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The Illusion of MSY

Laurie Kell[1] and Jean-Marc Fromentin[2]

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Contact author: L Kell

1 Cefas Lowestoft laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT UK [tel:+44 (0)1502 524257,fax: +44 (0) 1502 513865, e-mail: Laurence.kell@cefas.co.uk].

2 IFREMER, Centre de Recherche Halieutique Méditerranéen et Tropical, BP 171, 34203 Sète Cedex, France

Abstract

An important driver for future European fisheries policy is the World Summit on Sustainable Development, under which the EU is committed to maintain or restore stocks to levels that can produce Maximum Sustainable Yield (MSY) by 2015. The main value of MSY is that it combines biological and economic concepts (i.e. biomass and yield) into a single point, providing a common reference that can be used to assess the current and desired status of a stock. However, this is also its main weakness; since fisheries are one of the most complex systems to understand and manage because of the mix of biological, ecological, economic and social processes that are all dynamic and further interact with each other. Therefore MSY cannot be, in many cases, robust objective in the face of uncertainty (i.e. due to the natural stochasticity in biological and economic processes) as it is a simplistic measure. For example, natural variability can mask the effects of exploitation, for example initial overexploitation is not detectable until it is severe and often irreversible. Exploitation, even at moderate levels, further induces complex and important modifications in population resistance and resilience through e.g. changes in habitat, population structure, genetic diversity or trophic interactions. Also, the short-term gain can result in a lack of interest in sustainability and the huge variety and complexity of systems makes it difficult to generalise. In this paper we review the various factors related to sustainability and illustrate their importance by reference to selected case studies conducted by the EU project FEMS (Framework for the evaluation of Management Strategies).

Introduction

An important driver for fisheries policy is the World Summit on Sustainable Development (WSSD, 2002; COFI, 2003), under which signatories are committed to maintain or restore stocks to levels that can produce the maximum sustainable yield (MSY) by 2015, and to monitor and regulate fishing capacity in line with fishing opportunities. In addition recognition of the ecosystem approach to fisheries (EAF) mean that it is necessary to consider interaction between species and to recognise that depletion or recovery of a harvested species might result in changes in populations of other ecologically and economically important species.

Some management bodies, for example the International Commission for the Conservation of Atlantic Tunas (ICCAT) already have MSY as a management objective (ICCAT 2003a). While others, such as the European Commission, are proposing long-term fishery-based plans to bring all major fish stocks under their jurisdiction (i.e. in EU waters, and those stocks jointly managed with third countries) to rates of fishing at which MSY can be achieved. These will be developed through consultation with stakeholders through the Regional Advisory Councils (RACs).

The main value of MSY is that it combines biological and economic concepts (i.e. biomass and yield) into a single point, providing a common reference that can be used to assess the current and desired status of a stock. However, this is also its main weakness; since fisheries are one of the most complex systems to understand and manage because of the mix of biological, ecological, economic and social processes that are all dynamic and further interact with each other. Therefore MSY cannot be, in many cases, robust objective in the face of uncertainty (i.e. due to the natural stochasticity in biological and economic processes) as it is a simplistic measure (Rosenberg and Restrepo, 1994). For example, natural variability can mask the effects of exploitation, for example initial overexploitation is not detectable until it is severe and often irreversible. Exploitation, even at moderate levels, further induces complex and important modifications in population resistance and resilience through e.g. changes in habitat, population structure, genetic diversity or trophic interactions(e.g. Birkeland and Dayton 2005, Jennings et al. 2002, O'Brien et al. 2000). Also, the short-term gain can result in a lack of interest in sustainability and the huge variety and complexity of systems makes it difficult to generalise.

It is therefore difficult to define and estimate MSY in a biological sense and to implement appropriate plans because of the inherent uncertainty of the systems being managed, limits in our knowledge and our ability to assess stocks and to implement management actions, particularly in mixed fisheries. However, the application of the Precautionary Approach to Capture Fisheries (FAO, 1996) and the "The Code Of Conduct For Responsible Fisheries" (CCRF) requires that uncertainty should not be used as an excuse for postponing management action, i.e. a reversal of the burden of proof.

In this paper we review the appropriateness of MSY as a management objective for a range of fisheries types.

Management Strategies for European Fisheries

The CCRF, WSSD & EAF are all recognised within the fisheries management objectives of the EU and the Common Fisheries Policy (CFP; Council Regulation No. 2371, 2002) defines several objectives: "... ensure exploitation of living resources that provides sustainable economic, environmental and social conditions" and "For this purpose, the Community shall apply the precautionary approach in taking measures designed to protect and conserve living aquatic resources, to provide for the sustainable exploitation and to minimise the impact of fishing activities on marine ecosystems. It shall aim at progressive implementation of an ecosystem-based approach to fisheries management. It shall aim to contribute to efficient fishing activities within an economically viable and competitive fisheries and aquaculture industry, providing a fair standard of living for those who depend on fishing activities and taking into account the interests of consumers". Additional constraints are imposed due to the principle of relative stability (Articles 32 to 37 of the EC Treaty; Holden, 1994): based in particular on historical catch levels, which requires the maintenance of a fixed percentage of effort by the main commercial species for each Member State and that fishing effort should be generally stable in the long term..."

Previously the ICES scientific advice framework was based upon limit reference points, F_{lim} and B_{lim} for fishing mortality and biomass defined to indicate overfishing and an overfished state respectively. The precautionary approach was implemented by defining reference points (B_{pa} and F_{pa}), which take into account assessment uncertainty, and which trigger management action to prevent the limit reference points being reached. ICES scientific advice therefore sits within a reactionary framework based upon limits, where action is triggered by events. However, obligations under the WSSD require implementation of an MSY based strategy and a move towards targets. Subsequently there has been a move towards biological reference points such as $F_{0.1}$ (e.g. the value of F for which the slope of Yield per Recruit against fishing mortality is 1/10th of the value at the origin) that are proxies for F_{MSY} (the fishing mortality that would generate MSY) and harvest control rules (HCRs), for example recovery measures for sole stocks in the Western Channel and the Bay of Biscay (COM/2003/0819). However, harvest control rules are not necessarily precautionary in practice (Kirkwood and Smith, 1996) if they are not evaluated formally to determine the extent to which they achieve the goals for which they were designed, given the uncertainty inherent in the system being managed (Punt, in press).

Maximum Sustainable Yield

MSY provides a simple and easily understandable approach, is widely known and provides a single point to indicate whether exploitation is above or below a target. It combines biological and economic factors and provides a consistent and coherent operational management objective and management/science interface especially since it is generally fixed over time.

Although the concept of MSY is attractive from a management perspective as it is almost universally understood, serious shortcomings have been pointed out for more than 30 years by the scientific community. For example long-term fishing at MSY values in a randomly varying environment can rapidly lead to commercial extinction (Beddington and May, 1977; Sissenwine, 1978; Rosenberg and Restrepo, 1994; Mace, 2001, Powers, 2005). To compensate, more conservative proxies for F_{MSY} have been developed such as $F_{0.1}$ (Caddy and Mahon, 1995; Jensen, 2002). Further uncertainty will result from changes in population dynamics, as the effects of the environment on fish stocks are not commonly fully characterised, while species interactions are generally not taken into account. Indeed, there are issues when calculating and maximising MSY for multi-species complexes (Larkin, 1977, Walters et al., 2005). It also remains unclear whether all stocks can be recovered and maintained at MSY simultaneously, since MSY also depends upon the mix of fleets and any by-catch in non-target fisheries (Maunder, 2002, Powers, 2005). Furthermore, the MSY concept also ignores some key economic and social considerations (Larkin, 1977) and our ability to implement management. All of these factors will become increasingly important as we attempt move towards higher stock levels in the future.

Sustainability

It has been pointed out by numerous authors that rather than concentrating on a single concept such as MSY that we should focus on ensuring sustainability or sustainable development, the most commonly quoted definition of which is that of the Brundtland Report (WCED, 1987) **"***Sustainable development is development that meets the needs of the present without compromising the needs of future generations to meet their own needs."* The concept contains two key concepts: that of

- needs, in particular the essential needs of the worlds poor, to which overriding priority should be given, and:
- limitations imposed by the state of technology and social organisation on the environments ability to meet present and future needs.

Often in fisheries it has been argued that the precautionary approach gives highest priority to conservation of the resource - without which there will be no social or economic benefits to consider Mace (2001). However, others such as Ludwig et al. (1993) argue that even if difficulties appear as biological problems of the stock under exploitation that human motivation and responses have to be included as part of the system to be managed since the short sightedness and greed of humans underlie difficulties in management of resources. Ludwig et al.(1993) also pointed out the limitations of science and recommended action before scientific consensus is achieved, not to rely on scientists to recognise problems and to distrust claims of sustainability and to confront uncertainty.

Cunningham, and Maguire (2002) argued that there are four components required to ensure sustainability: biological/ecological, social, economic and institutional

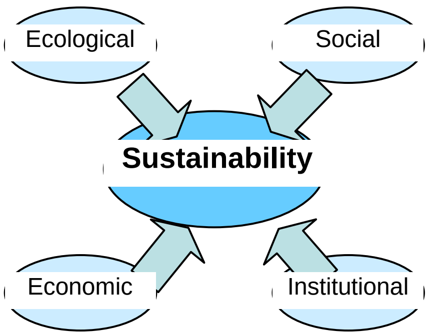


Figure 1. The four components of sustainability (from Cunningham, and Maguire; 2002)

A key question still to be fully answered is what is sustainability in practice for fisheries, rather than how to rebuild and maintain stocks to a level that would support MSY, particularly given the effect of fishing on the ecosystem.

The EAF is intended to ensure that the planning, development and management of fisheries will meet social and economic needs without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems (FAO 2003). This requires that a wide range of fisheries impacts on ecological, economic and social factors must be considered when setting objectives for fisheries as well as attempting to achieve MSY. With consequent requirements for reliable scientific advice and effective management decision making (Jennings, 2002)

Both biological and economic processes are important since if two policies have same biological impact but differing economic impacts, then can derive a preferred option e.g. days at sea verses fleet reduction verses temporal or seasonal closures, also if a policy sends a fleet bankrupt then it is not likely to be implemented particularly since fishers respond to changes in economic incentives.

From a biological/ecological perspective a range of factors at a variety of levels need to be preserved, to ensure sustainability of the exploited natural resources (and other species within their ecosystem), i.e. to avoid collapse by maintaining resistance of population to exploitation and environmental variations (e.g. climate change, eutrophication) i.e.

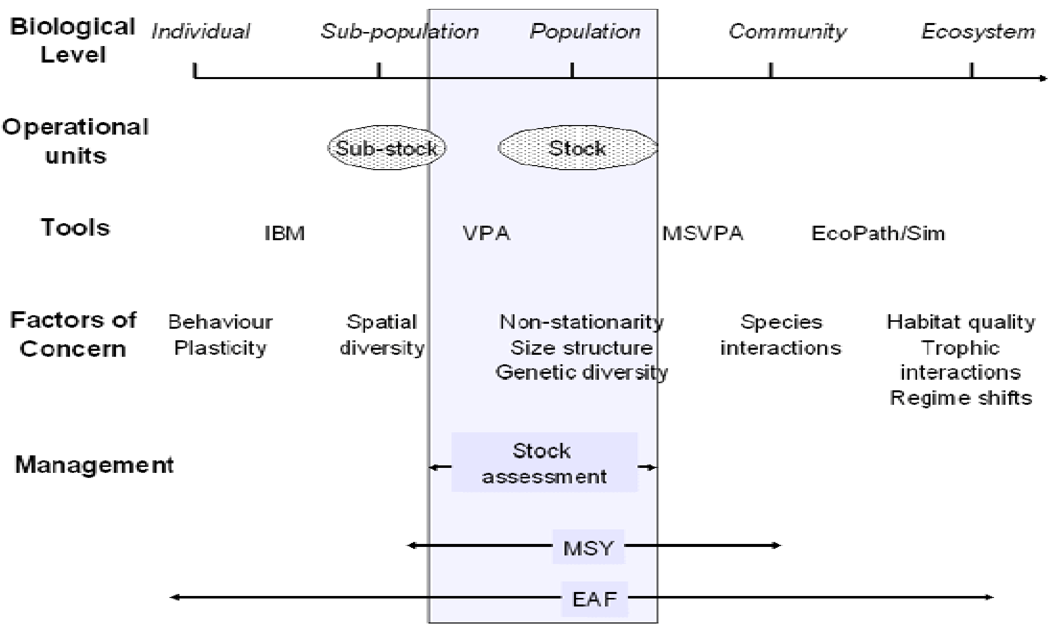
- Individual level: genetic diversity
- Sub- population level (metapopulation): sub-unit diversity
- Population level: productivity, size/age structure
- Community level: trophic & spatial interactions
- Ecosystem level: biodiversity

While from an economic/social perspective factors that need to be preserved, to avoid crisis in fisheries sector and allow its adaptability to changes due to variability in exploited populations, market, technology, governance and resources include.

- Fleet benefits, e.g. profitability
- Fleet & fishing opportunity diversity
- Level of employment in the fisheries sector
- Supply chains development

Figure 2. Relationship between biological sustainability and fisheries management.

Figure 2 presents a range of biological factors related to sustainability and attempts to illustrate how current ICES advice on fish stocks addresses them, i.e. the blue shaded area. Although attempts are being made to move towards fishery based advice, most work is still single species in nature. While stocks can be defined on an ecological, and evolutionary basis (Waples and Gaggiotti, in press) that used by ICES is an operational one, i.e. to perform stock assessment and provide management advice. It is assumed that all



catches from an area are from a single homogeneous population and that there is no immigration or emigration, i.e. as required by Virtual Population Analysis (VPA). Even where sub-stocks are recognised, due to data constraints and to allow the allocation of quotas, stocks are defined by management area (e.g. North Sea) rather than biological criteria. This may mean that if single-species stock advice management (e.g. North Sea flatfish) includes area-based mesh regulations fishing mortality-at-age may vary between stocks, which might affect recovery, especially if it impacts on spatial diversity.

Advice on appropriate limits and targets is then based upon biological reference points and projections which assume stationarity, i.e. although processes like growth and productivity vary that there has been no particular trend over time. However, examination of historic trends (Kell et al, 2006, Fromentin & Kell, submitted, Pilling et al. Submitted) has shown that there is often considerable variation over a variety of time scales which can have significant impact of productivity, and hence limits to exploitation and expected yields, from stocks. If reference points are allowed to change however advice is not all ways straight forward; for example in the case of west Atlantic Bluefin (ICCAT, 2005), where there has been a recent reduction in recruitment, if it is assumed that recent low recruitment scenario is related to a regime shift then the TAC can be increased since the value of B_{MSY}, the rebuilding target, is reduced.

Reference points such as MSY are commonly calculated by combining yield per recruit analysis with stock-recruitment models. Stock-recruitment models imply that the survival rates of offspring do not substantially change with the age or the size of the spawners. This assumption is now seriously questioned, for example Cardinale and Arrhenius (2000) showed for cod that older individuals contribute to both the largest amount of eggs but also recruits with the highest rates of survival (i.e., contribute a larger proportion of recruits than expected from the number of eggs). Older fish also have a different, and most often a greater, spatial and temporal window for spawning than younger ones, so that their larvae have higher probabilities of encountering favourable environmental conditions for survival (Birkeland and Dayton 2005). While Berkeley et al. (2004b) concluded that the age structure of the spawning stock combined with a broad spatial distribution of spawning and recruitment is at least as important as spawning biomass in maintaining long-term sustainable levels.

Other important factors are the implications in terms of genetic diversity/erosion and evolution of the exploited populations. Studying populations of an exploited small pelagic fish, Conover and Munch (2002) showed that harvest of large fish initially produced the highest catch but quickly evolved a lower yield than controls, whereas harvest of small fish did the reverse. The underlying mechanism was that heavy fishing induces the selection of genotypes with slower or faster rates of growth. Similar process has been advocated by Hauser et al. (2002), who showed, using a time series of archived scales, a significant decline in genetic diversity in a New Zealand snapper population during its exploitation history. Effective population sizes estimated both from the decline in heterozygosity and from temporal fluctuations in allele frequency were five orders of magnitude smaller than census population sizes from fishery data. All these recent works (see Birkeland and Dayton 2005 for a review), conclude that fishing large individuals induce a loss of natural genetic variability that potentially results in reduced adaptability, persistence and productivity of the exploited populations. A process that could explain why long live species, such as cod, do not, or hardly, recover from overexploitation (Hutchings 2000).

Such findings on maternal effects and genetic diversity reveal that protecting old and large fish may be as crucial as protecting young ones. Age-structure and older fish appear, thus, to have a key role on both the recruitment success and sustainability of exploited fish populations and if so should be considered by management bodies (Longhurst 2002). Although recognition of this idea is increasing, it remains still difficult to find operational and efficient management measures to apply it. Berkeley et al. (2004b) identified three main directions: (i) a substantial reduction of the fishing effort over the whole exploited population, (ii) slot size limits in which there is both a minimum and a maximum size for retention and (iii) a network of marine protected areas. The authors, however, concluded that the first two options are difficult to implement and the third one may be the only viable solution to ensure the preservation of old-growth age structure in long-lived groundfish. However, this option is also known to be poorly efficient on highly migratory fish, such as tuna and sharks (Hilborn, et al. 2004).

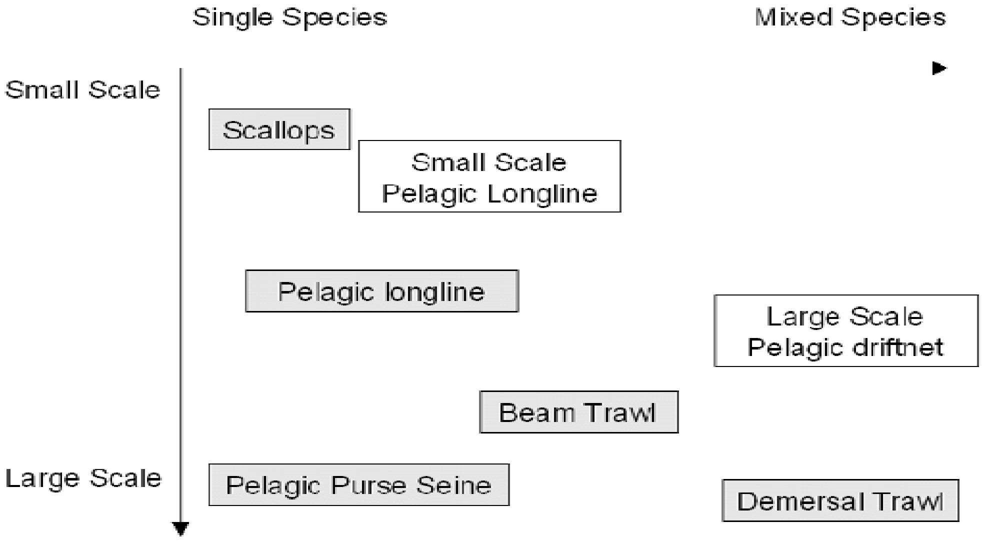
The generality for all fish species remains unclear, but it has been already demonstrated for several pelagic fish, rockfish and groundfish species (Conover and Munch 2002, Berkeley, et al. 2004b). It is likely that the maternal effect, for instance, may be more crucial for long-lived species than short-lived ones (Birkeland and Dayton 2005). So, long-lived species, which are known to be the most fragile to exploitation, are also the most vulnerable to the selective fishing of large individuals. Regarding tuna and tuna-like species, Atlantic and southern bluefin tuna as well as swordfish and sailfish (secondarily the marlins) display the longest lifespan (> 15 years old, Fromentin and Fonteneau 2001) and will be the most vulnerable to the exploitation of large individuals. Species such as Atlantic bluefin tuna are currently heavily exploited and it will be worth to consider this topic within the potential intensive bluefin tuna research program (an issue that should be considered from both its biological and management aspects).

As stocks recover interactions between species will affect predators and their prey, and Multi-species Virtual Population Analysis (MSVPA; Sparre 1991) has been used to estimate MSY in a multi-species context (ICES, 2003), MSVPA is essentially an add-on to single-species models, i.e. a “Minimum Realistic Model” (Punt and Butterworth 1995) that adds complexity in a piece meal fashion (extending single species VPA to estimate natural mortality by including predator/prey interactions). This is essentially different from models like Ecopath with Ecosim (Christensen et al. 2005) which are better used to evaluate the minimum level of realism needed when providing management advice, i.e. to evaluate the benefits of adding complexity rather than adding complexity for complexity sake.

Examples

Management objectives and therefore appropriate advice will vary between fisheries. Here we present a range of examples that contrast single and mixed and small and large scale fisheries in order to gauge the appropriateness of a common management objective such as MSY for fisheries management.

Figure 3. Fishery examples, contrasting scale of fishing and interactions between stocks.



For scallops, management is mainly by the imposition of a size limit; the maximum yield from sedentary species like scallops would be obtained by harvesting an entire area once losses due natural mortality were greater than gains due to growth, i.e. as in agriculture or forestry. The problems would be to ensure that subsequently settlement and recruitment occurs, while concern about the effect of scallop dredges on habitats such as reefs is growing.

For Atalntic and Mediterranean bluefin tuna, management is a combination of Total Allowable Catch (TAC), minimum size regulations and temporal closures of the Mediterranean Sea. Although the management objective is to main stocks a level that would support MSY, exploitation is currently about 2.5 times that of proxies for F_{MSY}. (i.e. F_{max}) . Substantial under-reporting and high catch of small individuals is occurring (ICCAT, 2005). The main problem is the high value and demand and the difficulties in enforcing management regulations for a highly migratory species exploited by a large range of gear and countries having contrasting interests. Although stock assessment data only extend back to the 70s spectacular fluctuations in catches have been seen since the 1600s. However, the cause is unknown and could be due to different processes, e.g. changes in recruitment or migration pattern (Fromentin & Kell, submitted). Kell & Fromemtin (submitted) performed a management strategy evaluation (MSE) and showed, current advice based upon VPA and a target exploitation rate of $F_{0.1}$ (a proxy for F_{MSY}) required knowledge of the true dynamics. While an alternative, simpler strategy based upon a size limit alone (e.g. scallops) performed as well, and in some cases better, particularly for yield than the VPA- $F_{0.1}$ system. However, the key to successful management is implementation.

The biological characteristics of North Sea flatfish (plaice and sole) have changed considerably in recent years that affect stock productivity, while the resilience of these stocks is unknown. Pilling et al. (submitted) evaluated the consequences of this uncertainty for limit and target reference points, including MSY and its proxy $F_{0.1}$, in terms of fleet profitability. The biomass limit and target reference points were strongly affected by changing biology, to the extent that under particular conditions the stock would crash if fished at the biomass limit level. While fishing mortality reference points were relatively unaffected, the resulting profits and yields at these effort levels did vary widely with system productivity. This has obvious socio-economic consequences since management might be able to set appropriate effort levels (i.e. cost) but not yields (i.e. revenue) which does not sit well within the current ICES framework of TAC management. F_{MSY} and $F_{0.1}$ were found to have similar resilience to change, but similar implications for profit and yields. Indeed, the resulting profits at F_{MSY} and $F_{0.1}$ were extremely different. Profit at $F_{0.1}$ was close to the Maximum Economic Yield, while achieving F_{MSY} for each species required unequal adjustments in fishing effort between fleets fishing in the north and south of the North Sea (the southern fleet being more strongly controlled due to a smaller mesh size and greater likelihood of catching small plaice and sole). This imbalance in management of fleet segments is against the EU's principle of relative stability. Achieving MSY in the multispecies flatfish fishery in the North Sea therefore required managers to consider the trade-offs between fleets, economics, social considerations (maximisation of profit, or employment). In turn, this study did not consider the wider implications on bycatch species (of considerable value to the fishery) nor the impact of the gears used on the ecosystem.

With mean annual sea surface temperature in the North Sea is projected to increase by over a degree centigrade by 2040 (Gordon *et al*., 2000; Pope *et al*., 2000) poikilotherms such as cod (*Gadus morhua*), are likely to be affected through their metabolic rates and life history processes (Brett, 1979) regime shifts and climate change are attracting much recent attention. Kell et al. (2006), evaluated strategies for rebuilding and long-term management adopted by or under consideration by the European Commission, it was shown that despite contrasting climate change hypothesises, magnitude of the change in temperature and the mechanism through which it acts (i.e. juvenile survival or carrying capacity), the predicted recovery time was little affected. This was because recovery in the short term depended upon conserving fish that have already recruited, recovery would be delayed however if bycatch of cod in non-target fisheries was not controlled. Long-term advice is dependent on the definition of productivity and limits to exploitation, advice normally given in the form of reference points such as MSY and B_{lim} and F_{lim}. However, appropriate scientific advice depends upon identifying the correct hypothesis, since reduced survival of recruits requires the value of F_{lim} to be decreased while a reduction in range requires the value of B_{lim} to be reduced. The correct mechanism can only be detected through biological studies rather than through stock assessment.

Future Directions

Is MSY and appropriate management objective? The authors would argue that the real objective is sustainability and that MSY is only one possible reference point or indicator of sustainability. The wide range of objectives and processes that the management of fisheries has to address, especially within an ecosystem perspective, make MSY too simplistic and unsufficient, although useful. Therefore, MSY should not be considered as a property of the system, but as an indicator (among others) of its potential productivity. Although a single reference point has much appeal, especially from a management viewpoint, it may not be able provide a sufficiently flexible advice framework.

Jennings (2005) discussed how groups of indicators can be selected for different purposes to cover the various components and attributes considered representative of an ecosystem. Since knowledge and resources will always be too limited, components and attributes may not be directly measurable. Indicators therefore act as proxies for them (Fulton et al. 2004a,b), several may be needed to track the state of one component and attribute or one indicator may track the state of several components and attributes (Shin et al. 2005). The difficulty is finding appropriate indicators and management strategies that are robust to uncertainty in our knowledge and in their implementation and where the requirements for scientific advice which they assume can be fulfilled.

A major problem in fisheries is uncertainty, Ludwig et al. (1993) argue that in developing management plans that are robust to uncertainty one must consider a variety of plausible hypotheses about the world; consider a variety of possible strategies; favour actions that are robust to uncertainties; hedge; favour actions that are informative; probe and experiment; monitor results; update assessments and modify policy accordingly; and favour actions that are reversible.

The trend towards Management Strategies Evaluation (MSE) where computer based simulations of management strategies or plans are undertaken, partly addresses this. MSE requires the development of operating models that represent the underlying reality against which candidate plans are tested with respect to explicitly stated and prioritised management objectives. The approach allows replicates and controls to be created through simulation on computers, scenarios to be developed that compare alternative levels of exploitation and to evaluate the power of alternative management strategies to detect changes in state and their ability to control systems.

Butterworth and Punt (1999) noted the lack of any general software packages as a major impediment to the more wide spread use of management strategy evaluation. A problem that FLR (www.flr-project.org), an open source initiative, is hoping to address (Kell et al. Submitted). The ICES WG on Fishery Systems stated that it saw “the development of the **FLR** framework for stock assessment, management strategy evaluation and bio-economic modelling is a major step forward in developing a shared language that can be used among scientists, initially, and then can make a significant contribution to clarifying communications across the science boundary. In doing so it is anticipating the advice and knowledge communication needs of the Ecosystem Approach to Fisheries and fisheries-based advice" (WGFS, 2006).

However sophisticated the computer models are, they will never fully capture the complexity in natural and human systems. There has therefore also been an interest in adaptive management. However, exactly what that means in terms of monitoring and evaluation of outcomes is still unclear. Adaptive management is a way to learn about the dynamics of stocks and the effectiveness of management by viewing management actions as experiments and design them to produce critical information about the resource being managed. This information will help to reduce uncertainty and, more importantly, will provide a broader base of knowledge and experience that helps us to manage more effectively in the face of continued uncertainty and ever-changing conditions. This "learning by doing" (Walters and Holling 1990) is the essence of adaptive management (Johnson, 1999), first developed as part of industrial operation theory in the 1950s (Everett and Ebert 1986) and subsequently adopted as a resource management technique began in the 1970s (Holling; 1978). A less rigorous definition of adaptive management is where management decisions have to be taken on the basis of only partial information and outcomes of decisions are monitored and management decisions are altered if the outcome falls short of what was intended.

Management of uncertainty requires a framework for Risk Analysis that includes risk identification, analysis, management and communication. The first task is risk identification, i.e. agreeing and prioritising management objectives, for example what is the relevant importance of the factors of concern in figure 2. Risk analysis is i.e. choice of indicators and how to use them in practice as part of a management plan could be made depend upon performance, i.e. do they work, this can be done using MSE considering a variety of plausible hypotheses about the world to ensure that are robust to uncertainty Risk Management: The four Ts, tolerate, transfer, treat or terminate. Important to Risk Communication: Presentation of quantitative or qualitative information to allow choice on appropriate actions or risk levels. Where risks are related to the various factors in figure 2.

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Questions and Answers on Maximum Sustainable Yield (MSY)
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http://www.scotland.gov.uk/Topics/Fisheries/Sea-Fisheries/Strategy/Advisory/SWG060123-NSRACMSYPaper

Proposal for a Council Regulation establishing measures for the recovery of the sole stocks in the Western Channel and the Bay of Biscay

http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=52003PC0819&model=guichett

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http://www.are.admin.ch/are/en/nachhaltig/international_uno/unterseite02330/

Sakke's comments

hi,

I read your text yesterday. I think there are lot of good things, perhaps the structure and order could be improved (e.g. section Discussion could be something else, as the whole paper is a dicussion paper?)

What came to my mind, and what I would like to add, if you think it is useful, is something like:

- ICES is advicing according to the precautionary approach which is trying to prevent stocks to be depleted.
- in most cases this means lower B and yield, i.e. ICES supports that some of the long term gains are sacrificed for the short term interest of keeping current fishermen in work
- My understanding is that MSY (after Johannesburg) has now quite a similar political status as the PA had at the time when it was decided in ICES that advice should follow PA.
- As F MSY is in most cases clearly lower than F lim and F PA, it means biologically more safety policy, and in this respect it is more precautionary. If F 0.1 is used as proxy for F msy, it is also easier to estimate than PA values.
- Especially, it means higher profits for fishermen in the long run, so looking at the stock collapse risk as aim is the same as deciding that the short term employment must have high weight as objective compared to long term safety and profits, to my mind?
- I understand that ICES needs a stronger demand from customers to include MSY as one criteria. Hopefully we can help in that !! :)

-one should also think about the reactions of the outside world, i.e. it is difficult to explain why one would not aim to have a high income with low costs?
Between the F msy and F 0.1 there is a conceptual difference, and MSY is easier to justify than F 0.1. Hower, taking into account the uncertainties, F0.1 could be simple enough

- in your flatfish case the implementation becomes an issue, but is that mainly due to the difference in mesh size?

I Agree that sustainability is the real objective, but the MSY is good
concept. I have allways been a bit skeptical about adaptive management
(when experiments are used to estimate "correct parameter values". To my
mind it would be ok if we had correct and stable parameters e.g. for S/R function, but they seem to change so one set of experiments is likely not enough, in anyway?

I could write a section about these considerations, if you like?