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Canada at a crossroad: The imperative for realigning ocean policy with ocean science

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ABSTRACT

Canada's ocean ecosystem health and functioning is critical to sustaining a strong maritime economy and resilient coastal communities. Yet despite the importance of Canada's oceans and coasts, federal ocean policy and management have diverged substantially from marine science in the past decade. In this paper, key areas where this is apparent are reviewed: failure to fully implement the *Oceans Act*, alterations to habitat protections historically afforded under Canada's *Fisheries Act*, and lack of federal leadership on marine species at risk. Additionally, the capacity of the federal government to conduct and communicate ocean science has been eroded of late, and this situation poses a significant threat to current and future oceans public policy. On the eve of a federal election, these disconcerting threats are described and a set of recommendations to address them is developed. These trends are analyzed and summarized so that Canadians understand ongoing changes to the health of Canada's oceans and the role that their elected officials can play in addressing or ignoring them. Additionally, we urge the incoming Canadian government, regardless of political persuasion, to consider the changes we have documented and commit to aligning federal ocean policy with ocean science to ensure the health of Canada's oceans and ocean dependent communities.

1. Introduction

Bounded by three oceans, Canada has a deep cultural and economic connection to the marine environment and a strong global responsibility to protect it. The federal government, through the Department of Fisheries and Oceans (DFO), recognizes the oceans as being "an integral part of our identity as a nation" [1]. The Canadian economy remains tied to oceans, employing over 300,000 Canadians working on or around its oceans, and ocean-based industries contribute more than $26 billion a year to the nation's wealth [2]. An example of the close links between ocean health and the economy was the devastating impact of the

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collapse of the cod fisheries in the 1990s on the entire province of Newfoundland and Labrador, and much of Atlantic Canada; the collapse occurred despite repeated warnings by scientists that the stock required better management, resulting in the loss of 40,000 jobs [3] and a federal expenditure of over two billion dollars in income support, retraining, and fishing license buy outs [4]. Aboriginal peoples throughout the country, who themselves are in a unique jurisdictional relationship directly with Canada's federal government, rely heavily on fish and fisheries for cultural and ceremonial purposes, as well as for food and employment [5,6].

The Canadian government recognizes its responsibility in managing the country's oceans sustainably for the benefit of present and future generations of Canadians [2]. This reflects a global imperative: with an estimated 44% of the world's population living less than 150 km from coasts [7], the long-term health of oceans is arguably key to the long-term well-being of coastal nations worldwide. There was a time when ocean science played a strong role in defining ocean policy in Canada. Yet as illustrated in this paper, over the past decade decision-making at the federal level appears to have undermined the government's own mandates for the sustainable management of Canada's oceans. This paper focuses on the lack of federal leadership in three key areas: (1) implementing the *Oceans Act*; (2) alterations to habitat protections historically afforded under Canada's *Fisheries Act* [8]; and (3) implementing the *Species at Risk Act* (SARA). A more systematic erosion of marine science capacity and communication for government researchers in Canada is also discussed [9,10]. Restoring the capacity of Canada's government researchers to conduct ocean science can significantly improve the federal government's ability to implement its oceans legislation and thus to sustainably manage Canada's oceans and coasts. Reopening channels for science communication can improve public engagement and promote transparency in government science. Additionally, because of the global and complex nature of marine challenges, ocean research transcends institutions, making effective communication paramount. We propose recommendations to realign ocean policy with ocean science, and argue for legislative reform of the very system in which these poor decisions have been allowed to take place.

2. Canada failing its oceans[1]

Canada was once seen as a global leader in ocean management [11,12]. Canada's *Oceans Act* – which came into force in 1997 – was exemplary ocean management legislation. It provided a framework through which Canada could lead the world in integrated ocean management, ecosystem-based management, and marine protected area implementation. Canada was held up as a model for other nations to follow [11,13]. To better implement the *Oceans Act*, the government took action on two fronts. First, it developed Canada's Oceans Strategy, released in 2002, and Canada's Oceans Action Plan, released in 2005. Second, the government created a dedicated Oceans Branch of Fisheries and Oceans Canada (DFO)-as the lead agency to facilitate the implementation of the strategy-and hired new interdisciplinary managers, more capable of working in the modern ocean management environment [12]. As core commitments of the Oceans Strategy, DFO is to work collaboratively with other agencies and levels of government, share responsibility for achieving common objectives, and engage Canadians in ocean-related decisions guided by three principles: sustainable development, integrated management, and the precautionary approach [14]. The *Oceans Act* and subsequent strategy thus incorporated some of the best available practices, supported by science (both natural science and social science). In addition, the *Oceans Act* addressed Canada's commitment to international agreements. For example, the *Act* assigns responsibility to the Minister of Fisheries and Oceans to "lead and coordinate development and implementation of a national system (or network) of marine protected areas" (MPAs). This commitment to MPA development is essential if Canada is to fulfill its international obligations under the terms of the Convention on Biological Diversity (CBD), which Canada has signed.

Despite these positive initial steps, serious concerns have emerged regarding Canada's commitment to implementing the *Oceans Act*. Such concerns have arisen from diverse sources, including researchers [15] and the Auditor General of Canada [16]. The latter issued a 2005 report noting that "Fisheries and Oceans Canada has fallen far short of meeting commitments and targets for implementing key aspects of the Oceans Act" [16]. It highlighted that implementation has not been a government priority, that there had been no workable and consistent approach to integrated oceans management, that the department has not been held accountable to its *Oceans Act* commitments, and that essential elements to implementing the Oceans Strategy (e.g. strong leadership, coordination, adequate funding, an accountability framework with performance measures) were lacking [16]. It was hoped that such criticisms a decade ago would have instigated more effective action, but instead the federal government's role on oceans has diminished. The Department's response to the report was that it agreed with all of the audit's recommendations. Yet some seven years later, in a subsequent evaluation of DFO's Integrated Ocean Management (IOM) Program in 2012 [17], eight in 10 surveyed IOM stakeholders or more indicated that there is a continued need for federal attention to all of the key themes under integrated ocean management – science, engagement of stakeholders, and integrated oceans management planning. Three-quarters of stakeholders indicated that there is a continued need for federal action on designation of marine protected areas and protection of marine ecosystems.

Since 2005, a series of 'flagship' Large Ocean Management Area (LOMA) initiatives across the country have been delayed or abandoned, with only one of five management plans being endorsed by the Department. For example, after a decade of, albeit slow, progress in creating ocean management strategy within the Eastern Scotian Shelf Integrated Management (ESSIM) initiative off the Atlantic coast [15], the national government failed to endorse the stakeholder driven plan and the initiative was terminated in April 2012 [18]. On the Pacific coast, due to an inability to agree on the terms of the joint agreement, the federal government pulled out of a tri-partite arrangement with the Province of BC and First Nations to work on the Pacific North Coast Integrated Management Area (PNCIMA). With less than 1% of its waters designated as MPAs, Canada's MPA establishment continues to be slow or stalled [19] and will not allow Canada to meet the 10% target signed at the Aichi convention. For example, of the four pilot MPAs announced in 1999, one was established in 2003 (Endeavor Hydrothermal Vents) and another in 2008 (Bowie Seamount); the other two (Race Rocks and Gabriola Passage) are dormant [20]. As with integrated ocean management, the Auditor General of Canada concluded in its 2012 report that the federal government has failed to plan, establish and manage a network of marine protected areas in accordance with their legislative mandates and policies and that "…Canada's marine biodiversity remains at risk. By extension, the prosperity of many coastal communities in Canada with marine-based economies also remain threatened." [21]. This undermining of progress has cast Canada in a bad light internationally [9,22].

[1] Title taken from CBC, [89].

3. Fish habitat: why rock the boat?

The Federal[2] *Fisheries Act* is the principal piece of federal legislation through which the government executes its constitutionally mandated authority to manage and regulate fisheries within Canadian waters. In addition, the *Fisheries Act* operationalizes many management objectives required under international agreements that Canada has committed to (e.g., the United Nations Fish Stocks Agreement and 2 resolutions of the UN General Assembly on Sustainable Fisheries and on Oceans and Law of the Sea), the Convention on Biological Diversity via, e.g., the Aichi Targets [23], and the Reykjavik Declaration on Responsible Fisheries in Marine Ecosystems). Originally established in 1868, this *Act* is a living document that has undergone 17 amendments, and is Canada's oldest conservation law [24]. Historically, key components of the *Act* have included protections of fish habitat under Section 35 prior to 2012, while pollution that could adversely affect fish was covered under Sections 34 and 36 [25].

On November 25, 2013, the federal government dramatically revised Section 35 (1) of the *Fisheries Act* from "No person shall carry on any work or undertaking that results in the harmful alteration, disruption, or of destruction of fish habitat" to "No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery" [25]. Ahead of this change, a retired DFO scientist went public with leaked documents commenting that the proposed change "is a travesty for our fishery resources and the health of the entire ecosystem and it ignores the needs of our future generations" [26]. This was not the only scientist speaking out about the changes, or questioning the rationale [27]. In a letter to the federal government, 625 Canadian scientists requested that the planned changes be abandoned [28]. In addition, at least four former federal Fisheries Ministers representing different political parties also objected to the dramatic reductions in *Fisheries Act* protections being implemented [29].

There are several reasons why this change to the *Act* is problematic. First, the change requires the splitting of fish into valued (fishery-related) and non-valued categories. This can be detrimental because considering only the current fishery value fails to protect the option value, future potential value, or non-use value of marine ecosystems and the life they support. The revision also means that there is no longer protection for fish in remote locations where there are no humans and for fish that are not directly used by humans: no human use, no fishery, no habitat protection [30]. This change coincides with an overwhelming government research focus on a handful of fished species in the Atlantic and Pacific regions, and a lack of focus on Arctic ecosystems [31], ecosystems that are currently undergoing dramatic change [32,33]. Additionally, other amendments require those challenging an activity under the *Fisheries Act* to be responsible for providing proof of deleterious harm or adverse effect. In other words, the burden of proof is now reversed from what a precautionary approach would support. Species must now be judged to be of value – with values being particularly burdensome to define and measure – and harm must be proven, two extremely difficult measures to meet in many instances [34].

4. Saving species at risk starts at the top

With accelerating human impacts on the planet [35],[3] over one in five species of vertebrates [36], invertebrates [37], and plants [38] are at risk of extinction, with current rates of extinction estimated to be 1000 times higher than background levels [39]. Marine populations, specifically, have declined by nearly 50% since the 1970s [40]. Globally, efforts are growing to prevent or slow down this trend, such as the CBD's Aichi targets [41] which Canada has formally committed to. In 2002 the Government of Canada established the *Species At Risk Act* (SARA), Canada's primary legislative tool for protecting species at risk both on land and in the ocean [42]. When species are listed as threatened or endangered under SARA, they enter a planning process for recovery. Additionally, they receive two immediate protections: individuals of listed species cannot be killed or collected, and the "residence" of the species cannot be damaged or destroyed [43]. Importantly, while SARA provisions only apply to areas under direct federal government ownership or jurisdiction, virtually all marine species fall under the exclusive legislative authority of the federal government while in Canadian waters, so SARA protections should extend across their entire range.

Species become listed through a two-step process (see Ref. [44] for a process and timeline flowchart). First, scientific evidence on a species' population status and recovery potential is considered by a body of scientists acting at arms-length from government – the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC assesses the at-risk status of species; it does not consider cost of recovery efforts in assessments. Once an assessment has been received, the federal Minister of the Environment is meant to send the file to the appropriate ministry for a decision to be made about listing, indicating one of three options: (1) the species will be listed as the status recommended in the COSEWIC assessment, (2) the species will not be listed, documenting the reasons for doing so, or (3) more information is required in order to make a decision. This process is intended to prevent species at risk assessments and recommendations from stalling due to government inaction [45]. If a species is listed under SARA as threatened or endangered, the relevant department (DFO for marine species) is then asked to develop legally binding measures to protect the species, including a Recovery Strategy and subsequently an Action Plan [46].

Since SARA was enacted, concerns have been raised regarding its application to marine species [44]. Mooers and colleagues [4] demonstrated that marine fish are rarely listed regardless of their initial COSEWIC assessment status, a trend that continues today [44]. Of 39 marine fish species identified by COSEWIC as threatened or endangered, only five have been accepted for listing [47], with listings for freshwater fish less often rejected [48]. Schultz and colleagues [48] also identified that marine fish would not be listed for formal federal protection if the cost of listing the species was estimated to be greater than zero. This has resulted in listing decisions for marine fish that diverge widely from COSEWIC's advice.

A major rationale provided by DFO for not listing marine fish has been that protections under the *Fisheries Act* were sufficient to promote species recovery [44,48]. The *Fisheries Act* has been in place in some form since 1868, and amended repeatedly. If the *Fisheries Act* provisions alone were sufficient to promote species recovery, and if population decline was fishery-induced, then these declines should not have happened in the first place. In addition, since the modern *Fisheries Act* was enacted in 1985, 18 at-risk marine fish species have been assessed more than once by COSEWIC.[4] As shown in Table 1, however, the status of most species at risk has not improved, and the threats facing many of these species remain.

[2] Title taken from the Globe and Mail, [34].
[3] Title taken from the Globe and Mail, [90].
[4] (http://www.cosewic.gc.ca).

Table 1
The status of marine species reassessed by COSEWIC. Changes to status are given in the second column, trends in population sizes in the third column, and changes to the threats in the final column. Colour-coding indicates improvements (green), stasis (yellow), and declines (red). The status of marine species reassessed by COSEWIC. Changes to status are given in the second column, trends in population sizes in the third column, and changes to the threats in the final column. Colour-coding indicates improvements (light grey), stasis (grey), and declines (dark grey).

Species[a]	COSEWIC Assessment	Trend noted by COSEWIC[b]	Have causes of decline ceased?[c]
Atlantic Cod (*Gadus morhua*) [Newfoundland and Labrador]	Endangered (No change)	97-99% decline in 3 generations	No
Atlantic Cod (*Gadus morhua*) [Laurentian North]	Threatened → Endangered (2013)	76-89% decline in 3 generations	No
Atlantic Salmon (*Salmo salar*) [Inner Bay of Fundy]	Endangered (No change)	>94% decline in 3 generations	No
Atlantic Wolffish (*Anarhichas lupus*)	Special concern (No change)	Variable, overall declines	Yes [reduced commercial fisheries causing less by-catch]
Bocaccio (*Sebastes paucispinis*)	Threatened → Endangered (2013)	92% decline in 3 generations	No
Chinook Salmon (*Oncorhynchus tshawytscha*) [Okanagan]	Endangered → Threatened (2006)	<50 individuals; improved status due to migration from distinct US populations	No[d]
Cusk (*Brosme brosme*)	Threatened → Endangered (2012)	85% decline in 3 generations	No
Northern Wolffish (*Anarhichas denticulatus*)	Threatened (No change)	~>90% in 3 generations, small increases over the past decade	"Reduced but probably not ceased"
Pacific Sardine (*Sardinops sagax*)	Special Concern → Not at Risk (2002)	Pacific sardines reappeared in Canada in 1992 [breed in US]	Yes [reduced fishing and warming waters]
Porbeagle (*Lamna nasus*)	Endangered (No change)	74-77% decline in ~2.6 generations	No
Sockeye Salmon (*Oncorhynchus nerka*) [Cultus]	Endangered (No change)	92% decline in 3 generations	No[c]
Sockeye Salmon (*Oncorhynchus nerka*) [Sakinaw]	Endangered (No change)	87-99% in 3 generations	No[c]
Spotted Wolffish (*Anarhichas minor*)	Threatened (No change)	75-80% decline in ~2-3 generations, small increases since the 1990s	Yes

[a]Ignores species that went extinct historically (Atlantic Salmon, *Salmo salar*, Lake Ontario population, last recorded in 1898), species reassessed as data deficient (Blackline Prickleback, *Acantholumpenus mackayi* and Bering Wolffish, *Anarhichas orientalis*), species whose status changed due to previous data having been deemed "not appropriate for this purpose" (Eulachon, *Thaleichthys pacificus*, Nass/Skeena River populations), species where data reanalysis indicated that there were no trends given historic variability (Winter Skate, *Leucoraja ocellata*), and population designations that were reassigned.
[b] Obtained from technical summaries (e.g., "Estimated changes in the total number of mature individuals over the last 3 generations") in COSEWIC reassessment reports (http://www.sararegistry.gc.ca).
[c] Obtained from technical summaries (e.g., "Have the causes of the decline ceased?") in COSEWIC reassessment reports (http://www.sararegistry.gc.ca).
[d] Inferred from COSEWIC reassessment reports (http://www.sararegistry.gc.ca).

Another reason mentioned to reject COSEWIC's recommendation for listing is the socio-economic impact that protection measures could have on current commercial fisheries through limits on where or how fisheries can operate or what they catch or impact through their operations. However, such objections should not be a barrier to listing, as unintentional harm to *listed* species, through fishing, is routinely allowed through fishing permits in specific areas. For example, two SARA listed fish species present in Atlantic Canadian waters, Spotted Wolffish (*Anarhichas minor*) and Northern Wolffish (*Anarhichas denticulatus*), occur in many areas open to commercial fishing for other species. In these cases, the Minister of the Environment has issued specific permits to allow commercial fishing to take place where Wolffish may be caught as bycatch [49]. Doing so allowed for SARA's protections to enhance recovery of the stock, while avoiding complete fisheries closures in the region.

Beyond the bias against listing marine species, the implementation of SARA has fallen short at several steps, hampering recovery of species at risk in Canada. First, the listing of any species, not just marine, has completely stalled. Since 2011, none of the new recommendations for listing received by the Minister of the Environment from COSEWIC have been accepted by the government [50] (with the exception of three bat species that were listed following a request by the Nova Scotia government for emergency assessment [51]). The 67 newly evaluated species from COSEWIC join a total of 154 species waiting for listing or relisting, some of them waiting since 2005 (the average waiting time now stretches over 1500 days) [32,35]. Second, even after species listing, recovery strategies are often not completed within the time frame required by law [52]. Third, a full identification of critical habitat is often not provided for listed species [53]. Finally, in the thirteen years since SARA was passed, Canada has only released 13 of the required action plans, none of them being for a marine fish or marine mammal species.

These shortfalls are unlawful. As found in a report from Canada's Office of the Auditor General, "Environment Canada, Fisheries and Oceans Canada, and Parks Canada have not met their legal requirements for establishing recovery strategies, action plans, and management plans under the Species at Risk Act" [54]. Several court decisions agree. For example, in a 2014 Federal Court case involving four species (two of which were marine: Nechako white sturgeon and the North Pacific humpback whale), Justice Mactavish found "the Ministers' failure to include proposed recovery strategies for the four species in the public registry within the statutory time periods…to be unlawful" [55].

Notably, the lack of political will to meet the legal requirements under SARA does not reflect a lack of public will. Polling clearly indicates that Canadians support improved protection for species at risk, with 85% saying that federal laws protecting species at risk are "crucial to the diversity and abundance of wildlife, the Canadian economy, and Canadians' health" and 62% saying that the Federal Government is doing too little" [56]. The recognition by Canadians of the links between biodiversity conservation and sustainable ocean economies is in keeping with expanding international efforts to connect the governance of ocean uses, notably the fishing sector, with biodiversity concerns [57,58].

5. When science goes silent

Marine science should contribute to knowledge and provide evidence to decision makers to inform good public policy.[5] Unfortunately, two very real threats to these functions have materialized in Canada in the past decade. Government scientists have been limited in their capacity to do science due to funding cuts, closing of libraries, and the destruction of archived materials [10]. Government scientists have also been limited in their abilities to communicate their science to the public, what has been termed 'muzzling' of scientists [59,60]. We review these developments below.

In the past 10 years, Fisheries and Oceans Canada has closed seven of its eleven libraries, culled one third of its largely unique collections within these libraries (some 200,000 items), and restricted digitization of historic materials to only federally-owned documentation and not grey literature [10]. The loss of library collections is removing sources of information that should be shaping our public policy debates. The capacity for government scientists to do their work, which directly requires access to information, has been jeopardized. Major funding cuts to government spending on environmental programs have also occurred, including $160 million in cuts packaged together under Omnibus Bill C-38 [61], that received assent in June of 2012. Additional reductions of 35% and 42% to funding for biodiversity and pollution management and mitigation (marine and otherwise), respectively, have also been indicated [62]. The government's tendency to devolve research authority to universities and private organizations further hampers DFO's ability to manage Canada's oceans by distancing DFO from decision-making about research priorities and preventing DFO from being able to act on early (prior to publication) research results [61,63].

The cutbacks have impacted high-profile research programs, like DFO's Marine Contaminants Program that monitored pollution in Canada's three oceans [64]. The federal government announced further plans to cut $100 million from DFO over three years beginning in 2015 [65]. In light of the ongoing changes, DFO's 2012–2013 Departmental Performance Report noted "there is a risk that the Department's workforce may not have the capacity to successfully absorb and implement transformational changes" and that DFO "may not be able to adequately maintain public trust and confidence, and subsequently its reputation" [66]. The planned response to these risks centered almost exclusively around the implementation of internal and external "communications strategies" [66].

New policies for federal communications require that "All media inquiries must be referred to the Communications Branch or Regional Communications", and that all public communications by staff be "authorized" [67]. Ultimately, DFO scientists no longer have the right to speak freely with the public through the media, with the number of press releases issued by federal science departments declining by 58% since the current government came into power [68]. One of the most high profile examples of this new policy was the case of geneticist Kristina Miller from DFO's Salmon and Freshwater Ecosystems Division. Dr. Miller was prevented from discussing a viral infection implicated in the death of sockeye salmon in British Columbia. The study was already published in the peer-reviewed literature [69] and was the subject of substantial media interest [70]. Approvals for communication were sought from DFO's deputy minister, the minister's office, and the Privy Council Office (PCO, the secretariat of the federal cabinet). PCO ultimately denied Dr. Miller the opportunity to give interviews on the basis that, by the time this long process had run its course, she was scheduled to appear before an official investigation (the Cohen Commission) into the 2009 sockeye salmon collapse [71]. Similar processes have been reported for Environment Canada [72,73] and the National Research Council [74].

The control over government communications has also been extended to publishing. Leaked procedures from DFO's Publication Review Committee reveal a requirement that all journal articles and reports authored, and now including coauthored works, by DFO scientists be approved by the responsible Division Manager (or designated subject expert) before they can be submitted for publication [75]. The policy was confirmed by Kevin Stringer, an Assistant Deputy Minister in DFO, who argued that the changes were necessary to streamline the review process and protect DFO's intellectual property [76]. The process requires that draft manuscripts be reviewed for "concerns/impacts to DFO policy" and for "relevance to DFO outcomes" [77], making it possible to prevent publication for reasons other than scientific. While it is legitimate for governments to expect a certain amount of restraint from civil servants, these developments severely limit the ability of Canada's federal scientists to play their key role as the only scientists paid specifically to protect the public interest, and to inform government on scientific matters [60,78].

It is notable that the new procedures apply to collaborations involving DFO personnel, and have already begun to affect the development of agreements with national and international partners. A proposed renewal of an agreement between DFO and University of Delaware, one that had been in place since 2003, included a new appendix on "Intellectual Property, Confidentiality and Publication" [79]. The provisions stated that information arising from the project be "deemed to be confidential" and indicated "neither Party may release any such Information to others in any way whatsoever without the prior written authorization of the other Party". The University of Delaware researchers declared the new provisions to be a "potential muzzle" and refused to sign the agreement as proposed [76].

6. Discussion

Key areas where Canada's ocean policies have taken a turn away from being evidence-based were reviewed in this paper. In the 1990s, the *Oceans Act* set Canada as a world leader in ocean research and ocean policy, capable of addressing the range of challenges and opportunities for the country's coasts and oceans [11,80]. Yet instead of reaching that potential, Canada has failed to fully implement the *Oceans Act*. The same holds for the *Species at Risk Act* (especially as it relates to marine species), and recent changes to the *Fisheries Act,* which removed habitat and contaminants provisions, have been deemed unconstitutional and scientifically unfounded [27,28,30,81]. Canada, like other countries, must base its ocean policy and decision-making process on strong ocean science capability. In particular, government scientists must be supported in their efforts to contribute to our understanding of marine social-ecological systems and their sustainability. Furthermore, while the focus in this article has largely been on declines in the governmental capacity for natural sciences, the governmental capacity for social science research on the oceans is almost non-existent. This gap dates back far more than a decade, but must be addressed to generate the information needed to effectively manage our oceans in a knowledge-based economy. The integration of natural and social sciences is especially needed to inform policies for long-term ocean sustainability under uncertain futures of climate and socio-economic change. It is important to have the capacity for approaches such as scenario modeling, as undertaken by global environmental assessments [82,83], to show the economic and

[5] Title taken from Macleans, [91].

ecological trade-offs associated with alternative ocean futures in Canada.

The solutions for effective ocean policy in Canada should be addressed in both the short and long-term. In the short-term, Canada's government needs to commit to fully implementing the intent of the *Oceans Act* [11,12,15,16,84]. For example, a network of MPAs should become fully and rapidly developed, and monitoring programs that evaluate their effectiveness in meeting their conservation goals should be established. To allow Canada to better protect species at risk, obligations under SARA should be met by the federal government, including the completion of recovery strategies with fully identified critical habitat, as well as action plans, in the timeline specified by law. Problems with the existing SARA process must be addressed – notably in terms of biases, delays, and an excessive rate of rejections of scientific recommendations to list species. In relation to the *Fisheries Act,* while fisheries legislation is regularly revised, the lack of scientific consultation and advice in making broad, large-scale changes to fundamental environmental legislation is inconsistent with Canada's previously established ecosystem-based approach to management [30]. Protecting the habitat of all fish needs to be re-inserted into the *Fisheries Act*, both to protect marine biodiversity and to safeguard the future health and economic value of our oceans.

All these short-term changes require adequate financial and intellectual capacity. It will remain increasingly difficult for DFO to support its mandates for healthy oceans and coasts if financial support for scientific programs and research facilities available to government scientists is not forthcoming. While there is a growing trend towards governmental funding of more partnership research that includes government, industry and academia, the nature of these networked research programs is such that they do not serve as a substitute for the publicly mandated science needed to support policy that is the responsibility of government. The federal government needs to maintain oversight of historically federal programs, such as ocean habitat and contaminants, and funding for federal scientific programs that directly support implementation of the *Oceans Act,* SARA, and the *Fisheries Act* should be prioritized. This includes natural science, social science and humanities research programs, as well as ecosystem studies that take a comprehensive approach rather than restricting to only fisheries of important commercial value [31].

Scientific evidence creates an essential means for the public to hold policy makers to account, and should not be restricted in a free and open society. Specifically, silencing government scientists ultimately damages the common good [78]. A new approach for informing the public in a timely manner of the results of federal research should be adopted. It is also important that DFO administrators view the termination of programs important for the health and safety of Canadians as something more than a communications problem.

A Scientific Integrity policy should be developed for the federal public service that would allow government scientists to freely communicate their research in any forum, including traditional and social media. Developing this policy need not be onerous: an excellent model is offered by the United States' National Oceanic and Atmospheric Administration (NOAA), the federal agency responsible for overseeing and managing US oceans and fisheries [85]. Their policy states that “NOAA scientists may freely speak to the media and the public about scientific and technical matters based on their official work, including scientific and technical ideas, approaches, findings, and conclusions based on their official work.” In addition, the policy states that “NOAA scientists are free to present viewpoints, for example about policy or management matters, that extend beyond their scientific findings to incorporate their expert or personal opinions, but in doing so they must make clear that they are presenting their individual opinions-not the views of the Department of Commerce or NOAA.” Requiring this disclosure empowers scientists to communicate their findings without limiting the authority of government to adopt policies. This increased transparency would in turn empower Canadians to understand more clearly when the government is making a decision that differs from scientific advice, a policy that is in the public interest. What is of particular interest here is that this policy was a transformative choice for the US government to move away from the sidelining of scientists to a position of scientific integrity where the public can “trust the science and scientific process informing public policy decisions” [86]. The next Canadian government can, and should, make the same choice.

The above-mentioned solutions are short-term in their implementation scope, but a more systematic transformation in the legislative process for ocean policy in Canada is also needed. Specifically, it is crucial to move to a higher degree of clear and measurable accountability, through legislation that establishes sets of rules that government is mandated to enforce. For example, in the United States, various laws, including the Magnuson–Stevens Fishery Conservation and Management Act, have clearly defined goals, by which government performance can be evaluated. Government is held accountable, because of the possibility of lawsuits brought forward by civil society organizations [87,88]. Additionally, Ministerial accountability needs to be encoded into law to prevent repeats of what Canada has witnessed lately regarding SARA [55]. More broadly speaking, an informed public can also hold government accountable, hence reinforcing the need for open and transparent science communication in Canada.

7. Conclusion

Canada has in the last decades developed legislation and policies over the years to effectively protect its oceans and the life they support. These policies have, however, been recently weakened by Federal government action or inaction, something done both by directly undermining of these policies, and indirectly by cutting resources to government ocean science and muzzling scientists. This article has outlined urgent and immediate priorities for ocean policy and ocean science in Canada, and it is our hope that Canada's government, regardless of political persuasion, quickly and effectively addresses these issues. Our core recommendations are to: (1) fully implement the *Oceans Act*, including establishing Marine Protected Areas in accordance with Canada's international commitments, (2) fully implement SARA, and prioritize recovery of at-risk marine species, (3) restore the pre-2012 version of Section 35 of the *Fisheries Act*, mandating protection for fish habitat in all cases, (4) adopt a Scientific Integrity policy for the public service that permits all federal scientists to communicate their work freely to the public. The costs of undertaking these priorities are likely to be meager relative to the tremendous benefits afforded by sustainable, effective management of our marine environment.

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