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ARTICLE

What is "usable" knowledge? Perceived barriers for integrating new knowledge into management of an iconic Canadian fishery[1]

Vivian M. Nguyen, Nathan Young, Marianne Corriveau, Scott G. Hinch, and Steven J. Cooke

Abstract: Understanding the perspectives of knowledge users and the demands of their decision-making environment would benefit researchers looking to enhance the utility of the knowledge they generate. Using the Fraser River Pacific salmon fishery as a case study, we investigate the views of 49 government employees and stakeholders regarding the barriers to incorporating new knowledge into fisheries management. Our study uses analysis of qualitative data structured by a knowledge–action framework, which revealed that 90% of respondents perceived the contextual dimension (e.g., institutional structures and norms) as a barrier for incorporating new knowledge, followed by barriers related to the characteristics of knowledge actors (52% of respondents), characteristics of the knowledge (27%), time and timing (27%), knowledge transfer strategies (17%), and relational dimension (8%). The identified barriers have indirect–direct relationship with knowledge producers and appear hierarchical in nature. We note that informal relationships can enable conditions whereby knowledge users can access new knowledge, and knowledge producers can gain insights on users' needs. We discuss lessons learned from the case, which we believe can be applied more beyond fisheries.

Résumé : La compréhension des points de vue des utilisateurs de connaissances et des exigences de leur contexte décisionnel aiderait les chercheurs qui veulent accroître l'utilité des connaissances qu'ils génèrent. En utilisant la pêche au saumon du Pacifique du fleuve Fraser comme étude de cas, nous examinons les points de vue de 49 employés gouvernementaux et parties prenantes concernant les obstacles à l'intégration de nouvelles connaissances dans la gestion des pêches. Nous faisons appel à l'analyse de données qualitatives structurées par un cadre de connaissances–actions, qui révèle que 90 % des répondants perçoivent la dimension contextuelle (p. ex. structures et normes institutionnelles) comme étant un obstacle à l'intégration de nouvelles connaissances, suivie par des obstacles associés aux caractéristiques de ceux qui agissent avec les connaissances (52 % des répondants), des caractéristiques des connaissances (27 %), de la durée et du moment (27 %), des stratégies de transfert des connaissances (17 %) et de la dimension relationnelle (8 %). Les obstacles cernés ont un lien indirect–direct avec les producteurs de connaissances et semblent être de nature hiérarchique. Nous notons que des relations informelles peuvent rendre possibles des conditions permettant aux utilisateurs de connaissances d'avoir accès à de nouvelles connaissances et aux producteurs de connaissances d'obtenir de l'information sur les besoins des utilisateurs. Nous abordons les leçons tirées de l'étude qui, selon nous, peuvent être appliquées au-delà de la pêche. [Traduit par la Rédaction]

Introduction

In fisheries management, knowledge claims, including scientific knowledge, are embedded in a complex social web. Research methods and scientific findings that are widely accepted in the academic literature are often ignored or greeted with skepticism by practitioners (Young et al. 2018). This is largely due to the fact that knowledge is evaluated differently by potential users, who often scrutinize claims not only based on their methodological soundness, but for their credibility, legitimacy, and saliency to real-world social–ecological problems and concerns (Cash et al. 2003; Young et al. 2013, 2016*b*). Sometimes, uptake of new knowledge into fisheries management can be influenced by government models, political regimes, the geographic region, the organizational culture on information management, and personal and institutional interests and values of different stakeholders (Cossarini et al. 2014; Soomai 2017*a*, 2017*b*). The decision-making process in fisheries management is also complex and must often consider multiple objectives, disciplines, perspectives, and constituencies and respect economic and political realities (Cook et al. 2012). The fact that fisheries are tied to economies, cultures, and livelihoods make fisheries management and the use of new knowledge politically risky (Cochrane 1999). Producing knowledge that is usable in this context is not an easy task.

Understanding the decision environment of knowledge users (e.g., fisheries managers, decision makers, and stakeholders) and the capacity to which they interact with new knowledge is an important first step. For example, evidence has shown that results of scientific research may not always be in a format that is accessible or directly applicable to the needs of decision makers or resource managers (Dilling and Lemos 2011). In other cases, research fails to reach users in a timely manner, particularly in fields where policy and management decisions must be made

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V.M. Nguyen and S.J. Cooke. Department of Biology and Institute of Environmental Science, Carleton University, 1125 Colonel By Drive, Ottawa, ON K1S 5B6, Canada.
N. Young and M. Corriveau. School of Sociological and Anthropological Studies, University of Ottawa, 120 University Private, Ottawa, ON K1N 6N5, Canada.
S.G. Hinch.* Department of Forest and Conservation Sciences, The University of British Columbia, 2424 Main Mall, Vancouver, BC V6T 1Z4, Canada.
Corresponding author: Vivian M. Nguyen (email: vivian.m.n@gmail.com).

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Table 1. Components of the knowledge–action framework used to help code and structure the qualitative data analysis (summarized from Nguyen et al. 2017).

Element	Description
1. Knowledge production	Generation of "new" knowledge either in isolation by research institutions or co-created through participation and engagement with knowledge users.
2. Knowledge mediation sphere	The mediation is essentially the "gap" between knowledge and action. It emphasizes the nonlinearity and dynamic processes of knowledge movement. Further, it is broken down into two broad components: the knowledge network and the environmental and contextual dimension that lie outside of this network.
3. Knowledge network	A complex social network of interactions between knowledge actors and the knowledge produced as well as among the actors. The dynamics and interactions within the network can occur at multiple levels and time scales.
3a. Knowledge actors	The individual or players that are involved in the exchange and mobilization of knowledge.
3b. Characteristics and perceptions of actors	Who and where do the actors come from, their character, and how they are perceived may influence how knowledge is exchanged or mobilized.
3c. Relational dimension	The relationship and ties between knowledge actors.
3d. Characteristics of the knowledge	The type and attributes of knowledge that is entering the knowledge network can have influence on how it is perceived and mobilized.
4. Contextual dimension	Factors external to the knowledge network that can influence the movement of knowledge such as culture, institutional norms, economic context, and political context.
5. Knowledge–action outcomes	The outcome of the knowledge that may or may not be measured, as some may be less tangible, such as perception change or lack of action – lag in action.

quickly or in a set timeline (Soomai 2017*a*). In other cases, uncertainties and misunderstandings about methods, findings, and potential applications can hinder uptake (Refsgaard et al. 2007; Jones and Bence 2009; Nguyen et al. 2018). Finally, the literature suggest that the roles and goals of knowledge producers and users often differ, and these gaps contribute to a lack of mutual understanding of each other's values, priorities, and knowledge systems (Roux et al. 2006; Gibbons et al. 2008). In the science-policy literature, issues related to the paradoxical relationship between science and politics as well as the influence of governance structures are additional challenges to using science in decision-making (Soomai 2017*a*). These factors widen the gap between knowledge and action, which undermines the effective flow of information across knowledge and practice (Liu et al. 2008).

This study aims to (*i*) empirically identify the perceived barriers of integrating new knowledge, in particular scientific knowledge, into fisheries management practices and policies from the perspective of the potential knowledge users and (*ii*) identify what may constitute useable knowledge based on the data gathered and drawing on our own experiences. The research results can help bridge the gap between knowledge and action. We use a theoretical framework elaborated elsewhere (i.e., Nguyen et al. 2017) to conceptualize and classify the barriers. The case of the Pacific salmon fishery in the Fraser River, British Columbia, Canada, is important because it has been the subject of intense political and scientific interest in recent years, leading to emerging scientific methods and techniques that have produced novel evidence that, in principle, have management implications (see Cooke et al. 2008, 2012; Miller et al. 2011). In this article, we define evidence as encompassing both information and knowledge, whereby information is a tangible, factual output that has not been interpreted, while knowledge is a body of information learned and conveyed through processes (e.g., scientific, policy, story-telling), which is shaped by the perceptions and experiences of the "knower" (Posner et al. 2016). We use the term "knowledge" so as to not discriminate against other types of knowledge (e.g., local, traditional, and experiential knowledge), but focus on scientific knowledge as it is the most discussed knowledge claim in our case study.

Theoretical framework

The socially embedded nature of knowledge movement means that a sociological perspective and approach to understanding science integration is needed. A recent knowledge–action framework, developed by Nguyen et al. (2017), brings forward the social dimension of knowledge movement and can aid in identifying and analyzing the various dimensions of knowledge flow. Frameworks are useful for providing conceptual structure to a suite of ideas and can help align the analysis of field data to broader contexts and findings in the literature. Here, we use the knowledge–action framework (i.e., Nguyen et al. 2017), which is based on concepts of knowledge exchange and mobilization, to structure our research findings (see conceptual figure from Nguyen et al. 2017). The framework organizes variables that have been hypothesized to influence the movement of knowledge into components of a "knowledge mediation sphere", a space in which knowledge interacts with various social factors: (*i*) the knowledge network, composed of knowledge actors, the characteristics of the knowledge actors, and the relational dimension (e.g., relationships among actors and knowledge), and (*ii*) the contextual dimension, which describes factors external to the knowledge network such as norms, culture, and economic and political contexts that may influence knowledge generators and potential users. The framework also highlights the process of knowledge movement occurring at various scales and levels with potential interactions across them (Table 1; Nguyen et al. 2017).

The case: Fraser River Pacific salmon fishery

The history, economy, and culture of the west coast of Canada and northwestern United States have been linked to Pacific salmon for thousands of years. Historically, salmon were the staple of many First Nation (indigenous) people inhabiting the region for food, social, and ceremonial purposes. Today, salmon continue to be of major cultural and economic importance for Canadians, with important ecological roles (Groot and Margolis 1991; Cederholm et al. 1999). The Fraser River watershed is one of the most productive salmon rivers in the world and is thus one of the most socially and ecologically complex regions in Canada. The river is home to five species of anadromous Pacific salmon: Chinook (*Oncorhynchus tshawytscha*), chum (*Oncorhynchus keta*), coho (*Oncorhynchus kisutch*), pink (*Oncorhynchus gorbuscha*), and sockeye (*Oncorhynchus nerka*), as well as steelhead trout (*Oncorhynchus mykiss*). The Fraser River also hosts three major fishing sectors: First Nation, commercial, and recreational fisheries. Not surprisingly, the Pacific salmon fishery in the Fraser River is among the most intensively managed fisheries in the world, making it an interesting case study to examine for understanding the movement of knowledge into fisheries management.

There are controversies about the cause(s) of salmon declines in the Fraser River and contradicting scientific evidence related to the declines (Cohen 2012). The Cohen Commission judicial inquiry was a 2-year process that involved hundreds of witnesses and thousands of submitted statements and evidence related to the decline of Fraser sockeye salmon in 2009 (Cohen 2012). The inquiry is an example of the mounted pressure on officials to better manage and conserve salmon resources. The Cohen Commission made 75 recommendations, and even so, the government has been slow to implement them (Cohen 2012), and there is considerable pressure on fisheries managers and officials to demonstrate positive impacts from public investments as documented in the Office of the Auditor General petition catalogue (e.g., OAGC 2013).

Management of Fraser salmon is extremely complex (see Cohen 2012), involving the federal department of Fisheries and Oceans Canada (DFO), the Pacific Region DFO, and the Canada–US binational Pacific Salmon Commission (PSC). The mandate for DFO is multifaceted and includes promoting economic growth, ensuring sustainable harvests and ecosystems, conducting research, and consulting stakeholders. In the last few decades, DFO has focused on the co-management of key fisheries. For the Fraser salmon fishery, this is applied under PSC and the Fraser River Panel, which consists of stakeholder representatives, including First Nation groups. DFO also consults other advisory boards such as the Commercial Salmon Advisory Board, the Sport Fish Advisory Board, and the Marine Conservation Caucus (representation from environmental nongovernmental organizations, ENGOs). As such, stakeholders and resource user groups have a key role in the management of Pacific salmon in the Fraser River. DFO regional managers, in particular, are often expected to synthesize and translate multiple (often contradicting) knowledge claims and information into on-the-ground decisions (Young et al. 2013).

With respect to scientific capacity, there were 55 scientists (circa 2012) employed in the Pacific region conducting research on a variety of topics such as fish physiology, genomics, oceanography, aquaculture, and ecosystem dynamics, much of which is relevant to Pacific salmon (Cohen 2012: 53 scientists). DFO scientists also collaborate with academic institutions on projects that include biotelemetry tracking, genomics, population modeling, and physiological techniques (Patterson et al. 2016). Research conducted includes questions related to climate change, juvenile outmigration, adult upriver migration, fisheries interactions, and diseases, among others. Annual investments related to Pacific salmon alone by the Government of Canada reached $65 million in 2013 (DFO 2014). Of this amount, $20 million was directly related to Fraser River sockeye, which include fisheries science.

DFO also has an internal review process, titled the Canadian Science Advice Secretariat (CSAS), which coordinates the peer review of scientific issues for the DFO. The different regions of Canada conduct resource assessments, with national oversight, which is specific to the regional characteristics and stakeholder needs. CSAS works with the regions to develop integrated overviews of issues in fish stock dynamics, ocean ecology, and use of living aquatic resources and to identify emergent issues quickly. It exists for evaluating scientific claims on issues of concern to fisheries managers and includes stakeholder representatives (see Cooke et al. 2016 for description of evidence assimilation by DFO; Soomai 2017*b*). The CSAS process results in development of a science advisory document. Furthermore, the science-policy interface of DFO has been documented, in the Atlantic region, as an internal linear model whereby advice is provided by DFO Science Branch in response to management questions, which lead to other information sources and issues to be overlooked, such as local or academic knowledge (Soomai 2017*b*). However, nuances and complexities do exist in how science-policy issues are identified. Despite these resources and processes, scholars have critiqued DFO's hesitation to adopt new scientific tools and findings, particularly when findings originate from research conducted outside the department (Hutchings et al. 1997; Young et al. 2013; Patterson et al. 2016).

Regional fisheries managers possess important decision-making responsibilities and authority. With DFO's legislated co-management boards, consultation with stakeholders, and the substantial investments in internal and external scientific research on Fraser River salmon, managers have a complex role in fisheries governance that includes forecasting the status of different salmon species and stocks, consulting stakeholders, adjusting and regulating fisheries "in-season", and implementing ministerial directives. They are also expected by stakeholders and the public to make use of new scientific evidence generated by the public funds (i.e., investments by Canadians). Fisheries managers are thus important potential users of new science and represent an important interface for science and action (Young et al. 2013). It is therefore important to understand the perspectives of potential knowledge users and understand the challenges that may impede the movement of new knowledge into action.

External science informing Fraser River fisheries management — our experiences thus far

The author team associated with this study is part a broader interdisciplinary team of researchers from universities and DFO Science Branch who have been investigating the fundamental and applied (e.g., climate change, hydropower, disease, fisheries interactions) migration biology of anadromous Pacific salmon for over 15 years. Over the past 7 years, much of the research activity has focused on the fate of fish released after capture by different fisheries sectors. The team has interacted with fisheries management and stakeholders in various capacities described below.

The University of British Columbia (UBC) annual stakeholder workshop and symposium model

Our research team has engaged in annual stakeholder workshops and symposia as a communication and knowledge exchange tool. The annual full-day workshop and symposia are held at UBC and organized by Scott Hinch's Pacific Salmon Ecology and Conservation Lab (PSEC). What began 20 years ago as a small, informal gathering of researchers at UBC has grown into a large symposium with over 70 attendees in 2016. The workshop provides a forum for collaborative research groups (consisting of university principal investigators, graduate students, and government research collaborators across Canada and northwestern US) to update stakeholders on the ongoing relevant individual projects and connecting results strategically with critical management issues. The audience consists of nearly every interest group, ranging from DFO, PSC, private scientists, representatives from the First Nation, commercial and recreational fishing sectors, fish processors, and ENGOs.

CSAS Commissioning: the formal request from DFO Fisheries Management Sector to the Science Sector to develop scientific advice on catch-and-release mortality

In 2016, 2 years after the data collection of this study, the PSEC lab and its collaborators were commissioned by CSAS to create a research document that comprehensively reviewed the mechanistic (i.e., physiological) basis for how different factors (e.g., fish injury, temperature, physiological stress, gear types, population variations, and other) affect fishing-related mortality and reviewed mortality rates (described in Patterson et al. 2016). The CSAS process provides a direct link and mechanism for "external" science from the PSEC lab to be integrated into institutional guidelines for Pacific salmon management. This formal document will be shared with all stakeholder groups. Management changes will not occur until all groups have been consulted.

Table 2. Affiliations of the 49 respondents, grouped as government employees and stakeholders.

Government employees	*N*	Stakeholders	*N*
Fisheries management branch (DFO)	17	Commercial fishery	3
Science branch (DFO)	2	Recreational fishery	5
Pacific Salmon Commission	6	First Nation fishery	3
Other	2	Nongovernmental organization (NGO)	8
		Private consultants	2
		Other	1
Total	27		22

Methods

The research discussed in this article is part of a broader study entitled "Mobilizing new knowledge for fisheries management in the Fraser River", which investigates the role of academic science in the decision-making of government regulators and stakeholders involved in the co-management of Fraser River salmon fisheries (see Young et al. 2016*a*, 2016*b*). The interview schedule used for this analysis was developed in three stages. First, we conducted a literature review on knowledge exchange and mobilization to gather existing empirical measures. Second, our DFO collaborators reviewed the interview guide, and lastly, we pretested the interview guide with two government employees and two representatives of stakeholder groups. We used a mixed-methods approach with exploratory questions that are both closed- and open-ended (see Young et al. 2016*a*, 2016*b* for more details). For this study, we evaluated responses that pertain to barriers that may impede the integration of new science into fisheries management. In particular, we evaluate the following open-ended question from the interview schedule: "In your experience, what barriers do you believe exist in incorporating new knowledge into actual fisheries management practices?" The question was left intentionally open to respect multiple types of knowledge. However, respondents overwhelmingly referred to science and scientific knowledge in their responses to this question; therefore, this paper will focus exclusively on the utility and movement of scientific knowledge.

The sample was broadly divided into two groups, government employees and nongovernmental stakeholders, and was developed in consultation with senior managers at DFO and experts who have worked on Fraser River salmon fisheries for over 20 years. This was to ensure that key members of the sample population were identified. We used snowball sampling to supplement the original population when respondents voluntarily referred us to others. As per the breakdown shown in Table 2, the government employee respondents consisted primarily of fisheries managers. These are individuals who were most directly involved in daily decision-making and collaborations with stakeholders, as well as individuals who advise and provide data for decision-making (Table 2). It also included employees in the DFO Science Branch who were identified by the organization as working closely with fisheries managers and stakeholder groups. Several senior managers were also interviewed, and individuals from the PSC were also included in this group and were primarily fisheries stock assessment scientists. The stakeholder groups were more diverse and included representatives of commercial and recreational fisheries, First Nations communities and fishery, nongovernmental organizations, and private consultants (mainly scientists) who were hired by stakeholders and play a role in the co-management processes (see Young et al. 2016*a*, 2016*b*). We recognize that the term stakeholder does not comprehensively describe the diversity and nuances of all individuals involved shown in Table 2. Each of them has distinct interests, values, identities, and perspectives. This group is, however, distinct from government employees and has similar roles in that they are all involved in the co-management of Fraser River salmon but external to government (see Nguyen et al. 2016; Young et al. 2016*a*, 2016*b*). Therefore, we present the findings from the two perspectives of government employees and nongovernmental stakeholders. We illustrate the prevalence of the emergent themes as number of respondents who mentioned the theme and elaborate on the theme with illustrative quotes.

A total of 49 interviews relevant to this analysis were completed between November 2013 and September 2014: 27 with government employees and 22 with nongovernmental stakeholders. About three-quarters of the interviews were conducted face-to-face, and the remainder were conducted over the telephone. Some of the requests for interviews were communicated internally by DFO; therefore, response rates were estimated (approximately 66% for government employees and 63% for stakeholders). Interviews lasted between 40 min and 3 h (most were 1–1.5 h) depending on the level of detail provided by respondents. The study was conducted in accordance to the University of Ottawa Research Ethics Board.

We performed qualitative analyses using NVivo 10 software in a three-step process. First, responses were read and deductively coded by the primary author using themes from the knowledge–action framework (Nguyen et al. 2017) to structure and organize the responses (see Table 1 for framework themes). Responses were read and coded to a particular theme under the framework. Responses, now coded under a framework theme, were read a second time to inductively identify key subthemes (Thomas 2006), which subsequently provided a list of potential secondary codes that give more nuance to the framework themes. Last, responses were tallied and sorted under these subthemes (see Table 3) to provide a measure of their prevalence. A response may have multiple thematic codes if warranted. Overall, we illustrated areas of the knowledge–action framework that were most prevalent in acting as barriers to the integration of new knowledge into practice.

Results and discussion

The knowledge–action framework provided structure and organization for coding the open-ended responses. The framework themes revealed that 90% of the 49 respondents believed that factors under the contextual dimension (e.g., the capacity to use new knowledge) were among the greatest barriers to integrating new science into fisheries management, followed by factors under characteristics of knowledge actors (52% of respondents), characteristics of the knowledge (27%), relational dimension (8%), time and timing (27%), and knowledge transfer strategies (16%) (Fig. 1; Table 3). We present the findings based on the components of the knowledge–action framework and expand on the nuances of each theme by describing subthemes and illustrative quotes. We focus on concepts that had substantial weight (mentioned more than five times) but have captured the additional themes in Table 3.

Contextual barriers

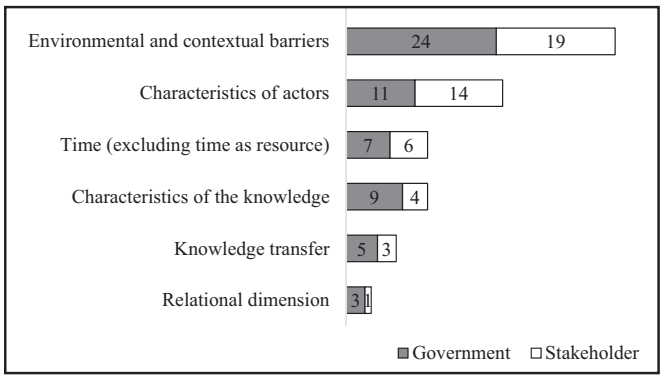
Contextual barriers identified by government employees and stakeholders include governmental and institutional barriers, political and economic barriers, and potential social implications of integrating new knowledge (Table 3).

Table 3. Coded themes that emerged using a knowledge–action framework (Nguyen et al. 2017) with subthemes (inductively coded) that provide more nuance and description related the framework categories.

Barriers coded	Government	Stakeholder	Total respondents
1. Contextual barriers	**24**	**19**	**43**
Government and institutional systems, structures, norms, and culture	21	16	37
The "process" (e.g., bureaucracy, consultations, review, approvals)	10	7	17
Constraints on human and financial resources (including time)	9	8	17
Decision-making tools (e.g., forecasts and models)	5	6	11
Lack of process	4	1	5
Management change and changes in management in environment (no continuity and relationship maintenance)	2	2	4
Political and economic factors	4	6	10
Contextual differences between knowledge producers and users	5	2	7
Social impacts (e.g., on livelihoods)	2	2	4
2. Characteristics of actors	**11**	**14**	**25**
Motivational factors and constrained decision-making (i.e., inertia, maintenance of status quo, lack of political will)	6	10	16
Social acceptance and buy-in of new knowledge by users	5	8	13
Perceived value of science	2	4	6
Compatibility with existing attitude, perceptions, and world views	1	4	5
Perceived lack of accountability by managers to act on new knowledge	0	2	2
3. Characteristics of the knowledge	**9**	**4**	**13**
Applicability–usability of the new knowledge (relevance, compatibility)	6	0	6
Complexity of the knowledge (variability, uncertainties)	0	3	3
Perceived reliability–credibility of the knowledge	2	1	3
Contradictory evidence	2	1	3
4. The relational dimension	**3**	**1**	**4**
5. Time and timing (excluding time as a resource)	**7**	**6**	**13**
6. Knowledge transfer strategies	**5**	**3**	**8**

Note: Numbers reflect respondents who mentioned each theme, and these numbers are not mutually exclusive.

Fig. 1. Distribution of the number of respondents that identified barriers for incorporating new knowledge into fisheries management practices based on the knowledge–action framework themes.



Government and institutional systems, structures, norms, and cultures

Institutional barriers were the dominant theme identified by both stakeholders (16) and government employees (21), such as its rigid management frameworks, lack of organizational support for new initiatives, bureaucracy, cost of new implementations, the government structure and culture, and funding issues (Table 3). Several respondents felt that it is challenging enough to keep abreast of their administrative tasks and that there is little to no time to engage with new science or knowledge:

> To be brutally honest, we are so busy with day-to-day management, and day-to-day operations, we don't spend much time paying attention to research. We wait until research has been vetted through all the processes…when the government have accepted this research and they are incorporating in what they are doing, then we start using it. (Interview #34; First Nation stakeholder)

> We have a process in the region for prioritizing our science requests, and then whether or not they get addressed, and how they get addressed, in what timeframe, depends upon resources available and competing interests for the use of people's time and money. (Interview #15; fisheries management)

There was extensive discussion by both groups about the constraints of human and financial resources, particularly due to the budget cuts in science and personnel during the tenure of Canada's Conservative government (2006–2015), which includes the study period (Peyton and Franks 2015). One fisheries manager said, "If we continue to see reductions in budgets, we can't even keep doing what we're doing now into the future."

It is worth noting that 11 respondents (five government and six stakeholders) identified the established decision-making and management tools as a barrier to incorporating new knowledge into fisheries management practices. This is also known as path dependence (Munck af Rosenschöld et al. 2014). For instance, quantitative modelling and forecasts are primarily used in the management of Fraser River salmon fisheries (especially for sockeye and pink), and fitting new data or new knowledge (particularly externally derived) into such existing tools can be challenging because of a lack of compatibility with existing practices. Indeed, some respondents critiqued the rigidity of the current management tools and the dependency of managers' decision-making on these models. For example:

> There are managers and others out there who were completely intoxicated with the thought that they can solve everything by modeling. Modeling is only as strong as the weakest information within it. The term assumption is the

> biggest problem because 'assume' is when you make an ass out of you and me. (Interview #10; DFO Science Branch)

Another noteworthy theme is what respondents referred to as "the process" (Table 3). The process occasionally referred to the CSAS process, the bureaucracy, the Fraser River Panel Process, a general "internal approval process" for vetting actions and communications, or an "external consultation process" that takes place with stakeholders. The latter appears to be linked to securing social acceptance and consensus. Government employees discussed the extensive process of stakeholder consultations as having a strong impact on their work:

> We consult beyond humanly possible and it still comes up short. The requirements are pretty onerous and costly and at times not humanly possible, because we're meeting with individual or group of First Nations, we're meeting with commercial, environmental groups…these are just the harvesting sectors, and then there's all the internal politics and the salmon commission. (Interview #15; fisheries management)

Political and economic factors as barriers

A number of respondents associated the use of new knowledge with change that would affect certain groups, as described here by a fisheries manager:

> Usually, new scientific information is going to result in change and that change is going to invariably affect somebody. That somebody is usually a harvester, and politically harvest groups are pretty powerful." (Interview #18)

Therefore, knowledge may become or be perceived to become "politicized" because it can be used to advance certain agendas or to maintain status quo. Stakeholders view political agendas and biases as originating in government and dictating how knowledge is or is not used (for example, the former Conservative government was frequently criticized for ignoring or undermining scientific research). Conversely, government employees tended to attribute politicization to the actions of stakeholder groups, specifically the political spin such groups were believed to extend on different types of research and knowledge to advance their interests.

Contextual differences between knowledge producers and users

The literature suggests that cultural and role differences between knowledge producers and users as a cause for the underuse of new knowledge (e.g., Cook et al. 2010, 2013; Young et al. 2013; Cvitanovic et al. 2016). Evidence of this difference creating barriers was also found in our study. One profound example of a retired government employee illustrates this disparity:

> You don't go into this business [fisheries management] with anticipation that you are right. You will always be wrong but it's how far you are wrong. You hope you get close and hope the impact of the analysis you have done won't put somebody out of work. I have been in tears a number of times of the mistakes that I have made, and profound regret. If you don't feel that, you are in the wrong business. Unfortunately, the researchers, they do not feel that. That is the problem with university environment they don't feel that pain. (Interview #25; PSC)

Social impacts and livelihoods

Decision makers and fisheries managers are often faced with difficult decisions because of the multifaceted environment that fisheries are entangled in and the number of interest groups associated with the fisheries. Here, a fisheries manager explains the challenges that they face:

> The department is put in a position of first of all ensuring conservation, then access to First Nations, then all other stakeholders. But somebody is always saying "You are not looking after my interests". We cannot make everyone happy. The goal is to piss as few people off as possible…. The department is trying to keep everybody happy, which is impossible. I've told managers privately, I've said, you look at yourself in the mirror and accept the fact that whatever the decision you make, you'll be wrong. And so, you make the best decision from your analysis. (Interview #8; fisheries management)

Characteristics of actors

Barriers associated with characteristics of the actors included motivations and the constraints that restrict decision-making (for example, pressures to maintain the status quo, lack of political will for change); the need for social acceptance and buy-in from knowledge users; the compatibility of the new knowledge with existing attitudes, perceptions, and world views of knowledge actors; and the perceived lack of accountability by managers to act on new knowledge (Table 3).

Motivational factors and constrained decision-making

The motivations of individuals and institutions appear to be an important barrier to integrating new knowledge and were variously described by respondents as "lack of political will", "inertia", "established patterns in big organizations", or being unable to "teach old dogs new tricks". Many fisheries practices are historical and established, making them difficult to change or incorporate new knowledge claims. Stakeholders, in particular, mentioned inertia and lack of political will more often than government employees, suggesting potential criticism of the governing body and structure (10 stakeholder versus six government respondents; Table 3). This is consistent with many contested areas of science policy, such as climate change policy, in which there is lack of motivation to use new knowledge at the institutional level (Munck af Rosenschöld et al. 2014; Stål 2015). Often, existing management solutions and strategies are familiar to decision makers and are viewed as an investment that has been legitimized; therefore, decisions makers are motivated to restrict their set of options and keep financial and political cost of decision-making low (Gezelius and Refsgaard 2007). Decision-making has also been found to be influenced by path dependence, previous decisions, incentives (personal and professional), or other social situations that are often defined by the role of the knowledge user and thus lead to a narrow decision space or bounded rationalities (Feldman and Ingram 2009; Lodge and Wegrich 2016). For example:

> There is no incentive to bring in new science, because it is troublesome and too much work and difficult. The political interest, and economic interest, it is calcified around the status quo. (Interview #46; private scientist)

DFO uses a linear science-policy model where requests for advice are initiated "in-house" instead of a more active adaptive management framework, which has potential trade-offs such as the cause of new knowledge and issues from other sources to be overlooked and discounted (Soomai 2017*b*). Soomai (2017*b*) revealed that DFO Maritimes Region preferred using their own fisheries scientific production and grey literature over peer-reviewed scholarly journals or individual authored publications because they are timely and reports are produced in an annual cycle that is relevant and in direct response to fisheries management questions. These government structures and processes create barriers for the utilization of externally derived scientific knowledge and could potentially be the culprit for the maintenance of the status quo.

Social acceptance and buy-in of new knowledge by users

In such a contested fishery, it is not surprising that new knowledge and knowledge claims are scrutinized by the potential knowledge users. Young et al. (2016*a*) found that potential knowledge users judge the reliability of knowledge claims based on multiple criteria (including judgements about the knowledge

claimant or source). Therefore, for new knowledge to be used it has to go through a process of sociopolitical evaluation. Others have termed this an evaluation of "social robustness" (e.g., Gibbons 1999; Nowotny 2003; Young et al. 2013), and this is illustrated in the following quotation:

> [People] want it to be proven among peer group…like a democratic acceptance that could also be a hindrance [to using new knowledge]. People can get hung up on that. Someone will say "Hey I did this study and this stock is being exploited too much". Then they will tell the managers to adapt the fishery, and in between people will say let's make sure you are right and that delays things. People just want a "perfect study" and it will slow down the process. Can't have top notch golden data, there is no money for that. There needs to be acceptance of some unknown. If there is disagreement on the model, let's say, that would take months to get proper people [experts] chosen, to get them together, etc. to talk about the "disagreement". For example, the CSAS critique. It's a long process, and is frustrating, but it's just the way it is. (Interview #16; fisheries management)

Scholars have termed this type of knowledge production as Mode 2 or context-sensitive science in which the knowledge produced is both reliable inside the laboratory and outside (Gibbons 2000; Hessels and van Lente 2008). The quote below illustrates the complexity of the sociopolitical context in which new knowledge enters:

> Now you've got a large number of ENGOs, First Nations communities, sports fishing groups as well as commercial fishing groups, all vying for a say in how these fish are managed…and many of them have now hired their own biologists…. So instead of having a single scientific authority that provides the best guess of the data…we now have a number of different groups presenting "the science" from their perspective, favouring their view of the objectives and outcomes they want to see, which makes for an informed debate, but also just adds to the difficulty and the complexity of the process. Whether or not you actually get better decisions is unclear to me. (Interview #36; stakeholder)

Perceived value of science

Some stakeholders felt that the undervaluing or underuse of science in fisheries management can cause delay in its incorporation, as illustrated here:

> I am not absolutely sure how valuable people [fisheries managers and DFO] consider research to be. They probably could take the time to read all the latest papers and really mull it over, but I don't think there is that many people within the government who can do that. (Interview #34; First Nation stakeholder)

The perceived value of science can potentially interact with other processes such as institutional barriers and system that drive priorities, resulting in the undervalue or underuse of scientific knowledge.

Characteristics of the knowledge as barriers

Barriers that relate to the characteristics of the knowledge include its perceived applicability–usability (relevance to manager needs or compatibility with existing knowledge); the complexity of the new knowledge (associated with variability, uncertainties, and challenges for interpretation); its reliability and credibility; and existing contradictory evidence (Table 3).

Applicability and usability (relevance, compatibility, representativeness) of the new knowledge

The applicability and relevance of the new knowledge is important to government employees and is a major question among scholars: how to produce "readily usable" information for decision-making? Government employees focused more on the technical aspects of knowledge claims, arguing that usable knowledge is characterized by objectivity and is free of biases and sociopolitical influences. This is consistent with Cash et al.'s (2003) argument regarding the importance of credibility, legitimacy, and saliency of knowledge claims in the eyes of users. It also strengthens the findings from Young et al. (2016*a*), which show that government employees judge the reliability of knowledge more closely to how it fits in their role and rely heavily on internal review processes. Stakeholders, on the other hand, judge new knowledge claims through a more social lens. They tend to look at "who" is influencing and interpreting the data and how credible that person is based on their "on-the-ground" experience and funders, for example. In this study, government employees were concerned about the **compatibility** of the new findings with their current management tools and frameworks, as well as how comparable the new findings are to currently used data. Second, it appeared that an applicability challenge is how **representative** the new knowledge is of the environment in which it is being implemented. Last, the applicability also refers to whether the new knowledge **answers the question** that fisheries managers need.

Within the stock assessment process, one major concern expressed by government employees was whether descriptive scientific studies could be turned into quantitative predictions. The quotations below illustrate the challenges that fisheries managers perceived when presented with new knowledge:

> How can we apply that knowledge to what we have and what we do? From what I can see, we have to be able to model it somehow, so it could be incorporated into our knowledge. (Interview #24; PSC)

> One of the main ones [barriers] would be applicability. The study has to be useable in the management environment. That could be due to a number of things. For example, for post release mortality rates. If you have 2 studies that is design A and a 2nd study that is design B, if they are not comparable it is challenging to incorporate into management. (Interview #25; fisheries management)

Complexity of the knowledge, reliability–credibility of the new knowledge, and contradictory evidence

The complexity of new knowledge can also undermine its application, as it carries uncertainties as well as variability. This can also lead to potential reliability issues that may delay its incorporation into fisheries management practices. Furthermore, the new knowledge can also have counter-contradictory evidence, which presents a challenge for incorporation as "reconciling the conflicting science is difficult", as stated by a government employee (Table 3):

> In my career working with so many people in stock assessment, complexity and data are simply used as an excuse in many cases. It's easy to say we don't have the science so we don't respond. That's what led to precautionary principle. We can't use data as an excuse or lack of data as an excuse. But there isn't any question that people did that throughout the 80s when we were really modifying how we did things out here. They were quite prepared to blame the next guy and not themselves. (Interview #39, ENGO stakeholder)

The relational dimension

Building trusting and meaningful relationships are core concepts in the literature that suggest people rely on their social network for gathering information as well as to judge the legitimacy and credibility of knowledge based on trust (e.g., Bayliss et al. 2012; Young et al. 2016*a*). The quotation below suggests that building knowledge producer–user relationships can create an informal avenue for knowledge exchange and enhance the use of new knowledge:

> There are gaps in the "team" of scientists, management and fishers. All this money is going into these great studies and data, and the products are good and ground-breaking. But, there is no procedure in place to get to them. We are sort of relying on communication, working and consultation groups and would hope that any significant findings do make it down the pipe. (Interview #18; fisheries management)

Another respondent explained the importance of developing trust not only among actors, but also trust in the instruments that are used to produce new knowledge. For example:

> Human nature is averse to change. There is a tendency to conform to what is familiar. How the new information is presented and communicated is important — compare the new to now — and it's important to do it in a pragmatic way. There was a transition in the 90s to move [from fish scale analysis for identifying populations] to genetic based stock discrimination. Even though you can describe in basic detail inheritance of genetic traits and adaptations, how do fishermen know how reliable this new technique is? A lot of comparisons and validations. Compare scale-based vs genetic results, always compare with what they know. It's important to communicate in the currency or the way the audience can relate to. Develop the trust in your expertise. Show them where it can screw up and clearly describe when it will fail. (Interview #25; PSC)

Time and timing

Various perspectives of time were discussed as a barrier to using new knowledge, such as (*i*) the timing of when the new knowledge is communicated; (*ii*) the time needed to implement a change or reform; (*iii*) the time for both scientists and managers to genuinely and meaningfully engage; and (*iv*) the time for the knowledge mobilization process to take place (i.e., time for the knowledge to be produced, for everyone to understand it, come to terms with it, and for it to come into practice). Decisions and planning exercises in salmon management are cyclical, occurring during specific times of the year. Sometimes, the failure to provide information at the right time can lead to the information losing virtually all of its value to the decision maker (Jacobs et al. 2005). This is consistent with findings from DFO Maritimes Region, in which the author reported DFO management's preference for DFO Science because it is matched with their annual cycle and have direct answers to fisheries management questions (Soomai 2017*a*, 2017*b*).

Knowledge transfer strategies

The inaccessibility of scientific findings is a well-known barrier to knowledge mobilization (Eden 2011; Bayliss et al. 2012; Crossin et al. 2017). A good deal of scientific information is still cloistered behind journal pay walls. Furthermore, accessibility is hindered by inability or disinterest in communicating science in lay language, which prevents potential users from engaging with key ideas and discoveries (Hulme 2014). In this research, eight respondents described barriers during the knowledge transfer and dissemination stage (Table 3). There were conflicting views on whose role is it is to ensure new findings are properly diffused. For example, one respondent asserted that it is the responsibility of management to seek out new and up-to-date knowledge if they want to improve their practices and management outcomes, while another respondent believed that scientists are responsible for effectively communicating their findings. Respondents also highlighted that no effective process currently exists for communicating or transferring new knowledge. One fisheries manager commented that the UBC–Carleton stakeholder workshop model is "one of the better kinds of relationship and communication, but unfortunately we do not have the same sort of relationship with other groups within academia".

Facilitators and potential solutions

Although not specifically requested in the interviews, 15 respondents (eight government and seven stakeholders) offered opinions on potential solutions. These included factors internal to the knowledge networks, such as seeking out collaborative solutions and actively brokering the movement of knowledge via a key individual. They also included factors beyond the control of scientists and managers, such as shifting management decision-making frameworks and changing institutional structures to streamline the movement of new knowledge into practice. These solutions are discussed in Table 4 and provide information and lessons learned on what constitutes usable knowledge in the eyes of our respondents.

Synthesis

Consistent with results from other studies, we found that "usable" knowledge needs to be (*i*) applicable to management needs and scales (relevant and compatible), (*ii*) socially robust (trusted and accepted by knowledge users), and (*iii*) congruent with the capacity of the knowledge users' decision space (e.g., align with institutional and rational constraints; Cash et al. 2003; Buizer et al. 2012; Cvitanovic et al. 2016). Evidence of path dependence was highlighted, and knowledge producers who seek to produce relevant information need to be mindful of the multifaceted environment that knowledge users engage with daily. This may prove to be a challenging task if no relationship or conversation exists between the knowledge producer and user. As a result, new models of knowledge production and approaches (e.g., Mode 2 production, co-production of knowledge, transdisciplinarity) have evolved to better integrate science, scientists, the public, and policy that can help break down barriers and path dependence (Gibbons 2000; Schusler 2003; Pohl 2008; Kirchhoff et al. 2013; Dick et al. 2016).

We used a knowledge–action conceptual framework to organize and interpret our findings. This framework demonstrates the complexity of the barriers involved, ranging from the characteristics of the knowledge, to the limitations of communication activities, to the particular contextual sociopolitical challenges facing potential knowledge users. We conclude this article with a discussion of the conceptual developments of the barriers to integrating knowledge into actions and what our findings mean for those interested in ensuring that their findings have the potential to be used.

Types of barriers: direct–indirect and hierarchical

Our results show that barriers to knowledge mobilization are both direct and indirect. In other words, there are areas where knowledge producers may have (*i*) little autonomy for facilitating knowledge integration, such as institutional structures, and political or economic factors (i.e., contextual dimension); (*ii*) some influence on barriers to knowledge use, such as user motivations, perceptions, and attitudes (i.e., characteristics and perceptions of actors) through building relationships and iterative interactions; and (*iii*) near total control in enhancing knowledge use through producing reliable and credible knowledge, simplifying the complexity of the knowledge, and producing relevant and usable knowledge (i.e., characteristics of the knowledge). Researchers must navigate these levels of barriers and focus their efforts on areas they may have greater direct impact to enable the use of new knowledge.

Relatedly, barriers to the use of new evidence appear to follow a hierarchical logic. First, there are barriers to accessing evidence such as time and capacity to interact with new knowledge, motivation and perceived value of science, or the contextual differ-

Table 4. Five solutions and facilitators discussed by knowledge users in the Fraser River salmon fisheries with illustrative quotations.

(1) Collaborative solutions: iterative dialogue, interactions and knowledge exchange between producers and users

An apparent theme was iteration — iterative dialogue, interaction, and knowledge exchange. This is widespread in the literature, suggesting that two-way dialogue, long-term relationships with knowledge users, and feedback is integral to successful knowledge exchange (e.g., Gibbons et al. 2008; Groffman et al. 2010; Reed et al. 2014; Young et al. 2014). These activities can increase interpersonal trust and promote the co-production of knowledge as well as solution-oriented agendas, which have been documented to facilitate and promote knowledge mobilization (Fazey et al. 2014; Cvitanovic et al. 2015, 2016)

(2) Holding workshops and increasing frequency of face-to-face interactions for feedback and development solution-oriented agendas

Respondents positively commented on a model used by a research group from The University of British Columbia and Carleton University, which consists of researchers being "very proactive in making their projects relevant and useful". Reasons why their model was preferred is illustrated below:

> I think the model that [university professor names] has in terms of outward reporting, which is a one-day in the Spring everybody comes and takes a look at what's been going on [research-wise]. We've also had meetings with them [university researchers] in the Fall, to say, well here are some of the questions we have that are outstanding, do you think that some of the projects might be useful. So, there's the pre-planning of projects, as well as the follow-up in terms of these are the results, which then leads to potentially more questions. (Interview #13; fisheries management)

(3) Involve a third party: knowledge brokering and boundary organizations

Boundary organizations or other bridging organizations and knowledge brokers are often individuals, teams, or organizations perceived as neutral and are trusted by the relevant parties (Berkes 2009). They play an intermediary role and are skilled in providing two-way communication among multiple sectors through translating and communicating information into more useful and usable forms. Furthermore, they can assist in producing boundary objects such as agreement on a common list of key resource management questions (Cash et al. 2003; Feldman and Ingram 2009; Clark et al. 2016; Lemos et al. 2012; Nel et al. 2016). In the case of the Fraser River salmon management, the use of a third party was viewed to also help alleviate burden with shrinking capacity. NGOs, in particular, have pivotal roles in actively engaging with knowledge and making change in environmental policy (Jasanoff 2010). These sentiments are illustrated below:

> To get them [fisheries managers] to engage with it [new science, disruptive science], it takes people, an organization, willing to take that science and ram it down their throats. Academics can't do that because they have to maintain their integrity. It takes organizations, conservation, First Nation and other organizations to ram it down their throats until they are finally breached, but it is very difficult. (Interview #46; private scientist)

(4) The role of researchers: being transparent, include broad and multiple lines evidence, and use tailored communication

There are certain solutions and facilitating factors that knowledge producers have autonomy over, for instance, demonstrating transparency of the science (disclosing uncertainties and limitations) and providing multiple lines of evidence to support knowledge claims (e.g., including local knowledge). Multiple lines of evidence are helpful to knowledge users, particularly decision makers, for adapting to the continually changing management context (Cook et al. 2012), especially because managing Pacific salmon is highly unpredictable. Knowledge users that have authority in management of salmon are more often concerned on direct applications of research to known problems, while stakeholders focus on the implications of this new knowledge in a sociopolitical context (Young et al. 2016*b*). As such, communicating in the same currency as the audience — in a way that the audience can relate to — can promote effective communication. Knowledge producers tailor their communications and engagement to align with the preferences, roles, understanding, and expectations of potential user groups (Groffman et al. 2010; Young et al. 2016*b*).

(5) Formalize review process for integration of external and broader knowledge

Formalizing the process for the use of "external" science (e.g., academia, traditional knowledge, local ecological knowledge) can be a solution to streamline and harness research more broadly and in a more coordinated way. For example, developing a formal process to streamline external science into the CSAS peer review process would give greater weight to the research, as illustrated below:

> We're having discussions right now [about new knowledge of 30% bycatch mortality rates], and one of the questions that keeps coming up is "well, has it been peer-reviewed"? So, I think that if this work was channeled through the CSAS process, or some similar process, with the same level of standard of review…then we are in a much better position to use that data. [If the new knowledge were reviewed through CSAS] The Department is then in a position that it can hold it up and say "hey we have a real credible study here that is suggesting that the impacts of this fishery are not the 70% [bycatch mortality] that was identified in that previous study, which had some problems". (Interview #21; fisheries management)

The administrative burden that some respondents describe in their roles can undermine the use of new knowledge and evidence-based decision-making for the sustainable management of Fraser River salmon. By streamlining and formalizing a process that brings in external science, it may alleviate some problems with shrinking capacity (human and financial resources):

> I don't think that to date we've done a good job of using academia, and I think that's where there may be an opportunity going forward. I think that's due to the declining resources within DFO in terms of people and budget…. We ought to try to formalize this process, either within CSAS or separate from it, to allow academics to formally provide advice to the Department to address some of the inadequacies within our organization to get some help on the things we can't do on a yearly basis. (Interview #21; fisheries management)

ences between knowledge producer and user worlds that prevent access to evidence. Second, there are barriers in the application of new knowledge. For instance, the institutional structures and bureaucratic systems that delay the use of new evidence, the buy-in of knowledge users, the compatibility of new knowledge with users' world views, and the perceived complexity, reliability, and usability of new knowledge. By combining our understanding of the direct–indirect as well as hierarchical relationships of these barriers, we can offer targeted recommendations to enhance the use of new knowledge.

Addressing the barriers: lessons learned

Based on our findings and experiences, there are multiple approaches to addressing the barriers presented. Table 4 offered solutions from participants' experiences and suggestions, while here, we present lessons learned from our own experiences, which may prove to be useful for others who seek to enhance the integration of knowledge into actions.

Lessons learned from the annual stakeholder workshop

Our findings identified the annual stakeholder workshop and symposium to be an effective model for the transfer of scientific knowledge about Fraser River fisheries to management and stakeholder groups. The workshop appears to foster relationship-building among scientists, fisheries managers, and stakeholder groups and demonstrates successful creation of a social network in which trust, credibility, legitimacy, and saliency of the research can be developed and built upon — a critical element for successful knowledge exchange (Young et al. 2013). This model can help address the barriers to accessing knowledge by inviting knowledge users to interact directly with researchers at a workshop and can address the barriers of applicability by co-creating research agendas and opening the line of communication.

The success of this model is maintained by the researchers' proactive approach to communication and engagement (Table 4) and also relies on the willingness of managers and other stakeholders to participate and engage. Ideally, this engagement should occur at the initial development of research questions and study design (i.e., co-creation of the research agenda), which the group has achieved through smaller, more targeted meetings with key stakeholders and managers. Researchers should also be cognizant about the interpretation of their research by other groups outside of the management environment (Patterson et al. 2016; Young et al. 2016*a*).

Lessons learned from the CSAS evaluation process

Although the CSAS process can be lengthy, fisheries managers view this formal process as an effective way to bring in external knowledge and broader lines of evidence that would satisfy the contentious and political arena that surrounds the management of Fraser River salmon as shown in Table 4. This approach appears to help address barriers of applying new knowledge through rigorous internal reviews at DFO and can facilitate solutions to indirect barriers by institutionalizing the science (e.g., making the science part of the review process and gaining approval). As discussed in Cooke et al. (2016), there are opportunities to refine the CSAS process to ensure that it is best positioned to synthesize different forms of knowledge.

The knowledge–action framework and future research

Understanding and identifying the types of barriers that exist in a particular context is useful for developing effective communication and knowledge mobilization strategies. The knowledge–action framework has proven useful for conceptualizing the barriers and organizing them into themes. Our study also furthers understanding of the barriers between knowledge and action by revealing potential associations or interactions among the barriers identified. For example, we speculate that a number of institutional processes, such as consultation processes, are linked to increasing social acceptance of new knowledge. Alternatively, we speculate that inertia and lack of political will are linked to institutional structures and political factors such as government priorities. However, these relationships were not possible to test and are beyond the scope of this study. From a mechanistic view, further research into these interrelationships and links is warranted to improve our understanding of the knowledge–action gap and help develop effective knowledge exchange–mobilization.

Conclusion

Our results reveal different types and levels of barriers that may interact differently with varying contexts. Producing usable knowledge thus requires the consideration of different barriers faced by knowledge users and understanding the environment in which they interact with new knowledge. In the case of the Fraser River salmon fisheries management, it was apparent that institutional structures and government processes play a large role in undermining the use of new knowledge by limiting the capacity of users to (*i*) access new knowledge and (*ii*) apply it. Respondents described governmental fisheries management as a machinery with many "processes" (e.g., bureaucracy, consultations, reviews, approvals) that are "indirect" barriers, which can delay the use of new knowledge. "Direct" barriers, such as characteristics of the knowledge, knowledge transfer strategies, or influencing individual perceptions, can be overcome by knowledge producers. As such, fisheries scientists outside of DFO must first build their social networks and relationships with potential knowledge users to facilitate access to their research and second co-create research agendas to facilitate the application of new knowledge as demonstrated by the positive feedback from the respondents regarding the UBC annual stakeholder workshop and symposium. The proactivity and persistence of the research team led to the incorporation of their findings and greater evidence-based policies that include multiple lines of evidence. Further research into documenting successful approaches (case studies) or experimenting on solutions in overcoming the various types of barriers would be of major value to bridge the knowledge–action gap.

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