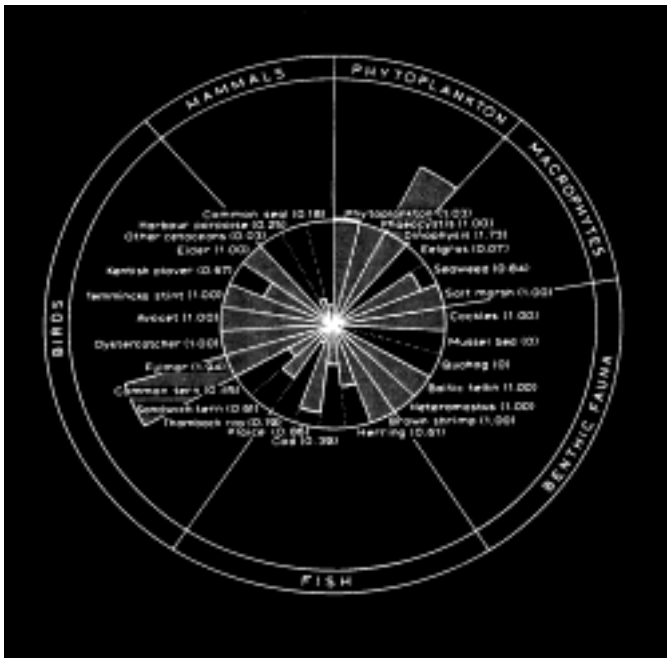

Figure 4.1 An assessment of the ecological status of the Dutch part of the North Sea in 1996 (after Lanters and Ensernik, 1998) *The circle represents the target level for each indicator; existing levels are indicated by shaded vectors*.

Implications for science - There would have to be agreement on the population indices and the data series used in monitoring the targets.
Management feasibility - As such an objective is already being used in the Wadden Sea, its feasibility is also proven. However, difficulties in agreeing arbitrary target levels might well increase sharply as the number of coastal states involved increases.

Problems for implementation - These are mainly related to the need for Ministers to agree target levels for all relevant species, a task which might prove difficult when divorced from objective scientific criteria.

(3) 'Essential Fish Habitat'

The objective is to avoid destruction of substrates essential to parts of the life cycles of particular species. Some marine species rely on particular substrates for fulfilling certain critical stages of their life cycles; for example, herring spawn on gravel beds, and some elasmobranchs deposit their eggs on hydroids. The objective would therefore seek to prevent such habitats being eroded by the inappropriate use of certain fishing gears or other potentially damaging operations such as dredging. In practice, a number of the more important and sensitive substrates are situated in inshore waters and are thus a concern for coastal state management.

Implications for science - Identification of habitats essential to the life cycles of particular species would be required. At present relatively little appropriate knowledge is available but could be progressively constructed.

Management feasibility - Similar objectives for protecting essential fish habitats already exist in the USA. In Europe, while the approach could be seen as a potential extension of the Habitats Directive more specific action through the CFP may be required. Achievement of the objective would require the closure of certain areas to specific fishing gears either seasonally or permanently.

Problems for implementation - Area closures do not necessarily imply a reduction in overall fishing effort but they may prove unpopular and be deemed discriminating where they prevent local fishermen from pursuing traditional fisheries, even when there is incontrovertible evidence that certain kinds of fishing activity may threaten the integrity of the essential fish habitat.

B Objectives which imply some protection to all species and which would probably require some significant reductions in fishing intensity.

(4) 'Rational Exploitation'

This entails allowing fisheries to affect the wider ecosystem adversely only to the extent that this is consistent with rational exploitation of the target stocks. All fishing causes some impacts on marine ecosystems, and in some instances fishing may put specific components of an ecosystem at serious risk of collapse. The aim of 'rational

exploitation' would be to avoid loss of biodiversity - viewed simply as species presence - except where there are sustainable economic benefits to be derived from actions leading to a reduction in diversity. Such an objective might only be acceptable where other measures existed to protect those biota at risk somewhere within its geographical range. This objective would presumably require reductions in the exploitation of some target species below levels currently planned, and changes in the balance of fishing effort applied by different gears.

Implications for science - Scientific estimates of some reference points and current fishing mortality rates are available for the more important target species, but for non-target species reliance would have to be placed on more pragmatic, precautionary estimates of current mortality rates, and potential jeopardy levels for limit reference points (MacDonald *et al*., 1994; ICES, 1994).

Management feasibility - Any substantial reduction in fishing intensity will be difficult to achieve, and this is underlined by problems of reducing fisheries to limit reference points for target species. However, there is an unanswerable case that it is wrong to permit serious damage to other parts of the ecosystem just to preserve fishing at excessive levels that degrade all reasonable fishing objectives.

Problems for implementation - Stated in its simplest form, this objective would result in the trade-off of non-target species and habitats with the optimal operation of the fishery. Agreement with environmentalists would be difficult. In practice, it is likely to give rise to calls for specific technical measures or further reductions in the fishery. However, this objective could be viewed as a transitional rather than a final objective.

(5) 'Ecosystem Limit Reference Points'

This objective would seek to avoid allowing any component species in an ecosystem to fall below safe biological levels, as for example permitting the spawning stock sizes of target and non-target species to fall below those essential for maintaining stocks at desired levels.
For this objective, no species - target or non-target - would be exploited beyond its limit reference point in any geographical area. The limit reference point would be set either as a fishing mortality rate, beyond which the continued replacement of the species could not be guaranteed, or at a conservative proxy for this - for example, a level that would reduce the spawning stock biomass to 10% or 20% of its unfished level. Fisheries would have to be restricted, and fishing gears adjusted so that no limit reference point was exceeded. The aim would be to maintain biodiversity, viewed as species presence in its historic range. This objective would impose the same form of overall constraints on fishing on non-target species as proposed for target species.

Implications for science - As with the previous objective, estimates of current and limit fishing mortality rates for non-target species are not currently available; though these could be created on the basis of precautionary estimates and gradually refined through scientific research.

Management feasibility - Although this objective is more exacting in terms of fisheries regulation than any of the previous objectives, it can be regarded as the minimum

interpretation of preserving marine biodiversity. It would, therefore, be difficult to argue against the objective except in terms of technical detail.

Problems of implementation - These are largely scientific and technical. The objective might well require a definition of the best current fishing practices which would ensure harvesting the fish with acceptable disturbance to the ecosystem. Ecosystem damage would have to be quantified and comparative information provided on direct and indirect damage caused by alternative fishing gears.

C Objectives which imply some optimisation of all parts of the system and probably substantial reductions in fishing intensity

(6) 'Maximum Economic Yield of the Ecosystem'

The marine environment provides extremely valuable - and, in some instances, potentially priceless - functions to mankind, for example atmospheric gas exchange, nutrient processing (Constanza *et al*., 1997). It also provides economic benefits in the form of profitable fish harvest. The objective would be to maximise the total value of the whole system, i.e. the fisheries value together with the intrinsic value of ecosystem service functions. The justification for adopting this objective would be to avoid diminishing the overall economic value of the ecosystem as a result of focusing only on catch value. Since this would very likely imply fishing at or below Maximum Economic Yield (MEY), substantial reductions in fishing mortality would be needed.

Implications for science - Estimates of the value of service functions would have to be elaborated and estimates of the true profitability of fisheries further developed. The latter are being developed for some fisheries through the Commission's Scientific, Technical and Economic Committee for Fisheries (STEFC), but are in their infancy. The greatest challenge would be quantifying the value of all aspects of the marine ecosystem.

Management feasibility - Economic optimisation of fisheries already implies a significant reduction in current fishing effort. It is very doubtful that a much broader economic objective, based on global estimates of ecosystem services (see below), can currently form a practical basis for European fisheries management.

Problems for implementation - In practice, the economic value of fisheries *per se* is extremely small in relation to the value of the ecosystem services. According to Constanza *et al*., (1997) marine services provide over 60% of the global total, estimated at *circa* US$33 trillion *per annum*; many of the most valuable services are associated with lower trophic levels. As a result, very little value can be ascribed to preserving some non-target species which provide neither commercial catches nor significant environmental services. The objective is a doubtful starter unless forced upon fisheries management through its adoption in relation to the ecosystem effects of pollution or eutrophication.

(7) 'Ecosystem Target Reference Points'

This refers to reducing fishing mortality on all species in the ecosystem to the maximum yield per recruit (Fmax) or lower. This objective would require exploitation levels for all species to be at or below MSY. These levels would need to be set for both target and

non-target species. The justification for this objective would be to maintain intergenerational equity, taking into consideration the fact that future generations might wish to exploit species other than those currently being exploited. A further justification would be to maintain biodiversity as indicated by 'healthy' population levels. Since many species in EU waters are already fished well beyond MSY, this objective would require a substantial reduction in fishing effort.

Implications for science - For most non-target species, MSY would probably have to be estimated on a per recruit basis, using analogous arguments to those used for limit reference points.

Management feasibility - This objective would require deep cuts in fishing effort to allow the generation of large populations of some slower growing and low fecundity non-target species. It would therefore be difficult to convince fishing interests and the general public of the justification for this objective.

Problems for implementation - There is a need to define 'desirable' target populations and mortality levels for all species. Although based on more objective criteria than A(2) above, this will prove practically and politically difficult.

D Objectives which involve a switch from a species level to a whole system approach probably requiring significant or substantial reductions in fishing intensity

(8) 'Optimum Size Spectra'

The overall size spectra of fish species, as estimated by trawl surveys, appears to reflect the overall level of exploitation of the systems. Figure 4.2 compares the slope of the curve of the size spectra for North Sea fish in 1904 and 1991. Clearly the slope has grown steeper and the ratio of small to large fish has increased over the century. Since the slope of a size spectrum appears to indicate the level of exploitation of the system as a whole, to achieve a particular target slope would require the overall fisheries exploitation levels to be brought into line. At present, the precise links between the slope of the size spectrum and ecosystem health are not fully understood, and this objective would therefore require some arbitrary slope to be achieved. The aim of this objective would be to maintain the general health of the system. Since it is likely that an arbitrary target slope would be set somewhere between that of 1991 and 1904 - some significant reduction in exploitation rates would seem probable. How this reduction would be balanced between different fisheries and different gears is not yet understood.

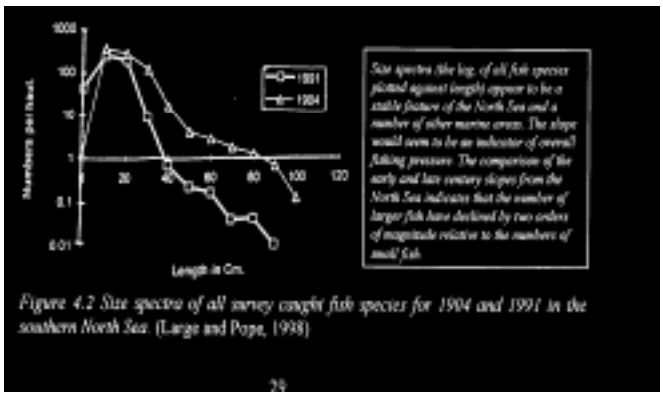

Figure 4.2 Size spectra of all survey caught fish species for 1904 and 1991 in the southern North Sea. (Large and Pope, 1998)

magnitude relative to the numbers of small fish.

Figure 4.2 Size spectra of all survey caught fish species for 1904 and 1991 in the southern North Sea. (Pope and Large, 1996)

Implications for science - It would be necessary to quantify both current and desirable size spectra for both target and non-target species, ideally throughout the range from fish to plankton. While it is fairly easy to measure current size spectra for fish species, target slopes would need to be designed and techniques for measuring size spectra for non-fish species developed.

Management feasibility - Of the various indices of biodiversity, the slope of the size spectra is perhaps the easiest for the non-specialist to understand. The objective is perhaps best considered as one of a group of ecosystem objectives, rather than a stand alone objective.

Problems for implementation - While a relatively easy to understand visual interpretation, as with any holistic measure, this may be difficult to justify to the fishing industry.

(9) 'Optimum Harvest of Trophic Levels'

Pauly *et al*., (1998) argue that fishing down the ecosystem to lower trophic levels ultimately reduces the overall yield and hence the ecosystem health of a system. If this is true, then an objective to achieve some optimal average trophic level in the catch might help to maintain ecosystem health. The justification of this objective would be to maintain both the general health of the system and the overall productivity of the fisheries. In practice such an objective would most readily be achieved by eliminating fishing on lower trophic levels, including, for example, many of the important industrial fisheries such as Norway pout and sandeels.

An ecopath is a simple trophic model of aquatic ecosystems used for estimating energy flows between major components of a system, (see Christensen and Pauly 1993 for several applications of the model). It provides a steady state for estimates of component biomass and inter-component energy flows and can give estimates of the average trophic level of a system.

Implications for science - This would require quantification of current and target average trophic levels. Ecopath models are already being created in other areas on the basis of relatively modest data, so it would presumably be possible to develop an ecopath model for marine ecosystems on the basis of existing scientific data.

Management feasibility - This is a fairly radical and complex objective and resistance from the fishing interests - especially those concerned with industrial fishing - can be anticipated.

Problems for implementation - Apart from management resistance, the choice of average trophic level might prove too coarse a measure for guaranteeing ecosystem health and viable commercial fisheries.

(10) 'Restoring the Integrity of the Ecosystem'

This suggests returning to a situation approaching a pristine state (Angermeier and Karr, 1994; Sparks, 1995) - the 'holy grail' for some conservationists. While initially such a goal may seem to imply 'zero tolerance' of disturbance to the ecosystem, it is possible that integrity of ecosystem function would permit some modest level of extraction. Alternatively, integrity might be restored to some smaller parts of the system through the designation of Marine Nature Reserves. The aim of this objective is to restore the system to as close to a pristine state as possible. This is likely to require reductions in fishing effort and the elimination of the more impacting fishing gears such as beam trawls and dredges.

Implications for science - 'Restoring integrity' is clearly problematic as there is practically no reliable scientific information concerning the nature of European marine areas in an unfished state and little opportunity to acquire such information.

Management feasibility - Marine Nature Reserves have had a chequered history in Europe. Those that exist are relatively small and are restricted to Member State waters and national legislation. The development of zones where selected fishing activities are allowed, combined with a series of No Take Zones (NTZs), might be feasible outside territorial waters. However, evidence suggests that some of the NTZs would need to be both extensive in area and permanent, thus involving considerable modifications to both fishing areas and fishing effort.

Problems for implementation - Depending on the number, size and location of permanently closed areas, considerable opposition from the fishing industry can be anticipated, especially as it is difficult to establish whether the intended goal is achievable.

4.2 Prioritisation of objectives

Table 2 summarises the foregoing analysis of the ten options for ecosystem objectives, ascribing notional scores (authors' best-guess), out of 10, for scientific and management feasibility and indicating the possible initial percentage reduction in fishing effort implicit in each option. Feasibility here embodies the notion of compatibility with existing scientific understanding and management systems, and also the implied costs - bearing in mind that cost will depend in part on the acceptable level of scientific refinement in the use of the precautionary approach.

The cut-off point, in the context of existing fisheries management, would seem to occur between options (5) and (6). Below this point, existing scientific knowledge and that which might be practically acquired with existing manpower would be unable to provide adequate scientific support, and/or the management systems would be unable to integrate the new objectives without radical restructuring. Moreover, the ecosystem objectives would prove totally incompatible with existing economic and social objectives. This is not to deny the feasibility of, for example, options 8 and 9 at some future date, given the further evolution of fisheries management philosophy, *vis-à-vis* ecosystem sustainability.

In effect, options (1) - (5) are extensions of the precautionary approach and the concept of responsible fisheries. They continue to place sustainable fisheries at the forefront of the

management agenda while providing coincidental but nonetheless potentially significant ecosystem benefits. They are unlikely to find favour with some environmental lobbies who would wish to reverse the priorities and to see a much more rigorous and exacting ecosystem centred set of objectives. However, options (1) - (5) do appear to constitute a very significant first step along the road to developing an effective ecosystem based approach to fisheries management.

Table 2 Summary of Ecosystem Objectives

Objective		Scientific feasibility	Management feasibility	Estimated fishing effort reduction (%)
1.	Understanding the consequences	9	10	0
2.	Ecological indicators	6	6	20
3.	Essential fish habitat	6	7	0
4.	Rational exploitation	8	7	30
5.	Ecosystem limit reference points	8	7	>30
6.	Maximum economic yield of the ecosystem	4	4	70
7.	Ecosystem target reference points	6	5	60
8.	Optimum size spectra	5	6	variable
9.	Optimum harvest of trophic levels	6	5	variable
10.	Restoring the integrity of the ecosystem	3	3	uncertain

The selected options (1) - (5) should be viewed as a single integrated package rather than as a set of alternative objectives. They nest together quite effectively to describe a management system in which:

- scientists are required to provide ecosystem impact assessments alongside the advice on fisheries management options (Objective 1);

- in order to maintain biodiversity within marine ecosystems, scientists are required to establish limit reference points for all target and non-target species within the ecosystem and, within these limits, managers should determine best fishing practice to guarantee minimum levels of disturbance to the ecosystem (Objective 5);

- in the absence of precise scientific knowledge, estimates of habitat and species target levels are used as indicators of a healthy environment (objective 2);

- particular action is required to protect essential fish habitats through a more widespread use of closed areas, developed on a permanent or seasonal basis, and the permanent exclusions of specific fishing gears (Objective 3); and

- fisheries managers are required to take all necessary actions to ensure that damage to the ecosystem (*viz*. excessive non-target species mortality and degradation of marine habitats) is not caused by intensities or forms of fishing activity beyond those required

for rational and responsible exploitation of target species within commercial fisheries. In effect, this will require most - if not all - fishing effort to be reduced to levels commensurate with limit reference points (Objective 4).

One outstanding problem is the integration of the new ecosystem objectives with other social objectives relating to the economic viability of the fishing industry and the social utility of marine fisheries. One of the basic weaknesses of many management systems, including the CFP, has been the reluctance to prioritise the established objectives relating to the maximisation of yields, economic returns and employment. In practice, it is simply not possible to satisfy all of these objectives simultaneously, and trade-offs are conducted. But fisheries policies rarely specify how such trade-offs should be made. Instead, they tend towards non-committal statements which leave the impression that all objectives are equally attainable. What is needed to set the overall goal for fisheries management is a clear statement of just how much each objective matters and how much of one objective can be traded off against another. In practice, this is very difficult to achieve and politically it may be inexpedient. Pope (1983) provides an example of how this challenge might be met (see Box 3). The introduction of an ecosystem objective would clearly complicate the system of trade-offs quite considerably as none of the three competing objectives (catch, profit and employment) can adequately serve as a surrogate for ecosystem health.

There is, however, a very strong case to be made in arguing that the ecosystem objectives are non-negotiable. These objectives are intended to provide the basis for the long term, strategic management of the tangible and intangible resources of the marine ecosystem, in place of the hitherto tactical manipulation of short term objectives for the survival of commercial fishing. In this new context, the overall goal of sustainability of the marine ecosystem and its resources demands that ecosystem objectives be given priority over all others, to ensure the long term survival of a profitable commercial fishing industry on a global scale. Moreover, in selecting the less exacting ecosystem objectives, the trade-off with existing economic and social objectives has already taken place. Through the notion of 'management feasibility', the selection process has already made significant concessions to ensure an acceptable level of compatibility with socio-economic objectives.

If we assume that the ecosystem objectives defined above are non-negotiable, then these new objectives serve to create a robust framework, within which the conflicts between economic and social objectives can be more effectively addressed.

In the context of Fig. 4.3 (Box 3), the effect of introducing the ecosystem objectives will be to impose a new maximum limit on the level of catches and enforce a progressive and quite rapid reduction in overall fishing effort, with very significant knock-on effects for both the structure of the fishing industry and levels of employment.

Having adopted the ecosystem objectives and accepted thereby the socio-economic consequences, the task for fisheries managers would be to renegotiate the trade-off between the economic and social objectives, always bearing in mind that the effects on the ecosystem of generating a particular level of fishing mortality on a given stock will depend on the types of gear deployed, their configuration and selectivity and the geographical areas of their deployment. The future of fisheries management - and the quest for rational and responsible fisheries - will be as much concerned with the search for the optimal combination of regulatory measures as it will with defining acceptable levels of overall fishing effort.

Box 3 - Trade-off between established objectives

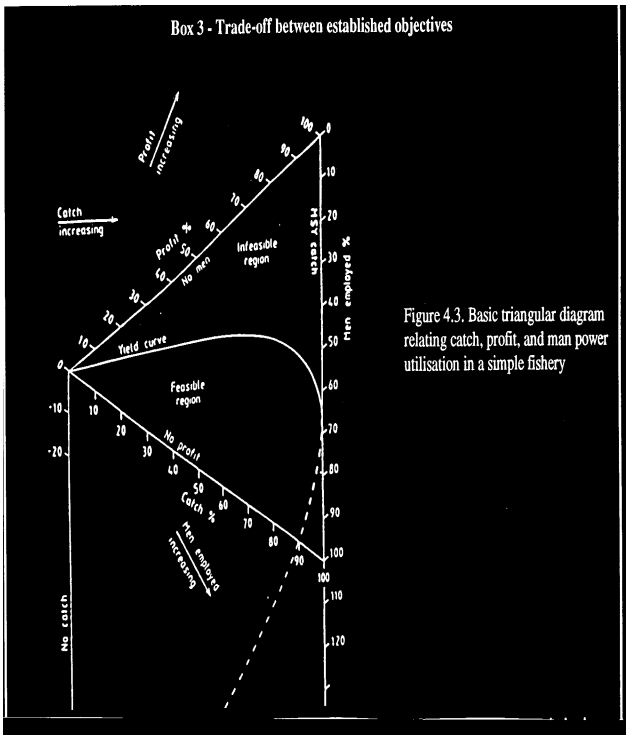

Figure 4.3. Basic triangular diagram relating catch, profit, and man power utilisation in a simple fishery

In the above diagram, three objectives are set for the fishery: maximisation of yield (**catch**), maximisation of economic returns (**profit**) and maximisation of social utility (**employment**). Each objective is expressed as a percentage of the value that would be obtained from fishing at maximum sustainable yield (MSY) *viz*

- **catch** is expressed as a percentage of the MSY catch;
- **profit** is expressed as a percentage of the MSY catch value; and
- **employment** is expressed as a percentage of those who would be employed under conditions of fishing at MSY.

As all three objectives are now expressed in the same units, they can be plotted on a triangular diagram (above). Clearly not all combinations of the three objectives are feasible. The line which separates feasible sustainable combinations from infeasible combinations is shown by the current yield curve from catch = O to

MSY, which assumes that current practice makes fisheries as efficient as possible. Combinations below the yield curve are feasible because they could be achieved by making fisheries harvest the fish less efficiently than at present, while combinations above the yield curve could only be achieved by making more efficient at catching fish than currently. Source: Pope, 1983.

The challenge for governments in adopting an ecosystem based approach to fisheries management, as outlined in this report, will be considerable. The implications of an ecosystem based approach will extend well beyond issues relating to fisheries management *per se*; they are likely to have profound consequences for the economic and social well being of fisheries dependent regions throughout the EU.

5. Marine habitat and wildlife conservation in the UK

As its title implies, this report is concerned primarily with developing approaches to marine ecosystem based management through the modification of current fisheries policy. Consequently the foregoing analysis has dealt mainly with the generality of impacts from fishing activity on marine ecosystems, rather than on specific habitats and species. Other forms of direct management action are designed to safeguard particular habitats and/or conserve marine wildlife, and these may have important implications for fisheries management. They will therefore need to be taken into consideration in developing an ecosystem based approach to fisheries management. This final section briefly reviews issues relating to the coordination of specific instruments for the protection of marine habitats and the conservation of marine wildlife, and their incorporation within the system of fisheries management.

Initiatives relating to habitat and wildlife conservation have been taken by the EU through its Birds (79/409/EEC) and Habitats (92/43/EEC) Directives, and independently by the Member States, as for example in the establishment of Marine Nature Reserves. Special Protection Areas (SPAs) under the Birds Directive are essentially terrestrial in location, and therefore appear to have little or no impact on marine fisheries, despite the fact that protected seabird colonies rely on foraging for food well offshore. By contrast Special Areas of Conservation (SACs) established under the Habitats Directive embrace both terrestrial and marine locations, although to date they apply almost exclusively to sites within the 12 nm territorial limits which, coincidentally, is the area reserved for coastal state management of fisheries under the existing derogation from the principle of equal access.

The outcome of a recent UK court case brought by Greenpeace on the applicability of the Habitats Directive beyond territorial waters ruled the responsibility and authority of the coastal state extends to the outer limits of the 200 mile exclusive economic zone or to the median lines. Whether or not wildlife conservation measures which would impact on fisheries management can be implemented by the EU or its Member States beyond this 12 nm limit - except through the mechanism of the CFP - is a moot point, although a Commission policy statement on *Fisheries Management and Nature Conservation in the Marine Environment (COM (1999) 363 final)* also infers that a Member State is free to enact conservation legislation throughout its 200 nm EEZ.
Two specific instruments for marine wildlife conservation are considered: Biodiversity Action Plans (BAPs) and Special Areas of Conservation. Both are intended to assist the implementation of the Convention on Biological Diversity (1992). Nonetheless, they have significantly different - but potentially complementary - origins, aims and objectives. While BAPs - originating from the UK Biodiversity Action Plan - attempt to define the general status, management objectives and recommended actions for selected types of habitat and particular species at risk from human activities, SACs - with their origins in the Habitats Directive - are intended to provide a network of designated sites supporting rare, endangered or vulnerable species or outstanding examples of habitats characteristic of a particular regions.

It is not yet clear how far SACs will require the moderation of existing fishing patterns in cases where ‘favourable condition’ is affected directly or indirectly by fishing activity. However, SAC management plans will work to improve conditions if and when the monitoring process exposes evidence of deterioration resulting from fishing - or any other human activity - through the existing powers of statutory bodies. Where legal action is required to alleviate a particular problem arising from fishing, byelaw legislation can be enacted - but this is a chronically slow process.

Neither BAPs nor SACs can operate effectively in isolation. There is a need for a more synergetic approach and for integration with other aspects of marine policy, including fisheries management, in order to maximise their potential for beneficial influence on marine ecosystems. At present both suffer from rather broad, non-specific aims which cannot be translated into operational objectives for management. Lack of sufficient scientific knowledge and understanding of the status and functioning of specific aspects of the marine environment largely precludes the formulation of precise, numerically structured targets for marine conservation. The success of the ASCOBANS Advisory Committee (1997) in arriving at targets for by-catches of small cetaceans in the Baltic and North Seas - constructed on a precautionary basis - suggests, however, that the absence of detailed scientific data may not be an insuperable obstacle.

Moreover, BAPs and SACs are both highly selective and fragmentary. By their very nature they disaggregate the problem of ecosystem integrity by privileging selected parts at the expense of the whole. There is a prior need to develop a coordinated and strategic approach to the implementation of instruments, like BAPs and SACs, in order to provide the glue that will bind what are at present diverse and imprecise objectives for the conservation of specific habitats and species with a broader appreciation of marine ecosystem management.

6. Conclusions

Discussion relating to the possible reform of the CFP in 2002 provides an unmissable opportunity to review current management policy in respect of both commercial fisheries and sustainable marine ecosystems in the light of recent international agreements and EU Treaty obligations. The CFP has not yet fully embraced these obligations. Nor has it so far developed a sufficiently robust framework for responsible fisheries, guided by the adoption of the precautionary approach to fish stock management and the protection of the marine environment.

The intention of the report has been to explore the basis for establishing an ecosystem based approach to fisheries management by examining a wide range of possible ecosystem objectives. It has identified a set of objectives which, in theory, could be integrated into current management practice without having to contemplate radical changes to either the institutional frameworks or existing systems of regulation as prequisites. The chosen bundle of objectives - while it may fail to meet all of the demands from environmentalists - should succeed in reducing the ecosystem impacts from fishing to tolerable levels within a relatively short time and, at the same time, provide a platform for the further evolution of fisheries management towards an even more ecosystem friendly position. What is outlined is an integrated approach to fisheries management in which the objectives of sustainable commercial fisheries and a sustainable healthy ecosystem are combined. This approach will also need to take into account the development of instruments dedicated to the protection of specific marine habitats and wildlife populations.

In practice, however, Europe's fisheries already face the consequences of prolonged overexploitation. Correcting this underlying condition will have serious implications for the intensity and nature of existing fishing activity and, therefore, potentially severe impacts on the structures, short term profitability and employment levels of the fishing industry. The adoption of an ecosystem based approach to fisheries management will add marginally to the scale of the task already confronting those responsible for fisheries management in Europe and to the magnitude of changes which will be needed if the concept of sustainable fisheries in a diverse, productive and well integrated marine ecosystem is to be realised.

Defining the objectives is only a first step towards creating an ecosystem based approach to fisheries management. The implementation of such objectives is arguably much the more difficult task, though if the objectives have been judiciously chosen that task is made somewhat easier. While the ecosystem objectives have been selected with a view to their compatibility with existing management systems, the development of an ecosystem based approach will clearly be enhanced by making key changes to the institutional framework and to the measures used to control fishing effort. These changes are considered in the second report *Achieving the Objectives*.

References

ANGERMEIER, P.L. & KARR, J.R. 1994. Biological integrity versus biological diversity as policy directives - protecting biotic resources. *Bioscience*, **44(10)**, 690-697.

ANTOINE, L., GOUJON, M. & MASSART, G. 1997. Captures accidentelles de dauphins dans les filets derivants á thon en Atlantique Nord Est, *CEIM* Mr 1997/Q10.

ASCOBANS. 1997. Cetacean by-catch issues in the ASCOBANS area. *Unpublished report of the ASCOBANS Advisory Committee Working Paper on By-Catch.*

CHRISTENSEN, V. & PAULY, D. editors. 1993. Trophic models of aquatice ecosystems. ICLARM, *Conf. Proc. 26*, 390p.

CONSTANZA, R., D'ARGE, R., DE GROOT, R., FARBER, S., GRASSO, M., HANNON, B., NAEM, S., LIMBURG, K., PARUELO, J., O'NEILL, R.V., RASKIN, R., SUTTON, P. & VAN DEN BELT, M. 1997. The value of the world's ecosystem services and natural capital, *Nature*, **387 (6230)**, 253-60.

FRCC. 1997. Towards an Ecosystem Approach to Fisheries Management. *Report of Environment and Ecology Workshop, University of Moncton*, December 15-16, 1997.

FOOD AND AGRICULTURE ORGANISATION. 1995. Code of Conduct for Responsible Fisheries, Rome.

FOOD AND AGRICULTURE ORGANISATION. 1998. (TO BE COMPLETED)

ICES. 1992. Report of the Study Group on Ecosystems Effects of Fishing Activities, *ICES CM 1992/G:11*, Copenhagen.

ICES. 1994. Report of the Working Group on Ecosystems Effects of Fishing Activities, *ICES CM 1994/Assess/Env.1*, Copenhagen.

ICES. 1996a. Seabird-fish Interactions, with Particular Reference to Seabirds in the North Sea. *ICES Cooperative Research Report* 216, Copenhagen.

ICES. 1996b. Report of the Multispecies Assessment Working Group, *ICES CM 1996/Assess: 3*, Copenhagen.

ICES. 1998. Report of the Working Group on Ecosystems Effects of Fishing Activities, *ICES CM 1998/ACFM ACME: 1*, Copenhagen.

INTERMEDIATE MINISTERIAL MEETING ON THE INTEGRATION OF FISHERIES AND ENVIRONMENTAL ISSUES. 1997. *Statement of Conclusions.* Oslo: Ministry of the Environment.

JENNINGS, S. & KAISER, M.J. 1998. The effects of fishing on marine ecosystems, *Advances in Marine Biology*, **34**, 201-351.

KAISER, M.J. & DE GROOT, S.J. eds (forthcoming). The Effects of Fishing on Non-Target Species and Habitats: Biological, Conservation and Socio-Economic Issues. Oxford: Blackwell Science.

LANTERS, R.L.P & ENSERINK, E.L. 1998. Integration of Ecological and Fisheries Objectives Through Indicator Development. *ICES CM 1998/T:11*

LINDEBOOM & DE GROOT. 1998. (TO BECOMPLETED)

MACDONALD, D.S., POPE, J.G., DAAN, N. & REYNOLDS, J.D. 1994. Impact of Fishing on Non-Target Species. *Report to the Commission of the European Communities,* Lowestoft: CEFAS, MAFF.

NATIONAL MARINE FISHERIES SERVICE. 1999. Ecosystem-Based Fisheries Management. *A Report to Congress by the Ecosystem Principles Advisory Panel*, NMPS, Department of Commerce.

NORTH SEA TASK FORCE. 1995. (TO BE COMPLETED)

PAULY, D.V., CHRISTENSEN, J., DALSGAARD, R., FROASE & TORRES Jr, F. 1998. Fishing down marine food webs. *Science,* **279**, 860-863.

POPE, J.G. 1983. Fisheries resource management theory and practice, pp 56-62. *In*: TAYLOR, J.L. & BAIRD, G.G., eds. *New Zealand Finfish Fisheries: the Resources and their Management*. Auckland: Trade Publications.

POPE, J.G. & LARGE. (TO BE COMPLETED)

SCOTTISH NATURAL HERITAGE. 1997. Natura 2000: European Maritime Sites - An Introduction to Management, Perth.

SPARKS, R.E. 1995. Need for ecosystem management of large rivers and their flood plains. *Bioscience,* **45(3)**, 168-82.

STAC. 1998. Prospects for Multispecies Fisheries Management in Chesapeake Bay, *Report of workshop held at Solomans*, Maryland, 1-3 April 1998. STAC Publication 98.

SVELLE, M., AAREFJORD H., HEIR, H.T. & ØVRELAND, S. 1997. Assessment Report on Fisheries and Fisheries Related Species and Habitats Issues. Oslo: Ministry of the Environment.

SYMES, D. 1996. Fishing in Troubled Waters. *In*: CREAN, K. & SYMES, D., eds. *Fisheries Management in Crisis*. pp 13-16. Oxford: Blackwell Science.

SYMES, D. 1998. The Integration of Fisheries Management and Marine Wildlife Conservation, *JNCC Report No. 287*. Peterborough: JNCC.

UK BIODIVERSITY TARGET GROUP (MARINE SUB-GROUP). 1999. *UK Biodiversity Action Plan: Introduction to the Marine Habitat and Species Action Plans* (draft).