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Uncertainty, anxiety, and optimism: Diverse perspectives of rainbow and steelhead trout fisheries governance in British Columbia



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ABSTRACT

Inland fisheries are complex social-ecological systems that can generate important nutritional, economic, cultural, and recreational benefits. Effective management of these systems for multiple user-groups requires an understanding of the complex natural and human dimensions interactions within them. We examine the perceptions of stakeholders, Indigenous rightsholders, and regulatory/governance groups on the current and future status of Oncorhynchus mykiss (including their resident form - rainbow trout - and their anadromous form - steelhead) populations and fisheries in British Columbia (BC), Canada from 65 qualitative interviews and 1029 quantitative survey responses. Participants generally did not believe resident rainbow trout were threatened at the provincial level but were definitive in assessing anadromous steelhead trout as threatened. Habitat alterations, water temperature extremes, and climate change, were key threats identified for all forms of O. mykiss while bycatch in commercial fisheries and predation pressure from pinnipeds were specifically identified threats for steelhead trout. Anglers did not perceive recreational fishing pressure as a key threat in contrast to regulatory and governance groups. Fisheries managers were praised for stocking programs and managing small lakes fisheries but criticized for not doing enough to protect fish populations, for an unwillingness to challenge or confront commercial and Indigenous interests which infringe on conservation, and for a lack of aquatic monitoring. Three factors identified by participants contribute to fishery mismanagement, inaction, and decision paralysis: (1) insufficient resources (funding, staff, time), (2) confusion in jurisdictional authority between provincial and federal governments, and (3) organizational structure of natural resource management agencies which are not autonomous from competing commercial and industrial objectives and directions. Despite conservation being purported as the highest priority of fisheries managers, economic, social, and political drivers are perceived as increasingly influencing conservation decisions and actions. These findings can inform fisheries management and conservation decisions, policies and practices to ensure that they are more salient, robust, legitimate, and effective.

1. Introduction

Inland fisheries are complex social-ecological systems that provide important nutritional, economic, cultural, and recreational benefits to people (Arlinghaus et al., 2013; Lynch et al., 2016). Fisheries are essential to the sustainability and well-being of many communities around the globe (Welcomme et al., 2010; Cooke et al., 2016) and regions across Canada (Cooke and Murchie, 2015; Castañeda et al., 2020). They include commercial, moderate livelihood, subsistence, ceremonial, and recreational fisheries, which often maintain a common interest in the same fish. Responsible fisheries management is essential for the conservation and sustainable use of fishes (Arthington et al., 2016). Yet, the biophysical environment of inland fisheries is increasingly threatened by rapid environmental change. Stressors such as habitat alteration, pollution, invasive species, overexploitation and climate change are putting pressure on inland fish populations around the globe (Reid et al., 2019) including in Canada (Desforges et al., 2021). Indeed, fish are among the most endangered organisms globally, especially in freshwaters (Cooke et al., 2013; Reid et al., 2019). Globally, populations of freshwater species have declined by an average of 83% since 1970 (Harrison et al., 2018; Grooten and Almond, 2018), while migratory fish which depend on freshwaters have declined by an average of 76% since 1970 (Deinet et al., 2020). Ensuring the sustainability of fish populations and fish habitat in biophysical environments is but one major challenge to inland fisheries management (Arlinghaus et al., 2015).

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Effective fisheries management must also consider the needs of humans, making decisions in the face of conflicting objectives, such as improving angling opportunities, conserving wild populations, and controlling costs (Smith et al., 1999; Riley et al., 2002; Varkey et al., 2016). The North American Model of Wildlife Conservation, the prevailing model of science-based regulated management of wildlife on behalf of the public (Organ et al., 2012; Krausman and Cain, 2013; Ryder, 2018; Mahoney and Geist, 2019), like the biophysical environment, is also changing rapidly. Fisheries management in Canada today involves engagement with recreational, commercial, Indigenous fishers, environmental non-governmental organizations (ENGOs), and other stakeholders and rightsholders with a vested interest in a fish or fisheries issue, program, action, or decision. There are high expectations of fisheries managers to include all fisheries actors in management processes, and high expectations of these diverse fisheries actors for involvement in those management processes (Endter-Wada et al., 1998; Decker et al., 2012; Krausman and Cain, 2013). In terms of governance, fish and fisheries are seen by some as too complex to be governed by a single agency, opening calls for co-management - joint action of multiple parties - which is also 'good' and 'ethical' because it promotes participation, power, and equity of user groups (Fennell et al., 2008; Berkes, 2009; Quimby and Levine, 2018). Even when hierarchical institutional regimes are efficient, effective management is dependent on stakeholder support and perceptions of legitimacy associated with trust in governing bodies (Turner et al., 2016). Fisheries management in Canada is also further complicated by institutional challenges - transboundary governance of fish, overlaps in governance between federal and state (i.e., province, territorial) level governments, and confusion over who has jurisdictional authority (Temby et al., 2015; Jeanson et al., 2022).

In British Columbia (BC), the most westerly province in Canada, rainbow trout (Oncorhynchus mykiss) are a native cold-water salmonid fish whose populations (when and where thriving) support recreational, subsistence, and ceremonial fisheries underpinning social, cultural, and economic well-being of BC's diverse population, including Indigenous peoples with deep connections to lands and waters. Rainbow trout include freshwater residents and an anadromous form called 'steelhead' trout, which migrate from marine to freshwaters to spawn. The longterm sustainability of these fish populations and their dependent fisheries are threatened by increased water temperatures (Meka and Mc-Cormick, 2005; Parkinson et al., 2016; Twardek et al., 2018), declines in dissolved oxygen in lakes (Jane et al., 2021), drought and low water conditions (Whitney et al., 2016; Gronsdahl et al., 2019). In BC, rainbow trout fisheries contribute \$957 million CAD (e.g., licence sales, accommodations, fishing equipment, boats, fuel etc.) to local and national economies and translates into the employment of 5000 persons (Bailey and Sumaila, 2012; Freshwater Fisheries Society of BC, 2013). The most preferred species in terms of total 2010 catch in BC are rainbow trout (58%) while steelhead trout are the 8th most preferred species (2%) (Freshwater Fisheries Society of BC, 2013).

Management of rainbow trout, fisheries and wildlife in BC is complex, involving both federal and provincial government agencies, as well as Indigenous communities and governments in specific territories. The main agency responsible for management of freshwater populations of fish like rainbow trout is the British Columbia Ministry of Forests, Lands, and Natural Resource Operations and Rural Development (FLNRORD), the provincial natural resources ministry. Marine fish and tidal waters are exclusive federal jurisdictional authority and the primary responsibility of The Federal Department of Fisheries and Oceans Canada (DFO) agency. Under the Constitutions Act (s. 91(12), 92(13)) The Government of Canada (i.e., DFO) is responsible for conservation and protection of all fisheries while the Province (i.e., FLNRORD) has jurisdiction over all other aspects of fisheries (e.g., licenses, who can fish, fishery leases). DFO and FLNRORD thus have shared agency and responsibility for inland waters (lakes and rivers) and steelhead management. The province (FLNRORD) has been delegated administrative authority over the recreational steelhead fishery but regulation of the commercial, First Nations and salmon fisheries (marine and freshwater) remains the responsibility of DFO (Government of British Columbia, 2016). In addition, there are non-governmental stakeholders, such as academic researchers, non-profit organizations, private consultants, and resource user groups (e.g., anglers) that are also involved in management processes of rainbow trout in BC. The Freshwater Fisheries Society of BC (FFSBC; https://www.gofishbc.com), under contract from FLNRORD, is responsible for the province's fish stocking program, improving angler access, as well as various conservation services (including outreach and education) (for study area and background see Appendix A, Supplementary Material).

Here we examine the perceptions of stakeholders, Indigenous rightsholders, and regulatory groups on the current and future status of rainbow and steelhead trout populations and fisheries in BC, Canada. We are particularly interested in views on the resilience of rainbow trout populations in BC, fisheries management, and decision making. As part of this study, we also sought out suggestions on possible policy responses to new environmental conditions affecting rainbow trout. We use a) qualitative data from in-depth interviews with members from natural resource management branches of Indigenous and parliamentary governments, as well as non-governmental stakeholder groups and b) quantitative data from surveys from rainbow trout anglers, to analyze the factors which govern the long-term sustainability of these fisheries in BC. These perceptions can inform fisheries management and conservation decisions, policies and practices that are more salient, robust, legitimate, and effective (Bennett et al., 2017).

2. Methods

2.1. Interviews

A qualitative approach based on open-ended semi-structured interview questions (Axinn and Pearce, 2006; Creswell, 2014; Young et al., 2018) was used to gather opinions and perspectives of actors connected to rainbow trout science and management. The interview questions (see Table 1) were designed to encourage open-ended discussion about rainbow trout management from a wide range of respondents. This study was conducted in accordance with the University of Ottawa Research Ethics Board (File Number: 02-18-08). We performed a pilot interview after ethical clearance that showed no issues. All participants gave informed consent to participate in the study. Although some interviewees granted permission to use their names, all quotes shared in this article are attributed anonymously in order to protect identities.

We developed the initial population frame for interviews by searching the BC Government Directory (https://dir.gov.bc.ca/) for government employees who work in fisheries management using the keywords "fish" or "fisheries". The population frame was then further developed in consultation with two senior managers in the provincial government and a senior scientist/officer with FFSBC to ensure that key government employees, stakeholders, and rightsholders were identified. The population frame was then supplemented by snowball sampling from voluntary referrals by respondents.

Interviews were conducted in person and over the phone between April and November 2018. A total of 65 interviews were conducted (response rate of 40%) with participants from natural resource management branches of Indigenous governments (n = 4), parliamentary governments (n = 33), as well as representatives from FFSBC (n = 7) and non-governmental stakeholder groups (n = 22) who have been involved in the management of recreational and subsistence rainbow trout fisheries (Table 2). An additional 96 individuals were contacted but did not participate because they a) did not respond to our request or b) declined to participate due to little interest or no expertise in rainbow trout (affiliations of these individuals are provided in Appendix B, Supplementary Material). Each of the 9 different resource management regions in BC had at least one representative interview participant, covering all areas

Table 1

Open-ended interview questions analyzed in this article and to which interviewee group they were directed: Natural resource management branches of Indigenous governments (FN); parliamentary governments (GOV); representatives from Freshwater Fisheries Society of BC (FFSBC) and non-governmental stakeholder groups (STKH) (Table 2). Also included are relevant survey questions analyzed in this article which were directed to n = 1029 rainbow trout and steelhead anglers. n/a = not applicable.

Interview Question	Interviewee Group	Survey Question
Conservation status assessment of rainbow and steelhead trout populations In your opinion, do you think that wild rainbow trout populations are currently threatened [under threat]?	ALL (<i>n</i> = 65)	Please indicate your level of agreement or disagreement with the following statements: - I believe that [previously selected fish] populations in British Columbia are currently at risk of decline due to environmental changes
[If yes] What do you think are the primary causes of these threats? Why do you think that?		
[<i>If no</i>] Why do you think that?		In your opinion, how much of a threat do the following factors pose to [previously selected fish] populations? – Agriculture, Climate change, Commercial bycatch, Dams, First Nations fishing, Fish diseases, Fish farming/Aquaculture, Forestry, Habitat alterations, Invasive species, Mining, Predation, Recreational fishing, Residential & commercial development. Water quality In your opinion, over the past ten years, water temperatures of the waters you regularly fish in British Columbia In your opinion, over the next ten years, water temperatures of the waters you regularly fish in British Columbia In your opinion, climate change in British Columbia is Please indicate your level of agreement or disagreement with the following statements: - I believe that climate change will not harm [previously selected fish] populations in British Columbia for many years Please indicate your level of agreement or disagreement with the following statements: - I believe that climate change will never harm [previously selected fish] populations in British Columbia for many
Praise and criticisms of parliamentary governments managing the rainbow and	steelhead trout fishery	
In your opinion, what are governments doing right in managing the rainbow trout fishery? Doing wrong?	FN, FFSBC, STKH (<i>n</i> = 32)	In your opinion, how much of a threat do the following factors pose to [previously selected fish] populations? - Poor management Please indicate your level of agreement or disagreement with the following statements: - I believe that the provincial government has provided sufficient resources to successfully manage fish populations in British Columbia Please indicate your level of agreement or disagreement with the following statements: - I believe that the provincial government has implemented the necessary regulations to successfully manage fish populations in British Columbia Do you believe that the federal government ought to be involved in the management of fish populations in British Columbia?
Fishery actors	GOV FFSBC	n/a
season?		
[If yes] Which ones? How frequently? In what ways? How important is stakeholder input/feedback/consultations in your decision-making? How do you balance the different demands/interests of stakeholders in your decision-making? How do you prioritize these competing demands/interests? <i>Prioritizing conservation concerns in decision-making</i>	(n = 39)	
In your opinion, at what point do stakeholder interests or demands override potential conservation concerns?	GOV, FFSBC	n/a
	(n = 39)	
Criticisms of decisions made with respect to fisheries management of rainbow t As you know, some people are critical of the decisions made with respect to fisheries management of rainbow trout populations. What are the most common criticisms that you hear? What do you personally think of these criticisms? In your opinion	rout populations GOV, FFSBC (n = 39)	n/a
are these criticisms valid?		

of the province. Interviews lasted between 18 min and 2 h, depending on the level of detail provided by the respondent. Anadromous wild steelhead trout were discussed by interview participants opportunistically and voluntarily (i.e., there were no steelhead-specific questions).

2.2. Data analysis

Interview transcripts were transcribed from audio to text using Trint (https://trint.com) and then coded and analyzed using NVivo 12 software (QSR International Pty Ltd., 2018).

The coding process involved two steps. In the first step responses were categorized according to the original interview questions (Table 1) in order to isolate relevant content. In the second step inductive coding was conducted, for which the coded responses were re-read for emergent themes (Thomas, 2006; Charmaz and Belgrave, 2012). Responses were read a third time to identify any additional themes and were then sorted under final themes to provide a measure of their prevalence. A response may have multiple thematic codes if warranted. All coding was performed by the first author. Because the coding task, in addition to transcription of data from audio to text, already consumed a signif-

Table 2

Affiliations of the 65 interview participants, grouped as members from natural resource management branches of Indigenous governments, and parliamentary governments, the Freshwater Fisheries Society of BC as well as non-governmental stakeholders.

Indigenous Governments (FN)	N	Parliamentary Governments (GOV)	N	Freshwater Fisheries Society of BC (FFSBC)	N	Stakeholders (STKH)	Ν	TOTAL N
Biologists	2	Biologists (FLNRORD)	17	Biologists	2	Academia	6	
Fisheries Managers	2	Directors (FLNRORD)	3	Officers and Executives	4	BC Hydro	2	
		Fish & Wildlife Section Heads (FLNRORD)	6			Environmental non-governmental organization (ENGO)	5	
		Human Dimensions Specialist (FLNRORD)	1			Private environmental consultants	6	
		Policy Analysts (FLNRORD)	2			Retired provincial government employees	3	
		Conservation Science Section (MOECCS)	3					
		Science Branch (DFO)	1					
Participant Sub-Total	(4)		(33)		(6)		(22)	65

icant amount of time and resources, using more than one coder was not viable in this research. Additionally, the coding system/frame *is* the collection instrument, not the coder, and should establish coding consistency. Multiple coders may have different theoretical biases and will organize codes into themes in different ways (Armstrong et al., 1997) thus it is not always clear if using different coders reduces susceptibility to bias or errors in judgement. Although we acknowledge using multiple coders will reduce the risk of human error and may be a limitation in the present paper. Figures were produced in GraphPad Prism version 9.2.0 (www.graphpad.com).

2.3. Survey

Interview data was supplemented with an online survey of BC rainbow trout anglers, titled "*Threats to Rainbow Trout and Steelhead in British* Columbia" (see Jeanson et al., 2021),. For several themes for which there is overlap between interview questions and questions in the online survey (see Table 1), interview results are augmented with results from the online survey to provide complimentary insights on the views of rainbow trout angler stakeholders.

The online survey was conducted in accordance with the Carleton University Research Ethics Board (#10733). Participants were required to give informed consent via the online consent form at the beginning of the survey. The survey consisted of multiple choice, Likert-style, and free-answer questions. The survey mechanism was built and operated using the online Qualtrics software. The survey was pre-tested with three anglers experienced in fishing for rainbow trout in BC. Pre-testing indicated a completion time of approximately 15 min. The survey was available for approximately 6 months from the beginning of April to mid-October 2018 and was distributed using a non-random, non-stratified broadcast sampling method to reach BC rainbow trout anglers. The survey was distributed through recruitment posts to personal social media accounts (Twitter and Facebook), paid targeted advertising (Facebook), and links in email newsletters of FFSBC and Anglers Atlas.

A total of 1171 individuals opened the survey link and viewed the survey but after removing individuals who did not: i) continue the survey after reviewing the consent form (n = 47), ii) fish for rainbow trout in BC (n = 6), and iii) did not respond to any question in Table 1 or Appendix C, Supplementary Material (n = 89) a total of 1029 surveys from rainbow trout anglers were retained. At the beginning of the sur-

vey, anglers were asked to select which subpopulation of rainbow trout they target most (rainbow trout in streams/rivers, large lakes, and small lakes, steelhead in streams/rivers) and answer all survey questions with that response in mind to account for differences in fishing experiences. We grouped rainbow trout anglers to facilitate comparison with interviewee responses but recognize anglers in our case are not homogenous and grouping angler subpopulations risks losing some nuance. Statistical differences in responses between rainbow and steelhead trout anglers were compared with a two-sample Mann-Whitney U (Wilcoxon rank-sum) significance test.

3. Results

Additional results on the following topics not covered in the maintext due to space limitation constraints are provided in Appendix C, Supplementary Material: 'Ensuring the long-term sustainability of rainbow and steelhead trout fisheries in BC'; 'Managing wild populations versus stocked populations'; 'Rainbow trout management plan'; and 'The most challenging aspects of rainbow trout management and conservation'.

3.1. Conservation status assessment of rainbow and steelhead trout populations

For non-anadromous resident wild rainbow trout, interviewees generally provided a nuanced answer to whether wild rainbow trout populations are currently threatened, rarely taking an extreme position (28% not at risk, 55% neither threatened nor not at risk, 8% threatened) (Fig. 1). The following quotations capture the majority sentiment of interviewees, "at the provincial level no, at a population-specific level, yes some are at risk" (Interview #1, FFSBC); "it seems unlikely that the whole species is threatened but there certainly are certain populations that are threatened, and I would say certain types of populations are much more threatened than other ones" (Interview #55, academia affiliation). Most interviewees qualified their responses, acknowledging that some rare populations of resident rainbow trout (e.g., ecotypes, ecomorphs) may be threatened. Particularly, wild river and stream populations such as those in the Kettle and Horsefly rivers, as well as recreationally prized, large-bodied piscivorous rainbow trout like the Gerrard rainbow trout of Arrow, Quesnel, Kamloops, Shuswap, and Kootenay Lakes. Angler survey respondents took more extreme positions, with



Fig. 1. Perceived threat level of rainbow and steelhead trout in British Columbia by members from natural resource management branches of Indigenous governments (FN), parliamentary governments (GOV), Freshwater Fisheries Society of BC (FFSBC), non-governmental stakeholders (STKH), and anglers. Rainbow trout: FN, GOV, FFSBC, STKH interviews n = 65, angler surveys n = 143.

58% of rainbow trout angler responses believing non-anadromous resident wild rainbow trout are currently threatened (Fig. 1).

For steelhead, 96% of interviewees were definitive in assessing the anadromous form of rainbow trout in BC as threatened (Fig. 1). For example, "and on the anadromous side it's a train wreck. It could not be worse" (Interview #46, retired provincial government employee), "they're on death's doorstep right now it seems" (Interview #59, retired provincial government employee), "Steelhead are critically imperiled. Their stock numbers have continued to decline precipitously" (Interview #48, FLNRORD). Interviewees particularly underscored declining steelhead populations on Vancouver Island and the southern interior Fraser populations (e.g., Thompson and Chilcotin river steelhead). Most steelhead angler survey respondents (90%) also perceived steelhead populations to be threatened in BC.

Loss or degradation of habitat, residential and commercial development, water temperature extremes (particularly high summer water temperatures affecting river and stream populations), climate change, recreational fishing pressure, and abstraction of water were the primary threats to wild rainbow trout identified by interviewees (Fig. 2A). A unique threat to interior populations of wild rainbow trout mentioned by several interview respondents is the outbreak of mountain pine beetle (*Dendroctonus ponderosae*) in British Columbia, which has altered freshwater and riparian habitats and hydrology through the subsequent timber salvage and forest cover loss (see illustrative interview excerpts in Appendix D, Supplementary Material).

Bycatch in commercial fisheries, habitat alterations, climate change, increased predation pressure from pinnipeds and marine mammals, water temperature extremes, and water quality (particularly declines in coastal oceanic condition and productivity) were the most frequently referenced threats to wild steelhead by interviewees (Fig. 2B).

Like interviewees, angler survey respondents identified habitat alterations and water quality as key threats to wild rainbow trout populations in BC (Fig. 2C). Rainbow trout anglers also aligned their opinions with interviewees around water temperature extremes (based on experiences of the water bodies they regularly fish): 59% are of the opinion that over the past ten years, water temperatures in British Columbia have increased (i.e., have become warmer), and 74% are of the opinion that over the next ten years, water temperatures in British Columbia will increase (i.e., will become warmer).

Angler survey responses for steelhead were similar to interviewees with commercial bycatch, habitat alterations, climate change, and water quality identified as key threats (Fig. 2D). As rainbow trout anglers did, steelhead anglers also agreed with interviewees around water temperature extremes (based on experiences of the water bodies they regularly fish): 71% are of the opinion that over the past ten years, water temperatures in British Columbia have increased (i.e., have become warmer), and 78% are of the opinion that over the next ten years, water temperatures in British Columbia will increase (i.e., will become warmer). Uniquely, steelhead anglers were also of the belief that First Nations fisheries are a large threat to steelhead populations. Steelhead anglers did not identify pinniped and marine mammal predation as much of a threat as interviewees did (Fig. 2D).

Neither resident rainbow nor anadromous steelhead trout anglers perceive recreational fishing pressure as a key threat, in contrast to interviewees (Fig. 2). Steelhead anglers perceived climate change as a much greater threat to their preferred fished population than resident rainbow trout anglers: 52% of steelhead anglers expressed that climate change in British Columbia is a very serious problem in contrast to 35% of resident rainbow trout anglers (p < 0.001); 76% of steelhead anglers strongly disagree or disagree that climate change will not harm fish populations in British Columbia for many years in contrast to 59% of resident rainbow trout anglers (p < 0.001); 90% of steelhead anglers strongly disagree or disagree that climate change will never harm fish populations in British Columbia in contrast to 79% of resident rainbow trout anglers (p < 0.05).

Additional results on the 'Conservation status assessment of rainbow and steelhead trout populations' are provided in Appendix C, Supplementary Material.

3.2. Praise and criticisms of parliamentary governments managing the rainbow and steelhead trout fishery

FLNRORD in partnership with the FFSBC were praised by interviewees for their stocking programs, which supplement and take pressure off wild fish populations in addition to generating economic revenue. They were also commended for their stocking of indigenous (wild) strains and deliberate attempts to separate wild populations from hatcherv populations to prevent introgression between them. They were also recognized for providing a mix of recreational angling opportunities and received specific compliments regarding the management of small lakes fisheries (e.g., "I think they're managed well. They have got the reputation of being some of the best, if not the best in the world" Interview #59, retired provincial government employee). FLNRORD was also commended for their working relationships with First Nations and fulfilling their legal duty to engage in "meaningful consultation" (Newman, 2009) and their receptiveness to reconciliation with Indigenous communities (a key policy priority for the Canadian and BC governments). From a regulatory perspective, FLNRORD were complimented for being increasingly conservative, prioritizing habitat protection, and being reactive to threats. Examples included harvest regulations; implementing temperature closures when rivers exceed a certain threshold; gear and bait restrictions such as the prohibition of live fish for bait.

Conversely, many interviewees (34%), including previous employees of the provincial government, were highly critical of governments, indicating that they are not doing enough in the management and conservation of rainbow trout. Responses focused on letting politics influence management instead of science (e.g., "the best science in the world is



Fig. 2. Perceived threat factors of (A) rainbow and (B) steelhead trout in British Columbia by members from natural resource management branches of Indigenous governments (FN), parliamentary governments (GOV), Freshwater Fisheries Society of BC (FFSBC), and non-governmental stakeholders (STKH) represented as a fraction of the total mentioned threats (n = 65 interviews); and of (C) rainbow trout (n = 883 survey responses) and (D) steelhead trout anglers in British Columbia (n = 146 survey responses). Statistical significance tests differences in survey responses between rainbow and steelhead trout anglers * $p \le 0.05$, ** $p \le 0.01$, *** $p \le 0.001$.

no use if you can not implement any of it. That seems to be the dilemma we face now", Interview #63, retired provincial government employee), a lack of accountability or government oversight over professional industry, unwillingness to confront First Nations interests which infringe on conservation (e.g., "governments seem to be falling all over themselves to deal with First Nations, according to the United Nations Declaration on the Rights of Indigenous Peoples and it just seems like that pendulum has swung too far to one side. A lot of stuff is being done Nation to Nation [i.e., direct negotiation between governments and Indigenous communities] without the rest of society having any input which is very troubling", Interview #59, retired provincial government employee) and unwillingness to confront or challenge commercial fisheries (e.g., "the federal government are not managing commercial interception fisheries that are catching steelhead as bycatch", Interview #61, BC Hydro).

Most angler survey respondents believe poor management is a major or critical threat to *Oncorhynchus mykiss* populations, with this opinion stronger amongst steelhead anglers (p < 0.001) (Fig. 3A); and disagree that the provincial government has implemented the necessary regulations to successfully manage *Oncorhynchus mykiss* populations, with this opinion also stronger amongst steelhead anglers (p < 0.001) (Fig. 3B). Slightly more than half of steelhead anglers believe that the federal government (DFO) ought to be involved in the management of steelhead populations in BC; while most rainbow trout anglers do not believe that DFO ought to be involved in the management of rainbow trout populations (p < 0.001) (Fig. 3C).

Aside from a handful of high-profile fisheries (e.g., Kootenay Lake, Kettle and Horsefly rivers), across all interviewee groups (29% of participants) governments were also criticized for their general lack of stock assessments, monitoring and information on rainbow trout populations, especially those in rivers and large lakes. A lack of government oversight of industry and enforcement (e.g., conservation officers) were additional criticisms. Many interviewees suggested that there are insufficient resources for government management agencies. Specifically, that governments are constrained by a lack of funding, depending on external funding to maintain their responsibilities; and are experiencing reduced staff levels, and reduced scientific capacity and knowledge. The following quotations captures the sentiment of many, "I guess in some ways they're always reactive, because they have to be. There's one fisheries biologist for a really large region. How on earth are we going to effectively manage the resource when we're so limited? During government budget cuts, first thing to go when you're trying to pinch pennies is all the environment people" (Interview #15, academia affiliation). Angler survey respondents expressed the same beliefs - generally disagreeing

In your opinion, how much of a threat does poor management pose to fish populations?



В

Α

I believe that the provincial government has implemented the necessary regulations to successfully manage fish populations in British Columbia

	Strongly disagree	Disa	gree	Neither agree nor disagree		Ag	ree	Strongly agree
Rainbow Trout Anglers	25%		28%		21%			24%
Steelhead Trout Anglers	50%				24%		14%	10%
	0%	25	%	50%	6	75%	 /o	100%

С

Do you believe that the federal government ought to be involved in the management of fish populations in British Columbia?



D

I believe that the provincial government has been provided sufficient resources to successfully manage fish populations in British Columbia



that provincial governments have been provided sufficient resources to successfully manage populations, with this opinion stronger amongst steelhead anglers (p < 0.001) (Fig. 3D).

Poor governmental organizational structure and strategic direction was a cross-cutting criticism. FLNRORD's mandate and organizational structure were questioned, citing a focus on resource extraction, with a lack of management plans or reference to fisheries management in service plans. For example, "I do not know to what extent your average statutory decision maker considers wild rainbow trout in making a decision about timber allocation. Most of those decisions are made by district managers of forests that probably have no training in aquatic ecology and fisheries management and I'm not even sure that they get any input from the few staff that are." (Interview #39, ENGO affiliation). Confusion between who has jurisdiction for management of anadromous fish was also a cross-cutting criticism. For example, "the Feds [DFO] do have jurisdiction, but I think the province has jurisdiction over some aspects of different types of fisheries and I think it's easier for governments to pass blame to each other and try to appease stakeholder groups than meet the primary objective of recovery. As soon as you start talking about habitat it gets blurry. Who's responsible for what? And conflict-

Fig. 3. Stacked bar plot of angler responses to online survey questions. A: rainbow trout (RBT) anglers, n = 761; steelhead trout (ST) anglers, n = 140; B: RBT anglers, n = 729; ST anglers, n = 133; C: RBT anglers, n = 737; ST anglers, n = 131; D: RBT anglers, n = 655; ST anglers, n = 119

ing objectives and municipal versus provincial versus federal and now First Nations are a part of that too. And it becomes exceedingly challenging." (Interviews #35 & 36, FFSBC). Poor coordination between the nine FLNRORD resource management regions was also cited, for example, "...you can have two regions side by side doing a totally different thing. Often, they do not know what the region next to them is doing. They're not allowed to travel between regions unless they get a Director's approval" (Interview #57, academia affiliation).

3.2.1. Freshwater Fisheries Society of BC

FFSBC was specifically referenced and praised by interviewees for their unique role in the governance and management of rainbow and steelhead trout. For example, "I think the creation of the Freshwater Fisheries Society and giving them the mandate that the government never really exercised, which is to actually promote and develop the fishery, was a great idea" (Interview #53, retired provincial government employee). The illustrative quotation in Appendix E, Supplementary Material provides more context to the formation and role of FFSBC and how that has altered the perception of government agencies like FLNRORD.

However, not all were supportive of FFSBC with one respondent particularly critical: "And then the final straw. They did what was called the core review and spun off and created the Freshwater Fisheries Society and that used to be within government, it was called The Fish Culture section. And so now that that's outside of government being run on contract. That took that role and that oversight away from the government and now it's being run essentially by a contractor." (Interview #57, retired provincial government employee).

3.3. Fishery actors

3.3.1. First Nations versus recreational interests

Fisheries managers described the difficulty in balancing intersections between recreational angling groups and First Nations, which often have different values and views. Interviewees discussed the challenges of the differing value propositions of harvesting fish for food and security versus recreational interests in catching and releasing fish and how those might be at odds with one another.

"When it comes to recreationally focused species like rainbow trout, that's where the disconnect is. A lot of times First Nations have more of a tie to the value for food and ceremonial purposes. The recreational element is part of the disconnect." (Interview #44, FLNRORD)

"For the most part, Indigenous peoples in BC have a fundamental disconnect with sport fishing. It is viewed as playing with their food. And one of the underpinning principles for sport fishing in BC, the use of catch and release as a management tool, fundamentally puts us into conflict with Indigenous peoples, especially with rainbow trout." (Interview #51, FFSBC)

3.3.2. Indigenous people's subsistence harvesting of rainbow trout

First Nations have a unique history in BC that is strongly tied to salmon and are perceived to have less interest in rainbow trout.

"First Nations in this area are much more salmon centric" (Interview #4, FLNRORD)

And where and when rainbow trout or steelhead are harvested, it is often out of necessity and not preference.

"Where we have anadromous fish and fisheries, Indigenous people are focused on salmon and rainbow trout are seen to be an afterthought. Rainbow trout just do not contribute to the harvest cycle for First Nations, where they would nomadically migrate through various camps to harvest moose, harvest caribou, harvest salmon, harvest berries when they're seasonally available. They never talked about the seasonal harvest of rainbow trout. It just does not register for them. They do not really see it in the same way as salmon." (Interview #51, FFSBC)

"In the wintertime when their salmon resources are depleted, they will go out and harvest steelhead, but many First Nations have said their preferred sustenance is salmon over steelhead, that they will eat a steelhead, but they much prefer salmon. They use steelhead as a last resort." (Interview #58, FLNRORD)

3.3.3. Emerging interest of Indigenous peoples in rainbow trout

Some respondents forecasted an emerging interest of Indigenous peoples in rainbow trout due to environmental changes affecting their preferred food sources, salmon, and due to economic opportunities that are potentially afforded by rainbow trout fisheries.

"There's a renewed interest, I think, from First Nations because of climate change some of those [salmon] populations are going to be a little bit more difficult to meet their sustenance needs and rainbow trout might be the one that they're able to fill the gap with because of the regeneration times and potentially their ability to be managed quicker and more effectively." (Interview #14, FLNRORD)

"The more progressive First Nations are seeing it as: what is the economic interest in rainbow trout? Are there some benefits rather than the traditional food, social, and ceremonial consumptive uses of rainbow trout? So, that is new and it's starting to appear more frequently across British Columbia, especially in the south, where economic opportunities are the driver now for First Nations interest in sport fishing. So, some of them are putting aside their fundamental dislike for sport fishing, if there's an economic interest in it." (Interview #51, FFSBC)

This emerging interest in rainbow trout and freshwater fisheries from not only Indigenous fishers, but also other salmon fishers, raises concerns of added pressures to these systems.

"As salmon stocks and saltwater and freshwater salmon fishing opportunities decline there's going to be more and more pressure put on large lakes, small lakes, inland rivers and non-anadromous fishing opportunities" (Interview #46, retired provincial government employee).

3.3.4. Interest in co-management of rainbow trout

Given the interests of some Indigenous peoples in ownership of economic fisheries, some First Nations are either in the process of developing or discussing co-managed or collaborative freshwater fisheries with the provincial government.

"In small lakes with rainbow trout fisheries, up until now we have not had a lot of First Nations involvement as they're so focused on salmon. With salmon stocks really declining we have been told by First Nations that they are going to start pursuing rainbow trout as a protein source. And so now they are actively looking to co-manage some of our fisheries. So that is changing so that's going to be a really big impact our stocking program." (Interview #18, FLNRORD)

"There are some [First Nations] that are very interested in becoming part of the stocking program and running it as an economic venture. And then there's others that just want to have absolutely nothing to do with it and think that it's something that nobody should do because they do not understand and do not value and just think that it's weird to play with your food." (Interview #54, FLNRORD)

However, co-managed or collaborative fisheries can prove to be difficult if provincial and First Nation government mandates do not align, clarified some interviewees.

Additional results on 'Fishery actors' specifically on the topics of 'Contact with stakeholders'; 'Stakeholder input, feedback, consultation in decision-making'; and 'Balancing different demands and interests of stakeholders in decision-making' are provided in Appendix C, Supplementary Material.

3.4. Prioritizing conservation concerns in decision-making

Consistent with the provincial government's allocation framework (see Appendix C section 'Balancing Different Demands and Interests of Stakeholders in Decision-Making', Supplementary Material), conservation is claimed as the first and foremost priority of government employees and FFSBC.

"Well, pretty much everything we do in BC, fundamentally conservation comes first. If we can not account for the conservation of the population, being able to maintain its stability looking forward, then there really is not any other options for us in terms of managing a fishery." (Interview #6, FLNRORD)

"We want to make sure that we're not jeopardizing the population based on our management decisions. That's the goal. Sustainable populations. Fisheries can occur but if we're getting to a place where we're threatening the population, we should not be fishing anymore." (Interview #43, FLNRORD)

While conservation is of highest priority there are certain scenarios where governments are often not prepared (or able) to fully intervene and implement conservation actions (e.g., "I actually do not think conservation in this province always comes first"; Interview #21, FLNRORD).

3.4.1. First Nations

"If there's a defined conservation risk, I think that the province has shown they will institute a conservation value. I think where that breaks down are situations where First Nations are involved." (Interview #35, FFSBC). First Nation communities are at times told they are no longer able to maintain a food source fishery and to stop fishing when there is a conservation concern, which becomes contentious when First Nations invoke their traditional and constitutional rights to fish. When these scenarios occur, First Nations and FLNORD agree, most of the Indigenous community is compliant and only a few are non-compliant. If there is a conservation issue, government employees aspire to deeply engage and consult with the community, sharing information back and forth to develop a conservation-based approach.

3.4.2. Economic factors

"Often, I think the economic drivers outweigh conservation elements" (Interview #14, FLNRORD). Decisions that generate economic benefits exert weight on fisheries management decisions and may ultimately tip in favor of economic value. "For conservation, we do not usually get a lot of push-back from the recreational angler. But if there's guides who are making money, if there is a commercial fishery that bycatches them, that's when you run into problems." (Interview #42, MOECCS).

3.4.3. Social and political factors

"Sometimes it's a political decision made at a higher level regardless of what maybe the science is saying" (Interview #18, FLNRORD). "At the biologist level or the lowest manager's level, I really try to focus on the conservation aspect. However, once an issue goes up the line, decisions tend to become more political. So quite often we recommend something that may be based on conservation and then we get told that from a political level you can not do that, or we have to find a balance somewhere. So, we try to be focused on conservation as much as we can but there's always a political aspect that plays into things which is what makes the job difficult at times" (Interview #26, FLNRORD). Political and social resistance was described in examples of stakeholder pushback to closing or limiting rainbow trout fisheries to deal with invasive species or to prevent hybridization with Westslope cutthroat trout. The political influence of stakeholder groups is also demonstrated in the following example, "Our Premier a couple of years ago, Christy Clark overturned a small regulation that we were going to change in Kamloops. We wanted to change the age and access regulations on this lake to allow for more children to be able to access it because on too many lakes these old guys were going every day and fishing and taking up all the access points. Everybody agreed, it seemed like a simple slam dunk. We got the Director to sign off on it and it went to the Premier's office and because it was an election and there were twelve disgruntled old guys that she might lose twelve votes on, she canned it." (Interview #40, FLNRORD).

"I think decisions and information gathered by regional biologist nowadays is significantly affected by the politics. Their management decision or proposals are undermined by outside influences. Best management practices do not rule the day. There's interference. Social interference." (Interview #46, retired provincial government employee)

Additional results on 'Prioritizing conservation concerns in decisionmaking' are provided in Appendix C, Supplementary Material.

3.5. Criticisms of decisions made with respect to fisheries management of rainbow trout populations

"We do not get a lot of criticism to be honest" was repeated by many fisheries managers (i.e., FLNRORD government and FFSBC employees). Most criticisms of fisheries management that are received are steelheadspecific, clarified interviewees. Table 3 presents the most common criticisms of decisions made with respect to fisheries management of rainbow trout populations. Overall, Table 3 shows that many stakeholders and actors are perceived to have completely opposing viewpoints (i.e., many feel that there should be more stocking, while others feel there should be less; many want to harvest more fish, while others want all fish to be released). Overall, these findings suggest people want more, and bigger fish, and they want more fishery access opportunities, but have very different opinions about how to achieve this (e.g., stock more, or restrict fisheries more so that fish grow larger). Some respondents described that often the most vocal critics are past fisheries managers: "Ex biologists. They're probably our biggest critic of all"; "All the retired biologists in the province have nothing better to do than to criticize what's going on".

Fisheries managers agreed that most criticisms were valid or warranted, "except the we're fresh out of university one". According to some interviewees, stakeholders are often not informed nor understand the complexity of government and making decisions in government. The diversity and contradiction in criticisms was often reconciled by fisheries managers who emphasized that they value and try to manage for diversity and quality of fishing opportunities (i.e., there is room for all gear-types and fisheries).

4. Discussion

Our results show that non-anadromous rainbow trout are not perceived to be threatened provincially, but some rare populations (e.g., ecotypes, ecomorphs) are of special concern. Conversely, anadromous steelhead trout are definitively perceived as threatened by every group of study participant which comes as no surprise given it has been emergency listed by COSEWIC – The Committee on the Status of Endangered Wildlife in Canada, an independent watchdog committee of wildlife experts and scientists (Government of Canada, 2018). Key threats identified by participants to both anadromous and non-anadromous *Oncorhynchus mykiss* populations were similar: habitat alterations, water quality, water temperature extremes, climate change, residential and commercial development, and abstraction of water. Predation pressure from pinnipeds (i.e., seals and sea lions) and bycatch in commercial fisheries were identified threats specific to steelhead. Recreational anglers underestimated their effects on fish populations relative to per-

Table 3

Criticisms of decisions made with respect to fisheries management of rainbow trout populations. Interviews containing at least one mention is the total number of interviewees who discussed this topic. Overall mentions are the total number of times a topic was discussed and coded. Code occurrence is a rough proxy of relative importance of each topic (parliamentary government [GOV] and FFSBC employees (n = 39).

Criticism	Interviews containing at least one mention	Overall mentions
Not doing enough; Do not know enough; Does not get out in the field enough; Are not experienced enough	15	19
Not enough fish – stock more fish	15	17
Regulations are too conservative – a lack of harvest opportunity (e.g., bag limits are too low)/management is overly risk adverse	10	13
Stock too many fish – lakes are overstocked and overpopulated	6	9
Fish are not big enough	5	6
Regulations favor a particular gear-type (e.g., fly fishing over others) or fishery (e.g., trophy fisheries over others)	5	6
Regulations should be more restrictive (e.g., more closures, more catch-and-release, smaller bag limits)	5	6
Lack of government investment in managing/enhancing fisheries (resources, staff)	5	5
Lack of fishing access and opportunity	4	6
Poor communication with stakeholders/governments are not listening	4	6
Regulations are too complicated	4	5
Not enough enforcement of regulations	4	4
Lack of communication between federal and provincial government/lack of communication between regions	2	2
Prioritize other species (i.e., Kokanee Oncorhynchus nerka, Westslope cutthroat trout Oncorhynchus clarkii lewisi)	2	2
Too many anglers	1	1

ceptions of other participants. Fisheries managers received praise for hatchery stocking programs and managing small lakes fisheries (like Rosenberger et al., 2004) but criticized for a lack of information on fish populations and being too passive in prioritizing conservation in practice (e.g., for an unwillingness to stand up to interests of actor groups which infringe on the conservation of fish populations). This may suggest genetic diversity of fish populations may be undervalued so long as fish stocks are abundant (and fishable). Interestingly, retired employees of the provincial government were often the most outspoken critics of current management efforts, suggesting an intergenerational disconnect and opposition. This case research suggests effective fisheries management is limited by insufficient resources (funding, staff, time), confusion in jurisdictional authority between provincial and federal governments, and poor organizational structure and strategic direction. We found evidence that political and economic influence may override conservation actions despite clear organizational mandates and policies of conservation as the top priority. We focus the remaining discussion on the main contributions relevant for inland fisheries research, conservation, and management in BC and beyond.

4.1. Conservation status assessment of rainbow and steelhead trout populations

Anglers generally believe that resident wild rainbow trout are more threatened than interviewees (i.e., fisheries managers) do (Fig. 1). This suggests disagreements regarding the magnitude of threats to wild rainbow trout or perhaps, systematic differences in social science instruments. Anglers may be subject to an emotional and enthusiasm bias, a closeness and connection to fish populations, perceiving the threats to favoured fish populations as greater than they are (Organ et al., 2010; Heffelfinger et al., 2013; Love-Nichols, 2020). What is clear is that almost all anglers are concerned for the long-term sustainability of the fish populations they like to fish (like Malcolm et al., 2021). Our interpretation of these findings is that both anglers and interviewees believe rainbow trout are not threatened at the species or provincial level, but certain isolated and vulnerable populations (e.g., wild river and stream, large-bodied piscivores) likely are. The implications of such a consensus warrants future natural and social science research into the diversity and characterization of vulnerable rainbow trout populations and eco-types; and into the social, economic, and cultural values of such populations and eco-types.

We revealed that both rainbow and steelhead trout anglers did not perceive recreational fishing pressure as a key threat. This is largely consistent with other human dimensions empirical research in the recreational fishing sector that demonstrates anglers perceive sportfishing as one of the lowest impacts on fish populations and that anglers appear to be more critical of other user groups (see Lynch et al., 2010; Gallagher et al., 2015; Nguyen et al., 2016; Danylchuk et al., 2017). However, recreational fishing has the potential to negatively affect fish and fisheries and may contribute up to 12% of global fish harvest (reviewed in Cooke and Cowx 2004), and in most inland fisheries in developed countries recreational fishing is the dominant user of freshwater fisheries resources (Arlinghaus et al., 2002; FAO, 2012). Our findings then suggest that anglers are unaware of potential angling threats and conservation solutions or are choosing to respond in a way that least impacts their recreational activities (if more conservative management regulations were established). This finding and others discussed below (i.e., predation, climate change) may also present a starting point for future conversations about the potential contribution of recreational fishing to not only fishery declines, but also human induced habitat degradations and alterations.

Interestingly, surveyed steelhead anglers did not identify predation pressure as a large threat to steelhead populations in contrast to interviewees. However, in DFO's recent recovery potential assessment for Chilcotin River and Thompson River steelhead trout (DFO, 2018), inshore predation from seals, especially harbor seals (*Phoca vitulina*), was identified as the single largest predictor of steelhead declines (see also Melnychuk et al., 2014; Berejikian et al., 2016; Sobocinski et al., 2020). Our research suggests anglers are generally unaware of the magnitude of this threat. Management levers for steelhead recovery are limited but survival between smolt and adult is needed for recovery regardless of fishing efforts which could suggest pinniped reduction (cull) which would require social policy choices at the ecosystem management level. Work from DFO (2018) suggests that reducing steelhead fishing mortality to zero or freshwater range expansion will not be nearly enough to recover steelhead.

Steelhead anglers perceived First Nation fisheries as a large threat to steelhead populations. As this was inconsistent with interviewees, it is difficult to surmise the true underlying perception of the threat to steelhead posed by First Nation fisheries. Perhaps interviewees were hesitant in pointing fingers at Indigenous communities they are attempting to establish more harmonious relationships with. This pattern of results is also consistent with previous literature which points to conflict between First Nation and recreational fishers, and particularly, complaints about First Nation fisheries use of nets for fishing (Nguyen et al., 2016). Transparently acknowledging situations when First Nations fisheries lead to steelhead mortality and bycatch and taking future preventative measures to reduce it may defuse conflict (Ibid). Steelhead anglers perceived climate change as a much greater threat than resident rainbow trout anglers. However, climate change is impacting freshwater habitats and hydrological processes at an alarming rate and is unequivocally a prime threat to resident rainbow trout (Wenger et al., 2011; Whitney et al., 2016). This implies there is a need for FLNRORD and FFSBC to educate and inform resident rainbow trout anglers on the magnitude of this threat and how it contributes to fisheries closures. Like Litt et al. (2021), our work suggests big gaps in angler awareness of threats, especially in our case of recreational angling and climate change for both rainbow and steelhead trout. If resident rainbow trout anglers appreciate the extent that climate change and other factors threaten beloved fish populations, this could promote climate activism and pro-environmental behaviours benefitting fish habitat (Cooper et al., 2015; Love-Nichols, 2020).

4.2. Implications

Our results have several implications for the management of rainbow and steelhead trout. Anglers as well as some interviewees were highly critical, identifying poor management as a major issue to conserving fish populations, wanting governments to do more in enforcing regulations and monitoring – similar to results found by Malcolm et al. (2021).

4.2.1. Insufficient resources (funding, staff, time)

Both interviewees and angler respondents expressed the same beliefs that the provincial government (FLNRORD) has not been provided sufficient resources to successfully manage rainbow and steelhead trout populations. Study participants linked these limitations with a lack of aquatic monitoring, government oversight of industry, and natural resource law enforcement.

4.2.2. Confusion in jurisdictional authority between provincial and federal governments

Study participants believed that the federal government (DFO) ought to be more involved in the management of steelhead populations in BC. Steelhead anglers likely place little trust and confidence in the governance of DFO affecting their perceptions of DFO's governance legitimacy (Turner et al., 2016). These results also suggest shared jurisdictional authority between federal and provincial agencies over anadromous fisheries enables mismanagement, inaction, and decision paralysis.

4.2.3. Organizational structure of natural resource management agencies which are not autonomous from competing commercial and industrial objectives and directions

Alternatively, this also supports the idea that fisheries management agencies in our case are organizationally structured in such a way that is not autonomous from competing commercial and industrial objectives and directions like forestry and commercial fishing. For instance, DFO was frequently criticized for their unwillingness to confront or challenge commercial fisheries. These findings imply a possible need for transformative institutional reform ensuring fish, fish habitat, aquatics research and management are all within the same department or ministry and uncompromised by other competing mandates. It also suggests for stronger cohesion, communication, and coordination amongst management agencies in transboundary or overlapping jurisdictions, even amongst adjacent regions.

FLNRORD and/or DFO were perceived as unwilling to step in and ask First Nations to forego their fishing rights in the name of conservation and protection of fishes. Of course, these relationships are budding and delicate after centuries of western exploitation and expropriation making any western parliamentary government intervention likely seem authoritarian (Simpson, 1999; 2001a; 2001b). Much work remains to be done to build true and lasting reconciliation, but our findings suggest that relationships in the pursuit of conservation are possible if trust and respect are placed at the core of interactions. This will be ever more important as our results suggest an emerging interest of Indigenous peoples in rainbow and steelhead trout for subsistence due to declines in salmon or for local economies as a source of income. This supports the Provincial Framework for Steelhead Management in British Columbia which suggests "First Nations in BC are interested in working together with both Provincial and Federal government to share management responsibilities and to address issues in steelhead management for the common good and to enhance the well-being of First Nations' communities" (Government of British Columbia, 2016). Co-managed or collaborative inland fisheries between parliamentary governments and First Nations may be difficult, but co-management (sharing of power and responsibility between government and local resource users) can deliver positive ecological and social outcomes and improvements in governance (Berkes, 2009; d'Armengol et al., 2018). Co-managed and collaborative fisheries are likely to be more successful if they're mindful of power and equity asymmetries and embrace adaptive management principles. Trust, respect, mutual learning, and open mindedness are crucial elements for collaborative and co-managed fisheries (Chapman and Schott, 2020; Cvitanovic et al., 2021) especially given the differing value propositions of harvesting fish for food and security versus recreational interests in catching and releasing fish.

Proposed solutions to improve relations with First Nations and commercial fishers suggested an increase in communication, focused on reducing bycatch mortality across sectors and groups.

4.2.4. Economic, social, and political drivers are perceived as increasingly influencing conservation decisions and actions

Our findings point to a concerning trend of economic, social, and political considerations influencing fisheries management and overriding conservation despite it being purported to be the highest priority amongst fisheries managers. These results support previous literature which have found management and conservation decisions eclipsed by influencing economic or political considerations (e.g., Morrison-Saunders and Bailey 2003; Carroll et al., 2017; Artelle et al., 2018). One trend that warrants highlighting is the lack of accountability of government oversight over professional industry. After years of cuts to the public service, the BC government is reviewing its "professional reliance" model which risks conflict of interest when professionals are employed by the same industry the government regulates (Smith et al., 2017; Heer and Girling, 2020). As our results also indicate, that science normally done by the province, and then outsourced to "qualified professionals" hired by industry and project proponents, has had little to no oversight (e.g., Appendix D illustrative extract 2, Supplementary Material). "By allowing professional reliance to run wild, I think the industry really had free will and range in the province of British Columbia" [Interview #45, private environmental consultant]. Overturning this model, and the austerity of governments investment in fisheries management (time, staff, and financial resources), would surely open pathways to more evidence and conservation-based decisions.

4.2.5. Stakeholders

Our work reveals several interesting trends in relationships between fisheries managers and stakeholders. FLNRORD government and FFSBC employees recognized the potential for 'agency capture' by stakeholder groups (i.e., undue influence on agency decision-making by special interest groups which lobby or advocate for personal interests, Artelle et al., 2018). In our case, fisheries managers exercise caution in weighting any one individual or groups interests over others, given that the most vocal angling clubs and associations represent a very small proportion of the full angling community. Our participants suggested memory recall and avidity biases may compromise angler perceptions (e.g., van Poorten et al., 2011; Howarth et al., 2021). Our results further indicate managers place greater emphasis on natural science evidence (e.g., stock assessment information), when it is available, than stakeholder information or preferences. Lastly, with the average age of angling participants increasing (see Brownscombe et al., 2014) our results imply this will have profound effects for angler-derived license revenue for FFSBC and HCTF and their programs and investments in fisheries and habitat conservation (see Appendix C section 'The most challenging aspects of rainbow trout management and conservation', Supplementary Material). This implies that FFSCBC and HCTF will need to maintain efficiency in the reduction of license revenue or conversely, seek alternative funding sources or inflationary increases in license prices for seniors.

4.3. Limitations

Our study population was highly biased to non-Indigenous fisheries actors. This was not intentional as we attempted to have a representative dataset. Nonetheless, this limits our ability to infer perceptions beyond primarily western decision-makers and resource users. Representatives from natural resource branches of Indigenous governments were few, as many of those contacted for requests for interviews expressed little or no interest or expertise in rainbow trout, citing identities linked primarily to salmon. The methods employed also presents limitations. In grouping rainbow trout angler subpopulations and interviewees to facilitate comparison we recognize these groups are not homogenous and grouping risks losing some nuance and difference in perceptions (e.g., by region, position within organization, fishery targeted). The interviewer, survey developer, and data analyst consciously or otherwise, may influence the direction of participant responses, or the coded emergent themes, through underlying personal biases or preconceptions. Errors in inference may also arise through measurement error and translation validity - the degree to which we accurately translated the construct of what interview and survey participants were saying. Poor quality audio in recording and errors in transcription from audio to text, and errors in interpreting and coding participant constructs are inherent limitations to this study; limitations that cannot be controlled by the use of software (e.g., NVivo). Admittedly, the magnitude of such methodological biases is quite low.

4.4. Conclusion

Inland fisheries are complex interconnected social-ecological systems that need to be explored further to enable effective fisheries management realizing long-term sustainability and resilience. This article examined the perceptions of stakeholders, Indigenous rightsholders, and government employees on the current and future status of rainbow and steelhead trout populations and fisheries in British Columbia, Canada. The nuanced perceptions of the conservation status and values of resident rainbow and steelhead trout suggests future natural and social science research is needed into the diversity and characterization of vulnerable rainbow trout populations and eco-types and their associated social, economic, and cultural values. Our findings suggest that anglers and other stakeholders and rightsholders are largely unaware of key potential threats to rainbow and steelhead trout (i.e., pinniped predation, climate change, recreational angling). This implies there is a need for science-communication research to engage fisheries end-users and the public. Particularly fisheries management agencies, like FLNRORD and FFSBC in our case, should be responsible for educating and informing anglers and the public on the magnitude of threats and how they contribute to fisheries closures. If anglers and other end-users appreciate the extent that climate change and other factors threaten cherished fish populations, this could promote pro-environmental behaviours benefitting fish habitat and populations. We found evidence of an underlying and concerning trend (see Morrison-Saunders and Bailey 2003; Carroll et al., 2017; Artelle et al., 2018) that despite being conservation purported as the highest priority of fisheries managers, economic, social, and political drivers are increasingly influencing conservation decisions and actions (see also Kadykalo et al., 2021). This raises questions as to whether the perceived diminishing priority of conservation in wildlife decision-making is indeed a true phenomenon and whether there ever was a 'golden era' of conservation-prioritized decision-making to recall back to. Moreover, it raises questions if the increased democratization of wildlife management (e.g., stakeholder and Indigenous consultation, co-management etc.) enables conservation-prioritized decision-making resulting in management outcomes that are beneficial for wildlife resources. (1) Insufficient resources (funding, staff, time), (2) confusion in jurisdictional authority between provincial and federal governments, and (3) poor organizational structure and strategic direction of natural resource management agencies which are not autonomous from competing commercial and industrial objectives may enable mismanagement, inaction, and decision paralysis in fisheries management (see also Jeanson et al., 2022). Future research is thus needed to determine the extent which adjacent governance jurisdictions coordinate to manage interregional ecosystem service/disservice flows, such as fisheries, and the extent to which social, economic, and political considerations influence final decisions in wildlife management. Further, empirical investigations of co-managed fisheries approaches are needed to assess their effectiveness and limitations in wildlife management contexts. We hope these perceptions inform effective fisheries management and conservation as rainbow trout governance and management approaches adapt to changing social and ecological conditions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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Supplementary materials

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