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Science and sustainable fisheries management in DFO

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Abstract

Sustainable management of Canada's marine capture fisheries is in the long-term interests of Canadians. This can best be achieved by making use of scientific information in a structured decision-making process within government. However, diminished and selective use of science, combined with de-professionalism, bureaucratization and commercialization, has been detrimental to government research for public good. Suggestions are made for improving the role of science and increasing value to Canadians in key policy areas such as sustainably managed fisheries.

Introduction

There is a long history of scientific excellence in the Department of Fisheries and Oceans and in the preceding fisheries research boards. Research is aimed at both improving understanding in the long-term and informing Government decisions in the short-term. Tax-payers money is invested in obtaining objective information that

promises a substantial return in the form of improved decision making in the interests of public good. However, public confidence in scientific advice has suffered with the collapse of the east coast groundfish and the ongoing crisis in Pacific salmon. Some have suggested that selective use of science by decision-makers and restrictions on the independence of the scientific process have been contributing factors. Increased bureaucratization of science management, de-professionalism of the civil service and commercialization of research can also detrimentally affect standards of scientific excellence within DFO and other government science departments and agencies. The influences of selective use, bureaucratization, de-professionalism and commercialization are explored in the context of scientific advice in support of sustainable fisheries management in Canada. Sustainable fisheries provides a good example because it is a key policy area in government for which there is considerable amount of scientific data to inform decision-making. Atmospheric research and climate change provides another example. Some suggestions are made with respect to reversing the weakening role of government science, encouraging scientific excellence and restoring public confidence.

Sustainable fisheries management

Sustainable fisheries management in Canada is widely endorsed by government legislation, policy and international agreements. Essential requirements for sustainable fisheries management are laid out in some detail in an international agreement ratified by Canada (United Nations Fish Stocks Agreement or UNFSA, 1982). UNFSA requires that signatories adopt measures to ensure long-term sustainability of straddling fish stocks and highly migratory fish stocks and promote the objective of their optimum utilization. By

implication, the same measures should be adopted for non-straddling stocks through domestic fisheries management plans. Such measures are required to be based on the best scientific evidence available and should be designed to maintain at, or restore stocks to, levels capable of producing maximum sustainable yield (MSY), as qualified by relevant environmental and economic factors. The Agreement also requires signatories to apply the Precautionary Approach (PA) and to maintain or restore populations to above levels at which their productivity may become seriously threatened. UNFSA states that the fishing mortality rate which generates maximum sustainable yield, F_{MSY}, is a minimum standard for limit reference points. For stocks which are not overfished, fishery management strategies need to ensure that fishing mortality does not exceed F_{MSY} and that biomass does not fall below a predefined threshold (B_{lim}). For overfished stocks, the biomass which would produce MSY, B_{msy}, constitutes a rebuilding target. The relationships between sustainable yield, biomass and fishing mortality are shown schematically in Fig. 1.

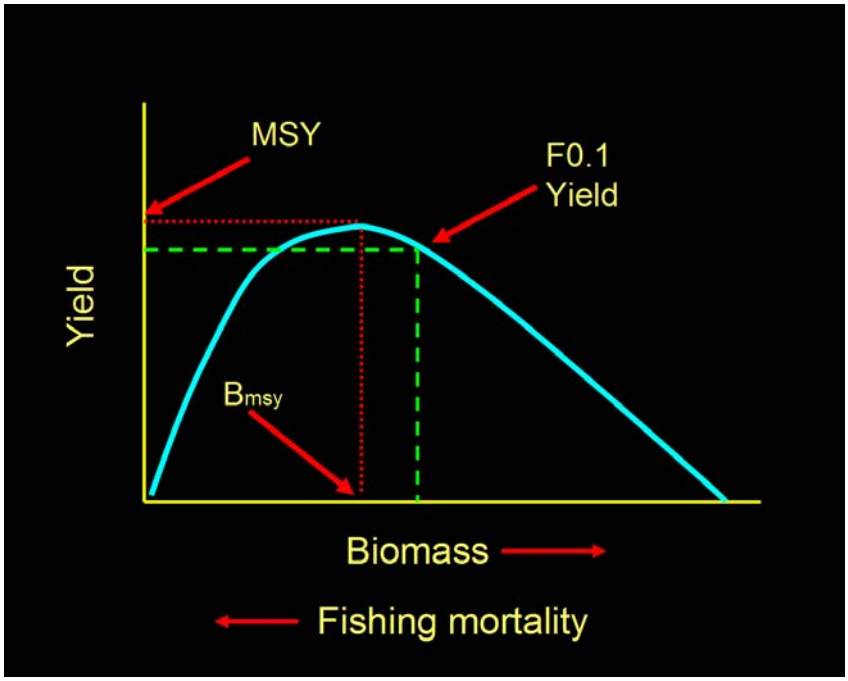

Fig. 1. Schematic showing relationship between sustainable yield, biomass and fishing mortality. MSY is the maximum sustainable yield and this occurs at a biomass denoted B_{msy} and a fishing mortality denoted F_{msy}. $F_{0.1}$ is a lower level of fishing mortality which results in a higher biomass through foregoing a small proportion of MSY. $F_{0.1}$ was widely implemented by Canada following extension of jurisdiction in 1977.

As suggested under UNFSA, sustainable fisheries management requires implementation of the Precautionary Approach (PA). Canada has developed a fisheries PA framework consistent with international sustainability standards (DFO 2006; Fig. 2).

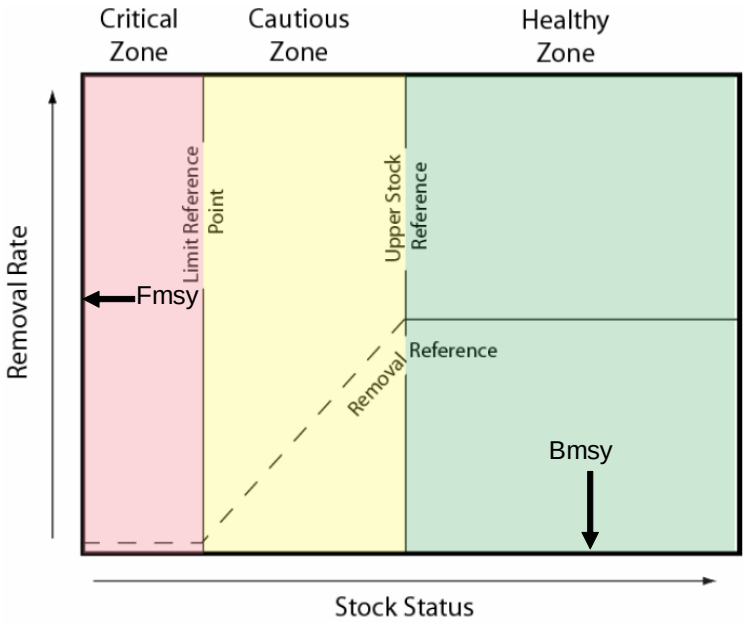

Fig. 2. Precautionary Approach framework developed for the management of Canadian fish stocks (DFO 2006).

To be compliant with the Precautionary Approach, and thereby meet basic sustainability criteria, fisheries management plans must have in place measures that keep fishing mortality below F_{msy} as well as harvest control rules that reduce fishing mortality should stock size decrease out of the healthy zone. The harvest control rules are aimed at returning the stock to the healthy zone within an acceptably short period of time, and ensuring low risk of the stock ever entering the Critical Zone. The PA framework defines specific roles for science: (i) determine biological reference points to demarcate the Critical, Cautious and Healthy Zones as well as B_{msy} and F_{msy}; (ii) assess the current status of the stock with respect to these reference points; (iii) evaluate the risk of alternative management options with respect the future status of the stock relative to the biological reference points; (iv) provide clear scientific advice to Government on

sustainable fisheries management options and associated risk consistent with the PA and sustainable fisheries.

Although Canada has endorsed sustainable fisheries management and the PA both nationally and abroad, routine implementation of PA-compliant fisheries management plans has lagged and, in general, Canadian fisheries cannot be considered to be sustainably managed. Why is this so? Sustainability may be difficult to achieve with regard to some invertebrate stocks, which can fluctuate widely as a result of environmental factors. In other cases there are inadequate data to determine the impact of a harvest on a stock. In such cases, scientific research to determine sustainable fishing levels is essential before further exploitation occurs. However, in the case of many stocks, including most groundfish stocks, sustainable fisheries management based on available scientific data is achievable now, if there were the will to do so.

Selective use of science

Assertions regarding the selective use of science and interference in the scientific advisory process surrounding the Atlantic cod stock collapses have been made a number of times in the published literature (e.g. Hutchings *et al*. 1997). Less well discussed are the events that followed. Expectations that cod would recover under the brief moratorium did not materialize and when income support to Atlantic fishermen dried up, limited fisheries were reopened on a number of stocks even though DFO scientific data showed that only one of these had demonstrated significant recovery. This created a situation where the decision to re-open the fisheries was at logger-heads with scientific

data related to government policy on sustainable fisheries. As a consequence, considerable pressure has been brought to bear on DFO Science over this period.

It could be argued that the decision to reopen fisheries was justified on socio-economic grounds despite the lack of any scientific evidence of recovery. Rural fishing communities in Atlantic Canada face very serious hardship and a small cod quota might make all the difference in terms of survival of local economies. Rather than dealing with these very difficult decisions head-on, there has been a tendency to second-guess the scientific advice and downplay the reliability and usefulness of stock assessments, while giving equal or greater weight to more optimistic anecdotal information provided by the fishing industry. There was a remarkable reversal of this pattern in 2003 when fisheries on northern and southern Gulf of St Lawrence cod, as well as northern cod, were placed back under moratorium on the basis that these stocks were "*below the levels where the harm is serious and it may be very hard to reverse this trend*" and that "*that rebuilding is a long process but we must begin now*". This specific wording by the Minister of the day is so consistent with concept of the Precautionary Approach that it was widely interpreted by DFO Science to mean that Canada had finally commenced implementation of the PA on domestic fish stocks. This would imply that we would now move forward on a path of science-based sustainable fisheries management within a structured decision-making framework. However, in 2004, despite no significant change in the status of the stocks as the result of a one year closure, the fisheries reopened. It was clear that *ad hoc* fisheries management was here to stay for the time being. Peer-reviewed published research results by DFO scientists have substantiated stock assessment results, demonstrating that

ongoing cod fisheries are removing all, or nearly all, the surplus production and that recovery will not occur under these conditions (Shelton *et al*. 2006).

It is unrealistic to expect that important decisions such as management of Canadian fisheries will be governed solely by scientific advice, even when this advice is consistent with stated Government policy, such as sustainable fisheries. However, it is reasonable to expect that scientific advice will be strongly supported by DFO management as the "best available scientific information", and effectively presented to the Minister, the media and public as such. The Minister has complete discretionary powers with respect to fisheries management decisions, however public support for decisions that are contrary to scientific advice on sustainable fisheries management may be stronger if the reasons can be explained in terms of the expected benefit to Canadians. This should be possible without resorting to denigrating the science or "*making the science invisible*" (Dr David Schindler, Evidence to the Standing Senate Committee on Fisheries and Oceans, May 11, 2004). In those situations where senior management feels that science is defective or inadequate in some way, SAGE (Science Advice for Government Effectiveness, 1999) prescribes a number of steps that can be followed.

Bureaucratization of science

The bureaucratization of science threatens the autonomy of science, its tradition, and the conduct of scientific research. Gradually, it takes away the freedom of the scientist and puts him in the hands of appointed administrators who are often strangers to science, ex officio bureaucrats who care more about appearance and public relations

than essence and who often lack the necessary training, understanding, and commitment to lead the institutions where science conducts its functions. The detachment of many "managers" of scientific institutions from science and from the practicing scientists and their constant and almost total preoccupation with the "customers," … leaves no time for them to think about what the institution is all about; whatever little is left of their time, they often use to talk amongst themselves. This engenders serious threats to the proper advancement of Science (Christophorou, 2001).

Bureaucratization of fisheries science in Canada has been gradual but incipient. The Fisheries Research Board of Canada (FRB), predecessor to DFO, was based on the belief that science should be run by scientists operating at arms length from government (Preface by J.R. Weir in Ricker 1975). A number of top scientists were hired under FRB to form world-class research teams. Examples include the Experimental Lakes Area (ELA) project in northwestern Ontario and the Marine Ecology Laboratory (MEL) in Dartmouth, Nova Scotia, both initiated in 1968. Scientists in these two labs were preeminent in their fields, authoring major research papers which would become citation classics, and substantial books that would define their fields for many years. However, FRB was considered an "administrative anomaly" (The Canadian Encyclopedia, online addition) and was dissolved by an Act of Parliament in 1979 "because of problems with the co-ordination of research and a lack of responsiveness of the board to the needs of fisheries management" (Dr W.G. Doubleday, Testimony to the Standing Committee on Fisheries and Oceans, November 6, 1997). Fisheries research was consolidated into the Department of Fisheries and Oceans and brought under standard government line

management control. For a while, eminent scientists hired under FRB continued in leadership roles in the ELA and MEL programs. However, conditions in DFO purportedly forced the highly respected scientific leader of the ELA project, Dr David Schindler, to resign in 1989. Zagorski (2006) records that reasons included bureaucratic pressure and interference in the interpretation of scientific data, and progressive reduction in program support. In testimony to the Standing Senate Committee on Fisheries and Oceans (May 11, 2004), Dr Schindler stated that when he joined FRB, all of the directors were professional scientists and that most of them were eminent people. They directly vetted research proposals and decided what research was done. He noted that now it is very seldom that you see a reputable scientist above the level of project leader. Instead scientists are told what to do by multiple layers of bureaucrats with little or no research experience. He suggested that to improve conditions in DFO, the many layers of bureaucrats should be replaced with a few layers of people that respected scientists and who understood the problems with which they were dealing, rather than the current middle manager bureaucrats who do not understand critical issues and are primarily concerned with protecting the minister from criticism.

Similarly, two highly eminent scientific leaders of MEL (Dr Alan Longhurst and Dr Ken Mann) were told in 1985 that their services were no longer required in leadership positions, and they returned to being bench scientists with little further role in science management within DFO. MEL was dissolved in 1987. Despite the tremendous productivity of this group, it would appear that as a research lab within DFO being managed by leading scientists enjoying a fair degree of independence, it was an org. chart

relic from FRB days, inconsistent with the emerging line-management model for doing science.

In some ways, research scientists in government departments and agencies may themselves be org. chart anomalies under the current bureaucratization trend. Their incumbent-based designation, pay scale, and freedom from "other duties as assigned" do not fit well with a shortest-to-tallest ordering within government departments. Their strong allegiance to the principles of the scientific method, specifically independent objective interpretation of data, creates problems when data are at odds with policy, and interferes with them being good "team-players". Other "science delivery models" exist which are not centered on PhD level researchers, and there is some indication that this is the direction in which government is headed (e.g. Oceans sector in DFO).

De-professionalism of science

In his authoritative review, Trecarten (2001) states that de-emphasis of program-dedicated professionalism and the de-valuing of knowledge, skill and experience began in the Canadian civil service in the late seventies and early eighties. At the management level this translated into more value being placed on a diversity of managerial experience rather than in-depth program-specific knowledge. Senior professionals in government, including scientists, were forced to convert to management category positions where work performance was assessed on the basis of managerial skills with less priority given to the professional content of their positions. Trecarten states "*What these entrants to the new category perceived was the notion that a three week attendance at Touraine or*

equivalent was as important or more important than the Ph.D. followed by their 10-15 years of intense knowledge development through professional seminars and on the job experience. The result - disassociation from their former profession and a perceived devaluation of the program expertise". He further notes that "*many of these programs, both in departments and at the central agencies, have faltered because of lack of understanding and support at the senior levels. In turn, subordinates come to see that what is important is not original problem solving but rather supporting the aspirations of the more senior official (who is incapable of understanding the more complex factors in the program content)*".

Trecarten considers that decades of downsizing have also had a major impact on the professionalism of the civil service. Science laboratories in government have been severely cut in many cases, resulting in specialists having to be recast as generalists, thereby de-valuing specialist knowledge and resulting in a lower level of expertise within the civil service. He notes that the Universal Classification System, had it been implemented, would have further devalued knowledge-based specialists within the civil service. He cites de-professionalism as having an impact on staff morale and the loss of highly qualified personnel. It may also be impacting the ability to hire top professionals. DFO was considered an employer of first choice by many young PhD graduates out of top Canadian universities such as McGill, UBC, Toronto and Dalhousie in the late 1970s and early 1980s. It is not clear that this is still the case.

Commercialization of science

The Dr Arthur Carty model of entrepreneurial science has been widely credited with reinvigorating NRC and transforming the way universities in Canada do business. It has also impacted the way science is done in government departments. Following major program cuts to government science in 1995 as part of Program Review, and a sequence of further cuts since then, DFO and other government departments and agencies have had to increasingly rely on external funding, partnerships, joint ventures and cost-sharing with industry, universities and stakeholders to maintain research programs. These have largely been viewed as positive steps by DFO science managers, in keeping with the general entrepreneurial model for science in Canada. But commercialization of research can have downsides that may not be consistent with the objectives of government departments and agencies. Government science can be considered to be pre-paid by taxpayers with the expectation that it will give a return in terms of better informed decisions leading to long term public good. Treasury Board allocates funding commensurate with the perceived public need for this service. Without additional revenue generation, the amount of science conducted in government would have to be tailored to this allocation. This may not be a bad thing. It would encourage science to focus on public good to a greater extent. All additional sources of funding come with some price, such as addressing objectives of specific client groups which may not reflect general public good, or compromising the perceived independence of the scientific data. Management of external funding frequently falls directly on the responsible scientist in the form of NSERC applications, joint-venture agreements, drawing up of contracts, writing progress reports etc. Generally the associated time horizons are short – 1 to 3

years, with the result that priority is shifted to short-term solutions to specific problems faced by clients rather than longer-term public good. Products paid for by clients may not subsequently be available to the general public. Management of science becomes problematic. No longer do mangers have to concern themselves only with the funds they control. Government researchers are now answerable directly to external clients and mangers struggle to assign priorities and evaluate performance. This has led to a breakdown in research project inventories in some regional laboratories of DFO. Without some knowledge of the individual scientific projects underway, it is not possible to effectively manage a scientific program in terms of public good. Government is also increasingly competing directly with private enterprise. If industry wants R&D to improve their profitability, be it in terms of an alternative stock assessment or information on how to improve aquaculture practices, it seems reasonable that it could seek out private enterprise to provide this service. The fact that government may be able to undercut private enterprise in the commercial science business is because some of the overhead is covered free of charge out of general revenue by taxpayers. In some cases additional funding has been generated directly by the misappropriation of public property itself, such as the sale of fish to pay for research. The Federal Court of Appeal recently ruled (in Larocque vs. the Queen, July 2006) that "*the Minister financed his scientific research program without first appropriating the funds necessary and by misappropriating, for all intents and purposes, resources that do not belong to him. He confused public funds and the public domain. Without appropriating public funds he appropriated public domain*." In support of the ruling, the Court stated the principle that

"*voted sums authorised by Parliament cannot be exceeded. Departments cannot exceed the sums authorised in the annual Appropriation Act without Parliamentary authority*."

Impacts and remedial action

The effects of selective use, bureaucratization, de-professionalism, and commercialization of government science have combined to weaken its public profile and make it more susceptible to cuts. At times, the only outspoken defenders of a strong and independent research capability within government departments and agencies funded with public money appears to be scientists themselves – both in government and academia. This could be dismissed as self-serving. Government itself gets quietly on with the job of accommodating budget cuts by downgrading, downsizing and dismantling in-house research capacity. The Professional Institute seems largely oblivious. The public appear to concur that government science is suspect, of low quality and not cost-effective, and offers little protest.

The following examples may serve to illustrate the increased vulnerability of government science programs in important policy areas such as atmospheric research - climate change and sustainable fisheries. In September 2004 DFO organized a Science Review Workshop at Gray Rocks, Quebec to mark the completion of the Departmental "Assessment and Alignment Project" (DAAP). The invited address was given by the ADM of Environment Canada - Meteorological Service of Canada. The title was "Re-inventing the Business – The MSC's Experience". The ADM explained that in order to meet budget reductions a "*modernization*" plan was put in place which included

"*increased outreach capacity, introduction of product and service enhancements and innovation, invigoration of the MSC's monitoring capacity, and restoring and developing the MSC's key skill sets*". The ADM reported that "*Year 1 of transition just passed and we are on course*". In stark contrast, in June 2004, just three months prior, 21 leading MSC and university atmospheric scientists from across Canada released a report entitled "Beyond the Breaking Point?" The report detailed the devastating effect of budget cuts to atmospheric and climate research in Canada, including the closure of the Eureka observatory in the High Arctic (subsequently restored by temporary funding from a university consortium), cuts to data collection networks, increasingly frustrating research environment, departure of top MSC scientists, and the general downgrading of MSC research capabilities. The authors suggest that the funding cuts may have been made in the belief that government does not need to be in the business of doing research. They stressed that MSC is (or was?) the backbone for virtually all major long-term atmospheric and climate research in Canada. In a media interview following the release of the report, one of the authors (Dr Miriam Diamond, Professor of Geography, University of Toronto) is quoted as saying: "*it's critical for the Canadian population to understand that federal funds spent on science are not wasted. We've been led to believe that the civil service is a waste of money. In fact, government science is extremely cost-effective and efficient. As Canadians we see great return on investment for money that goes into government science*."

In terms of sustainable fisheries, DFO has suggested that major cuts will be introduced to "refocus" stock assessment science. Planned budget reductions over the

period 2006-2007 are $1.2M per year, ramping up to $6.0M annually by 2009-2010, totaling a reduction of up to 75 FTEs by year five (Science Sector Union-Management Consultation Committee Meeting, Fisheries and Oceans Canada, April 28, 2005, public domain). To achieve this refocused program, it is planned that the frequency of stock assessments by DFO will be reduced and the role of government will gradually change. Instead of doing the research and managing the fishery, DFO will assist the fishing industry and First Nations in building their own capacity to take on more of the monitoring and assessment of fish stocks and to play a greater role in management through "shared-stewardship". It is expected that Government will continue to provide an audit, quality control and monitoring function. This function can be accommodated largely without the need to employ PhD level research staff.

Atmospheric and climate change research and research on sustainable fisheries can be argued to be very much in the interests of long-term public good. They are also key government policy areas. If these programs are vulnerable to "modernization" and "refocusing" then it seems likely that most other government research programs are also in jeopardy. If the overarching plan is for government to get out of the business of in-house research and retain only an audit, quality control and monitoring function, then one can let the program cuts and the current demographically driven attrition take their course and the objective will be achieved within a decade. If, however, government wants to retain a top PhD level research capacity in areas of core public good, then a number of remedial steps can be considered:

(i) de-layer science management, create a direct link between lead researchers and decision-makers, and re-establish a culture in which research teams are led by respected and successful scientists;

(ii) publicly support research results and scientific advice – don't bury or discredit the scientific data in the process of taking a decision that may be deemed necessary for some reason, but is not supported by science;

(iii) establish core areas of research that meet the public good criterion and leave R&D-type research, that addresses only the needs of specific client groups, to private enterprise;

(iv) attempt to re-establish public trust and support for government research in core areas of public good, such as climate change and sustainable fisheries, by demonstrating a long-term commitment, independence from special interest groups and cost-effectiveness of government science programs.

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