Harper, S. J., J. M. Burt, L. K. Nelson, J. M. Runnebaum, A. Cullen, P. S. Levin, K. L. Hunter, J. McIsaac, and N. C. Ban. 2023. Commercial fisher perceptions illuminate a need for social justice considerations in navigating climate change impacts on fisheries systems. Ecology and Society 28(2):21. https://doi.org/10.5751/ES-14142-280221

Research

Commercial fisher perceptions illuminate a need for social justice considerations in navigating climate change impacts on fisheries systems

Sarah J. Harper [1,2], Jenn M. Burt [2], Laura K. Nelson [3], Jocelyn M. Runnebaum [4], Alison Cullen [5], Phillip S. Levin [6], Karen L. Hunter [7], Jim McIsaac [8] and Natalie C. Ban [1]

ABSTRACT. Climate change will amplify stress on marine systems already challenged by conflicts and inequities relating to fisheries access, management decisions, and ocean uses across sectors. Understanding how those most connected to fisheries perceive the risks associated with climate change is critical to developing effective responses and establishing management priorities. Adaptation planning efforts may be hindered by perceptions of unequal or unfair distribution of resources and the processes in place to manage them. In contrast, adaptation planning that is more inclusive, transparent, and addresses social dimensions and perceptions of fisheries is more likely to garner support from fishers and fishing communities broadly. We elicited fisher perceptions of climate change impacts on fisheries, and responses to these impacts, through an online survey of commercial fishers in Canada's Pacific region. The survey highlights substantial concern for climate change, the impacts it will have on fishers' livelihoods and well-being, and some of the key challenges that may interfere with the ability of fishers and fisheries management to adapt. We frame the findings of the survey drawing from concepts of social justice, focusing on distributive and procedural justice, as necessary considerations, and context for climate change adaptation planning. Developing plans and processes to respond to climate change impacts on fisheries requires not only understanding ecological impacts and challenges, but also the social and institutional considerations that could help or hinder efforts to respond effectively and equitably to a changing ocean.

Key Words: *adaptation planning; climate change impacts on fisheries; distributive and procedural justice; equity and perceptions of fairness in resource management*

INTRODUCTION

Changing climate is impacting fish populations and the ecosystems that sustain them, with potentially profound consequences for the fisheries and communities that they support (Cheung et al. 2015, Savo et al. 2017, Bell et al. 2020). Climate change is already affecting the distribution and abundance of commercially fished species around the world, with impacts projected to increase substantially in the coming decades (IPCC 2021, English et al. 2022). Warming oceans will affect fish productivity and may cause fished species to migrate, move into deeper waters, or experience impacts related to ocean acidification and hypoxia (Poloczanska et al. 2016, Pershing et al. 2021). These changes will have implications for existing and future management decisions, which in many contexts are based solely on ecological objectives. Although there is increasing understanding of the impacts of climate change on marine ecosystems and fisheries (Smith et al. 2021), much less is known about the effects on fishers and fishing communities.

The ability of fisheries management to respond to climate change will require solutions that are timely and effective, but also considered equitable and fair (Friedman et al. 2018). Public perceptions are important in shaping and legitimizing public policies (Slovic 1997, Dieckmann et al. 2021), and influence decisions related to climate change (Cullen and Anderson 2017, Cullen et al. 2018). Therefore, fisher perceptions are pertinent to developing effective responses to climate change in the context of fisheries, where diverse actors are involved and engaged. Fair governance is considered an important component of institutional adaptive capacity in managing resources and mitigating climate hazards (Gupta et al. 2010, Grothmann et al. 2013), while perceptions of fairness are important because they relate to individual and collective willingness to respond to environmental change (Adger et al. 2016). Perceived unfairness can foster conflict and undermine cooperation (Gurney et al. 2021) and may elicit strong emotional or behavioral responses with implications for human well-being (Prilleltensky 2012), trust in management institutions (Ordoñez-Gauger et al. 2018), compliance with rules (Turner et al. 2016), and social engagement (Gurney et al. 2021). Conflict is inevitable given the plurality of actors, interests, values, and uses of marine spaces, and can become heightened when resources become scarce. Unresolved conflict may impede governance objectives and threaten the sustainability of social-ecological systems (Parlee and Wiber 2018); however, conflict can be an important part of improving systems, generating new ideas, and learning to work together (Ripley 2021). Being aware of existing conflicts and managing emerging conflicts is therefore a critical component of climate adaptation planning (Levin et al. 2021).

Increasingly, literature on environmental governance engages concepts of social and environmental justice to understand and

[1]School of Environmental Studies, University of Victoria, Victoria, BC, Canada, [2]Nature United, North Vancouver, BC, Canada, [3]School of Environmental and Forest Sciences, University of Washington, Seattle, Washington, United States, [4]The Nature Conservancy in Maine, United States, [5]Evans School of Public Policy and Governance, University of Washington, Seattle, Washington, United States, [6]School of Marine & Environmental Affairs, University of Washington, Seattle, Washington, United States, [7]Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC, Canada, [8]T. Buck Suzuki Foundation, Victoria, BC, Canada

navigate inequalities in the distribution of harms associated with environmental degradation, such as climate change, and to assess the inclusiveness of decision-making processes (Paavola 2007, Schlosberg 2013, Adger et al. 2016, Turner et al. 2016, Bennett et al. 2019). Engagement with these concepts in the climate change planning discourse has increased substantially in recent years, including language first appearing in the Fifth report produced by the Intergovernmental Panel on Climate Change (IPCC 2014:17), which states, "Mitigation and adaptation raise issues of equity, justice and fairness." Climate justice has emerged as an area of scholarship that deals specifically with how climate change will impact people differently, unevenly, and disproportionately (Sultana 2022). While scholars and activists may be increasingly engaging with concepts of social and environmental justice in climate change debates, there is a lag in mainstreaming these considerations into adaptation planning and policy at national or regional levels, and particularly those relating to fisheries.

It is broadly recognized that the impacts of climate change and the policies to address them will be unevenly distributed across society (Klinsky et al. 2017, Jardine et al. 2020, Sultana 2022). Existing inequalities and issues will likely be amplified by climate change, with notable consequences for the uneven distribution of fisheries costs and benefits, and perceptions of fairness related to management processes and outcomes. The varied socioeconomic conditions, values, and interests of fishers also have a bearing on their ability to respond in ways that either confer resilience or that can amplify negative impacts (Cinner et al. 2011) and the range of adaptation choices available to them (Szymkowiak 2020). Changes to fished species due to climate change (e.g., abundance and distribution changes) are expected to exacerbate issues such as the distribution of access and the associated benefits, requiring responsive and adaptive management to mitigate the impacts of climate change on fisheries-related livelihoods and well-being (Pinsky and Fogarty 2012, Bell et al. 2020, Jardine et al. 2020, Parlee et al. 2021, Smith et al. 2021). We argue in this paper that planning for climate adaptation in commercial fisheries must attend to, among other considerations, existing and emerging inequalities. We focus on the case of commercial fisheries in Canada's Pacific region, with an exploration of fisher perceptions of climate change impacts and the capacity for individuals, communities, and institutions to respond in a developed country, temperate region context.

Canada's Pacific region will experience, as with other temperate regions of the world, both positive and negative impacts of climate change on fisheries. Although the predicted impacts to the Pacific region may not be as stark as some other temperate regions (Lam et al. 2016) impacts are already being felt (Talloni-Álvarez et al. 2019, Whitney et al. 2020a). Although there are some efforts to understand and plan for these changes (Whitney et al. 2020b), overall, climate change adaptation strategies have yet to be integrated into commercial fisheries management in this region (Whitney and Ban 2019). Existing challenges to commercial fisheries systems in Canada, such as access, have been articulated as a threat to the future of the commercial fishing industry, with calls for reforming policies and processes in order to maintain the range of fisheries-related benefits to society, and especially to harvesters and coastal communities (Standing Committee on Fisheries and Oceans 2019, Bennett et al. 2020a, 2021a).

Ongoing processes in Canada that influence commercial fisheries access and operations include reconciliation with Indigenous peoples, Integrated Fisheries Management Planning (IFMP), Marine Spatial Planning (MSP), and Marine Protected Area (MPA) processes. Reconciliation in the Canadian context is a process that is in response to the colonial dispossession of lands and waters, and historical and ongoing mistreatment and marginalization of Indigenous peoples in Canada (Truth and Reconciliation Commission of Canada 2015). In Canada's Pacific region, Fisheries Reconciliation Agreements are being signed with First Nations to directly address and enhance access to, governance of, and benefits from fisheries (Brown 2021). All fisheries in Canada's Pacific region have IFMP processes where stakeholders raise concerns, provide insights, review science advice, access and allocation decisions, management objectives, conservation concerns, compliance plans, and commercial harvest plans to provide advice to the government minister. MSP and MPA processes have increased around the world in response to the many compounding uses of, and stresses on marine environments and how best to navigate them. In the Pacific region of Canada, existing and ongoing MSP and MPA processes have added to the complexity of fisheries management. Although these processes are meant to provide clarity on competing ocean uses (McGee et al. 2022) and important protection for vulnerable habitats or species (DFO 2014), they can lead to increased conflict when some groups feel that their interests are not being considered in these processes and their outcomes (Bennett et al. 2020b).

Here we engage concepts of social and environmental justice to frame and understand commercial fisher perceptions of the impacts of climate change, and the ability of commercial fishers and fisheries management in Canada's Pacific region to respond to these impacts. We focus on commercial fisheries because of their economic importance in the region (Teh et al. 2022), and because of interest by both commercial fishing organizations and the fisheries management agency (Fisheries and Oceans Canada, DFO) in this research. This study responds to calls for better integration of human dimensions and perceptions into climate adaptation thinking in Canada (Whitney and Ban 2019, Foley et al. 2020), and contributes new insights and examples of how concepts of social justice can inform climate adaptation planning in fisheries.

METHODS

We elicited commercial fisher perceptions about climate change through an online survey (March 2020 to September 2020). The survey was based on questions developed by the University of Washington (as described in Nelson et al. 2023), drawing on earlier work on perceptions of climate change risk broadly (Ballew et al. 2019), and in the context of natural resource-based livelihoods, including agriculture (Cullen and Anderson 2017, Cullen et al. 2018), and fisheries (Schumann 2018). It also includes established indicators of well-being in coastal social-ecological systems (Breslow et al. 2017) and was adapted to the commercial fisheries context of the Canadian Pacific region in a collaboration between the initial designers and those with knowledge of the local context (Harper et al. 2022). This project was a collaborative effort by academic, government, and industry partners, and non-governmental organizations, with a shared interest in the outputs. We sought input and engagement on survey design, delivery, analysis, and interpretation from the BC Commercial Fishing

Caucus, the BC Seafood Alliance, the United Fishermen & Allied Workers' Union (UFAWU-Unifor), the First Nations Fisheries Council of British Columbia, the Native Fishing Association, and Fisheries and Oceans Canada (DFO) climate adaptation researchers. The survey focused on questions related to perceptions of climate change impacts on commercial fisheries and the ability of individuals, communities, and management to adapt to these changes (see Appendix 1 for survey questions). Questions about the perceived ability to adapt solicited views on management flexibility, effectiveness, and equity, as important components of institutional adaptive capacity (Cinner and Barnes 2019, Bahri et al. 2021). Additional questions addressed the ease with which individuals and communities could anticipate, respond to, and recover from changes in fisheries species composition, distribution, or abundance, and their ability to take advantage of emerging opportunities (Barnes et al. 2020). The survey included both Likert style and open-ended questions.

The sampling frame for the survey was commercial fishers in Canada's Pacific region. We asked survey participants to provide information on demographic and other characteristics including age, port of call, fishing experience, and target species. We also asked questions regarding observations of changes in ocean conditions (ocean temperature, severe weather, and availability of target species over the past five years), and whether fishers felt their ability to catch fish had been or would be impacted by climate change and other activities and processes, which we refer to here as cumulative impacts. When asking about perceived fishery-specific impacts of ocean warming, we asked respondents to select from a 5-point Likert scale from negative to no-effect to positive, in addition to offering the selection of "I don't know." This was done to enable separating the scaled responses (people who feel they have knowledge about species impacts) from the responses that reflect either lack of climate-impact knowledge or less familiarity or knowledge about a given fishery. We display the results as proportions of the Likert responses only, along with the sample size of fisher respondents that this reflects.

The study and survey were reviewed and approved by the University of Victoria Ethics office (RAIS Application # 20-0462). The survey was supported technologically, and responses collected by a professional survey firm: Pacific Market Research Ltd; however, we were responsible for the distribution of the survey. We invited fishers to complete the survey online or via the phone. We sent invitations by mail to Pacific region commercial license holders and by email to fisher associations and networks by industry partners. The survey was initially mailed out to approximately 1200 unique addresses for Pacific region commercial license holders, but in a follow-up communication, the online survey link was shared more extensively, by reaching out through fisher networks and First Nations harvesting associations to try to increase Indigenous participation. Based on the initial mail out, the response rate to the survey was approximately 9%; however, in the end, the sample size of possible respondents was larger, thus a lower response rate.

We visualized responses to Likert questions using R (R Core Team 2021) and analyzed open-ended questions using NVivo software (QSR International Pty Ltd 2020). We coded open-ended questions about management flexibility and future concerns using themes that emerged from participants' responses (see Appendix 2 for codebook). We further grouped these themes into concerns and considerations that relate to distributive justice and procedural justice concepts drawn from theories of social and environmental justice (Schlosberg 2007, 2013, McDermott et al. 2013). Distributional justice is defined here as fairness in the distribution of benefits or harms associated with decisions and actions across groups (Bennett et al. 2019). Procedural justice refers here to the level of (or perceptions of) participation and inclusiveness in decision-making or governance processes (Bennett et al. 2019).

Environmental justice considers both distributional and procedural justice in terms of the distribution of environmental costs and benefits, and ease of engaging in environmental decision-making processes (Schlosberg 2007, 2013). In this study, applying an environmental justice lens translates into understanding perceptions about the distribution of costs and benefits associated with changes in commercial fisheries and aspects of the management of those fisheries. Environmental justice theory also includes a third consideration, recognitional justice, which focuses on respect for cultural difference and has been articulated most in terms of Indigenous cultural identity and self-determination (Martin et al. 2014). Although all three dimensions of environmental justice are important in the context of fisheries, here we focus on distributional and procedural aspects, selecting illustrative narratives from the survey responses and connecting these to existing literature to highlight the relevance of the concerns and considerations raised to climate adaptation planning.

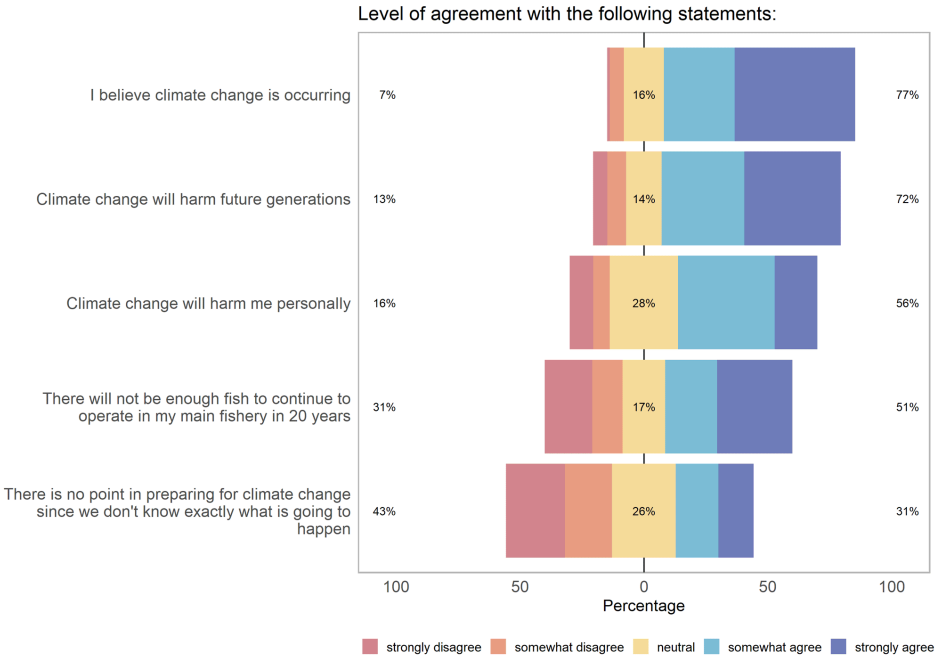
We presented preliminary results and analysis of the survey to industry partners, government collaborators, and stakeholder groups in a series of four online workshops to invite feedback and insights to assist in the interpretation and validation of the results. We then incorporated feedback and insights elicited through this process into the study, adjusting interpretations where necessary.

RESULTS

Out of the 105 commercial fishers who responded to the survey, the majority have been engaged in fishing long term; 82% reported that they have been fishing for over 25 years, and 72% reported having lived in their current community for over 25 years. Survey participants were engaged in a range of Pacific region fisheries, and they often participated in multiple fisheries, with 68% participating in salmon, 43% in other pelagic species (i.e., Pacific herring, tuna, hake, and sardine fisheries), 44% in groundfish (i.e., groundfish, halibut, sablefish, rockfish, lingcod, and dogfish fisheries), and 31% in invertebrate fisheries (i.e., shrimp, prawn, crab, geoduck, sea urchin, and sea cucumber fisheries). They also fished all around the region; 57% fished in the North Coast, 43% in the Strait of Georgia, 42% along Northern Vancouver Island, 42% in Haida Gwaii, including Hecate Strait, and 40% along the Central Coast.

The demographic characteristics of the fishers who responded indicated that 77% of survey participants were 50 years or older, 6% were women, and 94% were men, and people identifying as Indigenous represented 10% of survey participants. Although the age profile of the sample reflects the general commercial fisher population, the number of women and those identifying as Indigenous underrepresents the demographics of the actual

Fig. 1. Survey responses on perceptions of climate change impacts. Percentages on the left correspond to combined responses "strongly disagree" and "somewhat disagree" and on the right to combined responses "somewhat agree" and "strongly agree."



fisher population, which is 20% and 24%, respectively (Canadian Council of Professional Fish Harvesters 2018). The sample size was insufficient to analyze the results by age, gender, or identity, so are presented here in an aggregated format.

Fisher perceptions of climate change impacts

Of the 105 fishers who responded to the survey, 77% agreed that climate change is occurring, while 72% thought that climate change will harm future generations, and 56% indicated it would harm them personally (Fig. 1). Half of those surveyed indicated there may not be enough fish to continue to operate in their main fishery in 20 years. Although most fishers surveyed indicated concern over climate change impacts on their livelihoods, well-being, and on future generations, their concern for climate change impacts was just one of many concerns they had over threats to fisheries. One of the fishers surveyed reflected this in saying, "global warming is definitely having an impact but at the same time, for the same species, so might regulations, markets, costs... etc."

Fisher perceptions of the impact of warming waters on specific fisheries varied widely across fisheries. For example, for some fisheries (e.g., salmon) over two-thirds of participants perceived negative effects, whereas for other fisheries (e.g., albacore, hake, geoduck) there was a larger proportion of participants who perceived positive effects or no effects (Fig. 2). Salmon fisheries were perceived as the most vulnerable to the impacts of ocean warming, with sockeye salmon being perceived to be the most negatively impacted of the Pacific salmon species (Fig. 2). A considerable percentage of those who responded indicated that they thought ocean warming would not have any effect on dogfish, geoduck, and sea cucumber fisheries (Fig. 2). As for fisheries that would experience a positive impact, over half of the participants who responded to this question indicated a positive impact on the albacore tuna fishery, and a quarter of those who responded indicated a positive impact for the hake fishery (Fig. 2). These findings elucidate the impacts that fishers perceive climate change will have on particular fisheries, while also highlighting there is considerable fisher uncertainty in feeling confident about the direction and scale of the impact on fisheries with only a third of survey participants providing a categorical response for some fisheries (fisheries with $n < 35$ in Fig. 2; also see Harper et al. 2022).

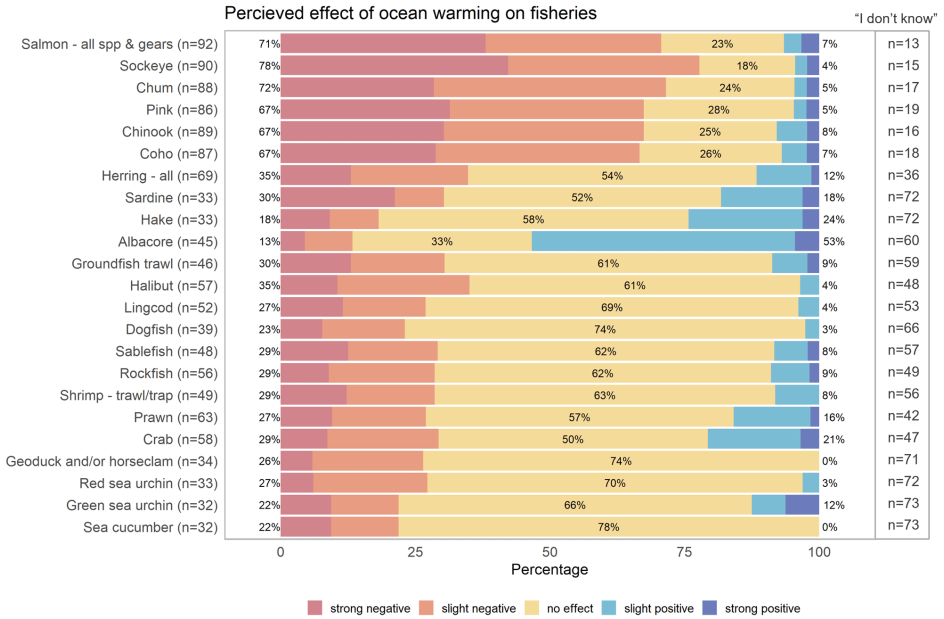
Cumulative impacts and conflict

Responses to survey questions related to additional stressors suggested existing challenges with other fisheries sectors and marine uses and processes. A large proportion of participants indicated that aquaculture (70%), recreational fisheries (70%), marine protected areas (70%), coastal development (62%), and marine spatial planning (56%) negatively impacted their fishery (Fig. 3). Many of the fishers surveyed (64%) agreed with the statement, "there is internal conflict within my own fishery."

In response to an open-ended question about concerns for the future of fishing or their community, one-third of survey participants brought up issues of competition and conflict within and across marine sectors and groups. Some quotes that highlight these sentiments include the following:

> *Coastal fishing towns are dying, too many cuts to commercial fishing opportunities, and sports fishing is not replacing the lost revenue that commercial fishing used to generate for the coastal communities.*

Fig. 2. Perceived effect of ocean warming on Pacific region commercial fisheries. The number of participants (n = x; out of the 105 total number of survey participants) who responded with a categorical rating is included in brackets beside each fishery and the number of survey participants who responded "I don't know" in the far-right column. Percentages listed on the y-axis along the left-hand represent negative responses (strong negative + slight negative), while the ones of the right-hand side represent positive (strong slight positive + strong positive) responses.



> *We are overrun by the so-called recreational fishery here. Where their boats are getting bigger, and they are getting more aggressive every year I would like to see some control put on them like we have. They show no respect to us who have lived here all our lives. Their boats throw one hell of a swell and when we let them know about this, they just swear back at us. It seems us commercial fishermen are targeted when there is no fish by DFO, and others get a free pass.*

The above responses reflect negative sentiments toward the recreational fishery, while the following relates to processes of Reconciliation and Marine Protected Area (MPA) establishment:

> *... my concern is First Nation Reconciliation and MPAs. I would like to see more First Nation involvement in our fishery, so they work with us not against us. The fair way to do this is to buy their way into the fishery with federal money so all of Canada pays not just a few fishermen that have put everything on the line to fish. MPAs are good but they don't work for us* [Invertebrate - dive fishers] *since our fish don't move, it takes anything in the MPA zone right off our TAC* [total allowable catch].

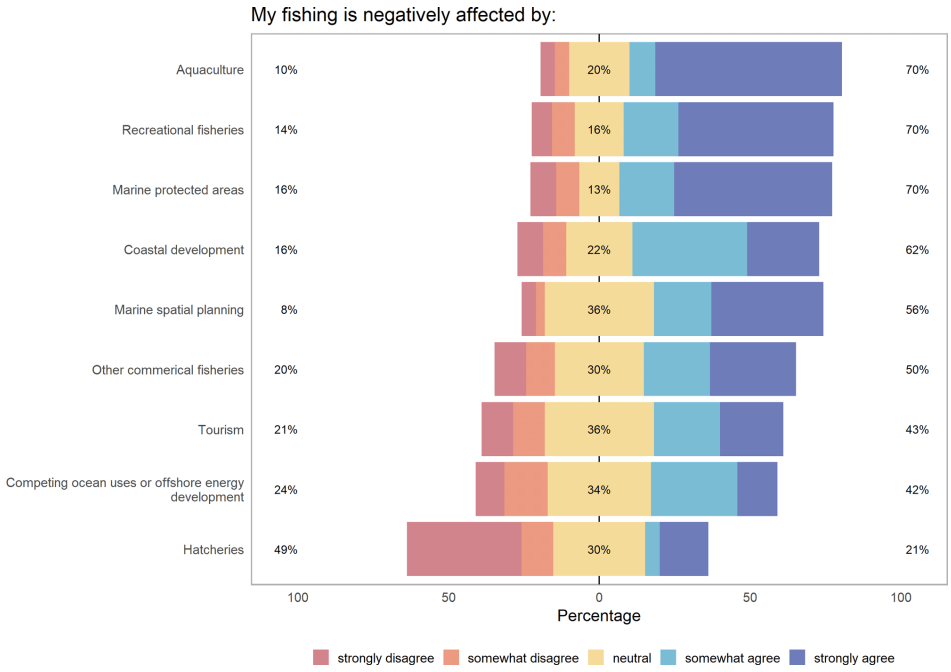
Access to and benefits from current and future resources: distributive justice

Perceptions related to equity were reflected in various survey question responses, including those specific to access and allocation of resources for current and future generations, and the associated distribution of benefits, relating to concepts of distributive justice (Table 1). Perceptions about equity were articulated in various ways throughout the survey. These included the expression of concerns over barriers that exist for young fishers and new entrants to the fishery, particularly considering the greying of the fleet that is visible from the demographic data of the survey participants and from the actual fisher population. The most recent available estimate indicates the average age of captains on the Pacific coast is 56 years and crew 43 years (Canadian Council of Professional Fish Harvesters 2018).

In terms of the ability to access and benefit from emerging opportunities, approximately 70% of survey participants indicated that moving into a new fishery or finding work in another natural resource industry would not be easy (Fig. 4). In responses to open-ended questions, 41% of fishers surveyed expressed concerns related to allocation, i.e., who gets what/how much? Some non-Indigenous fishers indicated a perceived lack of clarity around fisheries reconciliation processes and their impact on allocation to Indigenous and non-Indigenous fishers.

When it came to intergenerational equity considerations, 72% of participants agreed with the statement, "Climate Change will harm future generations" (Fig. 1), and 60% of participants said they would not encourage their children to be fishers. One participant elaborated on this by saying, "my concern is about the next generation of young fishermen. Most will have a hard time finding financing for the exorbitant prices to buy a boat and quotas and earn an honest living." This is also reflected in the

Fig. 3. Fisher perspectives on the impact of other fisheries sub-sectors and ocean uses on their ability to fish. Percentages on the left correspond to combined responses "strongly disagree" and "somewhat disagree" and on the right to combined responses "somewhat agree" and "strongly agree."



responses to questions about adaptive capacity, with half of survey participants indicating that alternative income sources are not easily accessible and 46% suggested getting loans or other financial support is not easy. Additionally, 45% of survey participants disagreed with the statement, "I believe my community has a strong and viable future" (Fig. 4). This lack of optimism for the future of fisheries and fishing communities is further reiterated in this statement, "Nobody I know in the industry with children wants their kids to be fisherpeople." The fact that many of the fishers surveyed said they would not encourage their children to become fishers is likely reflective of other issues in addition to climate change, reinforcing sentiments that fisheries are not a reliable livelihood for future generations, and that future generations may disproportionately bear the cost of changes that impact fisheries, including climate change.

Perceived ability to respond: procedural justice

Perceptions related to the capacity to respond to change, for individuals or institutions, were captured through various survey questions. Over half of participants surveyed indicated that they thought climate change should be considered in fisheries management (Fig. 4). A similar proportion (56%) felt they did not have a strong voice in fisheries management and 64% indicated that they felt fisheries were not managed effectively (Fig. 4). Additionally, 72% of fishers surveyed perceived fisheries management as unable to adapt and respond quickly to changing environmental conditions (Fig. 4) with 60% of participants agreeing with the statement, "I feel constrained in my ability to adapt to changes because of regulations," while 68% of participants disagreed with the statement, "the fisheries I participate in are managed in an equitable way," which was asked as part of a series of questions about sensitivity to changes in fisheries.

When asked what would make management more flexible, many pointed to the need for more inclusive and participatory processes, representation of fisher's knowledge and voices in decision making, and an overall increase in transparency and communication around management processes, which we frame here as a procedural justice consideration (Table 1). One fisher responded to this survey question by saying the following:

> *I am concerned we will not balance our conservation, economic and social goals moving forward. Each pillar is necessary to keep our industry afloat; and villainizing each other (within the fishing community and towards DFO) will only serve to weaken us.*

These quotes point to the need for more inclusive processes and approaches that reduce conflicts when addressing competing objectives and interests, both of which can be useful for advancing climate adaptation in fisheries.

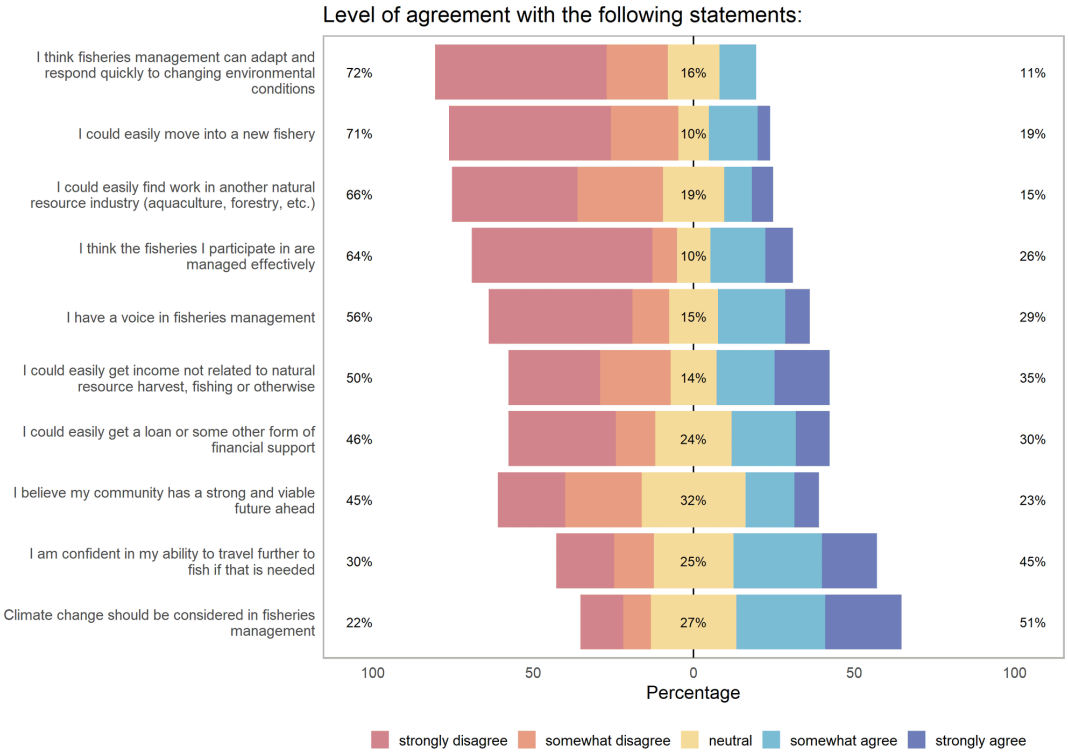
DISCUSSION

Drawing on insights that emerged from a survey of commercial fishers in the Pacific region of Canada, we engaged with principles of procedural and distributive justice to identify key perceptions for consideration in climate adaptation planning (Table 1). As impacts of climate change amplify pre-existing stressors (e.g., Cinner et al. 2011), they put further constraints on fisheries and the potential for conflicts among user groups increases

Table 1. Themes that emerged from the open-ended survey questions grouped into distributive and procedural justice concerns and considerations for improving fisheries management with relevant links to climate adaptation literature and concepts.

Themes	Suggestions from fishers for improving fisheries management	Relevance to climate adaptation
Distributive justice		
Young harvesters face barriers and lack incentives to enter fisheries.	"My concerns are about the next generation of young fishermen. Most will have a hard time finding financing for the exorbitant prices to buy a boat and quotas and earn an honest living." "Young fishermen need to have a stronger voice and access to licences and quota as it is their future, and they are the future of the industry."	New entrants into a fishery provide intergenerational succession and community resilience, whereby the intergenerational transfer of local knowledge about ecosystems contributes to adaptation (Neis et al. 2013, Donkersloot et al. 2020).
There is a lack of understanding and clarity for commercial harvesters regarding fisheries reconciliation and goals to increase Indigenous ownership and co-management.	"Reconciliation needs to be defined." "My concern is first nation reconciliation."	Centering reconciliation with Indigenous peoples in climate adaptation policy (McGregor 2019) in combination with better communication about the intentions, rationale, and implementation of new fisheries management arrangements will increase legitimacy of management and reduce conflicts among groups (Runnebaum et al. 2019).
Marine Protected Area (MPA) establishment limits access to harvesters for the purpose of conservation.	"MPAs are good but they don't work for us since our fish don't move, it takes anything in the MPA zone right off our TAC [total allowable catch]."	MPAs work well for fisheries where fisheries management is limited or non-existent (CPAWS 2015). There is evidence to support that well-designed MPAs can support climate resilience by protecting refugia sites and maintaining key trophic relationships (Micheli et al. 2012, Carr et al. 2017, Hofmann et al. 2021). Ensuring that MPAs have clear, well-communicated objectives, and engage fishers from the beginning in their design and monitoring, may improve how they are perceived by harvesters (Ordoñez-Gauger et al. 2018).
Procedural justice		
Harvesters seek more participatory processes	"Fishermen and communities need to start working together to get their voice heard rather than being in competition with each other." "Improve upon Gov/Industry collaborative processes which develop co-managed responses to the changes often required for both ecological and socio-economic improvements for fisheries." "Fishermen-led processes of the last couple of decades have proven to be extremely valuable. Governments should respect and encourage more processes like this rather than just develop policy in Ottawa designed for the east coast only." "In fisheries where management and stakeholders co-manage to a great extent - i.e., halibut, geoduck, those fisheries are prime examples of successful and sustainable fisheries."	Stakeholder participation and co-management arrangements can bolster adaptive capacity (Brugere and De Young 2020, Whitney et al. 2020b, Bahri et al. 2021).
Harvesters feel that their on-the-water and experiential knowledge about fisheries and the industry could be better engaged.	"Listen more to the knowledgeable commercial fishers." "Fishermen should be more involved in decisions made about fish stocks." "Better communication with fishers who are actually on the frontline who also have valuable information and knowledge of the industry."	Engaging local, place-based, and Indigenous knowledge can support more effective climate adaptation (Nakashima et al. 2012, Galappaththi et al. 2022, Mclean et al. 2022).
Harvesters suggest cooperation and coordination across agencies and jurisdictions could improve outcomes	"As for salmon, we need more positive cooperation between the Provincial and Federal governments to reduce the negative impacts on watersheds."	Collaboration and cooperation across departments, scales, jurisdictions, and organizations is a necessity for adaptation (Whitney and Ban 2019, Lomonico et al. 2021).
Harvesters feel that management communication could be improved.	"Better opportunities for DFO to celebrate and communicate their successes ... as this would add more confidence and trust in the department from the general public resulting possibly in better funding from politicians."	Climate adaptation could be advanced through improved communication and education programs specific to practitioners and communities (Whitney and Ban 2019, Brugere and De Young 2020).

Fig. 4. Level of agreement of survey participants with statements related to perceptions of how fisheries management can adapt to change. Percentages on the left correspond to combined responses "strongly disagree" and "somewhat disagree" and on the right to combined responses "somewhat agree" and "strongly agree."



(Mendenhall et al. 2020). Perceived exclusion, lack of transparency, or unfairness can stoke conflict (Gurney et al. 2021); therefore, understanding perceptions around the harms associated with climate change and the distribution of fishery stressors and benefits is key to climate adaptation planning that considers a social justice lens. In line with such an approach is to understand barriers to and promote equitable access (e.g., across generations, across sectors, across user groups) to fisheries and sustainable use of these resources. Added to this is a call for inclusive and fair processes for participating in fisheries decision making. Applying a social justice lens that emphasizes equity considerations in climate adaptation planning and policy, requires efforts to better understand differentiated impacts at the outset and mitigating them more effectively, while also finding approaches to reduce conflict.

Rising temperatures, compounding stressors, and heightened conflict

Cumulative impacts and conflicts within and across marine sectors and related activities may become more intense with climate change if appropriate interventions are not engaged and supported (Salas and Hayhoe 2021). Fishers surveyed in this study perceived their ability to fish as being negatively affected by numerous marine-use activities that compete for ocean space and/or fisheries resources. If left unaddressed, the consequences of conflict may become compounded by climate change, especially for fisheries where fishing opportunities may already be limited.

In Canada's Pacific region, salmon fisheries illustrate the kinds of multiple pressures that fish and fishers are facing (Standing Committee on Fisheries and Oceans 2021). Diverse and compounding stressors have led to salmon population declines and decreased fishing opportunities across the Pacific region. Ecosystem change, including climate-related changes, is outpacing the ability of salmon to adapt (Grant et al. 2019). In response to declining stocks, recent closures have been imposed and allocations shifted, with substantial impacts on fisher livelihoods (Government of Canada 2021a). Meanwhile, there is still some access, albeit limited, for recreational salmon fishers, which has stoked controversy and criticism of fisheries management and friction between groups (Fawcett-Atkinson 2021). Additional pressures on salmon fisheries include aquaculture, which has been recognized as a threat to wild salmon populations on the Pacific Coast (Connors et al. 2012), with efforts underway to transition away from open-net salmon farming in BC (Government of Canada 2022). Although a substantial portion of fishers surveyed recognized aquaculture as a threat to their ability to fish, fewer perceived hatcheries as having an impact on their fisheries, despite evidence that hatchery salmon compete with wild populations and reduce their resilience in the face of climate stressors (e.g., Naish et al. 2007, Ohlberger et al. 2022).

Fishers surveyed expressed concern over the impacts of various planning processes and competing sectors, signaling potential

areas of friction and conflict. For example, numerous First Nations have come together, developed, and signed fisheries reconciliation agreements with the federal government as part of Canada's ongoing reconciliation process (Brown 2021). This involves increasing fisheries access and allocation to First Nations, Inuit, and Métis in Canada to redress past and ongoing injustices. Although the announcements of agreement signing are public (Government of Canada 2021b), there is not a lot of information available on how these processes will proceed. For example, the text of the agreements is not available to parties who are not involved, and the implementation details are still being worked out by the parties. The limited transparency perceived by commercial fishers who participated in this study, may increase speculation and the spread of misinformation among some groups, as has been highlighted with recent friction over the lobster fisheries on Canada's East Coast. Given the plurality of actors, interests, values, and uses across marine spaces, conflict is, to a certain degree, inevitable (Parlee and Wiber 2018). Although some conflict can be constructive, heightened and unresolved conflict can interfere with governance objectives, threatening the sustainability of the social-ecological systems being governed (Foley et al. 2020). It is possible that creating forums for information transmission and dialogue could help harvesters have improved clarity, understanding, and preparedness for forthcoming industry changes. For the same reasons, identifying and understanding points of conflict should be a key consideration for climate adaptation planning. Evidence suggests that enhancing social cohesion among groups through collaborative processes can help avoid or alleviate conflicts in natural resource management (Baker et al. 2021).

Equitable access to fisheries resources

The survey revealed concerns for new entrants and next generation fishers, highlighting existing access challenges and barriers, obstacles that have also been articulated by researchers and organizations representing Pacific Canada harvesters through the national Standing Committee on Fisheries (Standing Committee on Fisheries and Oceans 2019, Bennett et al. 2021a). These concerns may become even more heightened with climate change, as stocks shift and resources fluctuate, especially where access and intergenerational succession considerations do not follow pace, and this includes the ability to take advantage of and benefit from emerging opportunities. Neighboring Alaska, which faces similar access barriers, has proposed solutions that include locally designated, small-scale access and apprentice permits, as well as developing fishery trusts or quota banks (The Nature Conservancy 2021). Some of these approaches, such as quota banks, have been implemented in Indigenous communities along the Bering Sea and elsewhere; however, access and equity issues remain within the current licensing system (Carothers 2011, National Marine Fisheries Service 2016). Constraints that fishers face in access to loans and other financial support reinforce the findings of a recent fisheries labor market study in Canada that suggests the need for mechanisms to facilitate the intergenerational transfers of fishing assets within fishing communities, for example, through license and quota banks or other innovative ways to transition ownership of licenses from retiring harvesters to new entrants, as a necessary intervention for the sustainability of Canada's fishing industry (Canadian Council of Professional Fish Harvesters 2018). Similarly, a recent report on the future of the BC salmon industry suggests that for young fishers to succeed, they need better access to low interest loans and funding for vessel modifications, in addition to training opportunities, supported through government programming (UFAWU-Unifor 2021).

Institutional considerations to bolster climate responsiveness of management must engage more directly with equity considerations and distributional impacts. In the context of Canada's response to climate change impacts on fisheries, alignment of policy and program objectives across ocean sectors with equity policies will contribute to a more nuanced understanding of the impacts of these initiatives on different groups, while also fostering legitimacy, trust, and support (Turner et al. 2016). This requires applying principles of equity and distributional justice in program and policy development and enhanced engagement with tools such as Gender-Based Analysis Plus (GBA+), a federal government developed and mandated intersectional analysis tool to gain perspective on the differentiated costs and benefits of plans and policies (Daly et al. 2021, Government of Canada 2021c). This tool has yet to be applied consistently and has been criticized for its limited use in ocean economy and climate adaptation planning, despite a mandate to do so (Native Women's Association of Canada 2020). In fisheries planning and decision making broadly, equity and fairness in economic conditions and outcomes need to be established as clear objectives that can be evaluated and measured (Foley et al. 2020).

Toward inclusive and flexible management processes

Fishers surveyed expressed a strong desire for more participatory processes, indicating lack of inclusion of their voices and perspectives in management and decision-making processes. This call is in line with accumulating evidence of the importance of participatory processes for legitimacy and credibility in management institutions, for reducing conflicts and encouraging compliance and positive actions in environmental decision making (Cash et al. 2003). However, participatory processes themselves need to go beyond inviting fishers to participate, to understand the barriers to effective participation and reducing areas of friction (Nordgren and Schonthal 2021). One avenue to enhance participation across groups and the flow of information necessary for management is through collaborative or co-management frameworks where authority and decision making is more equitably distributed, and roles and responsibilities clearly defined (Kearney et al. 2007, Wilson et al. 2018). For example, the co-management of Gwaii Haanas on Canada's Pacific Coast provides a formalized structure for shared decision making that engages broad participation through clearly defined roles (Council of the Haida Nation and Canada 2018). Stakeholder participation in decision-making processes is influenced by many factors, including travel time, opportunity costs, degree in the stake, and trust in the process (Lynham et al. 2017). The high costs associated with attending stakeholder meetings, for example, can result in participation by only those with extreme viewpoints, resulting in outcomes that are not representative of the broader set of interests (Lynham et al. 2017). Also, important to consider are existing power dynamics whereby certain people or groups are either under- or over-represented in decision making (Quimby and Levine 2018).

Where fishers may not participate, either by choice or because of persistent barriers, the role of communication and transparency in decision making is even more important in establishing support for management (Cash et al. 2003, Runnebaum et al. 2019). In this survey, for example, women and those identifying as Indigenous were underrepresented relative to the actual fisher population, which limits the perceptions being represented in the survey results. The conditions for effective governance require participatory, transparent, and openly communicated decision making (Stephenson et al. 2018). Transparency and communication about decisions could foster a better, and much needed, sense of fair process and legitimacy (Runnebaum et al. 2019, Archibald et al. 2021). Additionally, increased transparency of process and communicating decisions to all actors has the potential to reduce ongoing and future conflict. In the context of Pacific Salmon fisheries, testimony from rights holders and stakeholders calls for greater transparency on decision-making processes aimed to protect the long-term health of salmon and those who depend on them (Standing Committee on Fisheries and Oceans 2021).

Although participatory processes exist in fisheries management in Canada, there seems to be a disconnect between what fishers indicated in the survey and what is articulated as a key priority for fisheries management decisions by the federal fisheries management agency in terms of inclusive processes. From the survey results it appears that the bodies representing commercial fishers at participatory management tables (e.g., where input is given on Integrated Fisheries Management Plans) are not reaching some fishers in their report-back and engagement, hence creating the perception that management is not participatory. Although there is considerable evidence to highlight the value of participatory processes to enhance flexibility in the face of social-ecological system change (Cinner and Barnes 2019, Bahri et al. 2021), making this happen requires a better understanding of the context-specific barriers to effective participation in decision-making processes for different groups (Lomonico et al. 2021). Recent research from the East coast of Canada highlights discrepancies between the desired level of fisher participation in management and current involvement (referred to as the engagement gap), providing insights into understanding the nature and extent of participation in management and what some of the constraints may be to closing this gap (Puley and Charles 2022). Partnerships are proving an effective approach for bringing people together across diverse interests in response to fisheries and other environmental governance challenges, as a mechanism for identifying shared goals and values and increasing trust among groups and enhancing participation in decision-making processes (Charles 2018, Lomonico et al. 2021). And, although access to and involvement in decision making is important, not everyone will want to or be able to participate, even as barriers are removed, making transparency and communication around decisions and processes even more critical for developing trust and legitimacy in management in the face of rapid change.

Bringing forward social justice considerations in climate adaptation planning

Adaptation planning that is more inclusive, transparent, and addresses social dimensions and perceptions of fisheries is more likely to garner widespread support. Here we draw on social justice considerations to illuminate some existing concerns and challenges faced by commercial fishers on the Pacific coast of Canada that, if left unaddressed, may be amplified by climate change (Mendenhall et al. 2020). Although the climate change concerns and considerations that were brought forward by fish harvesters from Canada's Pacific region cannot be generalized, the importance of bringing an environmental justice lens to climate adaptation planning across ocean sectors is applicable broadly (Bennett et al. 2023). The findings of this study reinforce the need to collect and analyze human dimensions data to better understand the social, cultural, and economic context of fisheries systems (Whitney et al. 2017, Bennett et al. 2021b, Szymkowiak 2021). Improved availability, understanding, and integration of socioeconomic data on fisher livelihoods, the distribution of benefits, and well-being indicators is a tangible and necessary step toward mainstreaming equity considerations into fisheries management (Foley et al. 2020). This has particular urgency in the context of a changing climate where the diversity of fisheries actors and interests within the sector mean that there are varying degrees of vulnerabilities and capacities to adapt. Eliciting and understanding the different perceptions and values of fishers can improve management efforts while also reducing social-environmental conflicts (Mclean et al. 2022). As the fishing industry, communities, and management institutions around the world navigate a changing climate and its impacts on fisheries systems, acknowledging and addressing the social justice concerns and many complex considerations raised here will be critical for advancing adaptive and resilient fisheries into the future.

Acknowledgments:

We are grateful for the grant from the Lenfest Foundation to PSL and AC, which supported the development of the survey that was adapted for this study and its implementation by LN. SH was supported through a Mitacs Accelerate Grant and NCB was supported by NSERC. The authors would like to thank John Driscoll and numerous others for their insights and feedback provided at various stages of this project.

Data Availability:

Data and R code used in plotting survey responses are available at https://github.com/lknelson05/climate_perceptions https://github.com/lknelson05/climate_perceptions

LITERATURE CITED

Adger, W. N., T. Quinn, I. Lorenzoni, and C. Murphy. 2016. Sharing the pain: perceptions of fairness affect private and public response to hazards. Annals of the American Association of Geographers 106(5):1079-1096. https://doi.org/10.1080/2469445-2.2016.1182005

Archibald, D. W., R. McIver, and R. Rangeley. 2021. Untimely publications: delayed Canadian fisheries science advice limits transparency of decision-making. Marine Policy 132:104690. https://doi.org/10.1016/j.marpol.2021.104690

Bahri, T., M. Vasconcellos, D. Welch, J. Johnson, R. I. Perry, X. Ma, and R. Sharma. 2021. Adaptive management of fisheries in response to climate change. FAO Fisheries and Aquaculture Technical Paper. Food and Agricultural Organization of the United Nations, Rome, Italy.

Baker, D., G. Murray, J. Kaijage, A. Levine, D. Gill, and E. Makupa. 2021. Relationships matter: assessing the impacts of a marine protected area on human wellbeing and relational values in Southern Tanzania. Frontiers in Marine Science 8:673045. https://doi.org/10.3389/fmars.2021.673045

Ballew, M. T., A. Leiserowitz, C. Roser-Renouf, S. A. Rosenthal, J. E. Kotcher, J. R. Marlon, E. Lyon, M. H. Goldberg, and E. W. Maibach. 2019. Climate change in the American mind: data, tools, and trends. Environment: Science and Policy for Sustainable Development 61(3):4-18. https://doi.org/10.1080/00139157.2019.1589300

Barnes, M. L., P. Wang, J. E. Cinner, N. A. J. Graham, A. M. Guerrero, L. Jasny, J. Lau, S. R. Sutcliffe, and J. Zamborain-Mason. 2020. Social determinants of adaptive and transformative responses to climate change. Nature Climate Change 10 (9):823-828. https://doi.org/10.1038/s41558-020-0871-4

Bell, R. J., J. Odell, G. Kirchner, and S. Lomonico. 2020. Actions to promote and achieve climate-ready fisheries: summary of current practice. Marine and Coastal Fisheries 12(3):166-190. https://doi.org/10.1002/mcf2.10112

Bennett, N. J., J. J. Alava, C. E. Ferguson, J. Blythe, E. Morgera, D. Boyd, and I. M. Côté. 2023. Environmental (in)justice in the Anthropocene ocean. Marine Policy 147:105383. https://doi.org/10.1016/j.marpol.2022.105383

Bennett, N. J., N. C. Ban, A. Schuhbauer, D. V. Splichalova, M. Eadie, K. Vandeborne, J. McIsaac, E. Angel, J. Charleson, E. R. Gavenus, S. Harper, T. Satterfield, T. Sutcliffe, and R. Sumaila. 2021a. Access rights, capacities and benefits in small-scale fisheries: insights from the Pacific Coast of Canada. Marine Policy 130:104581. https://doi.org/10.1016/j.marpol.2021.104581

Bennett, N. J., N. C. Ban, A. Schuhbauer, D. Splichalova, M. Eadie, K. Vandeborne, J. McIsaac, E. Angel, J. Charleson, S. Harper, T. Sutcliffe, E. Gavenus, R. Sumaila, and T. Satterfield. 2020a. Fishing for a future: understanding access issues and wellbeing among independent fish harvesters in British Columbia, Canada. Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, British Columbia, Canada.

Bennett, N. J., J. Blythe, A. M. Cisneros-Montemayor, G. G. Singh, and U. R. Sumaila. 2019. Just transformations to sustainability. Sustainability 11(14):3881. https://doi.org/10.3390/su11143881

Bennett, N. J., A. Calò, A. Di Franco, F. Niccolini, D. Marzo, I. Domina, C. Dimitriadis, F. Sobrado, M. C. Santoni, E. Charbonnel, M. Trujillo, J. Garcia-Charton, L. Seddiki, V. Cappanera, J. Grbin, L. Kastelic, M. Milazzo, and P. Guidetti. 2020b. Social equity and marine protected areas: perceptions of small-scale fishermen in the Mediterranean Sea. Biological Conservation 244:108531. https://doi.org/10.1016/j.biocon.2020.108531

Bennett, N. J., A. Schuhbauer, D. Skerritt, and N. Ebrahim. 2021b. Socio-economic monitoring and evaluation in fisheries. Fisheries Research 239:105934. https://doi.org/10.1016/j.fishres.2021.105934

Breslow, S. J., M. Allen, D. Holstein, B. Sojka, R. Barnea, X. Basurto, C. Carothers, S. Charnley, S. Coulthard, N. Dolšak, J. Donatuto, C. García-Quijano, C. C. Hicks, A. Levine, M. B. Mascia, K. Norman, M. Poe, T. Satterfield, K. St. Martin, and P. S. Levin. 2017. Evaluating indicators of human well-being for ecosystem-based management. Ecosystem Health and Sustainability 3(12):1411767. https://doi.org/10.1080/20964129.2017.1411767

Brown, B. 2021. Coastal First Nations sign Fisheries Resources Reconciliation Agreement with Canada. Coastal First Nations Great Bear Initiative, Vancouver, British Columbia, Canada. https://coastalfirstnations.ca/coastal-first-nations-sign-fisheries-resources-reconciliation-agreement-with-canada/

Brugere, C., and C. De Young. 2020. Addressing fisheries and aquaculture in National Adaptation Plans. Food and Agriculture Organization of the United Nations, Rome, Italy.

Canadian Council of Professional Fish Harvesters. 2018. Fisheries seasonality and the allocation of labour and skills. Labour Market Information Study. Canadian Council of Professional Fish Harvesters, Gatineau, Quebec, Canada.

Canadian Parks and Wilderness Society (CPAWS). 2015. Seeking convergence: Proceedings of the MPAs and Fisheries Science Forum, Vancouver, British Columbia, Canada, 8-10 April 2015. https://cpaws.org/wp-content/uploads/2018/02/Seeking_Convergence_-_Science_Forum_on_MPAs_and_Fisheries_2015.pdf

Carothers, C. 2011. Equity and access to fishing rights: exploring the community quota program in the Gulf of Alaska. Human Organization 70(3):213-223.

Carr, M. H., S. P. Robinson, C. Wahle, G. Davis, S. Kroll, S. Murray, E. J. Schumacker and M. Williams. 2017. The central importance of ecological spatial connectivity to effective coastal marine protected areas and to meeting the challenges of climate change in the marine environment. Aquatic Conservation: Marine and Freshwater Ecosystems 27:6-29. https://doi.org/10.1002/aqc.2800

Cash, D. W., W. C. Clark, F. Alcock, N. M. Dickson, N. Eckley, D. H. Guston, J. Jäger, and R. B. Mitchell. 2003. Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences of the United States of America 100 (14):8086-8091. https://doi.org/10.1073/pnas.1231332100

Charles, A. 2018. Meaningful partnerships in meaningful ocean governance. Pages 28-33 in D. Werle, P. R. Boudreau, M. R. Brooks, M. J. A. Butler, A. Charles, S. Coffen-Smout, D. Griffiths, I. McAllister, M. L. McConnell, I. Porter, S. J. Rolston and P. G. Wells, editors. The future of ocean governance and capacity development: essays in honor of Elisabeth Mann Borgese (1918-2002). International Ocean Institute, Halifax, Nova Scotia, Canada. https://doi.org/10.1163/9789004380271_007

Cheung, W. W. L., R. D. Brodeur, T. A. Okey, and D. Pauly. 2015. Projecting future changes in distributions of pelagic fish species of Northeast Pacific shelf seas. Progress in Oceanography 130:19-31. https://doi.org/10.1016/j.pocean.2014.09.003

Cinner, J. E., and M. L. Barnes. 2019. Social dimensions of resilience in social-ecological systems. One Earth 1(1):51-56. https://doi.org/10.1016/j.oneear.2019.08.003

Cinner, J. E., C. Folke, T. Daw, and C. C. Hicks. 2011. Responding to change: using scenarios to understand how socioeconomic factors may influence amplifying or dampening exploitation feedbacks among Tanzanian fishers. Global Environmental Change 21(1):7-12. https://doi.org/10.1016/j.gloenvcha.2010.09.001

Connors, B. M., D. C. Braun, R. Peterman, A. B. Cooper, J. D. Reynolds, L. M. Dill, G. T. Ruggerone, and M. Krkošek. 2012. Migration links ocean-scale competition and local ocean conditions with exposure to farmed salmon to shape wild salmon dynamics. Conservation Letters 5:304-312. https://doi.org/10.1111/j.1755-263X.2012.00244.x

Council of the Haida Nation and Canada. 2018. Gwaii Haanas Gina 'Waadluxan KilGuhlGa Land-Sea-People Management Plan. Gwaii Haanas Archipelago Management Board, Skidegate, British Columbia, Canada.

Cullen, A. C., and C. L. Anderson. 2017. Perception of climate risk among rural farmers in Vietnam: consistency within households and with the empirical record. Risk Analysis 37 (3):531-545. https://doi.org/10.1111/risa.12631

Cullen, A. C., C. L. Anderson, P. Biscaye, and T. W. Reynolds. 2018. Variability in cross-domain risk perception among smallholder farmers in Mali by gender and other demographic and attitudinal characteristics. Risk Analysis 38(7):1361-1377. https://doi.org/10.1111/risa.12976

Daly, J., C. Knott, P. Keogh, and G. G. Singh. 2021. Changing climates in a blue economy: assessing the climate-responsiveness of Canadian fisheries and oceans policy. Marine Policy 131:104623. https://doi.org/10.1016/j.marpol.2021.104623

DFO (Fisheries and Oceans Canada). 2014. Canada–British Columbia Marine Protected Area Network Strategy. Fisheries and Oceans Canada, Victoria, British Columbia, Canada. https://www.dfo-mpo.gc.ca/oceans/publications/mpabc-cbzpm/index-eng.html

Dieckmann, N. F., R. Gregory, T. Satterfield, M. Mayorga, and P. Slovic. 2021. Characterizing public perceptions of social and cultural impacts in policy decisions. Proceedings of the National Academy of Sciences of the United States of America 118(24): e2020491118. https://doi.org/10.1073/pnas.2020491118

Donkersloot, R., J. Coleman, C. Carothers, D. Ringer, and P. Cullenberg. 2020. Kin, community, and diverse rural economies: rethinking resource governance for Alaska rural fisheries. Marine Policy 117:103966. https://doi.org/10.1016/j.marpol.2020.103966

English, P. A., E. J. Ward, C. N. Rooper, R. E. Forrest, L. A. Rogers, K. L. Hunter, A. M. Edwards, B. M. Connors, and S. C. Anderson. 2022. Contrasting climate velocity impacts in warm and cool locations show that effects of marine warming are worse in already warmer temperate waters. Fish and Fisheries 23:239-255. https://doi.org/10.1111/faf.12613

Fawcett-Atkinson, M. 2021. These Indigenous fishers hold DFO accountable for B.C.'s shocking salmon decline. National Observer, 4 October. https://www.nationalobserver.com/2021/10/04/these-indigenous-fishers-hold-dfo-accountable-bcs-shocking-salmon-decline

Foley, P., E. Pinkerton, M. G. Wiber, and R. L. Stephenson. 2020. Full-spectrum sustainability: an alternative to fisheries management panaceas. Ecology and Society 25(2):1. https://doi.org/10.5751/ES-11509-250201

Friedman, R. S., E. A. Law, N. J. Bennett, C. D. Ives, J. P. R. Thorn, and K. A. Wilson. 2018. How just and just how? A systematic review of social equity in conservation research. Environmental Research Letters 13:053001. https://doi.org/10.1088/1748-9326/aabcde

Galappaththi, E. K., V. B. Susarla, S. J. T. Loutet, S. T. Ichien, A. A. Hyman, and J. D. Ford. 2022. Climate change adaptation in fisheries. Fish and Fisheries 23:4-21. https://doi.org/10.1111/faf.12595

Government of Canada. 2021a. Minister Jordan announces long-term commercial closures and Licence Retirement Program in effort to save Pacific Salmon. Government of Canada, Ottawa, Ontario, Canada. https://www.canada.ca/en/fisheries-oceans/news/2021/06/minister-jordan-announces-long-term-commercial-closures-and-licence-tetirement-program-in-effort-to-save-pacific-salmon.html

Government of Canada. 2021b. Fisheries Resources Reconciliation Agreement (FRRA) between Coastal First Nations and Canada. Government of Canada, Ottawa, Ontario, Canada. https://www.pac.dfo-mpo.gc.ca/reconciliation/docs/frra-arrh-eng.html

Government of Canada. 2021c. Gender-based analysis plus (GBA Plus). Government of Canada, Ottawa, Ontario, Canada. https://women-gender-equality.canada.ca/en/gender-based-analysis-plus.html

Government of Canada 2022. The future of salmon aquaculture in British Columbia - toward an open-net pen transition plan: a framework for discussion. Government of Canada, Ottawa, Ontario, Canada. https://www.pac.dfo-mpo.gc.ca/consultation/aquaculture/bc-transition-cb/cadre-discussion-framework-eng.html

Grant, S. C. H., B. L. MacDonald, and M. L. Winston. 2019. State of the Canadian Pacific Salmon: responses to changing climate and habitats. Canadian Technical Report of Fisheries and Aquatic Sciences 3332. Fisheries and Oceans Canada, Nanaimo, British Columbia, Canada. https://www.dfo-mpo.gc.ca/species-especes/publications/salmon-saumon/state-etat-2019/abstract-resume/index-eng.html

Grothmann, T., K. Grecksch, M. Winges, and B. Siebenhüner. 2013. Assessing institutional capacities to adapt to climate change: integrating psychological dimensions in the adaptive capacity wheel. Natural Hazards and Earth System Sciences 13 (12):3369-3384. https://doi.org/10.5194/nhess-13-3369-2013

Gupta, J., C. Termeer, J. Klostermann, S. Meijerink, M. van den Brink, P. Jong, S. Nooteboom, and E. Bergsma. 2010. The adaptive capacity wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Environmental Science and Policy 13(6):459-471. https://doi.org/10.1016/j.envsci.2010.05.006

Gurney, G. G., S. Mangubhai, M. Fox, M. Kiatkoski Kim, and A. Agrawal. 2021. Equity in environmental governance: perceived fairness of distributional justice principles in marine co-management. Environmental Science and Policy 124:23-32. https://doi.org/10.1016/j.envsci.2021.05.022

Harper, S., J. Burt, L. Nelson, K. Hunter, P. Levin, J. Runnebaum, J. McIsaac, C. Burridge, A. Olson and N. Ban. 2022. Fishing for solutions: harvester perceptions of climate change vulnerability in Canada's Pacific Fisheries. Nature United, Toronto, Ontario, Canada. https://www.natureunited.ca/content/dam/tnc/nature/en/documents/canada/harvester-perceptions-climate-change-canada-pacific-fisheries.pdf

Hofmann, G. E., E. L. Hazen, R. F. Ambrose, D. Aseltine-Neilson, H. Carter, J. E. Caselle, F. Chan, D. Kone, A. Levine, F. Micheli, D. Panos, J. Sunday and J. W. White. 2021. Climate resilience and California's marine protected area network: a report by the Ocean Protection Council Science Advisory Team Working Group and California Ocean Science Trust. Sacramento, California, United States.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate change 2014: synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, R. K. Pachauri and L. A. Meyer, editors. IPCC, Geneva, Switzerland.

Intergovernmental Panel on Climate Change (IPCC). 2021. Summary for policymakers. Pages 433-440 in P. Zhai, A. Pirani, S. L. Connors, S. B. C. Péan, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou, editors. Climate change 2021: the physical science basis. IPCC, Geneva, Switzerland.

Jardine, S. L., M. C. Fisher, S. K. Moore, and J. F. Samhouri. 2020. Inequality in the economic impacts from climate shocks in fisheries: the case of harmful algal blooms. Ecological Economics 176:106691. https://doi.org/10.1016/j.ecolecon.2020.106691

Kearney, J., F. Berkes, A. Charles, E. Pinkerton, and M. Wiber. 2007. The role of participatory governance and community-based management in integrated coastal and ocean management in Canada. Coastal Management 35(1):79-104. https://doi.org/10.1080/10.1080/08920750600970511

Klinsky, S., T. Roberts, S. Huq, C. Okereke, P. Newell, P. Dauvergne, K. O'Brien, H. Schroeder, P. Tschakert, J. Clapp, M. Keck, F. Biermann, D. Liverman, J. Gupta, A. Rahman, D. Messner, D. Pellow, and S. Bauer. 2017. Why equity is fundamental in climate change policy research. Global Environmental Change 44:170-173. https://doi.org/10.1016/j.gloenvcha.2016.08.002

Lam, V. W. Y., W. W. L. Cheung, G. Reygondeau, and U. R. Sumaila. 2016. Projected change in global fisheries revenues under climate change. Scientific Reports 6(1):32607. https://doi.org/10.1038/srep32607

Levin, P. S., S. A. Gray, C. Möllmann, and A. C. Stier. 2021. Perception and conflict in conservation: the Rashomon effect. BioScience 71(1):64-72. https://doi.org/10.1093/biosci/biaa117

Lomonico, S., M. G. Gleason, J. R. Wilson, D. Bradley, K. Kauer, R. J. Bell, and T. Dempsey. 2021. Opportunities for fishery partnerships to advance climate-ready fisheries science and management. Marine Policy 123:104252. https://doi.org/10.1016/j.marpol.2020.104252

Lynham, J., B. S. Halpern, T. Blenckner, T. Essington, J. Estes, M. Hunsicker, C. Kappel, A. K. Salomon, C. Scarborough, K. A. Selkoe, and A. Stier. 2017. Costly stakeholder participation creates inertia in marine ecosystems. Marine Policy 76:122-129. https://doi.org/10.1016/j.marpol.2016.11.011

Martin, A., N. Gross-Camp, B. Kebede, S. McGuire and J. Munyarukaza. 2014. Whose environmental justice? Exploring local and global perspectives in a payments for ecosystem services scheme in Rwanda. Geoforum 54:167-177. https://doi.org/10.1016/j.geoforum.2013.02.006

McDermott, M., S. Mahanty, and K. Schreckenberg. 2013. Examining equity: a multidimensional framework for assessing equity in payments for ecosystem services. Environmental Science and Policy 33:416-427. https://doi.org/10.1016/j.envsci.2012.10.006

McGee, G., J. Byington, J. Bones, S. Cargill, M. Dickinson, K. Wozniak, and K. A. Pawluk. 2022. Marine Plan Partnership for the North Pacific Coast: engagement and communication with stakeholders and the public. Marine Policy 142:104613. https://doi.org/10.1016/j.marpol.2021.104613

McGregor, D. 2019. Reconciliation, colonization, and climate futures. Pages 139-150 in C. H. Tuohy, S. Borwein, P. J. Loewen, A. Potter, editors. Policy transformation in Canada: is the past prologue? University of Toronto Press, Toronto, Ontario, Canada. https://doi.org/10.3138/9781487519865-017

Mclean, E. L., G. E. Forrester, and C. G. García-Quijano. 2022. The disconnect between knowledge and perceptions: a study of fishermen's local ecological knowledge and their perception of the state of fisheries and how these are managed in the Dominican Republic. Human Ecology 50:227-240. https://doi.org/10.1007/s10745-022-00308-6

Mendenhall, E., C. Hendrix, E. Nyman, P. M. Roberts, J. R. Hoopes, J. R. Watson, V. W. Y. Lam, and U. R. Sumaila. 2020. Climate change increases the risk of fisheries conflict. Marine Policy 117:103954. https://doi.org/10.1016/j.marpol.2020.103954

Micheli, F., A. Saenz-Arroyo, A. Greenley, L. Vazquez, J. A. Espinoza Montes, M. Rossetto and G. A. De Leo. 2012. Evidence that marine reserves enhance resilience to climatic impacts. PLoS ONE 7(7):e40832. https://doi.org/10.1371/journal.pone.0040832

Naish, K. A., J. E. Taylor III, P. S. Levin, T. P. Quinn, J. R. Winton, D. Huppert, and R. Hilborn. 2007. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. Advances in Marine Biology 53:61-194. https://doi.org/10.1016/S0065-2881(07)53002-6

Nakashima, D. J., K. Galloway McLean, H. D. Thulstrup, A. Ramos Castillo, and J. T. Rubis. 2012. Weathering uncertainty: traditional knowledge for climate change assessment and adaptation. D. McDonald, editor. UNESCO, Paris, France.

National Marine Fisheries Service. 2016. Twenty-year review of the Pacific halibut and sablefish individual fishing quota

management program. National Pacific Fisheries Management Council, Anchorage, Alaska, USA.

Native Women's Association of Canada. 2020. Indigenous women's voices on marine safety, oceans, and waterway environmental protection: an initial discussion paper. Native Women's Association of Canada, Ottawa, Ontario, Canada. https://www.nwac.ca/assets-knowledge-centre/NWAC-Marine-Safety-Report-EN-WEB-3.pdf

Neis, B., S. Gerrard, and N. G. Power. 2013. Women and children first: the gendered and generational social-ecology of smaller-scale fisheries in Newfoundland and Labrador and northern Norway. Ecology and Society 18(4):64. https://doi.org/10.5751/ES-06010-180464

Nelson, L. K., A. C. Cullen, L. E. Koehn, S. Harper, J. Runnebaum, M. Bogeberg, A. Strawn, and P. S. Levin. 2023. Understanding perceptions of climate vulnerability to inform more effective adaptation in coastal communities. PLoS Climate 2(2):e0000103. https://doi.org/10.1371/journal.pclm.0000103

Nordgren, L., and D. Schonthal. 2021. The human element: overcoming the resistance that awaits new ideas. First edition. Wiley, Hoboken, New Jersey, USA.

Ohlberger, J., E. J. Ward, R. E. Brenner, M. E. Hunsicker, S. B. Haught, D. Finnoff, M. A. Litzow, T. Schwoerer, G. T. Ruggerone and C. Hauri. 2022. Non-stationary and interactive effects of climate and competition on pink salmon productivity. Global Change Biology 28:2026-2040. https://doi.org/10.1111/gcb.16049

Ordoñez-Gauger, L., L. Richmond, S. Hackett, and C. Chen. 2018. It's a trust thing: assessing fishermen's perceptions of the California North Coast marine protected area network. Ocean and Coastal Management 158:144-153. https://doi.org/10.1016/j.ocecoaman.2018.03.034

Paavola, J. 2007. Institutions and environmental governance: a reconceptualization. Ecological Economics 63(1):93-103. https://doi.org/10.1016/j.ecolecon.2006.09.026

Parlee, C. E., P. Foley, M. A. López Gómez, Md. R. Miah, C. Mather, and R. L. Stephenson. 2021. Full spectrum sustainability and a theory of access: integrating social benefits into fisheries governance. Marine Policy 134:104764. https://doi.org/10.1016/j.marpol.2021.104764

Parlee, C. E., and M. G. Wiber. 2018. Using conflict over risk management in the marine environment to strengthen measures of governance. Ecology and Society 23(4):5. https://doi.org/10.5751/ES-10334-230405

Pershing, A. J., M. A. Alexander, D. C. Brady, D. Brickman, E. N. Curchitser, A. W. Diamond, L. McClenachan, K. E. Mills, O. C. Nichols, D. E. Pendleton, N. R. Record, J. D. Scott, M. D. Staudinger, and Y. Wang. 2021. Climate impacts on the Gulf of Maine ecosystem: a review of observed and expected changes in 2050 from rising temperatures. Elementa: Science of the Anthropocene 9(1):00076. https://doi.org/10.1525/elementa.2020.00076

Pinsky, M. L., and M. Fogarty. 2012. Lagged social-ecological responses to climate and range shifts in fisheries. Climatic Change 115(3-4):883-891. https://doi.org/10.1007/s10584-012-0599-x

Poloczanska, E. S., M. T. Burrows, C. J. Brown, J. García Molinos, B. S. Halpern, O. Hoegh-Guldberg, C. V. Kappel, P. J. Moore, A. J. Richardson, D. S. Schoeman, and W. J. Sydeman. 2016. Responses of marine organisms to climate change across oceans. Frontiers in Marine Science 3:62 https://doi.org/10.3389/fmars.2016.00062

Prilleltensky, I. 2012. Wellness as fairness. American Journal of Community Psychology 49(1-2):1-21. https://doi.org/10.1007/s10464-011-9448-8

Puley, M., and A. Charles. 2022. Dissecting co-management: fisher participation across management components and implications for governance. Fish and Fisheries 23:719-732. https://doi.org/10.1111/faf.12645

QSR International. 2020. NVivo. QSR International, Melbourne Australia.

Quimby, B., and A. Levine. 2018. Participation, power, and equity: examining three key social dimensions of fisheries comanagement. Sustainability 10(9):3324. https://doi.org/10.3390/su10093324

R Core Team. 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Ripley, A. 2021. High conflict: why we get trapped and how we get out of it. Simon & Schuster, New York, New York, USA.

Runnebaum, J. M., E. A. Maxwell, J. S. Stoll, K. E. Pianka, and N. G. Oppenheim. 2019. Communication, relationships, and relatability influence stakeholder perceptions of credible science. American Fisheries Society 44(4):164-171. https://doi.org/10.1002/fsh.10214

Salas, R. N., and K. Hayhoe. 2021. Climate action for health and hope. The BMJ 374:19-20. https://doi.org/10.1136/bmj.n2100

Savo, V., C. Morton, and D. Lepofsky. 2017. Impacts of climate change for coastal fishers and implications for fisheries. Fish and Fisheries 18(5):877-889. https://doi.org/10.1111/faf.12212

Schlosberg, D. 2007. Defining environmental justice: theories, movements, and nature. Oxford University Press, New York, New York, USA. https://doi.org/10.1093/acprof:oso/9780199286294.001.0001

Schlosberg, D. 2013. Theorising environmental justice: the expanding sphere of a discourse. Environmental Politics 22 (1):37-55. https://doi.org/10.1080/09644016.2013.755387

Schumann S. 2018. Commercial fisheries resilience planning: a tool for industry empowerment. Resilient Fisheries RI, Rhode Island, USA. http://resilientfisheriesri.org/wp-content/uploads/2018/12/Commercial-Fisheries-Resilience-Planning-A-Tool-for-Industry-Empowerment.pdf

Slovic, P. 1997. Public perception of risk. Environmental Medicine 59(9):645-650.

Smith, K. E., M. T. Burrows, A. J. Hobday, A. Sen Gupta, P. J. Moore, M. Thomsen, T. Wernberg, and D. A. Smale. 2021. Socioeconomic impacts of marine heatwaves: global issues and opportunities. Science 374(6566):eabj3593. https://doi.org/10.1126/science.abj3593

Standing Committee on Fisheries and Oceans. 2019. West coast fisheries: sharing risks and benefits. House of Commons Canada, Ottawa, Ontario, Canada.

Standing Committee on Fisheries and Oceans. 2021. Pacific Salmon: ensuring the long-term health of wild populations and associated fisheries. House of Commons Canada, Ottawa, Ontario, Canada.

Stephenson, R. L., M. Wiber, S. Paul, E. Angel, A. Benson, A. Charles, O. Chouinard, D. Edwards, P. Foley, D. Lane, J. McIsaac, B. Neis, C. Parlee, E. Pinkerton, M. Saunders, K. Squires, and U. R. Sumaila. 2018. Integrating diverse objectives for sustainable fisheries in Canada. Canadian Journal of Fisheries and Aquatic Sciences 76:480-496. https://doi.org/10.1139/cjfas-2017-0345

Sultana, F. 2022. Critical climate justice. Geographical Journal 188:118-124. https://doi.org/10.1111/geoj.12417

Szymkowiak, M. 2020. Adaptations and well-being: Gulf of Alaska fishing families in a changing landscape. Ocean and Coastal Management 197:105321. https://doi.org/10.1016/j.ocecoaman.2020.105321

Szymkowiak, M. 2021. A conceptual framework for incorporating human dimensions into integrated ecosystem assessments. Frontiers in Marine Science 8:617054. https://doi.org/10.3389/fmars.2021.617054

Talloni-Álvarez, N. E., U. R. Sumaila, P. Le Billon, and W. W. L. Cheung. 2019. Climate change impact on Canada's Pacific marine ecosystem: the current state of knowledge. Marine Policy 104:163-176. https://doi.org/10.1016/j.marpol.2019.02.035

Teh, L. C. L., W. W. L. Cheung, and R. Sumaila. 2022. Assessing the economic contribution of ocean-based activities using the Pacific Coast of British Columbia as a case study. Sustainability 14(14):8662. https://doi.org/10.3390/su14148662

The Nature Conservancy. 2021. Righting the ship: restoring local fishing access and opportunity in Bristol Bay salmon fisheries. The Nature Conservancy, Anchorage, Alaska, USA. https://www.nature.org/content/dam/tnc/nature/en/documents/RightingTheShip_elec_2021.pdf

Truth and Reconciliation Commission of Canada. 2015. Canada's residential schools: reconciliation: the final report of the Truth and Reconciliation Commission of Canada. Vol. 6. McGill-Queen's University Press, Montreal, Quebec, Canada. https://doi.org/10.2307/j.ctt19qghck

Turner, R. A., J. Addison, A. Arias, B. J. Bergseth, N. A. Marshall, T. H. Morrison, and R. C. Tobin. 2016. Trust, confidence, and equity affect the legitimacy of natural resource governance. Ecology and Society 21(3):18. https://doi.org/10.5751/ES-08542-210318

United Fishermen & Allied Worker's Union (UFAWU-Unifor). 2021. The future of B.C. commercial salmon fishing. UFAWU, Campbell River, British Columbia, Canada. https://ufawu-unifor.org/reports/the-future-of-b-c-commercial-fishing-report/

Whitney, C. K., and N. C. Ban. 2019. Barriers and opportunities for social-ecological adaptation to climate change in coastal British Columbia. Ocean and Coastal Management 179:104808. https://doi.org/10.1016/j.ocecoaman.2019.05.010

Whitney, C. K., N. J. Bennett, N. C. Ban, E. H. Allison, D. Armitage, J. L. Blythe, J. M. Burt, W. Cheung, E. M. Finkbeiner, M. Kaplan-Hallam, I. Perry, N. J. Turner, and L. Yumagulova. 2017. Adaptive capacity: from assessment to action in coastal social-ecological systems. Ecology and Society 22(2):22. https://doi.org/10.5751/ES-09325-220222

Whitney, C. K., T. Conger, N. C. Ban, and R. McPhie. 2020a. Synthesizing and communicating climate change impacts to inform coastal adaptation planning. Facets 5(1):704-737. https://doi.org/10.1139/facets-2019-0027

Whitney, C. K., A. Frid, B. K. Edgar, J. Walkus, P. Siwallace, I. L. Siwallace, and N. C. Ban. 2020b. "Like the plains people losing the buffalo": perceptions of climate change impacts, fisheries management, and adaptation actions by Indigenous peoples in coastal British Columbia, Canada. Ecology and Society 25(4):33. https://doi.org/10.5751/ES-12027-250433

Wilson, J. R., S. Lomonico, D. Bradley, L. Sievanen, T. Dempsey, M. Bell, S. McAfee, C. Costello, C. Szuwalski, H. McGonigal, S. Fitzgerald, and M. Gleason. 2018. Adaptive comanagement to achieve climate-ready fisheries. Conservation Letters 11(6): e12452. https://doi.org/10.1111/conl.12452

Appendix 1: Survey questions on perceptions of climate change impacts on commercial fisheries

Background Information

This section will ask a few questions about you, the fisheries you participate in, and the regions where you fish.

1. **What Pacific coast commercial fisheries do you participate in?**
   Check all that apply.

PELAGICS

- [ ] Salmon - Troll
- [ ] Salmon - Seine
- [ ] Salmon - Gillnet
- [ ] Herring Roe - Gillnet
- [ ] Herring Roe - Seine
- [ ] Herring Spawn on Kelp
- [ ] Tuna – Troll
- [ ] Tuna – International
- [ ] Tuna – US waters
- [ ] Hake - Midwater Trawl
- [ ] Sardine

GROUNDFISH

- [ ] Groundfish – Trawl
- [ ] Halibut - Longline
- [ ] Sablefish - Longline
- [ ] Sablefish - Trap
- [ ] Rockfish – Hook & Line
- [ ] Lingcod - Hook & Line
- [ ] Dogfish - Hook & Line

INVERTEBRATES

- [ ] Shrimp - Trawl
- [ ] Euphausiid - Trawl
- [ ] Prawn and/or Shrimp - Trap
- [ ] Crab - Trap
- [ ] Geoduck and/o Horseclam - Dive
- [ ] Red Sea Urchin - Dive
- [ ] Green Sea Urchin - Dive
- [ ] Sea Cucumber – Dive

- [ ] Other: _____

2. **Which species or fisheries generate at least 25% of your fishing income? Check all that apply. Please think of these fisheries when you are asked other questions about your main or primary fisheries.**
Check all that apply.

PELAGICS

- [ ] Salmon - Troll
- [ ] Salmon - Seine
- [ ] Salmon - Gillnet
- [ ] Herring Roe - Gillnet
- [ ] Herring Roe - Seine
- [ ] Herring Spawn on Kelp
- [ ] Tuna – Troll
- [ ] Tuna – US waters
- [ ] Tuna – International waters
- [ ] Hake - Midwater Trawl
- [ ] Sardine

GROUNDFISH

- [ ] Groundfish – Trawl
- [ ] Halibut - Longline
- [ ] Sablefish - Longline
- [ ] Sablefish - Trap
- [ ] Rockfish – Hook & Line
- [ ] Lingcod - Hook & Line
- [ ] Dogfish - Hook & Line

INVERTEBRATES

- [ ] Shrimp - Trawl
- [ ] Euphausiid - Trawl
- [ ] Prawn and/or Shrimp - Trap
- [ ] Crab - Trap
- [ ] Geoduck and/or Horseclam - Dive
- [ ] Red Sea Urchin - Dive
- [ ] Green Sea Urchin - Dive
- [ ] Sea Cucumber – Dive

- [ ] Other: _____

3. **Below is a list of general marine regions. Please check the box of any region where you fish regularly.**
Check all that apply.

- [ ] Offshore (beyond the shelf break)
- [ ] Haida Gwaii (including Hecate Strait)
- [ ] North Coast
- [ ] Central Coast
- [ ] Northern Vancouver Island (north of Campbell River and Brooks Peninsula)
- [ ] West Coast of Vancouver Island
- [ ] Strait of Georgia
- [ ] Juan de Fuca
- [ ] International Waters
- [ ] US Waters

4. **Where is your homeport?**

_____

5. **How long have you been fishing?**
Mark only one oval.

- ◯ 0 - 5 years
- ◯ 5 -15 years
- ◯ 15 - 25 years
- ◯ more than 25 years

6. **Where do you live? Please include the name of your town/city and your postal code.**

_____

7. **How long have you lived in your current community?**
Mark only one oval.

- ◯ 0 - 5 years
- ◯ 5 -15 years
- ◯ 15 - 25 years
- ◯ more than 25 years

8. **What is your role in the fishing industry? (check all that apply)**
   Check all that apply.

   - [ ] License Owner
   - [ ] Captain
   - [ ] Vessel Owner
   - [ ] Crew member
   - [ ] Other: _____

9. **(If answer to previous question is captain or vessel owner) How many crew do you typically employ during your main fishing season?**
   Mark only one oval.

   - ◯ 1-3
   - ◯ 4-7
   - ◯ 7-11
   - ◯ greater than 11
   - ◯ not applicable

10. **What length of vessel do you work on or operate most of the time?**
    Mark only one oval.

    - ◯ 25 ft. or less
    - ◯ 26 to 35 ft.
    - ◯ 36 to 45 ft.
    - ◯ 46 to 55 ft.
    - ◯ 56 to 65 ft.
    - ◯ 66 to 85 ft.
    - ◯ 86 ft. or greater

11. **Do you currently participate in fisheries in any U.S. waters (Alaska, Washington, Oregon, California, Hawaii) in addition to those off of British Columbia?**
Mark only one oval.

- Yes
- No

12. **(If yes to previous question) Where and which fisheries?**

_____

13. **What percentage, if any, of your annual income comes from jobs or sources outside of fishing?**
Mark only one oval.

- none
- 10% or less
- 10% to 25%
- 25% to 50%
- more than 50%

14. **How old are you?**
Mark only one oval.

- Under 30
- 30 - 40
- 40 - 50
- 50 to 60
- 60 to 70
- over 70 years

15. **What is your gender identity?**
Mark only one oval.

- Female
- Male
- Prefer not to say
- Other: _____

16. **Do you identify as North American Indigenous, Aboriginal, Inuk or Metis?**
Mark only one oval.

- Yes
- No

Observations of ocean change

This section asks about your observations and understanding of changes in the ocean and how those changes may have impacted fisheries. There is not a right or wrong answer to these questions, we are trying to get a sense of what you have seen or experienced.

17. **Please indicate any changes you have observed in the waters off of British Columbia in the last 5 years.**
Mark only one oval per row.

	Decrease	No change	Increase
Ocean temperature	◯	◯	◯
Severe weather	◯	◯	◯
Availability of your main target species	◯	◯	◯
Other:_____	◯	◯	◯

18. **Do you think your ability to catch fish has been affected by climate change?**
Mark only one oval.

- ◯ Yes, positively affected
- ◯ Yes, negatively affected
- ◯ No
- ◯ I have not observed any changes

19. **Please elaborate if you answered yes to the previous question.**

Impacts on fisheries

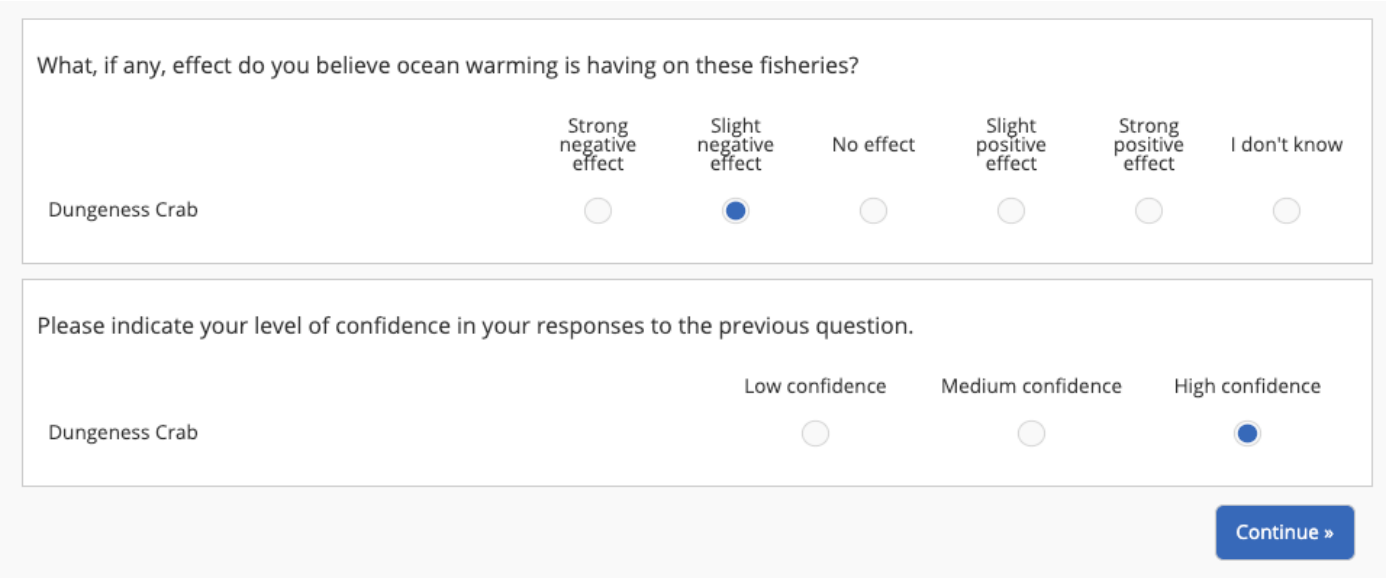
For the next question, you will be asked what, if any, effect you believe ocean warming is having on specific fisheries. For each fishery, we would like you to indicate if you think ocean warming is having a strong or slightly negative effect, no effect, or a slightly or strongly positive effect. You many also answer I don't know. Then you will be asked about your confidence level in that answer.

20. **What, if any, effect do you believe ocean warming is having on these commercial fisheries?**
Mark only one oval per row.

	Strong negative effect	Slight negative effect	No effect	Slight positive effect	Strong positive effect	I don't know
PELAGICS						
Salmon (all species, all gears)						
Herring (Roe herring, Spawn on kelp, Food & bait)						
Albacore Tuna						
Sardine						
Hake						
GROUNDFISH						
Groundfish Trawl						
Halibut						
Lingcod						
Dogfish						
Sablefish						
Rockfish						
INVERTEBRATES						
Shrimp (trawl or trap)						
Prawn						
Crab						
Geoduck and/or Horseclam						
Red Sea Urchin						
Green Sea Urchin						
Sea Cucumber						

21. **Please indicate your level of confidence in your responses to the previous question.**

The questions will read like this. Using the species listed in the question above.



22. What, if any, do you believe ocean warming is having on the commercial fisheries for the following salmon species?

Mark only one oval per row.

	Strong negative effect	Slight negative effect	No effect	Slight positive effect	Strong positive effect	I don't know
Sockeye						
Coho						
Chum						
Chinook						
Pink						

23. Please indicate your level of confidence to the previous question.

Mark only one oval per row.

	Low confidence	Medium confidence	High Confidence
Sockeye			
Coho			
Chum			
Chinook			
Pink			

24. **Are any of your primary fisheries being affected by changes in other marine species?**

Mark only one oval.

- Yes
- No

25. **If yes, how is it being affected?**

The next two questions ask you to how fishing in recent years compares to 30 years ago. If you were not fishing 30 years ago, please answer based on what you have heard from others or your understanding of what it was like during that time.

26. **When you compare the last 5 years to 30 years ago, have you seen changes in the range of your primary target species?**
Mark only one oval.

- Yes
- No

27. **If yes, how has it changed?**

_____

_____

_____

_____

_____

28. **When you compare the last 5 years to 30 years ago, has the time of year of when you fish shifted at all?**
Mark only one oval.

- Yes
- No

29. **If yes, how has it changed?**

_____

_____

_____

_____

_____

Perceptions of Exposure and Risk

This section asks about environmental, fishing, and community issues; your level of concern about those issues; and how often you think about them.

30. **What Pacific coast species or fisheries do you think are most likely to be negatively affected by climate change?**

_____

31. **Are there any species or fisheries that you think will be positively affected by climate change?**

_____

_____

_____

_____

_____

Below is a list of issues that may affect fishing success, your wellbeing, or the wellbeing of your community. For the following questions, please mark 2 answers in each row - 1 indicating your level of concern and 1 for how often you think about the topic.

32. **Marine Environment**

Check all that apply.

	Not concerned at all	Somewhat concerned	Very concerned	Never	Occasionally	Frequently
Warming waters	☐	☐	☐	☐	☐	☐
Ocean acidification	☐	☐	☐	☐	☐	☐
Increases in severe storms	☐	☐	☐	☐	☐	☐
Sea level rise	☐	☐	☐	☐	☐	☐
Changing weather patterns	☐	☐	☐	☐	☐	☐
Ocean water quality (including decreasing oxygen levels)	☐	☐	☐	☐	☐	☐
Harmful algal blooms	☐	☐	☐	☐	☐	☐
Habitat degradation or loss	☐	☐	☐	☐	☐	☐
Other _____	☐	☐	☐	☐	☐	☐

33. **Fishing**

Check all that apply.

	Not concerned at all	Somewhat concerned	Very concerned	Never	Occasionally	Frequently
Size of fish populations	☐	☐	☐	☐	☐	☐
Bycatch	☐	☐	☐	☐	☐	☐
Landed value	☐	☐	☐	☐	☐	☐
Costs associated with fishing (fuel, vessel maintenance, etc.)	☐	☐	☐	☐	☐	☐
The stock assessment process	☐	☐	☐	☐	☐	☐
Travel time to fishing grounds increasing	☐	☐	☐	☐	☐	☐
Access to licences or quota	☐	☐	☐	☐	☐	☐
Regulation	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐

34. **Community and infrastructure**

Check all that apply.

	Not concerned at all	Somewhat concerned	Very concerned	Never	Occasionally	Frequently
Aging labor force	☐	☐	☐	☐	☐	☐
Community cohesion in the fishing community	☐	☐	☐	☐	☐	☐
Community cohesion in your residential community	☐	☐	☐	☐	☐	☐
Coastal and port infrastructure	☐	☐	☐	☐	☐	☐
Access to markets	☐	☐	☐	☐	☐	☐
Adequate local processing facilities	☐	☐	☐	☐	☐	☐

35. **Personal**

Check all that apply.

	Not concerned at all	Somewhat concerned	Very concerned	Never	Occasionally	Frequently
Physical health problems	☐	☐	☐	☐	☐	☐
Mental health problems	☐	☐	☐	☐	☐	☐
Safety at sea	☐	☐	☐	☐	☐	☐
Familial relationships	☐	☐	☐	☐	☐	☐

36. **Please indicate your level of agreement with the following statements.**
Mark only one oval per row.

	Strongly disagree	Somewhat disagree	Neutral	Somew hat agree	Strongly agree
I believe climate change is occurring					
Climate change will harm me personally					
Climate change will harm future generations					
If I had a choice I would leave fishing					
It is a big risk to move into a new fishery					
There is no point in preparing for climate change since we don't know exactly what will happen					
There will not be enough fish to continue to operate in my main fishery in 20 years					

37. **Fisheries occasionally have conflicts with other fisheries or other activities that take place in the ocean or coastal environment. Please indicate your level of agreement with the following statement. My fishing is negatively affected by .**
Mark only one oval per row.

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
Recreational fisheries					
Other commercial fisheries					
Internal conflict within my commercial fishery					
Aquaculture					
Hatcheries					
Tourism					
Coastal development					
Competing ocean uses like shipping/transport					
Marine Protected Areas					
Marine Spatial Planning					

Sensitivity

Below is a list of statements that may indicate the degree to which community and individual wellbeing is sensitive to changes in the health of fisheries and the environment. Please indicate your level of agreement with each statement.

38. **Conditions**

Check all that apply.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	I have not observed any changes
Changes in fisheries have negatively impacted my overall wellbeing	☐	☐	☐	☐	☐	☐
Changes in fisheries have negatively impacted my physical health	☐	☐	☐	☐	☐	☐
Changes in fisheries have negatively impacted my mental health	☐	☐	☐	☐	☐	☐
Changes in fisheries have raised my stress levels	☐	☐	☐	☐	☐	☐
Changes in the environment have negatively impacted my overall wellbeing	☐	☐	☐	☐	☐	☐
Changes in the environment have negatively impacted my physical health	☐	☐	☐	☐	☐	☐
Changes in the environment have negatively impacted my mental health	☐	☐	☐	☐	☐	☐
Changes in the environment have raised my stress levels	☐	☐	☐	☐	☐	☐
Changes in the environment have negatively affected my safety while fishing	☐	☐	☐	☐	☐	☐

39. **Connections**

Mark only one oval per row.

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
I would encourage my children to be fishermen	⬭	⬭	⬭	⬭	⬭
Fishing is important to my identity	⬭	⬭	⬭	⬭	⬭
Fishermen are supported in my community	⬭	⬭	⬭	⬭	⬭
I am passing down fishing knowledge to the next generation	⬭	⬭	⬭	⬭	⬭
I feel a connection to my environment	⬭	⬭	⬭	⬭	⬭
I feel a connection to my community	⬭	⬭	⬭	⬭	⬭

40. **Capabilities**

Mark only one oval per row.

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
I make enough money to support my family					
I am able to plan two years out in the future					
I am satisfied with my job					
I think the fisheries I participate in are managed effectively					
I have access to the data and information I need for successful fishing					
I can find qualified crew with the skills they need to do a good job					
I have a voice in fisheries management					
Climate change should be considered in fisheries management					

41. **Cross-cutting**

Mark only one oval per row.

	Strongly disagree	Somewhat disagree	Neutral	Somew hat agree	Strongly agree
The fisheries I participate in are managed in an equitable way					
There are opportunities for people who are not currently fishing to enter into west coast fisheries					
There are opportunities for deckhands and other lower level crew to advance					
Other external forces positively impact my fisheries (treaties, trade agreements…etc.)					

Adaptive Capacity

Responding to changes, stemming from climate or other issues, will require adaptations by individuals, communities, and governance structures; this section asks for your perspective on their ability to do so.

42. **With regard to the future security of yourself, your residential community, or your fishery, please indicate the extent to which you agree or disagree with the following state ments:**
Mark only one oval per row.

	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree
I could easily move into a new fishery					
I could easily find work in another natural resource industry (aquaculture, forestry, etc.)					
I could easily get income not related to natural resource harvest, fishing or otherwise.					
I could easily get a loan or some other form of financial support					
I am confident in my ability to travel further to fish if that is needed					
I believe my community has a strong and viable future ahead					
I am concerned that climate change may lead to people moving out of my community.					
I think fisheries management can adapt and respond quickly to changing environmental conditions					
I feel constrained in my ability to adapt to changes because of regulations.					

43. **What sorts of changes could quicken response time and make fisheries management more flexible as it responds to future challenges?**

44. **Are there other concerns or thoughts you would like to share about the future of fishing or your community?**

Appendix 2: Codebook for analyzing questions about management flexibility & future concerns.

Code/theme	Description
Access to licences & quota	Concerns over equity of access between stakeholders and rights-holders
Barriers to entry	Concerns over the ability of new or young harvesters to enter the industry and/or diversify
Competition from other sectors & processes	Concerns over interactions with and impacts from other ocean sectors such as the negative impacts of salmon aquaculture on wild populations; consequences for fishers of Marine Protected Area establishment
Consolidation	Calls for regulation of quota ownership to restrict corporate consolidation; move to owner-operator policy in Pacific region
Local or devolved management	Desire for increase in local decision-making power; calls for devolved or nested governance
Stakeholder engagement	Requests for more local input from harvesters; fisherman's voices represented; local knowledge
Communication & transparency	Appeals for better communications across government departments, across regions, among stakeholders and with communities; efforts to respond to misinformation; reconciliation better defined
Coordination across agencies & jurisdictions	Calls for better coordination across relevant agencies and jurisdictions, e.g., between Federal, Provincial, local, and/or Indigenous governments