

ICES Journal of Marine Science (2011), 68(8), 1689–1698. doi:10.1093/icesjms/fsr067

The role of fisheries data in the development evaluation and impact assessment in support of European fisheries plans

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Simmonds, E. J., Döring, R., Daniel, P., and Angot, V. 2011. The role of fisheries data in the development evaluation and impact assessment in support of European fisheries plans. – ICES Journal of Marine Science, 68: 1689–1698.

Received 8 October 2010; accepted 21 March 2011; advance access publication 8 June 2011.

The European Commission has two formal requirements for developing multi-annual management plan policies: evaluation of the past performance of existing plans and impact assessments (IAs) of the potential benefits of new proposals. The new policies require the evaluation of fishery management in terms of three specific criteria: (i) effectiveness, i.e. the best method to achieve the objectives; (ii) efficiency, the cost-effectiveness, and proportionality; and (iii) consistency, i.e. limiting trade-offs across economic, social, and environmental domains. To develop policy, there is a need to collect relevant information, then to conduct appropriate analyses that provide documentation to support the policy objectives. This paper discusses the data requirements for good environmental, economic, and social understanding of fishery dynamics and management, describing how fishery data are currently linked to the analytical and management evaluation process using examples from 2009 and 2010. The type of information currently used is considered, along with the timetable of data availability, and its effect on historical evaluation and IAs, which are now formally required when any changes to legislation are proposed in the European Union, including following stakeholder consultation. The possibilities and future needs for such data are discussed.

Keywords: CFP, data requirements, European fisheries policy, evaluation, impact assessment.

Introduction

Scientific advice and European Union (EU) Fisheries policy are closely coupled. The Common Fisheries Policy [CFP; European Commission (EC), 2002] explicitly requires “taking into account available scientific, technical and economic advice”, and in particular, the reports of the Scientific, Technical, and Economic Committee for Fisheries (STECF), which is formally established under that regulation. The EC annually formulates its harvest policy for the following year and informs Member States by a communication (e.g. EC, 2008), which defines how the scientific advice will be used to set fishing opportunities and how the process can include further requests for scientific and economic advice from STECF. Within this framework, multi-annual plans developed with the help of scientific advice are the basis for setting some of the fishing opportunities. These plans are perhaps the best examples of good practice in European fishery management [see, for example, the case of North Sea (NS) herring since 1997, reviewed in Simmonds, 2007, and the NS plaice and sole plans reviewed in STECF (2010a)]. Since 2001, the EC has established a programme of data collection [through the Data Collection Regulation (DCR; EC, 2001) and the Data Collection Framework (DCF; EC, 2007) in support of biological and

economic aspects of policy. Here, we consider how the multi-annual aspects of fishery policy and regulation lead to a formal legislative need for historical evaluation (HE) of past policies and impact assessments (IAs) of new proposals (see detailed description below), together with the requirement for relevant data.

Policy drivers

The overall objectives for fisheries under the CFP are those of sustainability. The World Summit on Sustainable Development held in Johannesburg (Anon., 2002; paragraph 31a of the implementation section) stated that there would be a “commitment to restoring [fish] stocks to levels that can produce maximum sustainable yields (MSY) by 2015”. The EC’s approach to sustainable development is stated in a general framework (EC, 2009a) that includes a requirement to carry out IAs of any proposal with a significant impact on EU policy. Following the Lisbon Treaty which came into force in 2009, this requirement must follow the ordinary legislative procedure, formerly known as the Codecision Procedure (i.e. between the European Council and Parliament), by which directives and regulations are adopted. This procedure now applies to all fisheries legislation, except for the annual setting of fishing opportunities. For new or revised legislation

†This paper represents solely the views of the authors and cannot in any circumstances be regarded as the official position of the European Commission.

under this procedure, the EC submits a legislative proposal to the Parliament and Council. This submission includes a requirement for an HE of past policy and an IA of the new proposal.

HEs and IAs in the EU

The IA is a key tool to ensure that EC initiatives are coherent with other legislation. EU legislation is expected to be prepared based on transparent, comprehensive, and balanced evidence. This is a formal approach giving the steps to be followed when preparing policy and/or legislative initiatives. The advantages and disadvantages of various policy options are presented, assessing their potential impacts as evidence for political decision-makers. Conducting such an IA is a key feature of developing EC initiatives, and the College of Commissioners will take the IA report into account when making decisions. The IA is therefore an aid to political decision-making, which it supports but does not replace, because the adoption of a policy and/or legislative initiative is always a political decision made by the College alone.

EC policy-decisions must be based on sound analysis supported by the best data available. The EC has a specified approach to IA (EC, 2009b), which extends beyond fisheries *per se*. The main analytical steps in preparing legislation are:

- (i) identifying the problem (nature and extent, key actors, drivers, and underlying causes);
- (ii) defining the objectives (with coherence at several levels, from general to specific operational matters, consistent with existing EU policies and strategies, e.g. the Lisbon Treaty, sustainable development strategies, and respect for basic rights);
- (iii) developing the main policy options (a shortlist of potentially valid options; distinguishing between them under the proportionality principle—see below) and measuring against criteria for effectiveness, efficiency, and coherence;
- (iv) analysing their expected impacts (economic, social, and environmental; who is affected and in what way; assessing the impacts against the baseline of no-action in qualitative, quantitative, and monetary terms, and the administrative burden; considering the risks and uncertainties in the policy choices, including potential simplification and any obstacles to transposition or compliance);
- (v) comparing the options (the positive and negative impacts of each one).

(The principle of proportionality is a political maxim that states that no layer of government should take any action that exceeds that which is necessary to achieve the objective of government, regardless of intent of objective. It is a basic principle of EU law. According to this principle, the EU may only act to exactly the extent needed to achieve its objectives, and no further. This principle has underpinned the European Communities since their inception in 1957. In the currently applicable primary law, the principle of proportionality is clearly formulated in the third paragraph of Article 5 of the Treaty establishing the European Community as “Any action by the Community shall not go beyond what is necessary to achieve the objectives of this Treaty”. This principle is also explicitly specified in the new Treaty of Lisbon).

Scientists produce a technical report, from which the EC will write the IA report and choose the preferred options. Further, within this process, the EC has obligations to consult stakeholders,

and in the cases of fishery legislation to obtain the opinion of STECF. Multi-annual management plans are developed with the three CFP objectives in mind, i.e. biological, social, and economic sustainability. To evaluate the past performance of plans and the impact of new proposals, the STECF has developed a generic approach (STECF, 2010a, b). There is a common structure to both HEs and IAs. HEs deal with past performance, and additionally compare what would have happened in hypothetical alternative scenarios had no, or different, actions been adopted. To complement this, IAs evaluate similar questions but look to the future. For simplicity, in the sections below, we discuss mostly HEs, but we also consider aspects of IAs where they are different.

The main criteria

Defining the problem statement and objectives of a plan

This means that the scope of the problem to be addressed must be defined—why action is required and the link to any background studies or information. Although the general objective will be the CFP and MSY criteria, there can also be specific objectives in terms of other desired outcomes, often with a time-scale (e.g. achieving exploitation target F in X years). Note that it is not possible to evaluate the performance of a plan without operational objectives in this form. Following discussion among managers, scientists, and stakeholders, STECF selects an initial set of objectives to compare different plans (STECF, 2010c). For each general objective, specific parameters are identified as the indicators to be measured or estimated. An example of the correspondence between general objectives under each of the three overarching criteria of the CFP, and specific objectives with identified parameters taken from STECF (2010c), is given in Table 1.

A good source of information on the selection of appropriate biological, economic, or social indicators and targets reference points is a full management strategy evaluation (Butterworth, 2007; ICES, 2008). However, this level of complexity is not always possible, and the MSY policy may instead be based solely on relevant biological targets such as F_{MSY} , the fishing mortality corresponding to MSY. Reconciling multiple objectives can be difficult (Horan *et al.*, 1999), and it may require the allocation of weights to the different objectives if they are in conflict or imply different strategies. The EC implements the MSY strategy though a target fishing mortality, with biomass having a secondary role. This follows from the view that the management actions aim to control fishing activities, not the stocks directly. Although the stocks are obviously affected by fishing pressure, they are also subject to environmental influences outside the control of management. Köster *et al.* (2003) reviewed a range of relevant variables, and although these may explain the stock response, if they are unpredictable in the medium or longer term, then the outcome for the stock is also unpredictable (ICES, 2007).

Estimating F_{MSY} can be done in several ways, which result from different assumptions and data and may give different target values. ICES has specified a framework (ICES, 2010), but it is not yet fully mature. An example for NS plaice is illustrated in Figure 1. The data required are the stock assessment, including information on both landings and discards. The evaluation method is that described in ICES (2010). It uses multiple stock–recruit relationships (Simmonds *et al.*, 2011) that include both Ricker and hockey-stick (segmented regression) functional forms (Needle, 2002), and a stochastic component in which 1000

Table 1. An example of the correspondence of identified parameters and their conditions, related to the conceptual objectives under the main criteria of the EU's CFP.

Type of objective	Conceptual objectives	Parameters to monitor	Targets or limits
Environmental/biological	MSY (2015 and later) GES (2020 and later)	Fishing mortality	(1) $F_{\text{target}} = F_{\text{MSY}}$ (2) If multiple objectives, $F \leq F_{\text{MSY}}$
Economic (for both fleet and infrastructure)	Maximum economic yield	Resource rent (gross value-added net profit)	(1) Maximizing resource rent (2) Ensure that a minimum resource rent is achievable across a three-year period
Social	Potential employment and quality of employment	Revenue (GVA, as an indicator of potential employment)	(1) Maximum revenue (2) Maximum GVA
Efficiency	Management/resource costs	Value of fishery, costs of management and enforcement	Cost/benefit ratio of management is maximized

different plausible populations, each with its own functional form and stochastic component, are derived from the assessment data. The use of multiple relationships therefore includes uncertainty in the knowledge of recruitment processes. Equilibrium is obtained (after 100 years), and the results for constant- F exploitation are plotted (Figure 1). MSY for the various populations occurs at different values of F , expressing the uncertainty in its estimation. Also, because of the substantial discards in the plaice fishery (>50% by number), the catch peaks at $F = 0.45$, which is much higher than that for maximum landings, $F = 0.25$. Estimates of F_{MSY} from the maximum mean landings and the median of the F_{MSY} distribution are similar. Maximum mean landings give a choice based on the integration of information over all values of F . The data needed to support this analysis are from a converged part of a fish stock assessment, but, importantly, must include discards as well as landings; comparing the F -values for maximum landings and catches shows the importance of having reliable discard data.

The choice of tactical methods

The term tactical methods refers to the different tools (and their measures) to be used to reach objectives. Tactics might be such aspects as TACs (total allowable catches), effort controls in terms of capacity or activity, closed areas, or technical aspects of fishing gear, such as mesh size. It is essential to select coherent operational objectives in terms of controllable and measurable variables that give information on implementation success against realizable criteria, such as changes in fishing effort and capacity, or TACs, with interannual stability criteria.

A plan should first be evaluated to see if it has in fact been implemented, before discussing its success in terms of the biological, economic, or social outcomes. For instance, if TACs are expected to control catches, has this been the case? If there were capacity or activity controls limiting days at sea, have the capacity changes been implemented, have days at sea controls controlled effort, or have too many derogations been granted so that the measures would be expected to be ineffective anyway? If there has been no reduction in fishing mortality, and there are no benefits in biological or economic responses because the planned reduction of landings or fishing effort has been unsuccessful, the issue may be mostly one of tactics rather than the aims and objectives of the plan. Where a plan has failed, identifying whether the problem is a failure of tactics or a failure of stock response is basic to understanding where different approaches are needed. The review of the recovery plan for southern hake and *Nephrops*

fisheries (STEFCF, 2010f) shows that under the plan, there is no reduction of fishing mortality. The landings controls have been ineffective in controlling TAC, and effort reductions have been ineffective because they were too small, allowing vessels to switch to more effective gears and allowing derogations for large fleets that have small catch per vessel but a substantial proportion of the total. In this case, the tactics have not been implemented, and a change to the plan that did not address this would not be expected to be perform any better.

Defining any overriding considerations of options

It is important to identify whether there are any significant parts of any options being proposed or evaluated that have failed in the past, or are unlikely to contribute to the overall objectives in the future. Removing unnecessary features, simplifying approaches, or replacing those that do not appear to work is part of good management, and in the context of IA is an important part of the procedure.

Environmental (biological) effects of plans

The expected impact on catches or landings of any of the following options in the plan should be shown:

- Identifying catch and effort limitations, either through TAC or effort management, expected from the different options. Evaluate whether any technical measures (e.g. closed areas or gear restrictions) in the options have delivered the results expected when a plan was proposed.
- The impact of control and enforcement measures – e.g. entry and exit rules, or allocation rights, and particularly the impact of any exemptions.

There is a need to consider what was or is the expected fishery response to the different options. Possible response strategies of fleets include shifts to other stocks or species, to other gears or métiers, changes in discard and slippage practice, and other behavioural issues.

For the NS sole and plaice fishery, there has been a movement of fishing effort towards the main landing ports, into areas with larger proportions of sole in the catches (STEFCF, 2010a); this may be attributable to higher fuel prices, but there is a consequent slower reduction in F for sole than for plaice (ICES, 2010). The data needs are spatially resolved catch, landings and effort data by fleet, information on species selectivity and catch compositions, and changes in fleet capacity. Modelling requires information on

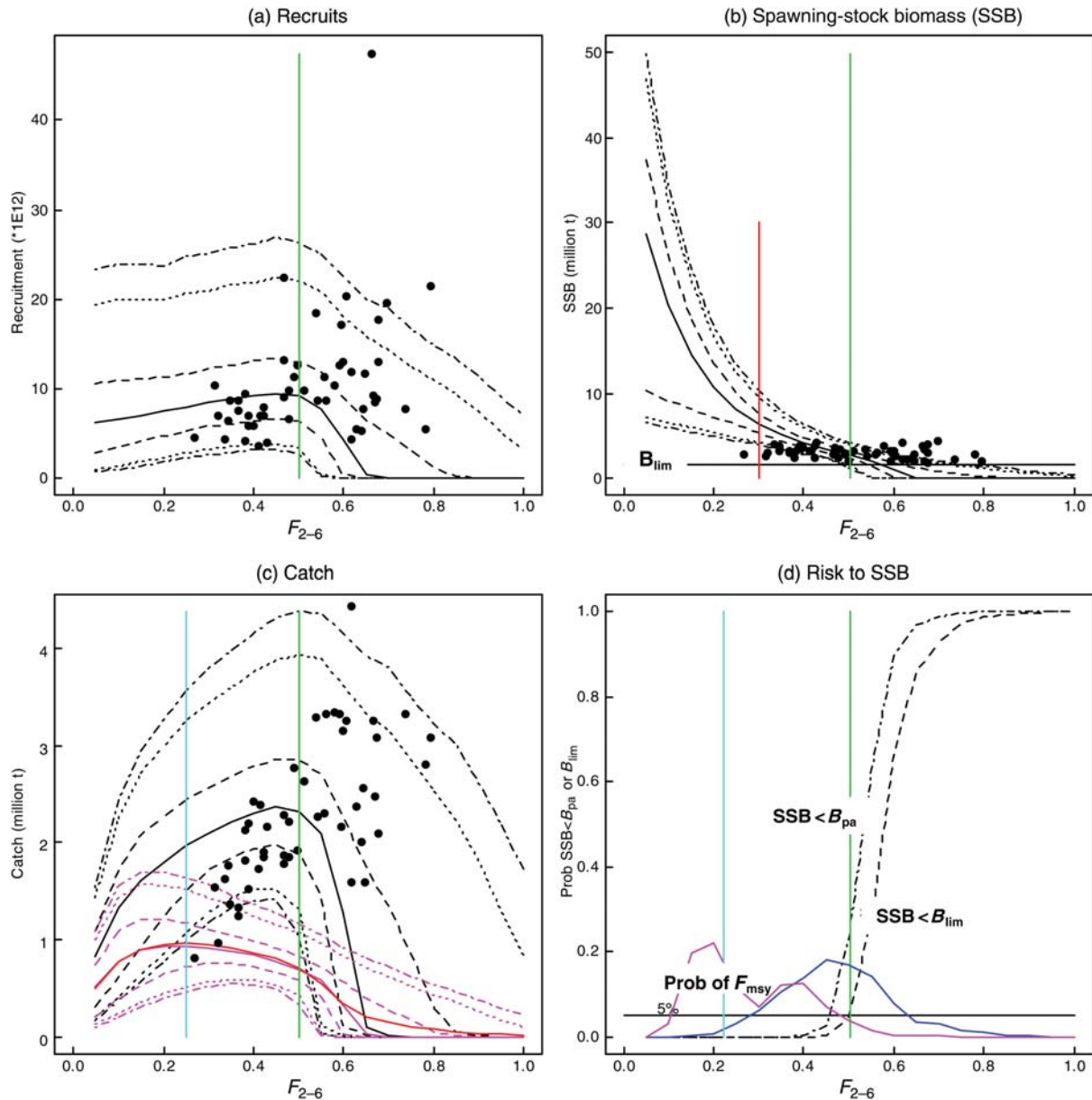


Figure 1. Estimation of biological MSY targets. Results of simulated equilibrium exploitation of NS plaice against age 2–6 fishing mortality (F_{2-6}). The model is based on recruitment data from 1957 to 2007 with observed growth and maturation rates from 2004 to 2008. The recruitment model includes both the hockey-stick and Ricker formulations: (a) recruitment; (b) SSB; (c) catches (black curve) and landings (red curve). The dots in (a)–(c) are historical observations of recruitment, SSB, catches, and F . Black lines are simulation quantiles at levels of 0.025, 0.05, 0.25, 0.5, 0.75, 0.95, and 0.975; the green line shows F for a 5% risk of $SSB < B_{lim}$ derived in (d). (d) Risks and F_{MSY} : the ogives (dotted curves) show the probability of $SSB < B_{lim}$ and $SSB < B_{pa}$; blue curve, probability of F giving maximum catch; red curve, probability of achieving maximum landings (F_{MSY}) based on the number of populations with maximum catch or landings at the specified F . The cyan lines (c and d) show the estimated value of F_{MSY} (landings); for (c), this is based on the value of F giving the maximum mean catch; for (d), F_{MSY} is estimated as the median F from the probability distribution of F giving the maximum yield. The two methods for estimating F_{MSY} are similar.

changes in fishing practices. Past adaptations of the fisheries may indicate future changes.

Evaluation of the effects of the plan on the stock

This involves evaluating the stock response to changes in the fisheries resulting from the plan, and checking whether the targets and other reference points specified in the plan are consistent with current knowledge, and whether the objective of achieving MSY by 2015 is attainable. Are the options likely to be considered

precautionary, and if not, why not? Finally, are all the measures in the plan required, or would something simpler achieve the objectives?

The data needs are similar to those of stock assessment. Modelling requires good understanding of the stock dynamics to test the different scenarios; this may be possible even without an agreed assessment, using only survey data or a converged VPA to provide realistic stock parameters (see, for example, Roel and De Oliveira, 2007; EC, 2009c).

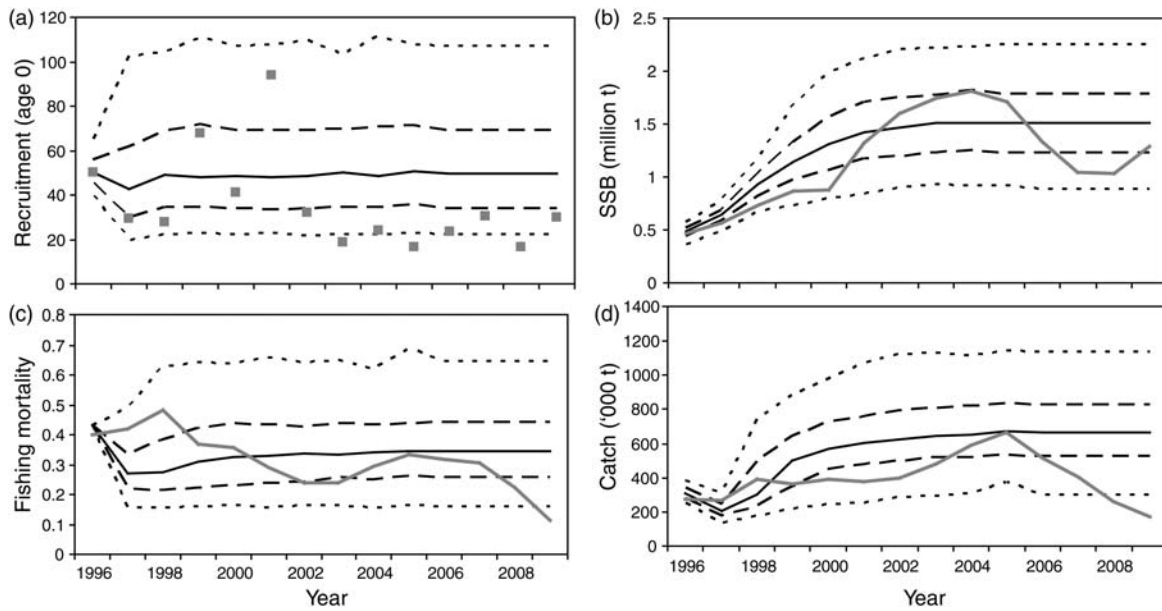


Figure 2. Comparison of stochastic medium-term predictions of NS herring using data available in 1996 incorporating 10% assessment and 20% implementation biases (black lines 5, 25, 50, 75, and 95 percentiles) against the actual trajectories of population parameters 1996–2009 according to the 2010 assessment (grey dots and lines; ICES, 2010): (a) recruitment; (b) SSB; (c) fishing mortality; (d) catch.

An example comparing a plan and its outcome (Figure 2) shows how the stochastic predictions relate to the outcome for NS herring (Simmonds, 2007). In early years, the recruitment and stock trajectories agreed fairly well with the predictions, but then unforeseen environmental influences caused an unexpected recruitment decline lasting for seven years, which adversely affected the correspondence between predictions and outcomes.

In addition to the magnitude of the stock response, we may also see changes in the spatial distribution, which compounded with different fishery practices, may help to explain the outcomes. For example, using the methodology of Bez and Rivoirard (2000, 2001) for NS sole and plaice, there is significant movement of plaice with age, but much less movement for sole (STECF, 2010a). These spatial differences between the two jointly fished stocks opens up possibilities for spatial management, because the F -ratios between sole and plaice are area-dependent.

HE of the effects of the multi-annual plan on the ecosystem

Ecosystem impacts of the different options of the plan might include changes in discarding practices, bycatch rates, catches of non-target species, and habitat degradation. Currently these may be characterized through agreed indicators or descriptors that are influenced by the options. In the longer term there will be a role for multispecies modelling, first to understand the past, then to predict the future, if the models are good enough.

Comparison with alternative scenarios

For HEs, a comparison between the outcome of the evaluated plan and other management scenarios can be made using historical re-evaluation (STECF, 2010a). Again NS herring is an example; Simmonds and Anderson (2010) give historical stock projections under different management scenarios (Figure 3), showing similar stock trajectories but with less variability in catches. Using a Ricker stock–recruit relationship, recruitment becomes stock- and hence management-dependent (Figure 3). Fixed

multiplicative deviations by year mimic stock-independent environmental effects on recruitment. The economic consequences of these scenarios are compared in Simmonds and Anderson (2010). The more-stable scenarios, with catches held constant unless the target catch changes by 10 or 15%, would have provided better overall economic performance than the actual plan implemented.

Social and economic effects of the plan

Fleet information

The economic data necessary for HEs and IAs were collected under the DCR until 2007 (EC, 2001) and the DCF from 2008 (EC, 2007). The data structure is based on national fleet segments specified in the regulation, and further divided into métiers, where appropriate and possible. This well-defined structure would suggest that the data are comparable between countries and fisheries. However, when the submission of data by fishers is voluntary, the data may be insufficient, especially those from small-scale fishers who are unwilling or unable to deliver. Sometimes only one or two companies form a fleet segment, and because of confidentiality issues, their data cannot be published. The basic European publication on economic data is the Annual Economic Report (STECF, 2010d). For these data, availability and confidentiality issues are a concern.

If sufficient data are available, the main indicators for a multi-annual plan HE are calculable: net profit, gross value added (GVA), or total costs. A series of economic indicators have been identified (Sabatella and Franquesa, 2004; STECF, 2007, 2009):

- (i) value of landings \sim revenue from the sale of fish;
- (ii) market price \sim ex-vessel prices and, where possible, prices along the chain;
- (iii) net profit \sim income less all costs, including capital costs;

- (iv) GVA ~ the contribution to gross national product, i.e. income minus all expenses except capital and crew costs;
- (v) fleet size, composition, and value.

It is important to identify which indicators are appropriate for the specific cases being assessed. However, it is likely that some of these will be unavailable in some cases. The issue is that an appropriate scale of study is needed to allow a manageable fishery, with sufficient economic information to describe an identifiable operational/manageable unit. If there are no specific economic or social objectives in the plan, then we must use the very general objectives of the CFP, making it nearly impossible to assess the economic success of plans. In such cases, improvement in some indicators may allow a claim for better economic performance, but without appropriate objectives, no quantitative statement of success is possible. For IAs lacking objectives, it is only possible to show likely trends of indicators for different options. Examples of such economic IAs include [Vieira and Tull \(2008\)](#) and [STECF \(2010a, e, f\)](#); for examples of analyses of different harvest strategies in the Western Channel sole fishery, see [Bjørndal and Bizabih \(2010\)](#), and for a more general discussion of single-species fisheries and uncertainty, see [Sarkar \(2009\)](#).

Processing sector

In the DCF, EU member states are also required to collect data on the fish-processing industry which, in many countries, are already

recorded by the national statistical offices. Often, however, it is only companies above a certain size (e.g. 20 or 50 employees) that are required to deliver data. For the others, data may be requested through voluntary questionnaires, providing the necessary though possibly incomplete information. In 2009, STECF analysed fish-processing data for the first time, and published a report on the sector ([STECF, 2010g](#)).

Information linking vessel landings with processing-sector inputs is generally available through sales notes. Though potentially helpful, this information has not yet been used for plan evaluation. In the absence of such detail, one solution is to use input/output multipliers to evaluate changes in the fishery in terms of GVA and employment in the economy as a whole. The different exploitation rates implied by the management options in [Figure 3](#) give different economic outcomes. [Simmonds and Anderson \(2010\)](#) show that the original management strategy gave the highest catches and landings, but the GVA approach was better for the less variable strategies.

Social aspects

Social objectives have had limited attention within the CFP so far, and in the context of fishery management, little has been done to measure or include these explicitly in management targets. While social objectives such as those of good environmental status (GES) have become explicit, little has been done to set them at the level of the individual fisher ([Symes and Phillipson, 2009](#)). At present, the

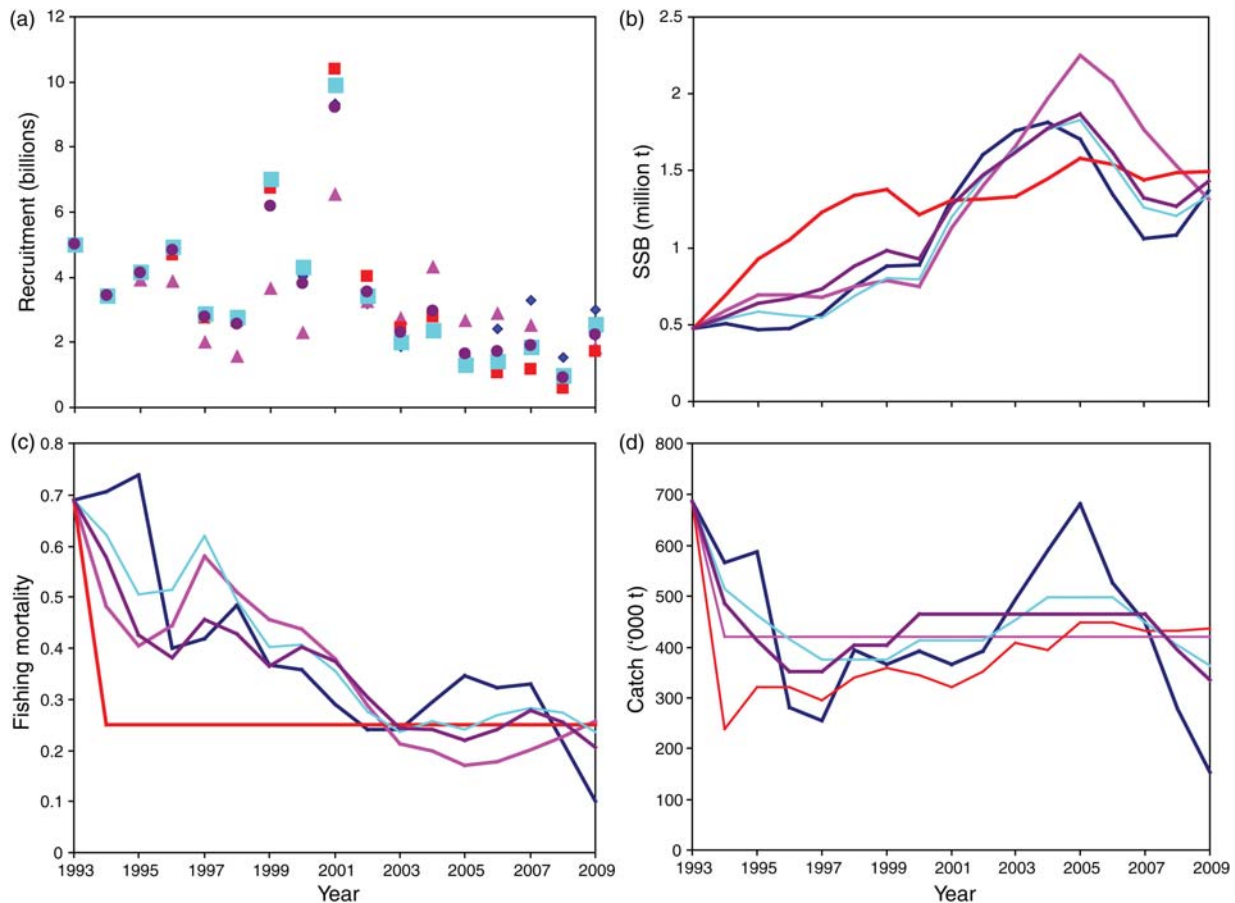


Figure 3. Alternative management scenarios, 1993–1999, showing predicted changes in (a) recruitment, (b) SSB, (c) mean F at ages 2–6, and (d) total catch for NS herring under five scenarios. Blue, original management; red, constant- F management under the 1997 plan without error; purple, constant catch of 420 000 t in all years; cyan and mauve, F -target for a constant catch unless the actual catch deviates by more than 10 or 15%, respectively.

only social indicator requested in the DCF is the amount of employment. There are no requirements to collect data on the regional importance of the fishery sector, job alternatives, or average salary compared with other sectors. Pollnac *et al.* (2007) show a limited social analysis of fishery-management outcomes. The key areas for social sustainability are the social consequences of management targets, and choosing approaches that foster cooperation, or have a high likelihood of compliance. Social indicators can be employment (catching and other fishery sectors), or the salary, to compare with non-fishery sectors (or the general job market).

Again, one approach is to consider input/output multipliers to estimate the overall impact on an economy, and on the potential for employment that can be based on multipliers of the landings value (Simmonds and Anderson, 2010).

Cost-effectiveness of control and enforcement

It is important to know whether different options have different implementation costs about their effectiveness in delivering the planned objectives. One option may deliver better conservation measures than another at comparable costs, or another may have similar conservation properties with differing costs. There is currently no methodology to provide a quantitative cost/benefit analysis of control and enforcement. Models such as the integrated fisheries management policy applied to groundfish off northwest Canada (DFO, 2010) give some insight into the costs and benefits of major monitoring programmes, with the total catch assessed through a combination of observers, cameras, and self-sampling. Transparency of information from fishers may be the key; greater openness leads to greater trust, better compliance, and more cost-effective enforcement. The use of incentives to reward good behaviour, or successful results-based management, may have lower control and enforcement costs, but still need good data to ensure that the incentives are scaled appropriately, and that the responsibilities and rewards are fair.

The data needs are the costs and effectiveness of enforcement, the economic benefits of the fishery, the economic incentives required to achieve better compliance, the costs and benefits of applying and complying with certification schemes such as those of the Marine Stewardship Council (MSC, 2010), KRAV (KRAV, 2010), or the Responsible Fishing Alliance (RFA, 2010).

Conclusions on HEs and IAs

HEs and IAs should be based on three main evaluation criteria:

- (i) effectiveness: the ability to achieve the objectives (the most likely to succeed);
- (ii) efficiency: the cost-effectiveness (the best cost/benefit ratio)
- (iii) consistency: the best trade-offs without major contradictions across the economic, social, and environmental domains.

Time-scale and process

In carrying out an HE of multi-annual plans, the data flow needs to be considered along with the questions that require answers. HEs cannot be attempted before the relevant data are available. A time-line (Figure 4) shows when differing types of information become available after the plan has been agreed. Once the type of HE has been selected, its timing is determined by the availability of information. For example, an HE of three years of biological data

can be done around month 48, whereas three years of economic evaluation must wait until month 60. The time-line (Figure 4) deals only with data from EU member states, the EC, and ICES, but in some cases fishery information from Regional Advisory Councils may be available sooner.

Discussion: the future of management and data collection

The key property of fishery management policy is that it acts by controlling the human activity of harvesting fish resources. Management actions are not aimed directly at the stocks, but rather the response of the stock is a secondary result of managing fishing activities. Therefore, IAs need to evaluate fishing activities and their effect on the stocks, rather than thinking of fishery management as providing catch opportunities for fishers. This emphasis has certain consequences, discussed below.

First, consider the scale at which management should be attempted. Management is currently directed at one or more unit stocks that are supposedly independent; any interaction is ignored. There is a need to identify overlaps of fleets and stocks, grouping economic entities (fisheries or fleets) and their impacts on particular stocks. Many European fleets catch the same species from different stocks, sometimes during the same trip, so an allocation of income by stock may be feasible, but separating vessel costs that way is impractical, and economic management by stock or métier is unworkable. Traditionally, fishers respond to stimuli by moving between métiers, and removal of that freedom could make fisheries less economically sustainable. Choosing the correct scale will reduce the number of unresolved issues hindering policy implementation. The scale will be region- and fishery-dependent.

Second, sampling métiers to describe the variability of fishing activities is attractive, but métiers are intrinsically dynamic because they respond to changing fishing opportunities. Therefore, sampling métiers on predefined criteria is hard to implement, and it may create gaps as fishing practices adapt. We think it better to detect and evaluate métiers retrospectively, rather than to attempt to define them on *a priori* criteria. By choosing to sample vessels, measuring their activity and catch, the population to be sampled can be defined from a fleet register.

Third, information needs to cover both catch (including discards) and landings. Modern technologies are needed to monitor and verify catch data. Whereas landings form the economic component, catch is the basis for biological IAs. However, landings and not catches are required for the parameter Y (the yield) in the objective of fishing at MSY. Economists have reported various consequences attributable to the separate consideration of catches and landings, and the behavioural response of fishers to specific incentives (see Hatcher, 2005, on quota management, and Vestergaard, 1996, on discard/highgrading behaviour in the Greenland shrimp fishery).

Fourth, we see the need to focus on a more harmonized biological and economic approach to data collection. The current DCF framework has a strong bifurcation between the requirements for biological and economic data, which currently cannot be linked because the fleet definitions are not coherent. Spatial information to link fleet numbers, costs, and fishing effort at an area level is not yet fully available. Targets for biological sampling are species- rather than fishery-based. Samples from different species

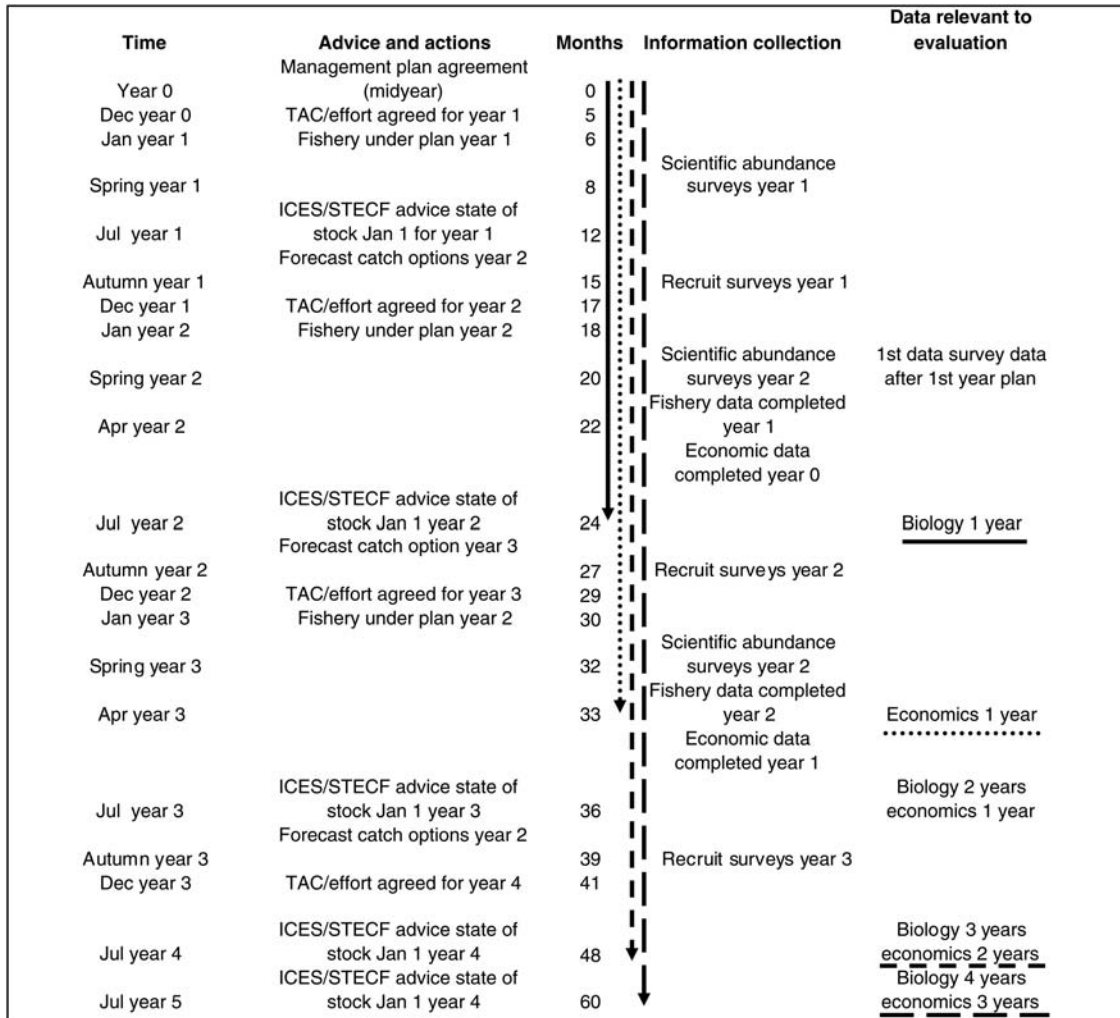


Figure 4. Time-line of actions and information relating to the HE of management plans.

do not come in a coordinated way from the same vessel, rather the different species are likely to come from different vessels although they are caught in a mixture. This species-based approach implies an assumption of homogeneity in mixtures that may be erroneous, and any correlation between biological characteristics among species may be hard to determine. A compromise is required so that fleet units need to be big enough to be fairly consistent, and identifiable for management purposes, but small enough to be spatially resolved to allow sampling at scales matching the stocks. It is important to monitor and sample all the economic components of fishing so that the full range of economic activity can be linked to a biological impact. The current practice of not sampling less significant groups results in a shortage of data for understanding the development of different fisheries over time, and allows gaps in knowledge to grow as new developments are missed. Some might consider that new data-collection procedures will disrupt the catch per unit effort (cpue) series used for stock assessments or as trend indicators. However, collecting data on one species in isolation may obscure an effort response in a fleet that would be understood if more-coherent multispecies data were available. Indeed, better understanding of cpue through economic information could result in better tuning of data time-series.

Finally, to augment a sampling programme approach, there are various sources of fishery data, such as e-logbooks, VMS records, and details on the economic performance of fishers, that would be extremely helpful for guiding good management. Currently, these data are often classed as confidential, but they need to be available to be of any use. In this context, we consider that hidden data contribute to distrust and aid non-compliance. One approach would be to consider that participation in a TAC-controlled fishery exploits a communal resource and therefore should oblige stakeholders to participate in the science and to provide data access accordingly.

Conclusions

There are explicit direct links between the policy objectives of the CFP, the legislative procedures of the Lisbon Treaty, and the data required to support fishery management and evaluation under the DCF. These links explicitly include the need for HE and IA of multi-annual plans. Comprehensive biological and economic data are required at regional or subregional level, linked to manageable fleet units. The definition of spatial and fleet units at the appropriate scale for management by region would help to structure data-collection protocols to meet these needs.

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