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Stories From the Front Lines

Tensions in the communication of science advice on fish and fisheries: northern cod, species at risk, sustainable seafood

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Providing science-based advice can be challenging. Personal in its reflections, the story that follows asks throughout: What constitutes an appropriate model for the communication of science-based advice that best serves society? The first "front line," in 1992, involved tenuous hypotheses on the collapse and recovery of Newfoundland's Northern cod (*Gadus morhua*), raising troubling questions about political influence on science-based advice and on its integrity. These questions subsequently motivated a critique written with two colleagues on the communication of science to decision-makers, provoking a telling invective from a government department in defence of the status quo. The story transitions to my 2000–2012 tenure as a member and then as chair of Canada's national body advising which species should be on the legally binding national at-risk register, illustrating how politically sensitive science-based advice can be objectively, effectively, and independently communicated, unfiltered by vested interests. Since 2009, I have served as independent science advisor on the sourcing of sustainable seafood to Canada's largest food retailer, providing a meaningful, impactful opportunity to advise their decision-makers. Science-based advice, free from political and advocacy-driven vested interests, is a requisite return for tax-supported investments in science. If provision of such advice is a "moral imperative," as argued more than 60 years ago by C.P. Snow, then scientists are obliged to be the best advisors that we can be.

Prelude

> "Nothing is so boundless as the sea, nothing so patient. It is not true that the sea is faithless, for it has never promised anything; without claim, without obligation, free, pure, and genuine beats the mighty heart, the last sound one in an ailing world. Many understand it scarce at all, but never two understand it in the same manner, for the sea has a distinct word for each one that sets himself face to face with it (Alexander Kielland, 1885).

Alexander Kielland, one of Norway's best-known writers of the 19th century, could certainly write a story. So can scientists. Each research paper is, in effect, a story. Of course, the stories we write are far removed from the stories we live. The former are planned enterprises (or contrived to appear so). The latter would constitute a research nightmare, inevitably involving unplanned turning (or tipping) points that come upon us unexpectedly, sometimes serendipitously, not always comfortably.

Stories—written by novelists or scientists—have potential to motivate, entertain, inform, engage, enrage, enlighten. The most thought-provoking offer alternative, compelling perspectives on topics that we thought we knew well. Individual responses to stories inevitably differ because our life histories have molded different value systems—intellectual and emotional beacons that guide our interpretation of events and their significance. Kielland makes

this point with respect to the sea which "has a distinct word" for each individual who sets themself before it; as with the sea, a story is there for the interpretation of all "but never two understand it in the same manner" (Kielland, 1885: 1).

This will almost certainly be true of the personal and professional reflections related in the story that follows. It ultimately concerns the provision of science-based advice (hereafter, "science advice") and how communication of that advice can be influenced by non-science factors. Although based on the experiences of a single individual, the story raises questions that are general in scope: What constitutes an appropriate model for the communication of science advice that best serves society? What are the personal and institutional costs of having political and other vested interests supersede, or be perceived to supersede, scientific integrity? Are there attributes of science advice that supplant some forms of science-based advocacy?

Following a brief prelude, the story begins with my initial appreciation of the extent to which politics and other vested interests can shape the communication and interpretation of science. The year was 1992. Scientifically tenuous hypotheses regarding the collapse and recovery of Newfoundland's Northern cod (*Gadus morhua*) appeared to be fuelling narratives that dampened institutional enthusiasm for research on overfishing. Five years later, these and other machinations motivated a critique written with two colleagues on the communication of fish and fisheries science advice in Canada. Our primary conclusion was that the conservation of natural resources is not always facilitated by science that is fully integrated within a politically led institution. This somewhat unremarkable conclusion provoked an institutional invective in defence of the status quo, ensuring my exclusion from science-advisory initiatives related to Canadian fisheries for many years.

The story transitions to Canada's national, politically independent committee responsible for advising government ministers on legal listings of species at risk. During my 2000–2012 tenure as member (eventually chair) of this committee, I discovered how even the most politically sensitive advice on a particular topic can be effectively and independently communicated to government, unfiltered by vested interests. After a decade of providing such advice as part of a large group, I was persuaded to serve as the independent science advisor on sourcing sustainable seafood to Canada's largest food retailer. This was a unique opportunity in many respects, not least of which was the remarkably short time that elapsed between receipt of advice and action based on that advice.

Some will disagree with aspects of the story, perhaps quite strongly, particularly of events that took place decades ago. However, my purpose is not to offer a comprehensive, retrospective analysis of what might have motivated past decisions by individuals or groups of individuals, be they government bureaucrats or species-at-risk advocates. Rather, the intent is to capture and contextualize—while being at one of three "front lines" (fishery collapse, species-at-risk assessment, sourcing of sustainable seafood)—contemporary personal reflections of experiences and incidents that served to shape my thinking about how science is communicated to decision-makers and to society. Perhaps this story will serve as a template for others to reflect on the ongoing challenges of providing science advice that is free from real and perceived vested interests, honest and objective about facts and the weight of evidence, clear about what is known and what is not known, and faithful to the peer-reviewed literature about what is relatively certain and what is highly uncertain.

Of fruit flies and cod

> "Males were prevented from mating by ablation of their external genitalia, using a microcautery procedure" (Chapman, Hutchings, and Partridge, 1993).

When the postdoctoral part of my career began in January 1991, my research interests were not focused on fisheries sustainability or fish stock collapse. I was interested in understanding and testing life-history theory. For example, how does the effort that an organism expends on reproduction affect its future survival? No one had empirically described the relationship between reproductive effort and reproductive costs. I thought I had done so, working on brook trout (*Salvelinus fontinalis*) in Newfoundland in the late 1980s, until my doctoral opponent, Graham Bell, adeptly deconstructed my logic during my thesis defence.

If trout were not ideal candidates for examining relationships between effort and costs, maybe fruit flies were. Supported by a Canadian postdoctoral fellowship, I allocated two years at the University of Edinburgh, under the tutelage of Linda Partridge, to find out. One experiment required that I sit before a dissecting microscope, position a two-pronged electrode on either side of a male fruit fly's genitalia, and burn them to produce flies that were "wild type" in every way except for the functional soundness of their genitals (maybe not so wild after all).

It was while I was castrating males (for reasons detailed by Chapman *et al.*, 1993) that the federal minister of Canada's Department of Fisheries and Oceans (DFO) shut down the fishery for Northern cod off southeastern Labrador and northeastern Newfoundland. The fishery was closed on 2 July 1992 because of a massive decline in the cod population—as much as 95%—since the early 1960s. The social and economic upheavals that ensued were staggering: 30 000 to 40 000 jobs (∼10% of the working population) vanished overnight.

The moratorium had been in place for four months when I returned to Newfoundland in November 1992, having been offered short-term work at DFO's Newfoundland Region in St. John's, facilitated by my colleague of 10 years, Ransom (Ram) Myers. Tasked with analysing large data sets to explore spatio-temporal patterns in cod reproduction and life history, I was being offered my first formal opportunity to study the species that had culturally and economically anchored the paternal side of my family since the mid-1700s.

The portrayal of "science" as science

> "A two-year moratorium offers the only chance for the spawning biomass to recover quickly to its long-term average, permitting resumption of the inshore fishery in the spring of 1994" (DFO, 1992).

DFO was created in 1979, shortly after Canada (along with many countries) had extended its fisheries jurisdiction to 200 nautical miles. Interviews with DFO personnel familiar with this period, undertaken by sociologist Chris Finlayson (1994), reflect an environment of confidence and enthusiasm: "Very specific benefits were promised which, in turn, created very specific expectations…In short, the state, DFO, and many individuals in these institutional structures had a substantial investment in the idea that the [cod] stocks would respond in predictable (and predicted) ways to science-based management strategies and practices" (Finlayson, 1994: 26). This sense of confidence may have contributed to a willing optimism that Canadian fisheries management measures would

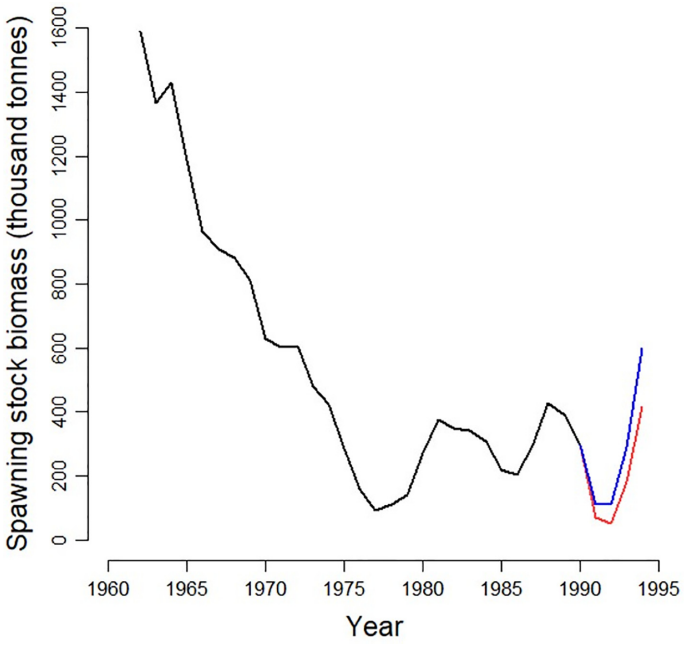

Figure 1. Spawning stock biomass (thousands of tonnes) of Northern cod, estimated in 1992, and predicted trajectories (blue and red lines). Re-drawn from DFO (1992).

be sufficiently robust and effective at restraining fishing mortality to a greater extent than proved to be the case.

The optimism inferred by Finlayson (1994) dissipated when previously unthinkable action—closure of the 500-year-old fishery—was necessary to allow the stock to rebuild. The 1992 moratorium announcement included the prediction that two years would provide sufficient time for recovery, permitting resumption of the coastal, inshore component of the fishery. According to a graph in the fisheries minister's press release (reproduced here as Figure 1), stock biomass would increase approximately 10-fold by 1994, attaining levels not seen since the early 1970s. If this predicted recovery had been realized (it was not; as of 2022, the biomass had not increased above its limit reference point), it would have reflected a remarkable per capita rate of population growth for fishes with the late-maturing, large-body-sized life history of Northern cod. From a science perspective, something seemed amiss.

Scott Campbell, head of DFO's Northern Cod Science Programme, provided insight as to how the prediction came about (personal communication, 27 May 1997). Prior to the moratorium announcement, DFO (Ottawa) had requested model output from Northern cod stock-assessment scientists in DFO's Newfoundland Region. The output was analysed by two individuals familiar with assessment modelling. Shortly thereafter, a meeting was held in Ottawa that included Campbell (acting for DFO's Regional Director of Science, Newfoundland Region) and representatives of DFO's Assistant Deputy Minister (Science), Fisheries Research Branch (Ottawa), and Gadoids Division (DFO Newfoundland Region). The projections were highly criticized, having been made in the absence of any form of peer review or consultation with the Newfoundland Region. The meeting attendees were informed that it was too late to change the predictions because the minister already had the graph in his briefing material.

There are troubling elements associated with the institutional constraint—the housing of fisheries science within a government-controlled entity—that rendered this communication of science-based information vulnerable to politically motivated priorities. Some might argue that the scientifically questionable two-year time frame was necessary to secure social-assistance payments for displaced fishery workers; government ministers needed to be convinced that such funding would not be required for a longer period. In other words, the "ends" (funding) justified the "means" (public deception). However, the erosion of scientific integrity to accede to political objectives is unlikely to come without personal and institutional costs to scientific credibility and societal trust.

Throwing cold water on culpability?

> "A devastating decline in the stock of northern cod off the east coast of Newfoundland and Labrador [has occurred], due primarily to ecological factors" (DFO, 1992).

In the aftermath of the moratorium announcement, there was palpable reluctance by government spokespersons to communicate the possibilities that Northern cod had been over-exploited, that fishing effort could not be controlled as effectively as once thought, or that catch quotas had inadequately reflected science advice and its uncertainties. During this period, some DFO scientists in Newfoundland were concerned that, "Scientific information [within DFO] is increasingly used as information of convenience" (DFO, 1993). (Harris (1998) provides a contemporary perspective on these and other matters related to the collapse of Northern cod).

The stage for a subservient causal role of overfishing was initially set with the claim that the collapse of Northern cod was "due primarily to ecological factors" (DFO, 1992). The minister's press release cited support from the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC; disbanded in 1992), a group comprised of DFO scientists whose subcommittee reports (which formed the core of the scientific analyses) were not available to the public and were not subjected to external peer review. Despite an absence of quantitative analysis (acknowledged by CAFSAC itself),

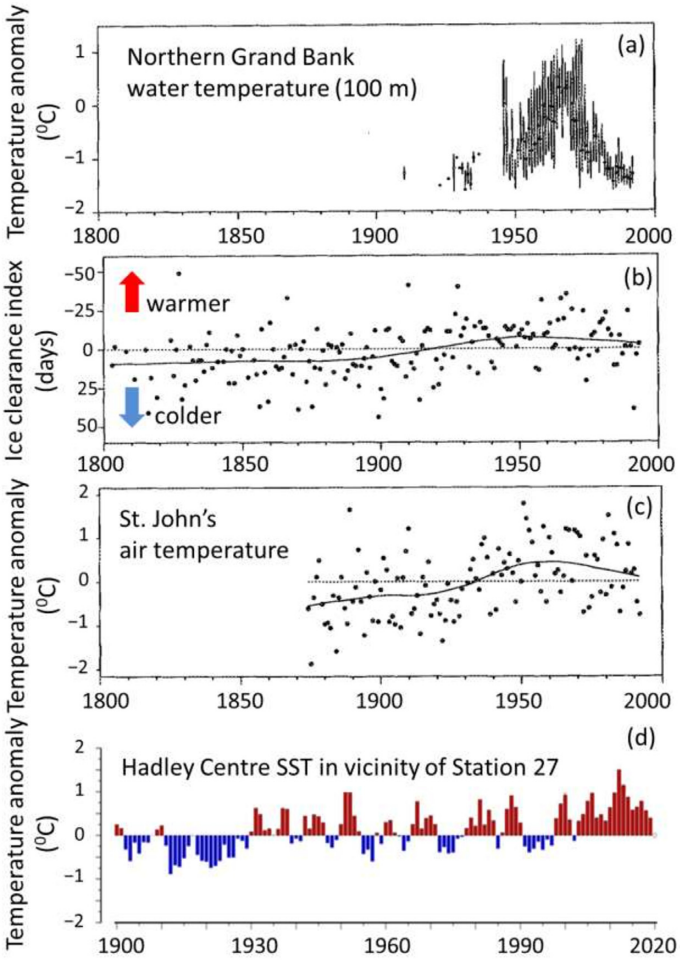

Figure 2. Historical trends in four metrics of water temperature in waters inhabited by Northern cod: (a) temperatures at 100 m on the northern Grand Bank (Northwest Atlantic Division 3L) are represented by the median with the upper and lower quartiles indicated by the vertical lines above and below each median, respectively (source: Marine Environment Data Section database, Ottawa, Canada); (b) ice clearance index represents the departure in days from the 1964–1984 median clearing date at Hopedale, Labrador (source: Newell, 1990); (c) air temperature anomalies from the long-term mean (1874–1992) recorded by the Canadian Atmospheric and Environment Service at St. John's, NL; and (d) sea surface temperatures (SST) of waters around oceanographic Station 27 (located five nautical miles east of St. John's, NL), as reported by the Hadley Centre (source: https://www.st.nmfs.noaa.gov/copepod/time-series/ca-50601/). Full details associated with all but the Hadley Centre estimates are available in Hutchings and Myers (1994a).

CAFSAC was reported to have concluded that the collapse could be attributed to an "increase in mortality…consistent with extreme environmental conditions in 1991. These include cold winter temperatures…, greater than normal ice coverage and low ocean temperatures. *The influence of these conditions has not been quantified* [*italics* added], but cod are known to have been killed by cold water in the past" (DFO, 1992).

The hypothesis of unusually cold water (let alone a causal link with cod survival) was not empirically strong. If one conducted an analysis limited in temporal and vertical (depth) scope, mean sea-surface temperatures (SSTs) recorded at an oceanographic station off St. John's (Station 27) in 1991 did appear to be unusually cold when compared to SSTs extending back to the mid 1940s. But if one compared mean temperatures at the same station at greater depths (from 50 m to the near-bottom at 175 m), the 1991 anomaly disappeared (Hutchings and Myers, 1994a). The purported anomaly also vanished if one applied a longer temporal lens. Multiple sources indicate that Northern cod experienced colder temperatures, for longer periods of time, from the mid 19th century to the early 20th century, apparently without having profoundly negative impacts on catches or stock size (Figure 2) (Hutchings and Myers, 1994a; Schijns *et al.*, 2021).

The focus on cold water, and purported correlates thereof, had the effect of diverting attention from the influence that small population size *per se* can have on probability of collapse and potential for recovery (for recent examples, see Perälä and Kuparinen, 2017; Neuenhoff *et al.*, 2019; Perälä *et al.*, 2022). One thing that was assuredly different in 1991 is that colder surface temperatures were experienced by a stock far smaller in size than it had been historically (Baird *et al.*, 1991; Bishop *et al.*, 1993; Schijns *et al.*, 2021). All else being equal, small populations are more susceptible to environmental change (including temperature, food supply, interspecific interactions) than large populations (Harrison, 1979; Lande, 1988, 1993). Greater susceptibility to stochastic environmental change can also result in increased variability in mortality when populations are small (Hutchings and Myers, 1993, 1994a; Minto *et al.*,

2008). And the greater the magnitude of population reduction, the longer and more uncertain the rebuilding period (Hutchings, 2000; Neubauer *et al.,* 2013). Thus, declining population size and high fishing mortality (Bishop *et al.*, 1993), coupled with potential distributional population shifts (deYoung and Rose, 1993), may have amplified any effects of colder water and other naturally occurring environmental variability on the productivity of Northern cod (Hutchings and Myers, 1994a; Shelton and Healey, 1999; Rose *et al.*, 2000).

An alternative narrative: overfishing

> "Management is fostering an attitude of scientific deception, misinformation and obfuscation in presenting and defending the science that the Department undertakes and the results it achieves" (DFO, 1993).

Having been implicated in fishery collapses in the past, one might have thought that overfishing would have been first and foremost among putative causes for the decline of Northern cod. But in the wake of the moratorium announcement, influenced perhaps by the cold-water narrative being espoused at the time, surprisingly little sanctioned research effort and funding was allocated to examining this possibility. DFO's flagship initiative at the time—the Northern Cod Science Programme (NCSP)—supported studies on: (i) cod reproduction, growth, migration, distribution, and diet; (ii) abundance, movements, and diet of seals; (iii) physical oceanography; and (iv) hydroacoustic and survey gear technology (Campbell, 1997). Of 26 papers published by the Canadian Journal of Fisheries and Aquatic Sciences (CJFAS) in a special supplement to highlight research by the NCSP and a DFO/industry-funded initiative called OPEN (Ocean Production Enhancement Network), only one dealt with fishing mortality (Myers *et al.*, 1997).

Now in the midst of a second postdoctoral award (*Visiting Fellowship in Canadian Government Laboratories Programme*), and after completing my assigned work on cod maturity (Hutchings and Myers, 1993) and spawning (Hutchings *et al.,* 1993; Hutchings and Myers, 1994b), I was motivated to work on something that had direct societal application. There seemed to be room for an analysis that would explore hypotheses that had been proposed to explain the collapse of Northern cod.

However, what I perceived in early 1993 to be a logical step in the process of rigorous scientific enquiry was apparently perceived by others to be a criticism of Northern cod stock assessment scientists. Not being a stock-assessment practitioner, a DFO employee, or someone with a science link to Northern cod prior to the collapse, I was an outsider. As noted by sociologists for some time (discussed within the context of Northern cod by Finlayson, 1994), people who regularly work together on similar topics and meet frequently tend to be far more receptive of the views of colleagues within their group than they are of those not part of the group. These group-level dynamics, coupled with the research priorities suggested by the cold-water narrative, may have contributed to a lack of enthusiasm for research that drew the unsurprising conclusion that the collapse of Northern cod could be attributed primarily to overfishing.

One illustrative example of this lack of enthusiasm emerged from collaborative work I undertook, beginning in late 1994, with DFO scientists Alan Sinclair and Ram Myers. We concluded that there was little support for the hypothesis that the collapse had been triggered by seal predation. The work was submitted to, and accepted by, ICES (International Council for the Exploration of the Sea) for inclusion in their meeting in Halifax in September 1995 on seal-fishery interactions. However, one week before the meeting, Sinclair was informed that he (as the study's lead author) would not be permitted to present the work because of misgivings that a Director General (DG) had with the working paper's conclusions. We countered that the primary purpose of the meeting was to present, discuss, and receive feedback on work in progress. The DG's final decision was that Sinclair could orally present the work, but that paper copies could not be distributed (as was normally done; the meeting pre-dated the electronic availability of pdf files). This thinly veiled attempt to influence the communication of science became well known among conference participants, generating greater interest in our work than might otherwise have been the case.

Communication of advice generated by science within government

> "I recently came across an article written by a Norwegian scientist during the 1970s, when I was Norway's Minister of the Environment. In the article, he argued that there was no such problem as acid rain and that "facts" and "science" did not belong in the arena of politics and policy. This assertion was counter to my own beliefs and made me react strongly" (Gro Harlem Brundtland (thrice elected as prime minister of Norway), 1997).

> "Politics should not move down the system below the Deputy Minister level. However, it is happening and…it will continue and worsen" (DFO, 1993).

As time progressed and tensions built, it was increasingly evident to me that science housed within a government-controlled entity can be subjected to influences that have little or nothing to do with science. In a government department, such as DFO, the greater the perceived political sensitivities associated with an area of research, or the science advice that might emerge from that research, the greater the potential for non-science influences to interfere with the communication of science. I was not alone in raising this issue, as reflected by multiple criticisms expressed by DFO scientists in an internal report in 1993 (DFO, 1993), although I was unaware of their concerns at the time.

My postdoctoral career at DFO ended in January 1995 when I was appointed to a tenure-track position at Dalhousie University. Although the new position allowed me to leave DFO, DFO did not entirely leave me. In October 1995, I was privileged with the opportunity to deliver the 1996 J.C. Stevenson Memorial Lecture at the 49th annual Canadian Conference For Fisheries Research. DFO (Ottawa), upon learning that I was to receive the award, but not knowing the content of my presentation, made the extraordinary request that DFO be permitted to present a rebuttal immediately after my award lecture (published as Hutchings, 1996). The request was denied. Nonetheless, DFO arranged to have regional science directors in Montreal for the purpose of attending my talk, along with the aforementioned DG and other bureaucrats from Ottawa. It was never clear what the purpose of this show of solidarity was, other than to sit together in a visually prominent position in the audience.

At the same conference, I introduced myself to David Cook, Editor of CJFAS. I handed him the draft of a manuscript entitled "Is scientific inquiry incompatible with government information control?," asking if it was the sort of topic that CJFAS might consider for publication. He later replied in the affirmative. Focussing on work specific to Atlantic cod and Pacific salmon (*Oncorhynchus* spp.), the manuscript raised the question of whether the integration of

fisheries science within a government department was a model that best served society.

The manuscript was daunting to write for two primary reasons. First, most examples of direct or indirect interference did not leave a paper trail, resulting in few citable references and limiting the empirical depth of the manuscript's main arguments. Had I been aware of an internal Science Branch report from the Newfoundland Region (DFO, 1993), detailing a myriad of concerns by DFO scientists, it would have made my task easier. But I was not, perhaps because I was not a DFO employee. Secondly, being an early-career researcher lacking a permanent position, I questioned whether I had the resolve to face the wrath that was certain to ensue if the manuscript was published. Here, I benefitted from the mentorship of Steve Kerr, a retired DFO scientist working in the office next to mine at Dalhousie and a stalwart defender of the manuscript (his contribution to the topic [Kerr and Ryder, 1997] eventually appeared in the same journal issue). Steve regularly provided sound advice that firmed my resolve, including the sensible suggestion that I seek senior-career researchers as collaborators. Fisheries scientist Carl Walters and fish oceanographer Richard Haedrich graciously agreed to co-author the perspective (Hutchings *et al.,* 1997). I was also buoyed throughout the writing process by the tremendously able assistance of a DFO scientist who, by virtue of their position, was and must remain anonymous.

Days after publication, we were overwhelmed by support from former, contemporary, and retired DFO scientists (including former members of CAFSAC), the editor of CJFAS (Cook, 1997), university academics, members of parliament, and the general public (see also Spurgeon, 1997). Also overwhelming was criticism from the upper-most echelons of the department (Deputy Minister, Assistant Deputy Minister), including an indignant piece faxed to all Canadian media outlets on the afternoon of 24 June 1997. Entitled "DFO Issues Challenge", the three-page document contributed little to the discussion of independence in the communication of science advice:

> "Hutchings, Walters and Haedrich have chosen to use the Canadian Journal of Fisheries and Aquatic Sciences as a platform from which to launch an unprofessional and unsubstantiated attack upon DFO, its scientists and its managers… [They] are locked in a time warp, citing and distorting incidents from the 1980s to support their agenda.…Their article is not a scientific paper. It is science fiction. It is based on innuendo and misrepresentation which have no place in a scientific journal."

Defending the status quo, one did not need to be the sharpest knife in the drawer to recognize the well-honed attempt by a government bureaucracy to "change the channel" and distract the uninformed reader.

Our key but, in DFO's view, apparently controversial conclusion was that reorganization of the link between scientific research and the management of natural resources merited consideration and debate (Hutchings *et al.,* 1997). We suggested that both society and its decision-makers would benefit from science advice communicated from a politically independent organization. Canada once had such an entity, the Fisheries Research Board of Canada (1937–1979). European countries in the North Atlantic realm benefit today from politically and bureaucratically independent stock-assessment analysis and other advice proffered by ICES. The Scientific and Statistical Committees of Regional Fishery Management Councils in the United States offer yet another alternative contemporary template for strengthening the independence of fisheries science advice in Canada (Winter and Hutchings, 2020).

At this stage of my career, I was acutely aware that opportunities for me to contribute to the provision of science advice within DFO's existing framework were nil. I turned instead to what I hoped would be a more meaningful science advisory experience.

Provision of independent advice within a legislative framework

> "Politics that disregard science and knowledge will not stand the test of time" (Brundtland, 1997).

The late 1990s coincided with Canadian legislative proposals for listing and recovering species at risk of extinction. Canada, the first industrialized country to ratify the Convention on Biological Diversity (CBD), passed the *Species at Risk Act* (SARA) in December 2002 (the act was implemented in June 2003), fulfilling a key obligation under the CBD. Under SARA, an independent science advisory body—the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)—was given responsibility for assessing species status and communicating advice regarding legal species listings to government. Notwithstanding some similarities with Australia's Threatened Species Scientific Committee, COSEWIC is unique in terms of mandated responsibilities, incorporation of Indigenous knowledge, breadth of expertise from within and without government, and legal consequences of its advice (Waples *et al*., 2013). There are more than 50 members of COSEWIC and more than 100 individuals serve on its species and Indigenous-knowledge subcommittees.

Prior to the passage of SARA, three positions on COSEWIC (founded in 1977; Shank, 1999; Hutchings and Festa-Bianchet, 2009a) had been assigned to Environmental Non-governmental Organizations (ENGOs). After SARA, these ENGO memberships, reflecting vested interests, were replaced by three "non-governmental science" positions. The Canadian Society of Zoologists nominated me to one of these positions in June 2000, my nomination was accepted, and I attended my first meeting of COSEWIC in November 2000, remaining a member until December 2012. (I also served on the inaugural Marine Fishes Species Specialist Subcommittee from 1999 to 2007. Other members of the Subcommittee in its early years included Richard Haedrich, Blair Holtby, Chris Foote, Lou Van Guelpen, David Methven, Doug Swain, and Robin Waples.)

COSEWIC possesses the aspirational hallmarks of an independent science advisory body. It is neither a government agency nor a conservation organization. It is a national advisory body whose independence is mandated by statute: "Each member of COSEWIC shall exercise his or her discretion in an independent manner" (SARA), meaning that votes on species status, and any other duties assigned to COSEWIC members, are not to be influenced by a member's affiliation. Thus, although COSEWIC is inclusive of government (jurisdictions are given representation), status assessments are made independently of government (the members are biologists who convey knowledge but do not represent their jurisdictions). It is COSEWIC's responsibility, not that of the government of the day, to prioritize which species are to be assessed.

Upon receipt of COSEWIC's annual listing advice (delivered simultaneously to the public, thus enhancing transparency), the federal department for the environment (Environment and Climate Change Canada or ECCC) and the federal cabinet are legally obliged to respond to COSEWIC's advice within mandated time frames. If COSEWIC's advice to list a species is accepted, this

triggers further timelines for government action regarding species protection and recovery.

Independent science bodies can lead the interpretation of policy and statute

> "In ocean management, as in most other areas of human endeavor, close cooperation between scientists and politicians is the only way to move forward. Science must underpin our policies" (Brundtland, 1997).

During my four-year term as chair (2006–2010), I was struck by COSEWIC's ability to wield influence in the interpretation of species-at-risk policy and statute. For example, under SARA the unit of assessment is a "wildlife species," defined as: "A species, subspecies, variety, or geographically or genetically distinct population of animal, plant, or other organism, other than a bacterium or virus." Thus, although SARA allowed for the assessment of units below the level of biological species, its definition of "variety, or geographically or genetically distinct population" offered no guidance as to what constituted a scientifically meaningful and operationally workable level of distinctiveness for assessment purposes.

The independence of COSEWIC allowed it to take on the task of defining these units in the absence of a government directive or approval to do so. As members of the 2005 working group charged with developing guidelines in this regard, my colleagues and I were able to apply our knowledge gained in the study of ecology, evolution, genetics, and conservation biology to help define what the assessment units should be. The working group, and eventually COSEWIC as a whole, interpreted SARA's definition of wildlife species as part of an intent to provide legal protection for irreplaceable units of biodiversity critical to the persistence of formally recognized biological species (COSEWIC, 2018a).

Another challenge facing COSEWIC was the assessment of species whose distribution or genetic make-up had been overtly manipulated by humans. Many fish populations, for example, are supplemented, for fishery or conservation purposes, by hatchery-reared fish. To what extent should these supplementations be considered in species assessments?

Once again, SARA was silent on how to proceed. Based on my communications with DFO, ECCC, and Parks Canada in late 2006, I sensed little enthusiasm for these government entities to jointly tackle the question of how to assess manipulated populations. However, as chair of COSEWIC, I was in a position to host a workshop on the topic. Attended by DFO, ECCC, and Parks Canada, all groups worked together to produce COSEWIC's inaugural *Guidelines for the Inclusion and Exclusion of Manipulated Populations in Species Status Assessments* (COSEWIC, 2018b). Also present were lawyers for ECCC and DFO, whose silent but observant participation was interpreted as a sign that these departments were treating the topic seriously. Indeed, the joint effort was a successful one.

Science advice and science-based advocacy

> "Advocacy reflects elements of personal value systems: social ideology, cultural tradition, employment experience, religious beliefs, education, and family upbringing. The personal value systems of scientists have no intrinsically greater merit than those of the decision-makers whom they advise or the citizenry who might be affected by the advice" (Hutchings and Stenseth, 2016).

When providing formal or informal expert advice, many would advise that personal views and opinions be set aside (CSTAS, 1999; Rice, 2011; RSC, 2015; Hutchings and Stenseth, 2016; Gluckman, 2020). Science advice should strive to be impartial, objective, independent of vested interests, and based on the peer-reviewed literature. Doing so increases confidence that the information provided is based on rigorous, evidence-based, arms-length assessments rather than on selective information provided by vested interests.

Advocacy reflects individual or group interests and does not always clearly distinguish peer-reviewed science from personal views or beliefs. Although the advocate might base their perspective on science, that perspective is influenced by how the information they provide might be used by decision-makers. Advocates selectively frame or shape information with the intention of favouring one policy or decision outcome over another. By intentionally shaping a personal or group message to decision-makers, science-based advocates render themselves no different from other vested interests, robbing their potentially expert information of the objectivity that decision-makers often value. For young scholars who wish to engage in advocacy, it would be prudent to be fully cognisant of the costs and benefits of doing so (Hutchings and Stenseth, 2016). Advocacy is not cost free.

Yet advocacy is very much part of the broad milieu that encompasses issues pertaining to species at risk. Although the focus of advocates in Canada (and, on occasion, in the U.S.) is often SARA, COSEWIC is not immune to such attention. In my experience, some of these interactions could be constructive, others less so. The Fisheries Council of Canada (representing the harvesting, processing, and marketing sectors of the seafood industry) was active in its efforts to amend SARA so that responsibility for marine fish assessments was transferred from COSEWIC to DFO (this has not happened); COSEWIC was perceived to curtail this lobbyist's ability to advocate their preferred fishery management decisions to DFO. In contrast, meetings with the Forest Products Association of Canada were always respectful, often leading to the provision of data and information that contributed to COSEWIC's assessments of boreal birds.

COSEWIC's advice was not always favourably received by advocates. During my tenure as chair, some of the harshest public condemnations came not from industry or business, but from those who identified themselves as conservationists. This was particularly true of COSEWIC's assessment of polar bear (*Ursus maritimus*) in April 2008. Days before the assessment, WWF-Canada tried none-too-subtly to influence COSEWIC by releasing media statements that articulated the ENGO's perspective on the plight of polar bears. When the assessment did not conform with WWF-Canada's preferred outcome, the organization publicly denounced the assessment, complaining that COSEWIC had taken the "easy way out. Every man on the street knows the polar bear's threatened" (International Herald Tribune, 26 April 2008), a belittling statement that ignored COSEWIC's arms-length status and obfuscated the legal condition that COSEWIC's assessments are not to be influenced by the potential consequences of its advice.

The IUCN Polar Bear Specialist Group (PBSG) was also critical, one member stating that if he still worked for Environment Canada (the predecessor of ECCC), he would not recommend that the minister accept COSEWIC's advice. Another member (a university academic) offered the perspective that COSEWIC had "'failed

miserably"' (Hutchings and Festa-Bianchet, 2009b). The IUCN PBSG, however, was a little quick off the mark; its own assessment of "Vulnerable" was later criticized by the IUCN's Standards and Petitions Committee (IUCN, 2014).

The vociferousness of the responses by WWF-Canada and the IUCN PBSG (and at least one journalist for a western Canadian newspaper) is not atypical of advocates. At the time, these groups (and others) were disappointed that COSEWIC had assessed polar bear as a species of "Special Concern" (making it a species at risk under SARA, one level lower than "Threatened"). But neither group (nor the journalist) was able to identify flaws in COSEWIC's application of the IUCN criteria upon which COSEWIC's assessments are based.

As time progressed and tempers dissipated, it turned out that some of the disappointed advocates had hoped that COSEWIC would assess polar bear as Threatened or Endangered to "send a message" to the Canadian government that climate change in the Arctic is a matter of serious concern. But it is not COSEWIC's purview—nor that of any science advisory body—to "send messages" to government. The advocates were fully aware of this but chose to ignore it because acknowledgement of COSEWIC's legislated functions and responsibilities would have tempered what they had hoped to achieve through advocacy. (Hutchings and Festa-Bianchet (2009b) provide a comparative analysis of polar bear assessments undertaken by COSEWIC, the IUCN, and the United States; the species was re-assessed as Special Concern by COSEWIC in 2018.)

Informal and confidential advice

> "Science advice occurs through two major routes. Formal processes of committees, panels, commissions and advisors and informal processes of discussion between key actors… "[T]he reality of political decision-making is very much dependent on informal advice… Informal advice by its nature is essential at least when it involves those scientists in roles specifically designed to provide it… Advice from these roles is common and highly influential" (Peter Gluckman, 2020).

Peter Gluckman, inaugural Chief Science Advisor to the Prime Minister of New Zealand (2009–2018), has written extensively about formal and informal science advice. As chair of COSEWIC, I was in the somewhat unusual position of being both recipient and provider of both. The individuals and groups I interacted with encompassed a breadth of interested parties: cabinet ministers; Directors General of ECCC's Canadian Wildlife Service; DFO's Species at Risk Secretariat; heads of government departments in Canada's ten provinces and three territories; Wildlife Management Boards (established through Indigenous land claims agreements); members of the public, academia, ENGOs, and the media. I needed to be vigilant as to whether the information I was receiving was advice or advocacy.

Being a university academic unfamiliar with the official corridors of government decision-making, I learned that informal advice is easier to receive than to provide. Time, patience, respect, and a willingness to learn are required before one earns a decision-maker's trust and confidence. I did not take this challenge lightly, allocating an average 165 working-days per annum (unpaid; for four years) to my responsibilities as chair of COSEWIC (my university offered no relief from teaching, research, and university administration duties). This involved a great deal of travel across a rather large country, listening to those whose interests or concerns overlapped with the assessment of species at risk: ENGOs; government scientists, managers, and politicians; Indigenous peoples; hunting, trapping, and angling organizations; industry lobbyists; members of parliament; the general public.

Consistent with Gluckman's remarks about the importance of informal advice, I learned that confidential discussions could have benefit not only to decision-makers but to the smooth functioning of COSEWIC and, by extension, to improved implementation of SARA. These discussions provided opportunities to explain COSEWIC's assessment procedures and to privately question government decisions that might negatively affect COSEWIC. They also provided opportunities for decision-makers to use the chair of COSEWIC as a sounding board for potential departmental or governmental decisions pertaining to specific species at risk. On occasion, these informal interactions included decision-makers from outside Canada (such as the U.S. Deputy Secretary of Commerce and the U.S. Office of Science and Technology Policy).

Science advice with immediate impact

> "Loblaw Companies have recently announced that we intend to move to a position of only selling sustainably sourced seafood by the end of 2013. Part of the policy is to have scientific advice that can help chart an appropriate course, and we were hoping that you could assist us with the role" (email from the Vice-President, Sustainable Seafood, Loblaw; June 2009).

The end of my term as chair of COSEWIC in May 2010 coincided with the beginning of a decisive shift in priorities by Canada's seafood retail industry. Despite the collapse of fisheries worldwide through the late 1980s and 1990s, consumers were offered little or no guidance as to which seafood products were likely to be sustainably sourced and which were not. In the late 1990s, UK food retailer Marks and Spencer (M&S) took the global lead in exercising corporate responsibility for the selling of sustainably sourced seafood (Bradshaw, 2015), relying on fisheries certified by the nascent Marine Stewardship Council (MSC). Henceforth, M&S committed to sourcing from sustainable suppliers, using a chain-of-custody framework that would allow them to chronologically document all of the constituent parts involved in the procuring of seafood from point of capture to point of sale.

In May 2009, Canada's largest buyer and seller of seafood, Loblaw Companies Ltd, became the country's first major retailer to commit to sustainably sourcing seafood in products ranging from fresh and frozen fish to pet food and health products (Loblaw, 2009; Schmidt, 2012). Interestingly, Loblaw did not simply commit to offering a sustainable option alongside an unsustainable option, which relies on the consumer to make the "sustainably correct" choice (Bradshaw, 2015); rather, seafood from unsustainable sources simply would not be sold. Within one month of publicly announcing that decision, Loblaw sought a scientist independent of vested interests to advise them on how to meet its new commitment. According to the Vice-President of Sustainable Seafood, Loblaw approached me because they wanted an "honest broker" to assist them amidst the often constructive, but necessarily vested, interests of ENGOs with whom Loblaw was also working.

By 2016, ~95% of Loblaw's fresh, frozen, and canned seafood was being procured from (i) MSC- or ASC (Aquaculture Stewardship Council)-certified sources, (ii) sources deemed sustainable with conditions (e.g. non-MSC-certified fisheries that had achieved target management reference points for fishing mortality and stock biomass), or (iii) sources, particularly in the

developing world, making meaningful progress toward sustainability (such as those supported by Fishery Improvement Projects; see fisheryprogress.org) (Loblaw, 2016).

As of 2022, I continued to serve as Loblaw's independent science advisor in its efforts to source sustainable seafood. In addition to assisting in the development of policies and evaluation criteria, I have provided science advice on >600 assessments and re-assessments, concerning >360 species of fishes and invertebrates sourced from wild-capture fisheries and aquaculture farms. The time that elapses between receipt of my advice and action by Loblaw is often in terms of days, sometimes hours. The experience has been personally fulfilling, offering the most direct, impactful, and meaningful opportunity I have had to provide science advice to decision-makers in a way that has short- and long-term benefits to sustainability.

In closing

> "It is not enough to say that scientists have a responsibility as citizens. They have a much greater one than that, and one different in kind. For scientists have a moral imperative to say what they know. It is going to make them unpopular… It may do worse than make them unpopular. That doesn't matter" (C.P. Snow; Weaver *et al.*, 1961).

Hutchings *et al.* (1997) asked if scientific inquiry was incompatible with government information control. In Canada, this rhetorical question was answered in the affirmative when the national government imposed a series of unprecedented measures (from 2007 to 2015) that severely restricted the ability of scientists in its employ to communicate with the public (Linnitt, 2013; Turner, 2014; Learn, 2017). In response, some DFO scientists retired early; others sought positions in non-government sectors; many strengthened research collaborations with academic colleagues or increased their service to national and international advisory bodies.

Strategies that reduce stress allow us to retain mental and emotional strength under trying circumstances. During the unsettling interactions described earlier, arising from assessments of cod and polar bears, my primary coping mechanism was a form of self-critical introspection during which I relentlessly put myself in the shoes of potential critics. I was most critical of my rationalization and interpretation of events in relation to the advisory-body attributes of objectivity and independence that so highly motivated me. When interacting with DFO bureaucrats, responding to critics of COSEWIC, or communicating with the media, was I always objective? Was I ever deceitful, selfish, or unduly defensive? Could an independent observer conceivably perceive me to have a hidden "agenda," as asserted by DFO when contesting the conclusions of Hutchings *et al.* (1997)? I found that I could cope with the stresses and "squeezes" (as one reviewer put it) invoked by vested interests if, after such introspection, I was satisfied that my arguments were as unassailable as I could render them to be. But if others could have defensibly perceived me to be a vested interest, coping with their criticism and attacks, however unfounded, would have proven difficult. This is one reason why advocacy has not appealed to me personally.

On a related point, a reviewer asked why anyone would spend 165 days per annum for four years working unpaid as chair of COSEWIC (2006–2010) while maintaining a full-time position as a university professor. The time I allocated (which does seem excessive in retrospect) was directly linked to what I perceived to be a tenuous future for this new government advisory body. When I began my term as chair, the *Species at Risk Act* had been in place for less than three years; many in government were still trying to determine what to make of this independent body whose advice (remarkably) triggered legislatively defined actions by government ministers.

My term as chair also overlapped with the first four years of a Canadian government that had become increasingly distrustful of science advice (Harris, 2014; Turner, 2014). These two factors—bureaucratic uncertainties in the practical functioning of COSEWIC coupled with increasing government distrust in science—meant that the committee could not be perceived to be a conservation organization or any other vested interest. To maintain its independence and functions, it needed to be, and to be perceived to be, objective and void of real or perceived conflicts of interest. I felt that the more time and energy I invested in COSEWIC, particularly in my interactions with bureaucrats, politicians, and advocates, the greater the probability that COSEWIC would persist in its unique capacity as an independent science advisory body to the Canadian government.

Being asked to provide advice because of your expertise is perhaps the highest calling one can have as a scientist. C.P. Snow, author of *Science and Government* (Snow, 1960), called it a "moral imperative" (Weaver *et al.*, 1961). Morally imperative it may be, but it has its challenges. As I discovered as a postdoctoral researcher, this can be particularly true for individuals within government departments, notably when dealing with science issues perceived to be politically sensitive. In hindsight, I was naïve to have thought otherwise. By questioning government narratives on what caused the collapse of Northern cod, I could easily have been perceived to be implicitly questioning the effectiveness of the management system, thereby affronting those running it. Hence, the forceful responses by DFO.

I have also learned that academia is far from being immune to the lure of advocacy. When offering information that falls within your area of expertise, it can be tempting to exaggerate scientific findings that conform with your personal views or to downplay (perhaps simply not mention) findings that do not support your opinions. Many a scientist, whether conversing with a journalist, appearing before a parliamentary committee, or communicating via social media, has found themselves straying into the self-promotion realm by over-stating the importance of their research and its relevance to government policy or societal well-being. Attractive as advocacy may seem as a vehicle for advancing one's opinions and values, it can be humbling to be reminded that the personal value systems of scientists have no intrinsically greater merit than those of the decision-makers whom they advise or the citizenry who might be affected by the advice.

Advocacy can come easy. Doing one's utmost to articulate a perspective free from real and perceived vested interests is much more difficult. Science advisors need to strive for, and ideally achieve, honesty and objectivity about facts and weight of evidence. They need to be clear about what is known and what is not known, about what is relatively certain and what is highly uncertain. Decision-makers benefit from knowing what the best possible evidence is both for and against potential decisions and where the uncertainties lie. Many want to be confident that their decisions are based on a full consideration of the evidence.

Transparent incorporation of independent science advice in government decision-making represents one of the greatest rewards to taxpayers in return for tax-supported investments in science. It costs a very great deal to generate scientific evidence; it can cost much, much more not to use it.

Data availability statement

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