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RESEARCH ARTICLE

Is Fisheries and Oceans Canada policy receptive to a new Pacific salmon health perspective?

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Abstract

The concept of health permeates priorities and policies for managing wild Pacific salmon (*Oncorynchus* spp.). Regulatory agencies rely largely on salmon abundance and (or) the absence of pathogens to declare if a population is healthy. Our goal was to determine if there was a receptive policy environment within Fisheries and Oceans Canada (DFO) to adopt a cumulative effects perspective of health. We used a previously developed health model along with a multiple streams framework and a narrative review of DFO policy to see how fish health was situated in DFO's salmon management problems, policy, and politics. We discovered that a cumulative effects perspective was consistent with policy goals and priorities. DFO's guiding principles and responsibilities for aquatic animal health were spread across multiple policies and regulations. There were no processes or people responsible for integrating information and activities. The use of the word health in policies and planning without a consistent definition meant that DFO could not explicitly assess if it has reached its management target of healthy salmon. An option for transitioning to cumulative effects perspective is to adopt a healthy public policy perspective and processes to integrate the diverse information linked to social and environmental determinants of health.

Key words: salmon, fish, policy, health, determinants, cumulative

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Introduction

Federal responsibility for wild Pacific salmon (*Oncorhyncus* spp.) in Canada is delegated to Fisheries and Oceans Canada (DFO). DFO is committed to maintaining "healthy and diverse populations of salmon that will support sustainable fisheries now and meet the needs of future generations" (Fisheries and Oceans Canada 2017). DFO largely relies on salmon abundance and (or) the absence of pathogens to declare if a population is healthy. The absence of disease approach provides no non-zero standard to define the frequency or amount of disease that is acceptable in healthy fish (Stephen et al. 2011). Abundance-based stock assessment does not address the nuances of what is happening during the life course of salmon (Dorner et al. 2013). Neither health standard defines health from a cumulative effects perspective.

The Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River (hereafter referred to as the Cohen Commission) directed DFO to consider cumulative effects to better manage salmon

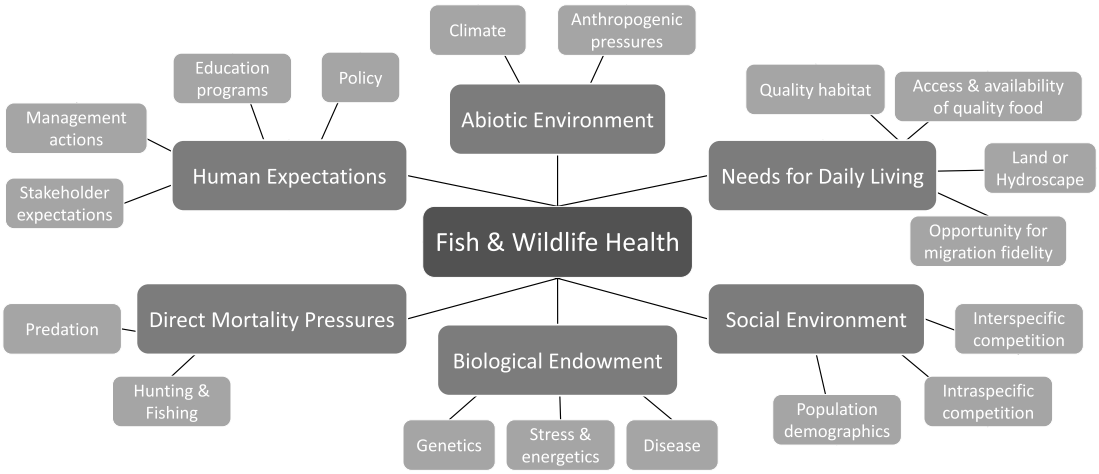

Fig. 1. Determinants of health model based on thematic analysis of fish and wildlife health and resilience literature. Six determinants of health categories were identified, with multiple drivers contributing to each category (used with permission from Wittrock et al. 2019).

(Cohen 2012a). No roadmap on how to accomplish this was provided for salmon health. Wittrock et al. (2019) argued that a determinants of health (DOH) framework (**Fig. 1**) could facilitate the development of a cumulative effects perspective of salmon health. The DOH model conceptualizes health as the result of interacting individual, population, social, and environmental factors. Developing a DOH approach for a new population is a four-step process: (*i*) establish a need, or will, to shift to a new perspective; (*ii*) define what a healthy population is based on scientific and social parameters; (*iii*) select population health indicators informed by the definition; and (*iv*) set indicator thresholds in accordance with scientific, political, and public perspectives (Frankish et al. 1996; Hancock et al. 1999). This paper addresses the first of this four-step process for DFO's mandate to manage Pacific salmon health. The Canadian Food Inspection Agency has a role to play in managing federally reportable diseases in Pacific salmon, restricting its policy framework largely to an absence of disease model. This paper focusses only on DFO because of its broader mandate for salmon health and influence on salmon determinants of health.

Change is more likely accepted and implemented if a receptive context for change exists (Butterfoss et al. 2008). Our goal was to determine if there is a DFO policy context to adopt a DOH approach. We examined 2018 DFO policy using a multiple streams framework and a narrative review of polices impacting salmon health using Wittrock et al.'s (2019) DOH model as a guide. We hypothesized that the DOH model is relevant to DFO salmon health management in British Columbia, Canada, because of: (*i*) the support in literature and practice for a DOH approach for salmon developed in Wittrock et al. (2019) and (*ii*) the prominence of Pacific salmon health issues as a DFO priority.

A DOH perspective is used to understand and manage what makes a population healthy or not (Cieza et al. 2016). It (*i*) considers interactions among the many contributing factors that influence health, rather than focusing on a pathophysiological or biological state alone; (*ii*) expands consideration of the scope of interventions, information, and expertise that can influence health; and (*iii*) along with information on adverse outcomes like disease, strives to implement a proactive, preventive approach (Frankish et al. 1996; Nordenfelt 2011; Stephen 2013, 2014). The DOH approach focuses on sustaining capacity to remain healthy, rather than delaying actions until harms occur (Frankish et al. 1996; Stephen 2014). Public health programs are regularly developed based on priorities identified using a DOH framework (Arah 2009). A more detailed discussion of the theoretical basis for a DOH approach for fish and wildlife health can be found in Wittrock et al. (2019); they concluded that

both the literature and experts supported the concept of fish health as a cumulative effect involving multiple factors that extend beyond the disease and pathogen focus of many health studies and legislation. Wittrock et al. (2019) identified six themes associated with fish health namely: (*i*) the biological endowment of the individual and population, (*ii*) the animal's social environment, (*iii*) the quality and abundance of the needs for daily living, (*iv*) their abiotic environment, (*v*) sources of direct mortality, and (*vi*) changing human expectations (**Fig. 1**).

Methods

Policy narrative review

DFO legislation and regulations on record in 2018 were found by searching Canada's Department of Justice's "Justice Laws website", the online source for Canada's Acts and regulations (Department of Justice 2018). We searched the DFO website (Fisheries and Oceans Canada 2018a) for policies and regulations, using the titles of the legislation and regulations found on the Justice Laws website as search terms. We sought relevant international law and reports from international commissions using the search terms "Pacific salmon" and "legislation" or "treaty" or "policy" or "regulation" in Google.

We subsequently conducted a narrative descriptive synthesis of the DFO policies found using guidelines from Popay et al. (2006) to inform the critical appraisal, data extraction, and exploration of the documents. Narrative synthesis systematically reviews and synthesizes multiple documents, relying on the use of words and text to synthesize and explain the findings. Our aims were to determine (*i*) if or how legislation and policy discussed health, (*ii*) themes and measures with which the legislation and policies were concerned, and (*iii*) if or how existing legislation and policy aligned with the six determinants of salmon health themes shown in **Fig. 1** namely: abiotic environment, social environment, needs for daily living, biological endowment, direct mortality pressure, and human expectations.

A scoping review of Web of Science Core Collection, Aquatic Sciences and Fisheries Abstracts, MEDLINE, Zoological Record, Ebscohost, and CAB direct was conducted using the words "due diligence", "fish surveillance", "fish health surveillance", plus variations using key concepts that establish due diligence (standards of practice, threshold, etc.) to seek evidence of policy-relevant health thresholds. The use of concepts related to due diligence and surveillance was an attempt to capture health goals or thresholds not found in policy but potentially explained in programs or research. The English literature between 1995 and 2017 was searched. Inclusion criteria was any peer-reviewed literature that included the search terms focused on surveillance due diligence in fish health or fish populations.

Assessing the policy context

We used Kingdon's (1984) multiple streams framework to situate and assess salmon health in policy. A policy priority arises when there is convergence of the problem, policy, and politics streams (Kingdon 1984). The problem stream outlines conditions as a problem that require government action. The policy stream includes the needs and expectations of policies and programs that have become the focus of a review for new initiatives. National mood, social pressure, and changes in administration priorities occur in the politics stream.

To assess the problem stream, we reviewed the Cohen Commission (Cohen 2012a, 2012b, 2012c). DFO had made a commitment at the time of this research to implement the Cohen Commission recommendations (Fisheries and Oceans Canada 2018e). The recommendations were therefore influencing DFO Fraser River sockeye policies and programs. We also reviewed Canada's Policy for Conservation of Wild Pacific Salmon (known as the Wild Salmon Policy; Fisheries and Oceans Canada 2005). We conducted an internet search using Google with the term "protecting wild salmon health", seeking news articles, blogs, and other grey literature. This was done to gain insight into the conversation in the media

and public perceptions on the topic. What people are searching for from Google can provide insight into what the public are concerned about or interested in (Scharkow and Vogelgesang 2011).

We used our policy inventory and narrative review to fulfill the policy stream component of Kingdon's approach. While conducting the narrative review, we identified whether there were needs or opportunities for a DOH perspective within DFO legislation, policy, and regulations or international agreements. A need existed if there was a gap between a perception of health as a cumulative effect of determinants of health and how health was mentioned in legislation and policy. If a policy document advocated for or described an aspect of the DOH framework that either did not exist in other documents or there was no evidence of its implementation, we classified this as an opportunity to introduce a DOH perspective.

To assess a political need to revise DFO's salmon health policies, we turned to the mandate letter from Canada's Prime Minister to his Minister of Fisheries, Oceans, and the Canadian Coast Guard (Prime Minister of Canada 2016). The Minster serving in 2018 was guided by the letter delivered in 2016. The mandate letter provides "a framework for what Ministers are expected to accomplish, including specific policy objectives and challenges to be addressed" (Prime Minister of Canada 2015). These letters are meant to guide the approach and priorities of the ministry's work (Prime Minister of Canada 2015).

Results

Policy inventory

Legislations governing DFO were: the *Coastal Fisheries Protection Act*, the *Department of Fisheries and Oceans Act*, the *Species at Risk Act*, the *Fisheries Act*, the *Health of Animals Act*, and the *Oceans Act*. We found 34 policies and regulations based on these Acts related to salmon. No Act defined or provided parameters or thresholds for measuring health. Components of each of the determinants of health could be found across numerous policies (**Table 1**). The Cohen Commission and the Wild Salmon Policy were the only documents that included references to or guidelines on all the DOH themes. The context in which salmon or health were mentioned was always for serving anthropocentric interests.

Need for policy change

Healthy runs, healthy sectors, healthy oceans, and healthy populations were mentioned throughout DFO policies. The Cohen Commission included 13 recommendations that highlighted health. DFO's Wild Salmon Policy had a goal, two principles, two objectives, and three strategies centering on or mentioning health. Despite using the word "health" over 400 times in the three volumes of the Cohen Commission and 27 times in the Wild Salmon Policy, neither defined health (**Table 2**). Recommendations and strategies in the Cohen Commission and the Wild Salmon Policy included: research and monitoring Fraser River sockeye salmon health from a cumulative impacts assessment perspective, linking health information to conservation, assessing the effects of salmonid enhancement facilities on wild sockeye salmon health, accessing and sharing fish health data, and determining if serious risks to health occur. The Strategic Salmon Health Initiative, a DFO response to Cohen Commission recommendations, focused on finding signals of pathogen presence (Fisheries and Oceans Canada 2016). Many policies focused on managing salmon abundance for harvest (**Table 1**; Direct Mortality Pressures). Several policies and recommendations cited healthy salmon and fish stocks as a management and conservation goal, but they either did not define how to recognize a healthy state or they used a single aspect of health to describe health status (**Table 2**).

The objective of DFO's fish health program in British Columbia in 2018 was to monitor and minimize the potential risks of disease within farmed fish populations and subsequent transmission to wild

Table 1. Documents guiding Fisheries and Oceans Canada (DFO) Pacific salmon population management, categorized by determinant of health categories identified in Wittrock et al. (2019).

Determinant of health theme	Canadian Federal Legislation, Policy, Regulations, and International Treaties directing DFO	Other documents influencing and informing DFO policy
Abiotic environment	• Policy for Conservation of Wild Pacific Salmon • Fish Toxicant Regulations • *Canadian Environmental Protection Act* • *Species at Risk Act* • *Canadian Shipping Act* • *Fisheries Act* • Pacific Salmon Treaty	• United Nations—In Dead Water • United Nations Conference of Straddling Fish Stocks/ Highly Migratory Fish Stocks Agreement • Standing Committee Report on 2004 Fraser River Salmon Fishery • Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River • United Nations Convention on Biological Diversity
Needs for daily living	• Riparian Areas Regulations • Policy for Conservation of Wild Pacific Salmon • *Fisheries Act* • *Fish Protection Act* • *Canadian Environmental Protection Act* • *Species at Risk Act* • *Oceans Act* • Pacific Salmon Treaty	• Standing Committee Report on 2004 Fraser River Salmon Fishery • United Nations Conference of Straddling Fish Stocks/ Highly Migratory Fish Stocks Agreement • Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River • United Nations Convention on Law of the Sea • United Nations Convention on Biological Diversity
Biological endowment	• Fish Health Protection Regulations • Policy for Conservation of Wild Pacific Salmon • *Fisheries Act*	• United Nations Conference of Straddling Fish Stocks/ Highly Migratory Fish Stocks Agreement • Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River
Social environment	• Policy for Conservation of Wild Pacific Salmon • *Species at Risk Act* • Pacific Salmon Treaty	• Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River • United Nations Convention on Biological Diversity
Direct mortality pressures	• Fishery Regulations • Policy for Conservation of Wild Pacific Salmon • *Fisheries Act* • *Species at Risk Act* • Pacific Salmon Treaty	• Provincial forestry regulations in British Columbia • Standing Committee Report on 2004 Fraser River Salmon Fishery • United Nations—In Dead Water • United Nations Conference of Straddling Fish Stocks/ Highly Migratory Fish Stocks Agreement • Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River
Human expectation	• Fishery Regulations • Policy for Conservation of Wild Pacific Salmon • *Fishing and Recreational Harbours Act* • *Fisheries Act* • *Oceans Act* • *Fisheries Improvement Loans Act* • *Fisheries Development Act* • *Coastal Fisheries Protection Act* • Pacific Salmon Treaty	• Provincial hydroelectric regulations in British Columbia • Pacific Salmon Resources in Northern British Columbia and Yukon Transboundary Rivers • United Nations Conference of Straddling Fish Stocks/ Highly Migratory Fish Stocks Agreement • Cohen Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River Reports for the Minister of Fisheries and Oceans Canada (Oceans Act and (or) Fisheries Act) • United Nations Convention on Law of the Sea • United Nations Convention on Biological Diversity

salmon (Fisheries and Oceans Canada 2018c). The Fish Health Protection Regulations (Fisheries and Oceans Canada 1984) and Pacific Aquaculture Regulations (Fisheries and Oceans Canada 2015) dealt only with diseases or pathogens. Fish Health Management Plans, a requirement of the National Aquatic Animal Health Program for aquaculture operations, emphasized biosecurity to

Table 2. Frequency and context in which the word "health" was used in federal policies, legislations, regulations, and other documents guiding Fisheries and Oceans Canada salmon health management found through a search of Canada's Department of Justice's Justice Laws Website and Fisheries and Oceans Canada website.

Documents reviewed (n = 43)	No.
Documents that do not mention health	31
Documents that only use health in reference to people and (or) livestock	9
Documents that use health without a definition	11
Documents that use health <30 times	9
Documents that use health >100 times	3

prevent the introduction and movement of infectious diseases, safe use of drugs and chemicals, and disease emergency response plans (Fisheries and Oceans Canada 2018b). No literature was found to define "due diligence" expectations for health monitoring or surveillance. DFO policies failed to identify thresholds that could indicate the action signals for health surveillance or monitoring. Some policies dealing with conservation topics included consideration of the abiotic environment, needs for daily living (i.e., access to essential ecosystem services including food and water security and safe habitat), biological endowment, and social environmental determinants of health themes (**Table 1**). Most of these documents did not provide detail or only mentioned single variables in isolation.

Our Google search found four main themes related to salmon health in British Columbia: (*i*) risks to wild salmon from commercial salmon aquaculture, (*ii*) protecting the needs for daily living for salmon (with an emphasis on protection of freshwater habitats), (*iii*) action on climate change and pollution, and (*iv*) the role for salmonid enhancement hatcheries to supplement wild populations. These coincide with areas of interest of the Cohen Commission and the Wild Salmon Policy. Some scientists, members of the public, and First Nations expressed concerns about threats to the health of wild salmon from aquaculture and that DFO was not doing enough to reduce these threats.

The Minster responsible for DFO in 2018 was expected to protect the health of fish stocks and to act on recommendations of the Cohen Commission. The Minister's mandate letter stated the "overarching goal will be to protect our three oceans, coasts, waterways and fisheries and ensure they remain healthy for future generations" and listed "protect[ing] the health of fish stocks" as a top priority (Prime Minister of Canada 2016).

Discussion

This exploratory study suggests there is a receptive policy environment to incorporate a DOH perspective into DFO salmon health regulation and management. Converting this policy opportunity into action would be challenging. DFO's responsibilities for salmon's determinants of health are spread across multiple policies and regulations (Fisheries and Oceans Canada 1984, 2005, 2013, 2018b, 2018d; Minister of Justice 2002; Cohen 2012a; Government of Canada 2017). There is no organizational framework to integrate information and activities derived from these diverse policies and programs. The lack of an integrative framework or capacity to develop a single perspective of salmon health is a recognized deficit in DFO's management approach (Cohen 2012a).

Political, policy, and public expectations emphasized health as a wild salmon management target but the use of the word health without a consistent definition means that DFO can not explicitly assess if it has reached that management target. The Cohen Commission noted that the lack of a health standard prevented scientists and regulators from properly assessing risks to wild salmon and taking

informed preventive actions (Cohen 2012c). Fisheries management regulations focussed on abundance or harvest as a surrogate for health, whereas fish health policies focussed on absence of a specific diseases. The lack of a policy vision for salmon health as a cumulative effect of multiple, interacting determinants of health along with the political motivation to create one has produced the need for a new policy perspective. Wittrock et al.'s (2019) DOH model may provide a framework for transitioning DFO towards a cumulative effects perspective.

The focus on absence of disease is an outdated definition for health (Stephen 2013), but no alternatives were provided in DFO policy apart from the implicit conclusion that if a population was abundant and (or) harvestable, it was healthy. The reliance on abundance to serve as a proxy for health is limited because methods for yielding precise and unbiased estimates of abundance are often cost-prohibitive or logistical challenges prevent fulfillment of the underlying assumptions of population sampling methods (Falcy et al. 2016).

We found no examples of how a DOH approach has been used in fish health. Other sectors have transited from defining and measuring health as survival or freedom from disease to health as the capacity to cope and thrive throughout the life course. Agriculture herd health and public health are examples. Their transitions were achieved through concurrent policy innovations, applied research, and social change. Growing economic pressures drove livestock producers towards views of health that emphasized providing animals with the physiological and environmental capacities to cope with diseases and the pressures of maximizing productivity. Concerns about social justice and the inability of the health care system to reduce the social impacts of illness drove public health innovation. In both cases, it was shown that health is achieved both inside and outside of the traditional health sectors and that effective leadership was needed to inspire change.

The Canadian Index of Well-being is an example that could guide the evolution of a salmon health program. It provides a broader depth of understanding needed to help make decisions that will build a healthy society. It tracks a subset of indices in eight domains of well-being. The goal of this Index is to communicate and monitor those things that make us healthy, rather than determine if a subjective optimum state of health has been met. As health is a social construct and the expectations for what constitutes healthy changes over time, there is no single optimal health. A similar fish health framework, when combined with more traditional risk assessment tools, could help communicate the implications of risk management decisions on the capacity of salmon to cope with life's challenges and meets societies expectations.

A healthy public policy perspective could help DFO transition its health programs. This perspective is built on the rationale that health is determined by multiple factors outside the direct control of the health policies. It considers the health implications of decisions across sectors and promotes awareness of how policies that seem unrelated to health could impact population health (World Health Organization 1986). Recommendations in the implementation plan for the Wild Salmon Policy for integrative research on salmon abundance, health, and condition could be supported by a healthy public policies perspective. The Wild Salmon Implementation Plan, published in 2018, re-enforces the recommendations of the Wild Salmon Policy, yet the mechanisms for implementing the Plan remained unclear at the time of this paper.

The second step in the four-step process in transitioning to a DOH perspective is to define what a healthy population is based on scientific and social parameters (Frankish et al. 1996; Hancock et al. 1999). From some perspectives, this is a relatively straightforward task of addressing the risk factors associated with outcomes like diseases and low return rates. This perspective adapts a linear, problem-solving approach to public policy. Other perspectives suggest that a government's policy decisions are based not only on scientific data but also on the vagaries of public opinion, electoral

considerations, personal preference, and crisis management (Willison and MacLeod 1999). In this perspective, health indicators might be selected by social and biophysical sciences but the thresholds for acceptability must be negotiated to address the various expectations of different rights and stakeholders. Developing indices and thresholds for multiple layers of organization (individual, population, ecosystems) is a complex, ongoing, and contentious process. There is not space to get into this topic in detail. Suffice it to say that the role of scientific evidence in policy making is variable, depending on the stage of the policy-making process at which it is introduced. Other organizations and governments with rights and stakes in salmon health management, including but not limited to First Nations and provincial governments, should be consulted in subsequent steps of the process of assessing the suitability of the policy environment for a DOH perspective. While outside groups such as these do not directly set DFO policy, as partners in fisheries management, their goals and expectations set the political environment that influence DFO policy development.

The primary critique of Kingdon's approach is its greater focus on agenda-setting than on the later stages of the policy process (Howlett et al. 2015). Others argue that agenda-setting determines the subsequent stages of the policy process (Barzelay 2003). As our purpose was to identify if there was a receptive policy environment for a DOH perspective, this critique is not applicable at this stage of our research.

Author contributions

JW and CS conceived and designed the study. JW, MA, and ML performed the experiments/collected the data. JW and CS analyzed and interpreted the data. CS contributed resources. JW, MA, ML, and CS drafted or revised the manuscript.

Competing interests

The authors have declared that no competing interests exist.

Data availability statement

All relevant data are within the paper.

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