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Biological Uncertainties in Fish Stock Management

A Discussion

by

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SPECIAL SESSION ON MANAGEMENT UNDER UNCERTAINTIES
RELATED TO BIOLOGY AND ASSESSMENTS

Introduction

All assessments of fish stocks and the derived biological advice on e.g. TAC are subject to uncertainties. These uncertainties originate from limitations in amount and quality of data, from mis-interpretations of these data and from limited theoretical understanding of the biological, economical/technical and social systems affected by fishing operations.

For the formulation and interpretation of a biological advice we must understand how our models function, among other things with respect to how variability and biased data may affect the advice. We must for a given assessment have some guess of the likelihood that a particular type of uncertainty occurs.

How variability, bias or theoretical misconceptions may affect the biological advice can to some extent be studied through computer simulations. But such studies can only help as long as we are able to specify the variability of the data or alternative population dynamics model in question. The unexpected reaction of the system or mis-interpretation of data are much more difficult to study. Case studies provide a look-back on the history and may provide some insight into the type of unexpected reactions of the ecological systems and how often such reactions occur. Similar, type and frequencies of mis-interpretations of data may be studied looking on past preformance.

Biological uncertainties play a role in management. It is the tesis of this paper that this role is best understood by considering the process leading to management decisions.

The question raised by this symposium obviously cannot be addressed without interference with both fishery managers and fisheries biologists, but is partly, when it come to discussing decision processes, outside the professional competence of a fisheries biologist. Even so, I offer the subsequent discussion.

Providing Biological Advice

Fisheries management affects the livelihood of people dependent on fisheries. This is by no means a unique situation and exists elsewhere in modern society e.g. restrictions on chemicals (pesticides, organics solvents, mercury, chlorine etc) or environmental considerations affecting agriculture, medical industry, chemical industry etc.

Analysis of a suggested management action by fisheries biologists may indicate its likely effects, but only if the projections are considered to be reasonably accurate, then an advice may be provided. When are we reasonably certain that the outcome of these analyses indicates the real effects ?. The "reasonably certain" depends on how grave the biological situation is assessed, how large the potential benefits are, the likely effects on the involved groups and how serious adverse effects could be, if the situation is assessed incorrectly. We cannot specify a generally applicable precision requirement.

Unexpected reactions by the ecosystem or elsewhere in the fishing systems because of possible miscomprehension of the system under analysis are everybody's guess.

The tendency is to transmit the results of the projections together with a description of the uncertainties. Much time, energy and ingenuity are spent in formulating advice for fish stock management and many words and careful formulations are laid down in adequately reflecting the analyses and the judgements on uncertainties.

An assessment of a fish stock is largely to distinguish unbiased from biased data, to distinguish stock indicators accurately reflecting stock changes from those indicators which are severely influenced by changes in environment or in fishing technology and to guess how precise the theoretical models will account for the reactions of the fishing system. The effects on the advice by some types of uncertainty can be analysed e.g. using computer simulation studies while other types are not easily tractable. To get some insight in this problem a classification of the uncertainties is given below.

Sources of Uncertainties in a TAC Advice

The data items considered in a fish stock assessment are

- catches, how much, when and where

- biological samples of the catches

- abundance estimates or abundance indicators (e.g. catch rates from the commercial fisheries, hydroacoustic surveys or trawl surveys)

- technical description of the fisheries e.g. mesh sizes used in a trawl fishery, discard practice, etc.

Uncertainties originates from several sources

- Variability in data, but the data are unbiased

- Bias in data

    - Incomplete catch statistics i.e. underestimation of the removals

    - Incomplete coverage of the stock in surveys or incomplete coverage when sampling the fisheries. Such incomplete coverage is likely to create bias in data. A particular example in the NAFO regulatory area is vessels flying flags of convience which catches have to guessed together with length and age compositions and other biological parameters

- Misjudgements of data on the parts of the scientists. These judgements involve discerning between trends and variability in the stock indicators, identify bias in data, interprete changes in stock indicators as being due to a stock change or to a change in fishing technology

- Incomplete or mis-understanding of the population dynamics and stock structure

Science brews a biological advice trying to sort out where each indicator belongs. These reports are transmitted to the Fisheries Commission, national governments etc. where the biological advice is weighted together with other considerations of relevance to fisheries before a decision on management measures may eventually be made.

The effect on a TAC advice varies dependent of which class of uncertainty a particular assessment is confronted with. Everybody involved should have a clear idea how the advice is affected by a each class of uncertainty and should be aware of the likelihood of a particular uncertainty being important.

Variability in data and even bias can be analyzed fairly simple if the magnitude of these are known. Computer simulations will provide inside in how much the advice would be affected, decisions can be reached with known risks and the possible adverse effects can be assessed. Mis-interpretations and deficiencies in the biological models are much more serious. Mis-interpretations may lead to management actions which are counter-productive to reaching the objectives. Management actions based on deficient biological models may lead to events which are not forseen at all and which may be highly undesirable. The discussion on the effects of a general mesh size change in the trawl fisheries in the North Sea may serve as an example. Single-species models indicate an increase in the high-value top predators while multispecies models because of the feed-back in increased predation on younger agegroups show none or a much smaller gain from such an action. The discussion of the Grand Bank Cod (NAFO Divs. 2J + 3KL) in Canada (Harris 1990) is partly based on a mis-interpretation of the trawl survey results which led to too high TACs and delayed management actions in spite of well defined objectives.

An advice with all its qualifications could easily make a manager dispair, and the scientific adviser sees with unrest the advise been taken forward with its qualifications toned down or simply forgotten. To account for uncertainties in the biological advice and any other analysis, management decisions are put up for revision regularly. This is done for most catch quota systems where TACs are revised annually.

Decision on Management Measures

Fishing is a complex undertaking affecting many different groups, the interested parties in fishing. These include

- fishing vessel owners
- fish processing plants owners
- fishing service industries (stevedore, harbours, ice, radio, fish finding equipment etc)
- bank owners
- fishermen
- workers in fish processing plants, in harbours, in retail and detail sales of fish, banks, in the service industry
- municipalities and government

The biological TAC advice with all its qualifications is considered together with economy, social life, fishery technology etc. by each interested party and compared with that groups objectives. If the problem concerns a stock under international jurisdiction, national priorities have to be agreed before discussions take place in Fisheries Commission or through bilateral negociations. An agreed TAC subsequently has to be

implemented and enforced on the national level. And again the actual enforcement scheme may be a matter for biological advice.

This process includes numerous decisions. A study of the decision process could cast light on how management deals with biological uncertainties.

Two models of how the decision process could be viewed are discussed below. These two models are

1) a search for a optimum solution

2) a search for an acceptable compromise

Biological uncertainties play a very different role in the two decision senarios and this suggests that such studies could be fruitful in understanding the role of biological uncertainties. Under 1) the biological uncertainties are contributing to the weight attached to the biological advice. High degree of uncertainty leads to little weight attached to the biological advice. Under 2) biological uncertainties are arguments which can be used or not used as the party sees fit in the negociations.

Any real situation is neither seen as a clean-cut rationale nor as a political decision process. The two models are considered extremes inbetween which a real decision process would actually take place. A decision process is not static in time and a real situation may in time flip to and fro and inbetween the extremes described below.

Decision Senario I. Rationale Model
A Search for the Optimum Solution

The first model is a rationale decision process where everybody agree on objectives and jointly search for an optimal solution.

This senario is characterized by

- Well defined objectives and well defined weighting of conflicting objectives

- Objectives and weightings shared by all interested parties. A clear understanding by all interested parties of these objectives

- Common acceptance of applicable management measures

The decision process is characterized by

- Analysis of how the different objectives can be reached using the accepted management measures

- Weighting the different objectives

- Calculating the overall optimum and reaching the decision almost mechanically

The biological advice is under this senario simply the optimum solution to the specified set of objectives and their weightings. In cases where these objectives are not clearly specified the biological advice is usually (a step towards) MSY. The biological uncertainties contribute to the weight attached to the biological advice. High uncertainty leads to little weight attached to the biological advice. If the knowlegde on how the biological system may react is limited i.e. the advice is given with high uncertainty, then analysis of that system will either have to be left out or be replaced by some rather arbitrary considerations, the management decisions will be taken by consensus between all interested parties.

Decision Senario II. Political Model
A Search for an Acceptable Compromise

The second model is a political process where the interested parties have more or less conflicting objectives but where everybody has an interest in reaching a compromise allowing fishing to continue. In this case the search for a solution is through negociations and the compromise involves elements like the importance a party attaches to the problem, political ability to explain a case to the public, and in general, the power base available to each interested party.

This senario is characterized by

- Conflicting objectives between interested parties and no accepted weighting between the different objectives.

- No general acceptance of management measures

- Different importance attached to the issues by different interested parties

- Objectives and the importance attached to the problem not known by other parties

- Different power base available to different interested parties

- An interest among all interested parties to reach a compromise as it is assumed that management decision is required for the continuation of fishing

The decision process is characterized by

- Establishing as general knowlegde the objectives of all interested parties and the importance each party attaches to its objectives

- Analysis of the systems to understand how each interested party's objectives are affected by different management decisions

- a search for a comprise both with respect to a subset of management measures which are non-objectionable and to a set of management measures which will to some degree fulfill the objectives of the interested parties

During the search for a compromise alliances may be formed and in the end a decision is reached because all parties have an interest in the continuation of fishing operations.

The role of biological uncertainties in this senario is rather unclear as is the role of the biological advice itself. Actually the biological advice forms the starting point of the negociations in several fora and as such taken into account when each interested party evaluate their position on the starting point of the negociation process.

During the negociation process the weight of the biological argument is evaluated against the biological uncertainties, but also against how much this advise is at variance with the objective of the interested party. Biological uncertainties in this senario are arguments which can be used or not used as the party sees fit.

Parameters affecting the Decision Process

While biological uncertainties play a different role dependent on the decision process, it may be pertinent to ask whether biological uncertainties are among the variables which determine how an actual decision process may evolve.

One element in a rationale decision process is the ability to simulate how fish stocks and the fishing industry are affected by management. Under high biological uncertainties these biological effects are not known, hence that element of a rationale decision process is not available. This does not imply that a rationale decision process is made impossible, but simply that the decision cannot be based on biological considerations. So to reach consensus and apply a rationale decision process would require a fairly low degree of uncertainty in our understanding of the biological system.

In a negociation process uncertain advice is easily put aside for any party for whom the advice is seen in conflict with its legitime interests. Vice versa is it difficult to make a firm stand on very shaky biological evidence.

It is therefore suggested that the decision shifts towards the political process with increasing uncertainty. Further in negociations shaky biological advice is ignored (as it rightly should be).

Discussion

Mr Holden (EEC) reviewed at the 7th ICES Dialogue Meeting (November 1989) why so many fisheries are mis-managed. He found that the main reason seems to be that different managers have different objectives and there are no single overall objective in most countries. A further problem is that only rarely is there agreement on how an objective is to be implemented. He suggested that a forum should be established where all parties involved could discuss these questions and try to reach agreement (ICES/CIEM information April 1990, issue no 15).

Mis-management in this context is over-exploitation and dissipation of the resource rent i.e. the output of the fisheries in biological and economical terms is less than what could have been achieved.

The mechanism implied is probably that decision making is done politically, where biological uncertainties (among other types of uncertainties) prevent management of the fisheries to the extent required should higher yields and economical benefits be possible.

This indicates that the aims suggested by macro economy (maximize the resource rent) or fisheries biology (maximize the yield) are either not shared by the dominating interested parties or that the means to achieve these objectives are not accepted in the short run. A third explanation could be that the uncertainties in the biological advices are too big to allow projections with such confidence that short term sacrifices are considered worth while.

These questions are for the interested parties to answer.

Fisheries biologists should consider if our projections are worthwhile or would the considerable sums of money spent on fisheries research be better invested elsewhere. Such questions can only be answered by identifying the actual degree of accuracy obtained in our predictions and relate this result to manegement practice.