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Fisheries scientists' struggle for objectivity

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Abstract

Traditionally, objectivity and neutrality along with testability and significance have been important standards of science. However, science has changed profoundly from small-scale experiments to large-scale problems of societal concern. Thus a revised set of scientific standards and ideals of quality is necessary. Fisheries scientists are educated at universities where traditional ideals are essential. In this paper I discuss objectivity and neutrality as measures of quality and how fisheries scientist relate to these ideals. Scientific ideals are challenged, and examples are discussed within fish stock assessment, whale counting and fisheries data.

Key words: scientific ideals, objectivity, fisheries science

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Introduction

Fisheries managers' statement that objective knowledge and advice is important in management is a result of their need to be trusted by different parties. The fishermen, the fishing industry, the green organizations and the public in general need to be convinced that decisions are essentially neutral and transparent. Managers make this possible by i.e. seeking quantitative advice from fishery scientists. Their management decisions can thus be claimed to be based on objective, scientific grounds.

The fishery scientists, on the other hand, need to communicate in a trustworthy manner. We wish to be heard and do a decent job. Why would anyone pay our salary and scientific projects otherwise? Our legitimacy is important both in society and within the science community. For decades, objectivity has been an overall ideal both within science and state policies in democratic countries. Thus, objective knowledge has been in demand.

Still, in our struggle for objectivity, subjective judgement is a significant part in fisheries science processes: the way data is collected, the way we evaluate assessments, how we define precautionary reference points etc. How apparent is this for the public, and to what extent should we aim at avoiding subjective judgements?

Objectivity

Objective knowledge means knowledge that does not depend too much on the particular individuals who author it. A maybe old-fashioned definition of objective knowledge would be knowledge corresponding to reality or the truth. Today one would rather say that objectivity is the attempt to create knowledge unaffected by personal interests, judgments, subjectivity, prejudice, nationality and language.
To attain this value-free knowledge, standards of scientific practice are followed. Quantification has played a major role in making knowledge neutral and transparent, but with the danger of suppressing the importance of personal skill. (For further discussion, see Funtowicz and Ravetz (1991)).

Today, objectivity and quantification are important societal and scientific ideals in western society. Porter (1995) shows convincingly how and why these ideals replaced expert skill and qualitative judgments during the last two centuries: In France, the major change was initiated by an increase of social concern and a demand for fairness. The state collected numbers to compare people's welfare from different social layers. In the process of handling such numbers, statistic analysis was developed (*statistic*: Latin *status* means *state*). Later, calculations were used to decide where to build railways and bridges, aiming to find the most profitable solution for the French society.
In the US, cost-benefit analysis was developed in the need for a decision tool in governmental engineering projects like flood control. And the IQ-test was developed in order to find the most suitable education for a potential student.

In both countries, the growing importance of quantification and objective knowledge was partly a result of the aim for fairness and impartiality but also the lack of trust in experts' advice was significant for this process. Situations where different interest parties were critical to presented solutions, made the experts respond with an increasing use of numbers and calculations. The objectivity was an adaptation to the suspicions of powerful outsiders. Numbers and calculations, Porter continues, have the appearance of being non-subjective and telling the truth.

The social sciences, followed by the natural sciences, were influenced by these trends in society. From mainly being qualitative and descriptive, the importance of quantitative methods increased. When the credibility of sciences like psychology and sociology were questioned in society, these sciences responded by emphasizing quantified knowledge. Statistics became standard methodology in almost all scientific fields. Even physics and mathematics were mainly qualitative until the middle of the 19th century.

Post-normal science

In the beginning/middle of the 20th century, the natural science communities were autonomous, deciding themselves what questions to be asked. The studies of simplified systems on a small time scale and quantitative methods contributed to the development of technology. Especially the science of physics was admired for its great success.

The last decades, however, the dominance in scientific questions has changed profoundly towards science for policy. Now, society wants to know how many fish we can catch and still avoid stock collapses; how should we protect our ecosystems; what is the impact of car pollution on the air quality; what are the dangers with nuclear waste, etc. etc. Scientists have to deal with global problems on long time scale. Many questions, where great uncertainty and ignorance dominates, are urgent and maybe impossible to know the answer to.

Funtowicz and Ravetz (1991) have introduced the notion *post-normal* science to mark the passing of an age when the norm for effective scientific practise could be a process of kuhnian puzzle-solving to uncover ignorance. Characteristics for post-normal science are that scientists have ethical and societal responsibility to clients, decision stakes are high, decisions are urgent and epistemological uncertainty and ignorance dominates.

Science for policy covers a wide area of scientific questions, which require quite different approaches. Funtowicz and Ravetz separate science for policy into three categories: *applied science, professional consultancy* and *post-normal science*. Characteristic for *applied science* is that the scientists use the same methods as in core science but produce results directly applicable for society. Several kinds of technology would be an example. Generally, uncertainty is just of a technical kind (measurement uncertainty), and the scientists do not have any societal responsibility. Decision stakes are low.

Professional consultancy, e.g. engineers and medical doctors, includes dealing with methodological uncertainties, which is a more severe kind of uncertainty than of applied science. Judgment and good practice are crucial skills. These professions are used to deal with responsibility and risk. Decision stakes are typically between low and medium, e.g. a person's or a community's safety might be at risk.

The difference between personal consultancy and *post-normal science* is that decisions in post-normal science depend on evaluation of the future state of the natural environment that is unknown or even unknowable. In addition decision stakes may be high. This category of science cannot pretend to be value-free or ethically neutral.

Funtowicz and Ravetz argue (1990) that there has been a shift from the importance of *knowing-that* in normal science to *knowing-how* in post-normal science. This means that scientific ideals like objectivity and quantitative knowledge will have to be partly replaced by subjective judgment and qualitative knowledge. (For their suggestion on methodology, see Funtowicz and Ravetz 1990).

Fisheries science is a broad field, which spans from core science to advice on management issues. Would making assessments be an activity within post-normal science? Western society's attitude to fishing and our knowledge about the oceans have changed profoundly the last century. First, we pictured the ocean as infinite and not vulnerable to extensive fishing activity and pollution, but lessons taught us that fish stocks can collapse. Different regulations have been developed and used. The recent focus on ecosystem management and the precautionary approach shows a change in attitude. Society has a growing concern for protecting our ecosystems. We now fear that human activity makes a deeper impact on the oceans than believed only a few decades ago. Non-targeted species get increasing attention as a consequence of the society's more holistic view on eco-systems. In Norwegian seas, e.g., vast areas of coral reefs were discovered recently, which were believed to be crucial feeding areas for quite a few species. However, extended use of trawls has caused damages to the reefs, and we do not know the total consequences of the damages. Our knowledge about the ocean contains huge gaps and to predict all consequences of human activity will remain impossible. Taking into consideration both the unpredictable nature of ecosystems and the society's concern for the future generations, assessing ecosystems is an activity fulfilling the characteristics of post-normal science.

As fisheries scientists we get our education from universities. We are basically raised with science ideals of traditional core science. In my opinion these ideals do not suit many of our activities, and we should aim at finding more suitable ideals. To illustrate how conflicting these ideals can be, we discuss different examples from fisheries science.

ICES ideals

ICES aims at being an objective institution. The following two citations from ICES' strategic plan (ICES 2000) illustrate this: i)'*ICES is responsible for the provision of the highest quality objective scientific advice on the sustainable use of living marine resources and the protection of the marine environment.'* and ii) '*[..] and informing the public objectively and effectively about marine ecosystem issues'*. In this context we must understand "objective" as partly meaning neutral, not autonomous or disinterestedness which would be ideals in core science, but neutral to different interests. In contrast to e.g. IWC and some fisheries science organisations in other parts of the world, ICES includes only scientists and not any of the stakeholders. This must be interpreted as an attempt to keep ICES neutral. Nevertheless, ICES has clients and aim at being responsible and credible and has therefore not the opportunity to be totally independent.

Neutrality is not just related to different interest groups in society: fishermen, green organizations etc., neutrality is also linked to nationality. The majority of exploited fish stocks cross borderlines and are thus shared between different countries. ICES is an organization that gives advice and depends on its credibility internationally. Its strategy is to appear neutral in that scientist from all countries may attend working groups handled, also from countries with no political interest in the specific stock. Stakeholders are kept outside the assessment procedure. On the other hand, this strategy isolates the scientific community, which may affect the relevance of the advice given.

To fulfil these ideals, ICES aims at building its knowledge by objective and scientific methods. Through ACFM, ICES gives quantitative advice as a main rule, but with the opportunity of making qualitative comments. The quantitative setting of advice consists of several estimates and quantitative predictions of fishing mortality rates, catches and spawning stock biomass. These are linked to quantitative reference points.
Repetitiveness and testability as well as significance calculations are quite important standards in core science. Fisheries scientists know that core science and fish stock assessments are not comparable in this sense. Instead, ideals like transparency and neutrality in scientific procedures are emphasized. We would like to address a few issues within stock assessment and discuss how they relate to scientific ideals: how data are collected, the process of estimating/predicting stock abundance and how results from ICES working groups and ACFM are presented.

Collecting data

There is no doubt that personal skill is crucial in collecting data for stock assessment. Data sampling, age reading, echogram judging and cruise-track planning are all tasks that require non-objective methods.

An echogram is a representation of the signals received by an echo sounder. Judging is interpreting the echogram to determine what or what species have reflected the sound waves from the echo sounder. To be able to do this kind of analysis, a period of learning-by-doing is required in a teacher-pupil situation. All though there are projects going on which try to make this kind of analysis automatic by computer programs, personal skill is still superior. If a portion of tacit knowledge is required in judging, which might well be the case, translating the complete knowledge into computer programmes will remain impossible. Still, the correctness of judging is impossible to know fully since both uncertainty and bias is connected to this activity. In spite of this, judging is recognized to improve the quality of the survey data.
The last few decades it is commonly accepted by philosophers of science that personal skill and tacit knowledge are important factors in all scientific activity.

In several fisheries, fishermen and other actors from the fisheries play an active role in the collecting of data. First of all, the fishermen have the responsibility of reporting what he/she has caught. In addition, they may be given part of the responsibility of taking samples from the catches. These data are used for estimating the composition of what is removed from the stock. It may also be used as a supplement to the samples from scientific surveys.
Another source of data collected by the fisheries is effort data, used in estimating stock levels. There are several projects going on to utilize more detailed information from the fisheries.
In contrast to most other scientific fields, fisheries science utilizes data, which to a large extent is collected by people outside scientific institutions. In some scientific fields amateurs contribute in collecting data. But we, fisheries scientists, use data collected by stakeholders. How well is the objectivity in these processes taken care of? Incidents of misreporting and discards are well known, but the extent is hard to evaluate.

Fisheries scientists have clients who pay for specific tasks. Lack of time and funding make it impossible to neglect catch and effort data. Quotas are usually set every year, and fisheries managers do not have the time to wait until the scientists have objective and settled knowledge. Even though fisheries data are not objective and there is a chance that they are manipulated, it is concluded that the quality of fish stock assessments improve by using these data. In my opinion, advice should therefore contain a qualitative evaluation of the data and a transparent discussion on the collecting of data.

Counting minke whales

Whale hunting causes strong feelings. Many people around the world values the whales highly and wish to protect all whales from hunting. Norway, on the other hand, is a traditional whale-hunting nation and has opened for a yearly quota on minke whale for sustainable use. Norwegian decision makers claim to base their decision on objective scientific grounds (even though IWC (International Whaling Commission) does not recommend a quota yet).

In 1995 (Øien, pers. com.), a Norwegian research survey was carried out to estimate the number of minke whales in the northeast Atlantic. This was a huge operation with many vessels and quite a number of observers. Minke whale is a whale species that is difficult to catch sight of. People who had experience in observing whales or other animals/birds were hired for the survey. 20% of the observers were international while the rest were Norwegian whale hunters and some bird watchers. It turned out that the biologists produced more precise data on whale species, but the whale hunters observed far more minke whales. One should expect that whale hunters have personal skill in catching sight of these whales and are able to collect data of better quality; they have far more training in this specific task. On the other hand, whale hunters belong to an interest group where a large number of observed whales will serve them. The data are thus not neutral. From the following year on, the scientist in charge chose mainly whale hunters as observers on the surveys.

Fish stock assessment

Estimating stock abundance is not merely running a computer programme once and accepting the results right away. Our limited knowledge and data of poor quality make it necessary to evaluate every output. Results can be discarded of several reasons: statistical, technical (model specifications), after evaluations of data quality or of more vague reasons like impressions of different kinds. Program runs can produce quite different results. Finlayson (1995) uses the term *interpretive flexibility* to describe the data which stock estimates are based on. Interpretive flexibility is the possibility to a priori draw equal plausible conclusions from one set of data. Hauge (1998) describes the process of an ICES working group and suggests that tacit knowledge and personal skill contribute to narrow this flexibility. (Unfortunately, there is no thorough study on this subject.)

ICES working groups end with one single point estimate of stock abundance. This is in accordance with the proposed ICES quality manual (ICES 1999) where consensus is one of the quality ideals in advice: '*Many issues on which ICES advice is sought are controversial, both scientifically and politically. [..] Conflicting views expressed to Clients are confusing and of little value.*'

I would like to add that occasionally, consensus on a single point estimate is hard to reach, not necessarily because of controversies, but because we just do not have any strong reasons or feelings for choosing one result in favour of the others.

In my opinion, the scientific controversies and the situations where choosing is more or less arbitrary, may say something important about uncertainty, ignorance and indeterminacy. How is this non-quantitative uncertainty communicated? Either a comment is put in the text in the ACFM advice, or the working group report, which is not much read by outsiders, might reflect that the process had not been equivocal.

Transparency is another quality ideal that ICES suggests: '*This means that it must be clear how the advice was reached and that each stage in the process can be identified.*' (ICES 1999). When advice is as uncertain as fisheries management advice, transparency is a natural ideal.

Discussion

We are, as fisheries scientists, educated at universities and raised with university ideals. These ideals form our identity as scientists. Our maybe main ideal has been to be objective, both politically and methodologically. Fisheries managers depend on this ideal when claiming that management decisions are taken on objective scientific grounds. Most of us experience that these ideals are hard to fulfil in parts of fisheries science, and some defend themselves by arguing that fisheries science is not a science. But science is not homogeneous or unambiguous, and scientific method has changed through history. Funtowicz and Ravetz

(1990) acknowledge that science for policy may have quite different characteristics than core science. They suggest the notion *post-normal science* on science where decision stakes are high, decisions are urgent and ignorance is a major part of the uncertainty. It is argued earlier in this paper that fish stock assessment has the characteristics of post-normal science. One of the characteristics is that it cannot pretend to be value-free. We, as scientist, take part in the responsibility to protect the ecosystem and to provide an income for the fishermen. Occasionally this issue is quite explicit at ICES working groups. Since stock abundance for previous years are re-estimated every year, and point estimates can fluctuate quite a bit, it has occurred that scientists have argued that the choice of estimate that year should not exceed too much from the previous year to keep the quotas more stable, assuming that stable quotas are preferable. When abundance estimates are surprisingly high, it happens that the group agrees on choosing a computer run that gives a lower estimate to avoid the risk of collapsing a stock. It is no doubt that the scientists in these situations are doing what they think is relevant to their clients, the fisheries or the society. Outsiders as well as fisheries scientists may oppose to this kind of argument, claiming only neutral and objective arguments to be relevant. There is always a risk that fisheries scientists may be moving outside their competence in judging what is relevant for their clients. Indeed, *relevance* is an ideal for fisheries scientists, but since there are contradictory views on what is relevant, the process should be transparent.

ICES has put a lot of effort in developing precautionary reference points. Choosing the actual level of precaution is a political question. Should ICES be more neutral in that sense? In this connection, perhaps we should ask ourselves whether the scientists are an interest group. After all, we find our job more meaningful and respected when we are listened to and have the opportunity to influence the management process.

Quality and objectivity are conflicting ideals in minke whale counting in Norway. Whale hunters, who obviously belong to an interest group, are hired to observe minke whales from research vessels. The whale hunters will naturally benefit from observing as much as possible. Their observations are not neutral, but on the other hand these people are uniquely trained. Minke whales are hard to catch sight of and whale hunters have the personal skill that can improve the quality of the data. In this case, the scientist in charge had to choose between the conflicting ideals of objectivity and quality. Members of green organizations e.g. may disagree on this choice. In situations where there are opposite views on management actions, it is important that the whole process is transparent. The subjective choices should be clear and the reasons for them too.

We have seen that personal skill and subjective judgment play an important role in stock assessment within the ICES system. These skills narrow the interval of plausible point estimates, and may thus improve the quality of the concluding advice. Still there may be a disagreement on what estimate is the most plausible, or there may be an agreement that there is no strong indication that one specific estimate is more plausible than the other. In this case, the ideal of *consensus* may contradict the ideal of *transparency* and *relevance*. One could ask why consensus is an objective. Obviously, consensus in a working group may prevent political interests in an imagined situation where a scientist is ordered to defend a certain political agenda. An additional explanation would be that the fisheries science community tries to defend their credibility by hiding the inexactness of their knowledge. Our clients order point estimates, and to achieve this, consensus is necessary.
According to ICES' proposed quality manual (ICES 1999), consensus helps preventing the clients from getting confused. In situations where there is a controversy, ICES thus assumes

that the best solution is a single choice found by democratic principles. Consensus based on somewhat arbitrary subjective judgment, may therefore hide the degree of uncertainty and the advice may thus be misleading. By communicating a forced consensus, we may be patronizing our managers and taking a too large part of the responsibility in the management of that particular fish stock.

As fisheries scientists we get into conflict with our scientific ideals. We want to appear as neutral and credible scientists who give relevant advice. Fisheries managers order advice on a form that is unattainable: exact, quantified advice. Fishermen and society in general notice when the scientists turn out to be wrong. Perhaps we are loosing credibility because society pictures science as an exact enterprise? A way out could be to educate our managers and the society in general, to make them aware of how science has changed and that stock assessment will remain uncertain. And we, as fisheries scientists, should re-evaluate how advice ought to be given: Has the quantity of quantification become absurd; Can qualitative advice replace quantitative advice; Do we pretend to know more than we do; Should interest groups evaluate the relevance and quality of our advice earlier in the calculation process? We ought to do something in order to become more trustworthy.

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