Knowledge Co-Production & Centering Indigenous Voices in Pacific Salmon Monitoring & Management

By

Jade Ryan Steel

Master of Resource Management, University of Akureyri, Iceland, 2020

Bachelor of Science, University of Victoria, Canada, 2017

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We acknowledge and respect the Lək^{w}əŋən (Songhees and X^{w}sepsəm/Esquimalt) Peoples on whose Territory the University of Victoria stands, and the Lək^{w}əŋən and W̱SÁNEĆ Peoples whose historical relationships with the land and waters continue to this day.

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Abstract

Indigenous Peoples across the west coast of what is now known as North America (the Pacific Northwest region) face persistent and systemic challenges stemming from the legal, regulatory, and environmental context of the fisheries upon which they depend. Despite commitments to reconciliation (e.g. the United Nations Declaration on the Rights of Indigenous Peoples), interactions between colonialism and centralized fisheries management continue to generate governance inequities and have contributed to ongoing declines of many Pacific salmon populations. Current fisheries management regimes frequently overlook or marginalize Indigenous Knowledge Systems that have sustained Pacific salmon populations for millennia. At the same time, critical data gaps in fisheries and population monitoring persist, further constraining conservation efforts and limiting Indigenous Peoples' ability to rightfully access and steward their fisheries. Given the interconnectedness between coastal Indigenous Peoples and Pacific salmon, these cumulative impacts and governance realities erode Indigenous food sovereignty, undermine food systems, cultural practices and lifeways, and the overall well-being of Indigenous Peoples.

This dissertation responds to these challenges through research action. Specifically, the overarching aim of this PhD dissertation is to center Pacific salmon, Indigenous Peoples, and their Knowledges within fisheries monitoring and management contexts, and to offer recommendations for assessing and transforming colonial policies that continue to shape Pacific salmon fisheries in Canada. Three guiding research questions founded the work. The first research question asked, *how can an assessment tool be co-developed with First Nations to reflect Indigenous perspectives on the implementation of Canada's 1999 Salmon Allocation Policy (SAP), particularly regarding conservation objectives and Canada's stated commitment to priority access for Indigenous Nations to salmon fisheries in British Columbia?* To address this question, we partnered with 51 First Nations across British Columbia to co-develop a Salmon Allocation Policy Assessment Tool. Through this research, findings revealed systemic failures of the Canadian Government and Fisheries and Oceans Canada to uphold both conservation and First Nations' priority access objectives of the policy since its inception in 1999. The second research question this dissertation asked was, *what are some of the motivations, challenges, and outcomes of active Indigenous-led salmon monitoring programs throughout the Pacific*

Northwest and how does Indigenous-led monitoring support collaborative fisheries management? In collaboration with 31 Nations and Native Tribes from Alaska, Yukon, British Columbia, Washington, and Oregon, and in partnership with the Tamamta Program, we conducted in-depth interviews that revealed Indigenous-led salmon monitoring as both an exercise of sovereignty and a fundamental means of generating independent data. Thirdly, this dissertation asked, *How can an Indigenous-led salmon monitoring program strengthen knowledge of local salmon populations while supporting management priorities and community requirements for Food, Social, and Ceremonial fisheries?* Working in close partnership with the Haíłzaqv Nation in the Central Coast of British Columbia, we answered this question by analyzing 2,002 dockside surveys and 472 Genetic Stock Identification data to evaluate local coho salmon fisheries. This research revealed significant conservation risks facing local coho salmon populations, while also identifying opportunities for precautionary, Haíłzaqv-driven fisheries conservation reform.

Together these findings emphasize that Indigenous-led salmon monitoring and Indigenous Knowledge Systems are essential to stewarding Pacific salmon while sustaining access for Indigenous communities. This dissertation also contributes both practical and theoretical insights in to how knowledge co-production can re-shape fisheries monitoring and management for Pacific salmon, offering innovative recommendations for both localized and broader fisheries policy reform throughout the Pacific Northwest. This research demonstrates that centering Indigenous sovereignty and stewardship through monitoring can advance more just, effective, and collaborative fisheries management. such steps are urgently needed to secure the future of Pacific salmon and support transformation in fisheries monitoring and management for all.

Table of Contents

List of Tables

List of Figures

Acknowledgements

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I want to first thank all the Knowledge Keepers who have participated in the many interviews, surveys, and workshops in Bella Bella and around the Pacific coast with me. I'm especially grateful to the Elders, youth, stewardship staff and fishers who work tirelessly to defend their lands and waters, ensure their communities have enough fish, and have graciously shared pieces of their cultures with me through stories, songs, dances, harvests and cultural practices, ways of being, and moving through the physical and spiritual worlds we are collectively apart of. Thank you for sharing your precious time, energy, hearts, and spaces with me. Sometimes this was on a boat, dock, truck, in your homes, office board rooms, fish plants, airplanes, conference spaces, zoom meetings, on FaceTime, sharing a meal, drinking coffee, tea, wine, or picking berries.

Thank you to my courageous mentors, supervisors, and collaborators. The way I think about life, research, and friendship have all been shaped by you and I certainly would not be the human I am today without your steadfast guidance, encouragement, and trust.

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complete previous degrees with stellar grades, savings, or a college fund, let this be your sign that it is possible to be a funded graduate student. Thank you Mitacs, the Social Science and Humanities Research Council of Canada, the University of Victoria graduate student awards, the Heiltsuk Integrated Resource Management Department, the Central Coast Indigenous Resource Alliance, the First Nations Fisheries Council of British Columbia, and the Pacific Salmon Foundation Community Fund. Thank you for believing in me when I didn't believe it was possible to fund a student like me.

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Walas ğiáxsix̌a to the friends I now consider ẇáẇáx̌tus. Since the spring of 2019 you have and continue to make me feel so loved, welcomed, and a part of the beautiful Haíłzaqv community. Please know that I so appreciate all the shared meals, fishing, canoe and camping trips, invitations to witness momentous potlatches, celebrations, and feasts, karaoke nights, berry harvests, kitchen dance parties, car rides, boat rides and sleepover dates more than you ever know. Special thanks to Jayda Wilson, Jess Housty, Desiree Lawson, Mike Wilson, Erin Wilson, Megan Humchitt, Clea Humchitt, William Housty, Faye Housty, Zakoiya Peel, and Kyri Peel. You're stuck with this q̓vn̓xsiwa for as long as you'll have me.

Thank you to my lovely friends across the Atlantic Ocean in Bergen, Norway. It is by no coincidence that we met and became fast friends during our master's degrees at the edge of the Arctic in Iceland. I appreciate your constant love, support, and friendship across time zones (no easy feat). Writing my comps essays in such a magical corner of the world made all the difference. Thank you, Andrea, for always being there and cheering me on, too. Quesnel is also very far away.

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Finally, to my Dan, my love, my best friend in this life and every life, thank you.

We did it, I'm so proud of us.

Dedication

I would like to dedicate this dissertation to the lands, to the waters, and to the salmon who have and continue to teach me, ground me, and guide me. I would also like to dedicate this work to the past, current, and future fishers who gift us all with so much, even when so many -have and continue to- take more than they could ever need.

It is my hope that some small piece of this work may serve you well now and perhaps in the future, too.

Figure 1. Maxine Brown, Fisheries Monitoring Technician for the Heiltsuk Integrated Resource Management Department, Summer 2025. Photo by Kyri Peel.

Positionality Statement

I express my utmost gratitude for the opportunity to spend time with Indigenous and non-Indigenous fishers throughout British Columbia over the last decade of my life. The profound wisdom, knowledge, and trust openly gifted to me has and will continue to shape my thinking and actions for the rest of my days. As Dr Shawn Wilson has wisely expressed "if research doesn't change you as a person, then you haven't done it right" (2008, p.135).

In reflecting on Shawn Wilson's teachings, my experience leading and participating in fisheries research has led me to sincerely believe that we must all practice accountability. For me, sharing this positionality statement is one step towards practicing and living that accountability -by being transparent about who I am, the privileges I hold, and the commitments I bring to this work. Naming these things openly is part of holding myself responsible to the communities I work for, as well as to the broader responsibilities of conducting ethical and respectful research. Through my experiences, I have also come to learn that there is no one right way to achieve this, rather, it is through multiple pathways and intentional actions that we can best support and respect the objectives and priorities of research partners and collaborators. With each step, meaningful change is possible. My dear friend Dr Janessa Esquible and her colleagues, remind us (particularly non-Indigenous graduate students) of the importance of continuously reflecting on accountability in research, especially the ways in which research processes and outcomes can and do directly impact Indigenous communities (Esquible et al. 2024). It is my hope that this PhD dissertation reflects my commitment to the ongoing hard work of unlearning, learning, and centering reciprocity, care, and respect in all that I do, including a dedication to accountability through actionable research. Let us move away from just 'doing research' to '*doing action through research*'.

Conducting research that is helpful, respectful, and grounded in the priorities of collaborators is central to my academic approach and at the forefront of my ethical commitments. I am deeply inspired by and grateful for the generous guidance of Indigenous scholars, academics, knowledge holders, and friends, whose teachings shape not only my own work, but also how much of the broader research community strives to engage today. Dr Shawn Wilson's Research is Ceremony (2008) has profoundly shaped how I understand relational accountability as central to all

research. Menzies et al. (2022), Ojeda et al. (2025) as well as Reid et al. (2021, 2022, & 2024) offer inspiring examples of co-creating fisheries research through their processes that are centered in community priorities, Indigenous Knowledge Systems and clearly explain the power of partnership through research action. I also draw encouragement from many non-Indigenous scholars whose genuine intentions and actions through research demonstrate that co-creating knowledge takes time, energy, capacity, and love; for example: Ban et al. (2019); Beveridge et al. (2021); Carothers et al. (2021), Cadman et al. (2024), and Sleigh (2024).

Upon spending time with my Haíłzaqv ẇáẇáx̌tus, I have also learned that it is essential to not only genuinely show up in our work, but that good work always starts with introducing oneself. Thus, I would like to share some of my personal experiences and what has shaped me in my life to this point. I was born and raised on Vancouver Island, Canada into an immigrant family. My immediate and extended relatives had moved from the east coast of England to pursue commercial fishing -a serendipitous situation I didn't fully appreciate until well into my adult years. They sold nearly everything they owned and arrived first on the Central Coast of British Columbia on the promise of profitable commercial herring fishing. My parents were unmarried teenagers when I was born, so much of my upbringing was among other family members while my parents worked multiple jobs. Despite complicated family circumstances, I was and have always been surrounded by lots of love.

Upon my reflection of growing up while writing this positionality statement, one thing that stood out is how much I struggled in school. I didn't get good grades. I didn't enjoy learning, nor did I enjoy the process of functioning through the public school system. I remember going to bed some nights wishing- to anyone or anything out in the universe- that I could be 'smart'. I wished I could read without jumbling letters, spell without stumbling, to understand a second language, finish assignments on time, and avoid failing yet another class. I also remember the exhaustion of trying so hard in school -dark bags under my eyes and unfortunate haircuts became part of my signature childhood and teenage look- and when my trying was never sufficient, I gave up. Instead of academics, I poured most of my free time into swimming and then later into theater and dance. Despite my horrendous grades, a lack of financial support, and to the great surprise of nearly everyone around me, I decided to pursue an undergraduate degree. Somehow, I was

miraculously accepted into a general arts program, funded through student loans, multiple part-time jobs, a stubborn desire to prove myself, and what I think is pure grit. Everything really changed in second year university, when a sympathetic undergraduate advisor suggested I attempt a semester of Earth and Ocean Sciences courses. I eventually switched into a degree in coastal physical Geography, and I began to sincerely enjoy my coastal focused classes. I was inspired by my professors and peers, and to my own bemusement, I started passing my courses. Dare I say, I even started excelling in upper-level field classes. Around this time, I also finally received a dyslexia diagnosis which allowed me to reframe my past struggles as a different way of learning, not failures.

I owe a great deal of gratitude to Chris Dairmont, Jess Housty, Will Atlas, and William Housty. Before completing my undergraduate degree, I travelled to Koeye camp as a student attending the Koeye Field School. During my time as a visitor at Koeye camp, I met Will Atlas, Jess Housty, and the Haíłzaqv weir crew. I was inspired by Haíłzaqv lands and waters, the fish, the people, the culture, and the energy. I was instantly motivated and intrigued by what graduate school could possibly look like outside of the classroom. A few years later while pursuing my master's degree in Iceland, I reached back out to Will and William at the Heiltsuk Integrated Resource Management Department (HIRMD) to inquire if there may be any potential work I might be able to contribute to through my master's thesis. As chance would have it, there was. Since 2019, I have worked for and with HIRMD supporting their salmon fisheries monitoring program. This long-standing relationship and my evolving roles supporting their program has not only shaped my academic path, but also much of the basis and purpose of this PhD dissertation.

In hindsight, the throughline from my family's fishing journey to my current place in the world feels almost inevitable. Yet, I also recognize that I carry many flaws and biases, and that I hold inherent privilege because of the colour of my skin and the place I was born. I am a non-Indigenous, first-generation Canadian working at the intersection of Indigenous governance and fisheries sciences. Internally, this is somewhat of a difficult position to hold. On one hand, I am situated within a western academic institution, trained in scientific methods that shape how I see and approach the world. This training provides me with some level of power but also limits my perspectives and risks perpetuating harm if I do not acknowledge these biases and teachings. I

further recognize that I will never be perfect in the way in which I show up in my work. At times, I have been labeled too forward, too passionate, too vocal, too emotional, too social sciences, too naive, too independent, too focused, too unaware, too feminine. But I will never stop trying to learn and unlearn. I view this as part of my ethical responsibility, not only as a graduate student, but also as a human being. I don't believe this responsibility stops when my degree ends, either. I am proud that my strengths allow me to grow from my experiences and mistakes. I know that many things known, and unknown have culminated and aligned just right to allow me to be where I am in this moment. My PhD journey has been at times so hard, yet so rewarding and empowering, especially as a woman working in a predominantly male-oriented field. I'm also profoundly grateful to be the first in my family to receive a university degree, and to have made it all the way to writing a PhD dissertation feels a little like magic.

Thank you for taking the time to learn a little bit about what makes me, me and how I strive to show up for the people, places, and things I love. I truly believe that "nothing worth having comes easy, nor should it" (Douglas Neasloss/Muq'vas Glaw, Chief Counsellor Kitasoo Xai'xais Nation).

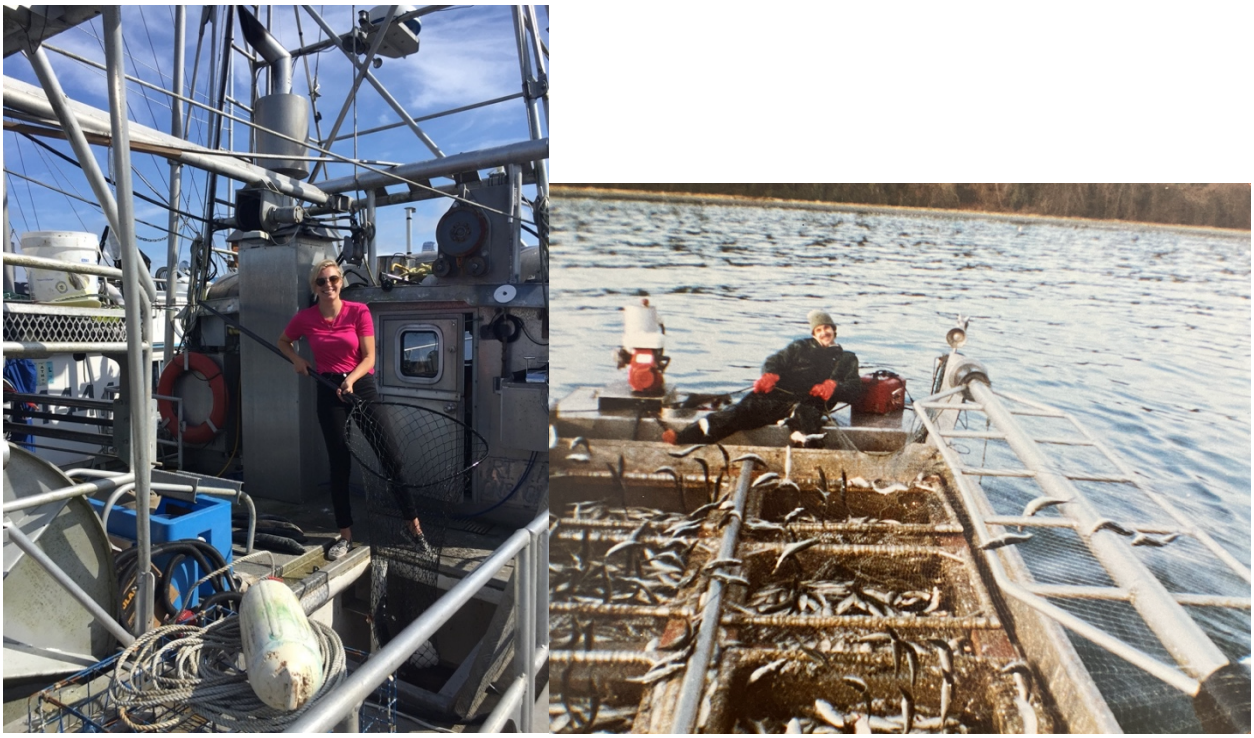

Figure 2. Shown on the left is a capture of author (Jade Steel) on a sunshine filled day sampling a Haíłzaqv gillnet fishers' salmon catch in Bella Bella, British Columbia (circa 2019). Shown on the right, the authors grandfather (Tony Steel) is pictured displaying herring catch abord an aluminum punt on a sunshine filled day, also in Bella Bella, British Columbia (circa 1981).

Chapter 1. Introduction

Pacific Salmon Relations

Today, humanity is confronted with interconnected global challenges, many of which were entrenched in the enduring legacies of colonization and the ongoing marginalization of Indigenous Peoples[1] (Alfed & Corntassel 2014; Truth & Reconciliation Commission of Canada 2015; World Bank 2025). Such challenges include accelerating impacts of anthropogenic climate change, the degradation of ocean ecosystems, collapsing biodiversity, and a growing food insecurity worldwide (Douglas & Cooper 2020; Fletcher et al. 2024). These challenges are manifesting differently across local contexts, further complicating efforts to fully understand and address their distinct yet compounding impacts (Abbass et al. 2022; Barnett & Campbell 2010; IPCC 2022; Reyes-García et al. 2024). Scholars and policymakers have formally recognized that these pressures will continue, mounting to cascading impacts, which include more frequent and severe weather events, rising sea levels, species extinctions, and other unpredictable yet devastating consequences (Fernández-Llamazares et al. 2021; Reed et al. 2024). These interrelated challenges are evident across biophysical and sociocultural systems, landscapes, and manifest through the continued suppression of Indigenous rights, access, stewardship, and governance of lands and waters. Suppression of Indigenous Peoples to their lands and waters is fueled through structural legacies of colonization, greed by the world's wealthiest, and the unrelenting imperative of growth and extraction required by capitalism (Hanaček et al. 2022; Reed et al. 2024).

Indigenous Peoples (approximately 476 million people, or about six percent of the total world's population -with a significant majority living near or on ocean coastlines) maintain long-standing, place-based connections to marine and coastal ecosystems that shape and underpin cultural identities, spiritual practices, social relationships, and economies (Cisneros-Montemayor et al. 2016; World Bank 2025). These connections are built in and through diverse Indigenous

[1]Indigenous Peoples is a broad term used to describe the original inhabitants, stewards, and their descendants of the lands and waters. While diverse and challenging to define universally, Indigenous Peoples are distinct social and cultural groups, Nations and Tribes that hold ancestral ties, inherent rights, and titles to the lands, waters, humans and non-human beings, where they live, occupy, or from which they have been displaced by colonial forces (Mathews & Turner 2017; World Bank 2025).

Knowledges[2], Indigenous Knowledge Systems and stewardship[3] practices, which influence and sustain food sovereignty[4] and security, foster equitable governance[5], and ensure the long-term health of lands and waters (Cruz da Silva et al. 2024; Turner 2020). Importantly, there is no single Indigenous Knowledge System, and Indigenous Knowledge and Indigenous Knowledge Systems cannot be selectively described through discrete pieces of information as Knowledge is embedded within the worldviews and traditional practices of an Indigenous community (Black 2017). Indigenous Knowledge Systems offer critical insights for protecting, sustainably managing, and restoring land and water ecosystems, contributing meaningfully to climate change mitigation, adaptation, and biodiversity conservation (Bodwitch et al. 2024; Reed et al. 2021, 2024). Conservation scholarship increasingly recognizes the importance of Indigenous Peoples and Indigenous Knowledge Systems in improving conservation outcomes and supporting more effective and just governance of marine and terrestrial spaces (Buschman & Sudlovenick 2022; Dawson et al. 2021; Garnett et al. 2018; Levis et al. 2024; Townsend 2022; Reid et al. 2022). This growing recognition underscores the need for conservation processes and colonial management institutions to more fully and respectfully engage and collaborate with Indigenous Peoples and their ways of knowing and stewarding. At the same time, Indigenous governance holds importance beyond its contributions to conservation initiatives, reflecting enduring systems of responsibility and decision-making that have and continue to guide how territories are cared for and stewarded (Reed et al. 2021).

[2]Indigenous Knowledge can be described as holistic and "garnered from experience within one's own Indigenous context and in relationship to all living beings, centered on spirituality and Indigenous values of respect, relationships, reciprocity, among others. This Knowledge is acquired from direct experience out on the lands, waters, hunting, fishing and gathering, thus it is inherently adaptive. It is also accumulated over thousands of years through living in connection with one's Creator. It is further passed down generation to generation, with each building upon the previous Knowledge through everyday experiences" (Black 2017).

[3]Indigenous stewardship can be defined as the responsibilities, practices, and philosophies through which Indigenous Peoples care for, manage, and sustain the lands, waters, and ecosystems within their respective and shared territories (McLeod et al. 2024). Indigenous Knowledge Systems further embody ways of knowing and being that emphasize relational connections with nature and the interdependence of all things. Stewardship is thus a central expression of Indigenous Knowledge Systems, whereas ecological, social, and spiritual dimensions are active practices expressed by "individuals, communities, companies, organizations, and governments -singularly or together" (McLeod et al. 2024).

[4]Food sovereignty has been described as the right to define and access healthy, culturally appropriate foods (Cisneros-Montemayor et al. 2016).

[5]Equitable governance can comprise of principles such as recognizing and respecting all relevant actors' knowledge and diverse values, rights to ancestral territories, and cultural practices as well as ensuring full and effective participation in decision-making (Dawson et al. 2024).

The plight of Pacific salmon (*Oncorhynchus* spp.), the focus of this dissertation, illustrates the cumulative impacts of climate change and colonization. Once abundant and central to the very fabric of food, social, ceremonial, cultural, ecological, and economic systems of First Nations and Native Tribes[6], many Pacific salmon species now face dramatic and unprecedented declines (Atlas et al. 2020; Carothers et al. 2021; Nesbitt & Moore 2016; Jacob et al. 2010; Yoshiyama 1999; Whitney et al. 2020; Wilson et al. 2025). These declines are driven by a myriad of factors, including but not limited to, habitat loss and fragmentation, warming waters, shifting ocean conditions, and the compounded effects of historical and contemporary management paradigms that systematically exclude Indigenous Peoples, their knowledges, stewardship, and governance authorities (Bradford & Irvine 2000; Mills et al. 2013; Oke et al. 2020; Reid et al. 2022; Wilson et al. 2025). Thus, the Pacific salmon crisis reflects not only an unprecedented ecological and conservation emergency, but also a profound and ongoing injustice for Indigenous Peoples, sustained by enduring structures of coloniality and associated powers that be.

Colonial fisheries governance, management and policies can be defined as systems of regulation and decision making that are grounded in and perpetuate through colonial structures of power. Lavoie et al. (2025) describe these systems as emerging from two interconnected structures (coloniality and colonialism) that began with colonization and persist today throughout the Pacific Northwest region. Coloniality can refer to enduring hierarchies that appropriate resources, control people and knowledges, and sustain political, economic, and social domination for capitalistic growth (Islam et al. 2024; Lavoie et al. 2025). Colonialism upholds and intensifies this power by displacing Indigenous Peoples from lands and waters (Whyte 2016; 2018; Wolfe 2006). In Pacific salmon management and policy, these structures are evident in the regulatory approaches that continue to generally privilege non-Indigenous fishers, impose western scientific frameworks over Indigenous Knowledges, and marginalize Indigenous rights and livelihoods (Lavoie et al. 2025). Throughout this dissertation, we utilize the term ‘colonial’ to refer to current, non-Indigenous fisheries monitoring, stewardship and management for Pacific salmon.

[6]The Canadian Constitution legally recognizes three distinct groups of Indigenous Peoples: First Nations, Inuit, and Métis. In the United States, Indigenous Peoples are commonly recognized as Native Americans, Native Tribes, or Alaska Natives.

Some suggest that a shift to equitable fisheries governance first requires the formal recognition of the diversity of human–environment relationships and the full inclusion of legitimate knowledge and rights holders in decision-making (Díaz et al. 2018; Fernández-Llamazares et al. 2021; Pascual et al. 2021; Yletyinen et al. 2022). Yet, within contemporary colonial fisheries management and policy structures, diverse perspectives and ways of knowing, particularly non-western scientific views on why fisheries and marine systems matter and how they should or should not be protected, harvested, and/or managed, remain underrepresented (Pascual et al. 2021). This dissertation emerged from experience witnessing the impacts of the Pacific salmon crisis on Indigenous Peoples (e.g. First Nations and Native Tribal communities) and a desire to act in allyship and in service. Persistent gaps in the recognition and inclusion of Indigenous Knowledges in advancing Pacific salmon fisheries monitoring, management, and policy -both in practice and in academic literature- further reinforced the necessity of this research. My experiences supporting collaborative Indigenous-led salmon research, along with partnerships with the Heiltsuk Integrated Resource Management Department (HIRMD) and the Central Coast Indigenous Resource Alliance (CCIRA) through the Salmon Fisheries Monitoring Program (see Positionality Statement), shaped the many collaborations that underpin this dissertation, informed how the research was carried out, and directed the shared goals for research outcomes.

The overarching aim of this PhD dissertation is to center Pacific salmon, Indigenous Peoples, and their Knowledges within fisheries monitoring and management contexts, and to offer recommendations for assessing and transforming colonial policies that continue to shape Pacific salmon fisheries in Canada, so they are more inclusive of and guided by multiple knowledge systems. Specifically, this dissertation explores three interrelated yet often siloed themes: (1) Indigenous stewardship and governance of coastal ecosystems across the Pacific, (2) Pacific salmon fisheries management and policy assessment, and (3) Pacific salmon fisheries monitoring. Below I review these themes, highlighting key challenges and gaps in existing literature, as well as my efforts to address them holistically through collaborative and applied knowledge co-production.

Theme 1. Indigenous Stewardship & Governance of Coastal Ecosystems

Globally, it is estimated that Indigenous Peoples speak more than 4,000+ different languages, reflecting the vast diversity of cultures, worldviews, ways of knowing, and environments in which Indigenous Peoples live (Ford et al. 2020). Across these contexts, Indigenous Peoples continue to exercise sovereignty and governance over their lands and waters, actively stewarding terrestrial and marine systems through practices that have sustained ecosystems, cultures, and communities for millennia (Alexander et al. 2021; Turner et al. 2022; Reid et al. 2020). These approaches, passed down through generations and adapted to changing conditions, ensure the continued well-being of lands, waters, and communities for future generations (Carothers et al. 2021; McMillan & Prosper 2016; Winter et al. 2023). Indigenous Knowledge Systems are fundamentally place-based and informed by thousands of years of lived experience, while remaining dynamic and responsive, evolving alongside environmental, social, and cultural changes (Ford et al. 2020).

Around the world, past and ongoing colonization has profoundly disrupted Indigenous Peoples' ways of life, eroding thousands of years and generations of Indigenous Knowledge Systems, stewardship practices, and governance structures (Whyte 2016). Across continents, Indigenous Peoples have been and largely continue to be excluded from decision-making over lands, waters, and resources by colonial governments (Layden et al. 2025; Silver et al. 2022; Wilson 2021). Many current governance systems, built on centralized, state, provincial, or federal authority, assert exclusive ownership over Indigenous traditional territories and resource access, systematically displacing Indigenous jurisdiction and rights (Artelle et al. 2019; Bodwitch et al. 2024; Silver et al. 2022). European colonization entrenched inadequate, state-dominated regimes that continue to systematically dispossess Indigenous Peoples of their marine and terrestrial territories (Atlas et al. 2017, 2021; Wilson 2021). Depending on imperial objectives, European colonizers sought either to eradicate Indigenous jurisdiction to enable full settler control over lands, waters, and bodies or to subjugate Indigenous governance within imposed boundaries to exploit resources for extraction, markets, and imperial defense (Ford 2010; Wilson 2021). These strategies positioned Indigenous Peoples as "dependents" of the colonial state, with the goal of displacement, dispossession, or elimination according to settler interests (Bodwitch 2017; Silver et al. 2022).

Yet despite the profound and harmful impacts of colonialism, Indigenous Knowledge Systems, stewardship, and governance persist. Although colonial authorities have employed many different mechanisms in attempts to claim ultimate control, Indigenous laws and governance systems have endured, often in concealed or transformed forms (Benton & Ford 2013; Duve 2017; Pasternak 2014; Wilson 2021). Today, Indigenous Peoples across Canada for example, are revitalizing governance structures, reawakening traditional laws, and implementing them in ways that honor their territories and cultural responsibilities, while often simultaneously navigating and contesting colonial-imposed governance systems that seek to erase or diminish their existence (Ellam Yua et al. 2022; Heiltsuk Tribal Council 2025; Lawson 2024).

Indigenous Peoples have maintained sophisticated stewardship systems that sustain ecosystems and support cultural lifeways (Fernández-Llamazares et al. 2021). These practices include sustainable hunting and fishing, fire management, erosion prevention, soil enhancement, and the cultivation of diverse and resilient landscapes and natural systems (Lake & Christianson 2019; Fernández-Llamazares et al. 2021; Waller & Reo 2018; Whyte 2018 & Whyte et al. 2021). For example, along the Pacific Northwest coast of what is now presently known as British Columbia, the Kwakwaka'wakw Peoples -colonized in stages by British authorities throughout the eighteenth and nineteenth centuries, to this day- have long nurtured clam gardens that enhance shellfish productivity while maintaining healthy marine ecosystems (Deur et al. 2015; Lawson 2024). In Karuk ancestral Territory, in what is now presently known as California, the Karuk Tribe continue to practice systematic cultural fire stewardship that strengthens forest food systems and the species they depend on (Marks-Block 2020). These intentional fire stewardship practices promote desired habitats, increase resource abundance, and have shaped landscapes since time immemorial (Hoffman et al. 2021; Lake & Christianson 2020; Thoreson 2023).

Since the turn of the twenty-first century, there have been growing efforts across the globe to address the historical and ongoing harms experienced by Indigenous Peoples through international and domestic initiatives of reconciliation. These efforts include the development of international frameworks and forums aimed at affirming and advancing Indigenous rights, such as the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), the United Nations Permanent Forum on Indigenous Issues, the creation of various Truth and Reconciliation

Commissions, and the Food and Agriculture Organization of the United Nations Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (Berkes & Franz 2025; Wilson 2021). Among these efforts, UNDRIP has been widely viewed in principle as a significant catalyst for advancing reconciliation objectives. Adopted in 2007, UNDRIP affirms Indigenous Peoples' rights to self-determination, collective ownership of lands and resources, and meaningful participation in decision-making, while explicitly seeking to redress the consequences of historical and ongoing rights violations (Ignace et al. 2023; Pereira & Gough 2013; UNDRIP 2007). In response to UNDRIPs adoption, several countries, such as Bolivia, have amended their constitutions to establish plurinational statehood to explicitly recognize Indigenous self-government (Murphy 2019; Iamamoto 2022). Similarly, Ecuador introduced constitutional reforms aimed at building a more inclusive political system with greater Indigenous participation (Becker 2011). After having initially voted against UNDRIPs adoption at the United Nations in 2007, Canada officially adopted UNDRIP in June 2021 and implemented its principles into law through Bill C-15, The United Nations Declaration on the Rights of Indigenous People Act (Howell & Dennis 2023; Ignace et al. 2023). The FAO's voluntary guidelines for small-scale fisheries also incorporate provisions that safeguard the marine rights of Indigenous Peoples, including the protection of their spiritual and cultural relationships with traditionally occupied waters and coastal seas (UN General Assembly 2007).

These reconciliation initiatives align with broader international commitments, including the Sustainable Development Goals (particularly Sustainable Development Goal 14), which focuses on oceans and the recently announced UN Decade of Ocean Science for Sustainable Development (2021–2030) (UN General Assembly 2015; UN Decade of Ocean Science 2020; Wilson 2021). Collectively, these global declarations and frameworks signal a growing recognition of Indigenous governance as an international priority. However, as some scholars note, these marine focused commitments often receive far less consideration within national frameworks than comparable terrestrial rights (Artelle et al. 2019; Bavinck et al. 2018; Swerdfager & Armitage 2023; Wilson et al. 2021). Despite these efforts, there is a general lack of tangible action and meaningful reconciliation by colonial governments and agencies. While frameworks like UNDRIP provide important avenues for Indigenous Peoples to have their histories, rights, and relationships formally recognized at an international level, their practical

impact remains constrained, as such declarations are non-binding and often fail to translate into meaningful action unless adopted into domestic law (Cambou 2020; Ignace et al. 2023).

Meanwhile, there has been a growing recognition within parts of the academic community of the importance of knowledge pluralism in sciences and of conducting 'good' research (Adams et al. 2024; Ball & Janyst 2008; Dion et al. 2020; Ignace et al. 2023; Reid et al. 2024). Knowledge pluralism refers to the recognition that multiple knowledge systems -each with their own validity, values, and methods- can coexist and contribute to our understanding of the world (Bingham et al. 2021). In the context of fisheries research and management, it acknowledges the ontological and epistemological diversity of Indigenous and scientific knowledge systems and their respective ways of understanding, generating evidence, and defining well-being (Hoelting et al. 2024). This approach moves beyond dichotomous thinking and instead emphasizes collaboration, recognizing that Indigenous and scientific knowledges are dynamic, mutually informative, and can be mobilized together in decision-making processes (Bingham et al. 2023; Carter et al. 2019; Reid et al. 2020).

Advancing knowledge pluralism in fisheries research necessitates creating space for multiple worldviews and methodologies, which in turn can shape who is involved in research, what questions are asked, and how knowledge is generated and applied. Furthermore, Reid and colleagues (2024) state that research conducted in a 'good' way denotes participation that honours spirit, meaning that it acknowledges and respects sacred relationships, respects more than human kin, and reflects the interconnectedness central to many Indigenous worldviews. Research in a good way is a commonly used expression employed across many distinct Indigenous cultures. In a research context, this is understood to mean that "topics under investigation are identified as priorities by Indigenous People, reinforce Indigenous values, are informed by Indigenous frames or reference, and yield benefits to Indigenous individuals and groups" (Reid et al. 2024) and supports Indigenous data sovereignty (Ball & Janyst 2008; Dion et al. 2022). Indigenous data sovereignty describes the fundamental rights of Indigenous Peoples to control, access, interpret, steward, and collectively own data about or related to their communities, lands, waters, resources, and cultures, ensuring it is managed in accordance with their laws, values, and governance systems and practices. It also means that Indigenous

communities, Nations, Tribes, and individuals are active partners and not subjects in the overall research process (Walter et al. 2020; Williamson et al. 2023).

Although growing recognition of the importance of knowledge co-production and of conducting research in a 'good way' has only been piecemeal, progress over the past 25 years has accelerated compared to previous generations. In the conservation-focused literature, for instance, there is increasing acceptance by academic institutions, western-trained scientists, and organizations that Indigenous Knowledges and Indigenous Knowledge Systems can significantly enhance collaborative resource management and reconciliation efforts (Beveridge et al. in review; Esquible et al. 2024; Frid et al. 2023; Lee et al. 2019; Seidler et al. 2024; Steel et al. 2021). Sustainability and conservation objectives are often implicitly embedded within traditional resource-harvesting practices. These practices can in turn offer highly detailed, place-based insights into long-term resource use and ecological change (Haggan et al. 2006; Jones et al. 2017; Reid et al. 2021). While inherently grounded in relationships to specific places, Indigenous Knowledge Systems have been shown to support biodiversity conservation at broader scales through the cumulative influence of long-standing Indigenous governance across extensive territories and shared lands and waters (Garnett et al. 2018; Halim et al. 2013; Wickham et al. 2022).

Amidst the growing interest within parts of the academic community to "weave," "pair," "braid," and/or "bridge" Indigenous Knowledge and western science, such efforts carry inherent risks, including the reproduction or perpetuation of colonial harms. These contemporary approaches mark a shift from earlier 'integration' efforts by researchers that commonly sought to 'fit' Indigenous Knowledges into pre-existing western scientific frameworks. Such efforts often treated Indigenous Knowledges as data to be extracted, translated, or validated through scientific logics (Roue & Nakashima 2018), whereas 'weaving' and 'braiding' oriented approached aim to uphold the integrity of multiple knowledge systems and way of knowing (Mehltretter et al. 2024). Indigenous and non-Indigenous scholars such as Bohensky & Maru (2011), Cruikshank et al. (2000), Ignace et al. (2023), Nadasdy (2005), Reid et al. (2022 & 2024), and Wong et al. (2020) have critiqued these knowledge "integration" efforts for often overlooking the underlying power imbalances between Indigenous governance systems, colonial states, and non-Indigenous

researchers. They further caution that co-produced knowledge can possibility end up serving the interests of non-Indigenous scientists or state policies, rather than those of Indigenous Knowledge holders and their communities.

While international frameworks and scholarly discourse increasingly recognize Indigenous sovereignty and the value of knowledge co-production through collaborative research, marine and fisheries management systems remain predominantly shaped by colonial institutions and western sciences. This has resulted in limited advancement of Indigenous fisheries rights and involvement, with few governance processes restructured to be grounded in Indigenous laws and priorities, and a lack of practical, co-developed tools to support Indigenous-led decision making. Existing efforts to "integrate" Indigenous and western knowledges in fisheries management often progress without addressing the underlying power asymmetries that currently shape decision making authority, risking the perpetuation of colonial dynamics rather than promoting transformation. In this context, there is a clear need for place-based research centred on true collaborations and in partnerships with Indigenous Peoples, governments, and agencies to document current fisheries governance practices and outcomes, develop policy-support tools, and strengthen capacity for exercising Indigenous authority over marine and coastal resources.

Importantly, we do not view western science itself as the 'problem', rather, inequities have emerged from the way non-Indigenous scientists, institutions and governments have and continue to operate. Western science has often been used to make inaccurate or overly authoritative claims against Indigenous Peoples and their relations with the non-human world, frequently without free, prior, or informed consent (Jessen et al. 2021; Stein et al. 2024). Such claims have at times been used to justify colonial policies that restrict Indigenous Peoples' access to and stewardship of lands, waters, and resources (Adas 1997; Fernández-Liamazares et al. 2021). Moreover, many academic institutions and colonial governments continue to prioritize western science methods and knowledge systems in fisheries, frequently marginalizing or subordinating Indigenous Knowledge Systems in subsequent decision-making processes (Muhl et al. 2023; Silver et al. 2022). Within this dissertation, we draw on western scientific methods while also ensuring that Indigenous ways of knowing and collaborative processes of knowledge co-production hold equal agency and influence in shaping the research. Through this approach,

we aim to help mitigate harm by centering research priorities of our collaborators and partners, and ensuring that our work responds to Indigenous concerns, rather than reproducing patterns of exclusion or extraction.

Theme 2. Pacific Salmon Fisheries Management & Policy Assessment

Globally, Indigenous Peoples' reliance on coastal fisheries is up to 15 times greater than that of non-Indigenous populations (Basurto et al. 2025). Such profound connections to marine ecosystems shape Indigenous identities, cultural practices, spiritual beliefs, social structures, and economic systems. These connections also support food sovereignty, which is broadly defined as the rights of Nations and Peoples to define, control, and access their own food systems, including their own markets, production models, food cultures, and environments to procure enough healthy, culturally appropriate foods (Cisneros-Montemayor et al. 2016; Gavenus et al. 2023; Islam & Berkes, 2016; Martens et al. 2016). As culturally significant species, wild Pacific salmon have sustained Indigenous Peoples along the western portion of North America for millennia, supporting survival, cultural continuity, and complex socio-ecological and economic networks (Atlas et al. 2017; Carothers et al. 2021; Yoshiyama 2007). Archaeological and ethnographic records reveal extensive, long-term use of salmon in the Pacific region (Carlson 2006; Campbell & Butler, 2010; Efford et al. 2023; Jones 2002; Winbourne 2001), guided by sophisticated systems of stewardship, governance, and management (Atlas et al. 2017; Carpenter et al. 2000; Carothers et al. 2021; Berkes & Turner 2006; Reid et al. 2022). These systems which are grounded in traditional laws, customs, and spiritual beliefs, have long maintained salmon abundance while safeguarding against overharvesting and population collapse (Atlas et al. 2021; Harris 2001; Garibaldi & Turner 2004; Jacob et al. 2010). Many coastal Indigenous Peoples identify as "Salmon People," reflecting the deep interdependence between salmon and their cultural, social, and ecological relationships (Amberson et al. 2016; Brown 2021; Bingham et al. 2021; Esquible et al. 2024; Hill et al. 2022; Reid et al. 2022).

Indigenous Knowledge Systems, which includes governance systems, have long guided reciprocal relationships with salmon, emphasizing responsibilities to care for and sustain them (Atlas et al. 2021). Since time immemorial these relationships have been embedded within complex governance systems that define how, when, and where salmon-related stewardship and

governance practices are carried out (Bradford 2024). While each Indigenous Knowledge System is unique, shared worldviews commonly position humans as integral parts of ecosystems, holding relationships with the lands, waters, and all living and non-living beings (Gauthier et al. 2025; Whyte 2013; Kimmer 2024). Within many Pacific Indigenous Knowledge Systems around the Pacific Northwest, salmon are often understood as having their own rights and personhood (Langdon & Sanderson 2009; Claxton & Price 2020; Johnson 2020; Silver et al. 2022). For example, across many First Nations and Tribal Nations worldviews, Pacific salmon are understood to hold similar spiritual essences to humans (Carothers et al. 2021), creating moral obligations and responsibilities to treat salmon with respect and reciprocity (Langdon 2021). Prior to colonization, a wide range of cultivation, fishing, stewardship, and management techniques reflected these governance systems and lifeways. These included weirs and traps designed to work with tides and seasonal migrations (Atlas et al. 2017), estuarine root gardens which improved juvenile rearing (Deur et al. 2013), fish transplanting (Thornton 2015), and terraced rock walls that expanded intertidal clam habitat and served as fish traps (Groesbeck et al. 2014; Lawson 2024; White 2011). Such practices were codified and maintained through traditional laws and guided by oral histories, which offered teachings about how to care for rivers and fish, harvest with respect, and live in relationship with salmon and each other (Bradford 2024; Carothers et al. 2021; Esquible et al. 2024; Jones 2002; Reid 2022). In many cases, families or individuals held inherited responsibilities for specific territories, food systems, or salmon populations, with decisions about when and where to harvest overseen by hereditary leaders or designated caretakers (Atleo 2021; Gavenus et al. 2023; Turner & Jones 2000; Walter et al. 2000).

The arrival of Europeans, and subsequent colonization of the lands and waters that now make up the Pacific Northwest region of North America, brought profound disruptions to Indigenous salmon-human relationships and systems of Indigenous governance. Colonial powers imposed foreign fisheries management frameworks that ignored and actively undermined Indigenous laws and authority. Practices such as weir, trap, and net fishing were banned and criminalized (Harris 2001; Walter et al. 2000), while settler-controlled licensing systems restricted Indigenous access to salmon (Atlas et al. 2021; Newell 1993). Assimilationist and racist policies -including the residential school system and the Indian Act in Canada- further sought to erode Indigenous

Knowledge Systems and consolidate Indigenous Peoples within reservations that represented a tiny fraction of their historical territories (MacDonald & Steenbeek 2015). These colonial interventions displaced Indigenous Peoples from their lands and waters and fractured the governance systems that had sustained salmon for millennia (Silver et al. 2022; Steel et al. 2021).

Yet, Indigenous stewardship practices and governance systems persist, and Indigenous Peoples continue to uphold salmon stewardship through deliberate actions woven into every-day life (Sleigh 2024). Such actions sustain healthy ecosystems, support strong salmon populations, and maintain human-salmon relationships and well-being (Bradford 2024; M'sit No'kmaq et al. 2021). Indigenous Peoples actively assess watershed health, monitor salmon systems, enhance salmon migration and passage, move salmon to strengthen populations, harvest salmon predators, harvest from thriving runs, and follow principles of taking only what you need, and return salmon bones to waters (Adams et al. 2019; Atlas 2021; Bradford 2024; Jones 2002; Langdon & Sanderson 2009; Menzies 2016). These acts of reciprocity are fundamental to human-salmon relationships that have sustained Indigenous Peoples and in turn wild Pacific salmon populations for millennia.

Despite ongoing Indigenous-led efforts to sustain and steward salmon for future generations, wild Pacific salmon face complex and intensifying threats. Industrial resource extraction activities such as logging, mining, offshore oil exploration, and high-seas fishing, along with watershed pollution, fish farms, aquaculture, and intensifying coastal development, are degrading critical salmon habitats, reducing water quality, and weakening ecosystem resilience (Naman et al. 2024; Noakes et al. 2000; Price et al. 2017; Wilson et al. 2022). Large-scale salmon hatchery production (viewed as a restoration effort by some) is also posing additional risks to wild salmon, through reduced genetic diversity, diminished reproductive fitness from domestication, and increased competition between hatchery- and wild-origin salmon for limited food resources in nearshore and marine habitats (Connors et al. 2025; Bendriem et al. 2019; James et al. 2023; Ruggerone et al. 2023). Considering these challenges, many researchers advocate for more precautionary and conservation-focused approaches to salmon hatchery use across the Pacific region (Atlas et al. 2022; Connors et al. 2020; McConnell et al. 2019; Riddell et al. 2024).

Anthropogenic fueled climate changes are also intensifying pressures on wild salmon, by further exacerbating habitat degradation, altering freshwater and marine conditions, and compounding the impacts of overfishing. These cumulative impacts are driving declines in the productivity and abundance of wild Pacific salmon, fueling conservation concerns and reducing fishing opportunities and access for Indigenous Peoples and other fishing sectors (Bendriem et al. 2019; Harvey et al. 2025; Price et al. 2008; Ulaski et al. 2025; Whitney et al. 2020; Walters et al. 2019). These threats are further deepened by management failures of colonial governments. Limited fisheries monitoring by colonial government agencies and inadequate fisheries management policies leave critical data and governance gaps, while failing to meaningfully engage and include Indigenous Knowledge Systems and Peoples in decision-making (Wilson et al. 2025; Beveridge et al. in review).

Indigenous Peoples are continuing to lead salmon monitoring, management, and stewardship efforts -often directly addressing the gaps left by colonial systems (Esquible et al. 2024; Thompson et al. 2021; Sleigh 2024). Yet, these contributions remain largely unrecognized and undervalued within academic and colonial policy and resource management discourse. This is not a shortcoming of Indigenous-led efforts, but the ongoing systemic exclusion of Indigenous Knowledge Systems and governance in western sciences and fisheries. This underrepresentation stems from underlying barriers facing Indigenous Peoples, such as limited time and financial capacities, the persistent marginalization of Indigenous Knowledge within dominant western fisheries frameworks, and the warranted mistrust among Indigenous Peoples of western science-based research institutions and agencies. Thus, the issue is not the presence or validity of Indigenous-led salmon monitoring, management, and stewardship efforts, but the failure of colonial systems to adequately respect, engage with, and support them. Recognizing, uplifting, and amplifying Indigenous-led monitoring and governance is essential, not only for advancing salmon conservation, but also for ensuring more just and effective management in a global era that claims to pursue reconciliation despite recent reactionary backlash and racism (e.g. *Cowichan Tribes v Canada,* 2025 BCSC 1490) (Bingham et al. 2021; Cannon et al. 2024; Jones et al. 2024; Steel et al. 2021).

Theme 3. Pacific Salmon Fisheries Monitoring

Monitoring fishers' effort and harvest is essential for effective management, as it provides the information necessary to balance conservation objectives with harvest opportunities (Morrow et al. 2022). Given the diversity of Pacific salmon fisheries (herein denoted as salmon fisheries), there are a variety of monitoring regimes (Boenish et al. 2020). Since the imposition of colonial fisheries management throughout western North America, salmon fisheries monitoring has largely been shaped by colonial institutions and western scientific frameworks, which aim to reduce uncertainty in salmon population estimates and harvest dynamics through statistical and modeling approaches (Connors et al. 2020; Inman et al. 2021). Western science-based salmon fisheries monitoring and subsequent management decisions typically rely on three central data components: stock-recruitment dynamics, expected run size, and the relationship between fishing regulations and anticipated harvest (Inman et al. 2021). These decisions are generally based on retroactive analyses of harvest data and population responses to previous management actions (Cunningham et al. 2019).

One of the most widely employed tools for linking fisheries monitoring data to population-level assessments and informing management strategies throughout global fisheries is Catch Per Unit Effort (CPUE). CPUE aims to estimate fish stock abundance by relating the amount of fishing effort (e.g., time spent fishing, gear deployed) to the number of fish harvested generally per hour (Branch & Hilborn 2010; Flynn & Hilborn 2004; Hoyle et al. 2024). While CPUE is a widely used management tool across salmon fisheries in the Pacific Northwest, it is not without limitations. CPUE can mask population declines when fish aggregate into smaller areas or when fishing fleets are able to effectively track dwindling populations, maintaining high catch rates despite reduced overall abundance or size (Maunder et al. 2006). CPUE may also obscure declines in average fish size -and therefore fecundity- as high catch rates can persist even when populations become dominated by smaller, less productive individuals. Moreover, when CPUE is applied at biologically irrelevant spatial or temporal scales it can distort stock assessments by overestimating population level abundance, particularly if range shifts, habitat degradation, or fisher behaviour in response to changing fish abundance are not accounted for (Maunder et al. 2006; Malick et al. 2023).

Fisheries monitoring approaches and intensity vary widely depending on the fishery's size, location, and regulatory context. Monitoring approaches are often categorized as fisher-dependant or fisher-independent, reflecting differences in data sources, reliability, and the roles of fishers themselves in generating knowledge (Table 1). At-sea monitoring of industrial scale fishing operations may include onboard observers for commercial vessels, satellite-based Vessel Monitoring Systems (VMS) and electronic monitoring using cameras and artificial intelligence to record catch and effort in real time (Boenish et al. 2020; Stokesbury et al. 2017; Sleigh 2024). Post-harvest and independent monitoring often occur dockside, where landings are validated, logbooks are submitted to management agencies (e.g. Fisheries and Oceans across Canada), and random catch sampling is conducted (DFO 2024; Faunce et al. 2015). Recreational fisheries (i.e. non-industrial scale) are typically monitored through fisher-dependant monitoring via creel surveys, and in some cases, aerial surveys for estimating effort in remote or dispersed fishing areas and locations of concern (Morrow et al. 2022; DFO 2024). Fisher-dependant monitoring through self-reporting is common, with fishers providing logbooks or using online reporting platforms to document their catches (see Table 1 for descriptions).

Table 1. Descriptions of Fisher-Dependant & Fisher-Independent Monitoring Methods (Adapted from Dennis et al. 2015 & Ducharme-Barth et al. 2022)

Monitoring Type	Description	Advantages	Limitations
Fisher-Dependant Monitoring	Fishery-dependent data includes catch and effort information collected by the fishing industry itself (e.g. through logbooks, self-reports, phone apps, dockside slips, etc.). Sometimes includes observer data collected on-board during fishing operations.	-Cost effective (data gathered during regular/routine fishing). -Broad spatial and temporal coverage due to large number of contributing vessels/fishers. -Encourages fisher participation and buy-in.	-Risks of bias or misreporting (e.g. underreporting, misidentification). -Catch Per Unit Effort may not reliably reflect fish population abundance (e.g. hyper-stability, variable fishing effort and power, errors). -Limited ability to verify without external audits or checks.
Fisher-Independent Monitoring	Fishery-independent data is based on data collected independently of fishers' economic or personal interests. Typically gathered by third parties, like management agencies, independent observers, scientists, or community monitors through surveys (e.g. trawl, test fisheries, sonar counts, genetic stock identification).	-Higher confidence in accuracy and objectivity. -Captures data some fishers may not be able to provide reliably (e.g. bycatch, discards, size composition). -Standardized protocols allow comparability across time and space.	-More expensive due to specialized staff, equipment, and data analysis/processing. -Lower spatial and temporal coverage compared to fisher-dependant data due to less frequent monitoring. -May cause tension if perceived as surveillance or policing by outside persons, entities, or agencies.

In Western Canada, Fisheries and Oceans Canada (DFO) applies fisheries monitoring methods to varying degrees, with monitoring intensity often reflecting fishery scale, geographic accessibility, and colonial management priorities (DFO 2024; Sleigh 2024). Historically, commercial fisheries have received greater monitoring requirements, while recreational and/or smaller-scale fisheries (including Indigenous Food, Social, and Ceremonial fisheries) often receive limited monitoring (Boenish et al. 2020). For example, most small-scale fishers are required to self-report their catch through online creel-style surveys, which are difficult to enforce (e.g. DFOs IRec Program). For-hire operations, such as recreational fishing lodges and guiding outfitters, are also required to self-report season-wide logbooks; however, these data may be inconstant or incomplete, and lack stock-specific information (i.e. populations of origin),

making it impossible to detect mixed-stock risk without additional methods like Genetic Stock Identification (GSI) (Maunder & Piner 2015; Staton et al. 2020).

For most of the twentieth century, industrial-scale salmon fisheries across the Pacific Northwest were supported by extensive coastwide monitoring systems, operated by agencies now known as Fisheries and Oceans Canada (DFO), the National Ocean and Atmospheric Administration (NOAA), the Pacific Salmon Commission, as well as state agencies (Stanton et al. 2025; Walters et al. 2019). In the late 1980s and early 1990's, however, severe reductions in commercial fisheries catches triggered widespread hardship and large-scale fisheries closures throughout the region. The closures cascaded into sustained budget cuts and reduced federal spending in salmon monitoring (Atkinson et al. 2025; Price et al. 2017). The collapse in catches, and concurrent reductions in monitoring effort, contributed to DFO's adoption of the Precautionary Approach as the foundation of 'modern' fisheries management in Canada (Archibald et al. 2021). Decades of budget cuts and reductions in federal investment in salmon fisheries monitoring, combined with the remote and expansive nature of many salmon bearing systems along North America's Pacific coast, have left significant gaps in fishery and population monitoring. Gaps are particularly common for populations that support non-industrial scale fisheries, such as Indigenous Food, Social, and Ceremonial (FSC) harvests (Atlas et al. 2019; Atkinson et al. 2025).

Significant fisheries monitoring challenges arise in mixed-stock fisheries, where multiple fish populations within an area and/or multiple species are harvested together. This is almost always the case for Pacific salmon, with the exception of Indigenous terminal fisheries (Atlas et al. 2017, 2021; Hilborn et al. 2003, 2012; Hutchinson 2008; Moore et al. 2021). Without reliable population specific monitoring, fishers risk over-exploiting less productive or weaker fish populations, potentially compromising vulnerable populations, further contributing to declines or extinction in some cases (Burgess et al. 2013; Connors et al. 2020; Okamoto et al. 2020; Ricker 1958). This risk is heightened across regions with substantial data gaps, where managers may not know which fish populations are being caught and by who, limiting their ability to apply conservation or precautionary management measures effectively (Connors et al. 2019; Postma et al. 2024). Methods for understanding heterogeneity among populations in mixed-stock fisheries are not currently well established yet are critical to addressing uncertainties when considering

management priorities and policies (Stanton et al. 2020). Genetic methods such as GSI can help address current management gaps in mixed-stock fisheries by providing stock-specific estimates of harvest, typically at the resolution of the level of the Conservation Unit (CU) in Canada (a unit of biological diversity), when employed alongside other fisheries information and knowledge (Jensen et al. 2021). GSI can determine the population of origin of a sampled salmon, and is widely used in mixed-stock fisheries, migration studies, and stock assessments (Beacham et al. 2020, 2022).

While jurisdictional complexity creates significant challenges for monitoring Pacific salmon, many of the most persistent barriers relate to technical, financial, and capacity limitations. In British Columbia, Canada responsibilities for Pacific salmon are fragmented across multiple governance levels and jurisdictions. For example, the federal government (Fisheries and Oceans Canada) manages salmon fisheries and stock assessments; the Province of British Columbia oversees lands and freshwater habitats, forestry practices, and water use that directly affects salmon and their ecosystems; regional and municipal governments make decisions that influence watershed health; and First Nations hold their own laws, authorities, and stewardship responsibilities within their territories. This layered and often conflicting governance landscape complicates efforts to monitor salmon populations and fisheries across marine and freshwater environments (Ban et al. 2021; Thompson et al. 2019).

Colonial government-led salmon monitoring programs, which are framed and based upon western science approaches, are often misaligned with Indigenous governance priorities and stewardship concerns (see Table 1). These programs frequently exclude Indigenous Peoples and Indigenous Knowledge Systems, which include their management objectives (Beveridge et al. in review; Thompson et al. 2018; Sleigh 2024). They also rarely account for other critical considerations, such as equitable access to preferred species or fishing areas, or incorporate fishers lived experiences, localized knowledges, or cultural perspectives. As a result, such approaches struggle to reflect the full scope of fisher's realities on the waters and in remote areas. These limitations point to a broader structural issue: current monitoring systems are not designed to capture the diversity of information needed to understand fisheries as they are experienced, used, and governed across different places. Importantly, this is not an argument for

expanding large-scale colonial monitoring programs. Rather, it highlights the need for more continuous, spatially distributed, and locally grounded monitoring across time and space -an approach that many Indigenous-led initiatives are already advancing at regional scales along the coast. By drawing on Indigenous governance systems, stewardship practices, and long-term place-based knowledges, Indigenous-led salmon monitoring can help address gaps left by colonial governments and agencies.

There have been rising calls across First Nations and Native Tribes for formal recognition of the importance of community-based and Indigenous-led salmon fisheries monitoring, management, and governance. These calls are especially urgent given the widespread reality of data limited fisheries and the social-ecological crisis of populations declines (Inman et al. 2021; Oviedo & Bursztyn 2017; Weber et al. 2004; Wilson et al. 2025). Atlas et al. (2023) further emphasize that these circumstances highlight the vital need for salmon fisheries harvest monitoring tools that utilize timely, in-season data, and enable adaptive decision-making. In this context, Indigenous-led monitoring can contribute to enhanced resilience and reduce the risks of boom-and-bust cycles that have characterized Pacific salmon fisheries since the forceful and ongoing removal of Indigenous fisheries monitoring, stewardship, and governance systems since colonization (Staton et al. 2025; Walters et al. 2019).

Dissertation Objective & Research Questions

The themes explored in this dissertation are strongly interconnected, yet they are seldom studied together within western fisheries sciences. Salmon research has often treated qualitative and quantitative information as separate domains, and discussions of fisheries monitoring, management, and policy seldom bring western sciences and Indigenous Knowledges together as equal knowledge systems. Therefore, this dissertation seeks to bridge these silos by engaging with three linked themes through a research continuum: Indigenous stewardship and governance of coastal and marine ecosystems, Pacific salmon fisheries management and policy, and Pacific salmon fisheries monitoring. When discussed together, these themes provide a multi-regional and multi-scaled perspectives on the realities Indigenous Peoples face when navigating conflicting scales of centralized monitoring, management, and policy across the Pacific Northwest region, specifically for Pacific salmon.

By multi-regional, this dissertation refers to research that spans the Pacific Northwest region, crossing both political boundaries (e.g., Canada and the United States) and ecological boundaries (i.e., defined by Pacific salmon ecosystems). While much of the research is centered in British Columbia, Canada -with a detailed case study from the Central Coast region for the Haíłzaqv First Nation- it also includes insights from Indigenous Peoples from across the Yukon, Alaska, British Columbia, Washington, and northern Oregon. This breadth reflects the transboundary and migratory nature of Pacific salmon themselves as well as the diversity of people who have and continue to rely upon Pacific salmon. By multi-scale, the research examines Pacific salmon issues across local, provincial and national management contexts. At the local scale, it considers the motivations and outcomes of Indigenous-led salmon monitoring programs within specific watersheds, and the management decisions tied to them. At the provincial scale, it evaluates current governance and management practices for salmon fisheries, looking at how these influence (or fail to influence) policy and political reform in support of reconciliation. At the national scale, our research engages with Canadian regulations and current allocation frameworks that define how fisheries are managed and subsequently monitored. Grounding this research within a multi-regional and multi-scaled approach is critical, as monitoring practices are both shaped by, and in turn shape the broader policy and political landscapes of which they are situated. This layered research approach demonstrates how decisions made at one scale can cascade into others, from high level fisheries governance through policy application to place-based stewardship through monitoring.

The overarching aim of this PhD dissertation is to center salmon, Indigenous Peoples, and Indigenous Knowledges within fisheries monitoring and management, and to offer recommendations for transforming colonial policies that continue to shape salmon fisheries in Canada, so they are more inclusive of and guided by multiple knowledge systems. This dissertation specifically identifies gaps in Pacific salmon fisheries monitoring, management, and policy assessment by co-developing a fisheries policy implementation evaluation tool for Canada's Wild Salmon Allocation Policy in collaboration with Indigenous partners. It also investigates the purposes, outcomes, and significance of some examples of Indigenous-led salmon monitoring programs across the Pacific Northwest. It further examines local monitoring

data, fisher perceptions, and the application of knowledge co-production in Haíłzaqv Territory to inform recommendations for coho salmon fisheries conservation and management in British Columbia's Central Coast. By undertaking this research, we fill current knowledge gaps related to local coho fisheries. Together, these chapters offer novel insights into how Pacific salmon fisheries monitoring, management, and policy assessment can be re-imagined to better reflect, respect, and centre Indigenous stewardship and governance while advancing salmon conservation and fisheries reconciliation in Canada.

The dissertation is structured around the following three research questions, which are addressed in specific chapters, and synthesized in the concluding chapter:

Chapter 2: *How can an assessment tool be co-developed with First Nations to reflect Indigenous perspectives on the implementation of Canada's 1999 Salmon Allocation Policy (SAP), particularly regarding conservation objectives and Canada's stated commitment to priority access for Indigenous Nations to salmon fisheries in British Columbia?*

In partnership with the First Nations Fisheries Council of British Columbia (FNFC), this chapter details the co-development of a fisheries policy assessment tool designed to evaluate the implementation of Canada's Salmon Allocation Policy since its inception in 1999. Through workshops and interviews with Indigenous representatives from 51 First Nations from across British Columbia, the research identifies meaningful indicators and criteria for assessing whether the SAP has been implemented as intended from the perspectives of First Nations fishers. Conventional fisheries assessment frameworks typically evaluate ecological conditions, protected areas, population status and trends, or fishery outcomes. Specifically, this chapter focuses on whether the SAP implementation has been consistent with its stated legal obligations under the Doctrine of Priority, including conservation of Pacific salmon and recognition of First Nations priority access. It was also designed to provide guidance for any future reviews or revisions of the 1999 SAP.

Chapter 3: *What are some of the motivations, challenges, and outcomes of active Indigenous-led salmon monitoring programs throughout the Pacific Northwest and how does Indigenous-led monitoring support collaborative fisheries management arrangements?*

This chapter explores the motivations, challenges, and outcomes of active Indigenous-led salmon monitoring programs through interviews with 31 Indigenous and non-Indigenous fisheries managers, stewardship leaders, and Knowledge Holders who work directly for First Nations and Native Tribes across Yukon, Alaska, British Columbia, Washington, and Northern Oregon (The Pacific Northwest Region). The interviews were designed to better understand the motivations behind Indigenous-led salmon monitoring programs and their significance in facilitating fisheries management leadership, both within traditional territories and via emerging collaborations with state and federal resource managers and agencies.

Chapter 4: *How can an Indigenous-led salmon monitoring program strengthen knowledge of local salmon populations while supporting management priorities and community requirements for Food, Social, and Ceremonial (FSC) fisheries?*

This chapter draws upon a longstanding partnership with the Heiltsuk Integrated Resource Management Department (HIRMD) and utilizes data from the Haíłzaqv fisheries monitoring program alongside salmon Genetic Stock Identification (GSI) results collected between 2019 to 2024. The chapter presents a case study and snapshot of Haíłzaqv Food, Social, and Ceremonial (FSC) fishery dynamics throughout some areas of Haíłzaqv Territory, with particular attention to coho salmon. By analyzing Haíłzaqv FSC and recreational fishers catch data, together with the perspectives from 259 Haíłzaqv salmon fishers, this research explores the conditions shaping access to Pacific salmon, the interactions between fisheries management and local harvesting, and the implications for conservation. The aim is to situate coho fisheries within Haíłzaqv stewardship and governance priorities, offering insights to inform more locally appropriate approaches to fisheries management.

Chapter 5: Conclusions

Finally, this chapter provides a synthesis of key points and findings from all previous research described above (Chapters 2 through 4) and discusses how they contribute to our understandings of Indigenous-led salmon monitoring, stewardship, and governance within the current fisheries management frameworks in Canada and across the Pacific Northwest. It also highlights both the limitations and future opportunities stemming from this research, including emerging research opportunities and potential collaborative work centering knowledge co-production in advancing collaborative management arrangements for Pacific salmon fisheries.

Dissertation Methodological Approach

Fisheries are inherently an applied science; accordingly, this dissertation is characteristically applied in nature, while also contributing to theoretical discussions in fisheries management, governance and knowledge co-production. The overarching methodological approaches guiding our work are centered around decolonial and knowledge co-production[7] frameworks. This requires the recognition of the long histories of suppression and marginalization of Indigenous Peoples in fisheries management and academic research. This orientation further requires critically examining power dynamics, centering Indigenous Knowledge Systems, sovereignty, and research priorities, as well as actively working to avoid reproducing colonial patterns of knowledge extraction in fisheries sciences. These methodological approaches position our research as both practically engaged and theoretically reflective between applied fisheries science and broader Pacific salmon political and cultural contexts.

The research that makes up this dissertation predominantly employs interdisciplinary, mixed-methods approaches that incorporates literature and policy reviews (Chapter 2), in-depth interviews (Chapter 2 and 3), creel-style surveys (Chapter 4), workshops (Chapter 2), data analysis and fisheries genetic information (Chapter 4) using multi-regional and multi-scaled perspectives. These methods draw on both quantitative and qualitative approaches and are

[7] We define knowledge co-production as a "process that brings together Indigenous People's knowledges and Knowledge Systems and western sciences together to generate new knowledge and understandings of the world that would likely not be achieved through the application of only one knowledge system…which emphasises the importance of equity in research relationships" (Ellam Yua et al. 2022). In this dissertation, it specifically refers to the process of bringing coastal Indigenous Peoples knowledge systems and western science together within Pacific salmon fisheries contexts. However, it is important to note that knowledge-coproduction and its components move beyond definitions and are intrinsically linked to actions (Zurba et al. 2021).

informed by theoretical contributions from knowledge co-production literature (see Figure 3 below; Ellam Yua et al. 2022). Each chapter employs distinct research methods in collaboration with invited partners, and we strategically positioned our research to privilege and centre the voices, knowledge's, sovereignty, experiences, and expertise of Indigenous Peoples, in recognition of the long history of suppression and marginalization within both academia and contemporary fisheries management across North America (Moffat et al. 2025; Reid et al. 2020). Given that the research presented within this dissertation was conducted in close partnerships with many co-authors, collaborators, participants, and organizations, I intentionally use "we" and "our" rather than "I" when describing most of the research. This choice reflects both respect for the collective efforts that made this work possible, and that the research outcomes could not have been accomplished in isolation; nor would it be appropriate given my positionality as a non-Indigenous person.

While this work engages multiple knowledge systems (Indigenous and western sciences), it does not -and cannot- represent the full breadth of Pacific salmon knowledge held by Indigenous Peoples. All methods were co-developed with research partners and guided by frameworks of knowledge co-production and co-creation (Fitzsimmons et al. 2024; Gauthier et al. 2025; Robards et al. 2018; Ellam Yua et al. 2022). These frameworks emphasize the importance of equity in all research relationships and ensures the process remains iterative, inclusive, with continuous efforts to respectfully uplift and centre Indigenous perspectives, voices, and information (Ellam Yua et al. 2022). As outlined within the knowledge co-production framework as an integral element, this research also focuses on meaningful issues as identified by research partners, and engagement by all has been genuine, forthright, and ongoing (Robards et al. 2018; Cannon et al. 2024). Research protocols were updated as needed in collaboration with all project partners, Indigenous governments, stewardship staff, and the University of Victoria. All research activities underwent ethical review and received approvals from the University of Victoria (Ethics ID24-0363 for Chapter 2, ID23-0117 for Chapter 3, and ethics approval ID19-0186 for Chapter 4).

Figure 3. A research framework detailing the process of knowledge co-production, illustrated by Ellam Yua et al (2022). Figure 3 illustrates the guiding framework that informed this PhD dissertation methodological approach. I aimed to employ the knowledge co-production framework across all chapters, grounding each in principles of collaboration, reciprocity, and respect for multiple knowledge systems. By situating research within this framework, I further aimed to be responsive to the priorities of Indigenous partners & collaborators, relevant to community contexts, & attentive to the ethical responsibilities of conducting research in support of self-determined Indigenous governance. Permission to share this framework is granted by & made publicly available under a Creative Commons International Licence (https://creativecommons.org/licenses/by/4.0/).

This dissertation would not have been possible without the strong and diverse collaborations and partnerships with individuals, groups, communities, research and governing bodies across a variety of contexts, including salmon experts from around the Pacific Rim of North America and Indigenous Knowledge holders spread across the Pacific Northwest's vast salmon systems. The diverse perspectives shared and gained through life experiences and professional backgrounds, allowed for mixed methods approaches that bring this research to life. This includes Indigenous Knowledge and western sciences approaches where and when appropriate, as guided by Indigenous partners. We aimed to frame this research through a decolonial, collaborative, and participatory engaged lens, employing best practices highlighted for researchers in many helpful

and guiding works (e.g. Huaman & Martin 2023; Cadman et al. 2024; Cannon et al. 2023; Wilson 2008). Scholars such as Kimmerer et al. (2013) and Huaman & Martin (2023) share that true participatory and community-engaged research methods are critical to decolonizing research. Thus, this dissertation was carried out under the guidance and mutual understandings of the six Rs of Indigenous research, such as 'respect, reciprocity, relationships, relevance, representation, and responsibility' (Harris & Wasilewski 2004). We also recognize the potential for research to perpetuate colonial power structures and inequalities; therefore, we remained mindful of our own positions of power and how it may or may not influence the research or our processes, taking deliberate steps to minimize our biases through shared discussion, ongoing reflections, and collaborative review. Finally, to avoid exploitation of Indigenous Knowledge or communities for personal or institutional gain, this research in its entirety was carried out with the well-being and research goals of the collaborating communities as the primary goal, not for financial or any other forms of profit or advancement. We intentionally aimed to facilitate safe spaces for collaborators and partners to centre Indigenous Knowledges and Indigenous Knowledge Systems at every stage of this research. However, the partnerships and collaborations do not imply that we speak for or on behalf of all Indigenous Peoples. Rather this work offers a snapshot of some perceptions, goals, and research priorities shared by those involved. We recognize that we are not perfect, that we are still learning, unlearning, and that carrying out collaborative research is and always will be challenging.

Chapter 2. Co-developing A Fisheries Policy Assessment Tool: Evaluating British Columbia's Salmon Allocation Policy

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Introduction

Humanity is collectively witnessing the depletion and overexploitation of our ocean systems, including the general decline of fish populations, the degradation of marine and coastal ecosystems, and the erosion of fisheries' social, cultural, economic, and nutritional contributions on a global scale (Ferguson et al. 2022; Hilborn et al. 2020; Warren & Steenbergen 2021). In recent decades, the accelerated loss of access to fisheries has been attributed to various pressures, including climate change, globalization and commercialization of fisheries, and inadequate fisheries management and policy implementation (Allison et al. 2012; Beveridge et al. 2020; Bodwitch et al. 2024; Connors et al. 2025; Klain et al. 2014; McGreer & Frid 2017; Richmond et al. 2013; Whitney et al. 2020). These modern declines sharply contrast with the sustainable, adaptive and effective fisheries management systems of Indigenous Peoples that persisted for millennia prior to such colonial disruptions (Atlas et al. 2021; Lee et al. 2019; Reid et al. 2022;

White 2006, 2011). The ongoing legacies embedded in centralized, colonial fisheries management policies continue to adversely affect Indigenous fishers and communities through restrictive harvest regulations, overfishing by non-Indigenous fisheries and sectors, and the continued displacement of Indigenous Peoples from the successful and long-standing stewardship and management of their resources across the North American continent (Armitage et al. 2024; Carothers 2010; Kittinger et al. 2011; Richmond et al. 2013; Silver et al. 2022). Historical and contemporary governmental restrictions on ocean resources, such as salmon species, have and continue to disrupt Indigenous cultures and practices, and impede the ability of Indigenous fishers to fulfill their food, social, economic, and ceremonial requirements and their responsibilities to each other, to fish, and to their Territories. These restrictions violate legally recognized and protected Indigenous rights and title to fish in many countries (Bennett et al. 2021; Bodwitch et al. 2024; Carothers et al. 2021; Gauvreau et al. 2017; Richmond et al. 2013; Toki 2010).

The shift in relationships between colonial governance bodies and Indigenous Peoples in Canada, including in fisheries, builds on decades of legal and policy transformations. Over the past five decades, landmark Supreme Court decisions (e.g. *Calder v. British Columbia 1973*, *R. v. Sparrow 1990*, *R. v. Van der Peet 1996, Haida Nation v. British Columbia 2004*, *Tsilhqot'in Nation v. British Columbia 2014, and Daniels v. Canada 2016*) and successive legislation and regulatory reforms have incrementally strengthened Indigenous rights recognition, affirming the crown's duty to create space for collaborative decision-making and Indigenous governance. In 2021, Canada adopted the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) through Bill C-35, which recently became the UNDRIP Act (UNDA). To ensure that Canadian laws and policies are better aligned with stated UNDRIP principles, Canada also committed to developing an Action Plan, which was released in 2023 (Department of Justice Canada 2023; Provencher et al. in review).

Many Indigenous Peoples, First Nations rights and title holders, and scholarly critics argue that the Canadian government has not advanced fisheries reconciliation quickly or meaningfully enough to meet the ongoing challenges faced by First Nation communities (Bodwitch et al. 2024; Nagy 2022; Victor 2012). Although, notable updates have been made to the Pacific Salmon

Treaty between Canada and the United States (with the stated intention of preventing the Treaties application from affecting existing Indigenous rights), as well as the establishment of a 14 person transboundary Wild Salmon Advisory Council in British Columbia -which includes First Nations leaders and individuals representing a wide diversity of interests and experiences related to wild salmon in British Columbia. However, despite these high-level fisheries reconciliation efforts, some key fisheries policies –such as the 1999 Salmon Allocation Policy (SAP), have never undergone review or been updated to reflect reconciliation objectives.

In recent years, efforts to improve fisheries reconciliation in Canada has brought increased attention to the necessity of reviewing and updating fisheries policies to better align with Indigenous rights, historic and modern treaty rights, Indigenous Knowledge Systems, and conservation priorities. The Pacific Salmon Allocation Policy (SAP) is one such policy where reconciliation efforts are manifesting through salmon management in Canada. The SAP was originally adopted by DFO in 1999 following the defining Supreme Court decision in R. v. Sparrow 1990. In *R. v. Sparrow*, *1990* the Supreme Court of Canada established that the constitutional recognition and affirmation of Aboriginal and Treaty rights within Section 35 of the Constitution Act, 1982 requires the federal government to justify any infringement of such rights. Thus, DFO is legally required to manage fisheries in alignment with the principles outlined in *R. v. Sparrow* and subsequent court rulings. Specifically, this includes prioritizing First Nations fisheries for Food, Social, Ceremonial (FSC), and/or economic purposes over other fisheries (such as commercial and recreational), after conservation. FSC fisheries are constitutionally protected and affirmed in Canada (Constitution Act, 1982, Section 35) as an inherent right and "Indigenous harvesters can catch what is needed for themselves and/or their community for FSC purposes, during various times of the year" (*R. v. Sparrow 1990*).

Importantly, the 1999 SAP provides overarching management principles and establishes a Doctrine of Priority for allocating Pacific salmon resources in British Columbia (BC). The priorities outlined in the SAP are as follows: (1) conservation purposes, (2) First Nations FSC purposes, and (3) recreational and commercial fisheries. The 1999 SAP defines conservation as "the protection, maintenance, and rehabilitation of genetic diversity, species, and ecosystems to sustain biodiversity and the continuance of evolutionary and natural production processes" (DFO

2023). Beyond its foundational principles, the SAP provides guidelines for allocating wild Pacific salmon among non-Indigenous fisheries (commercial, recreational), across gear types, and by species. The SAP does not explicitly define the term 'allocation'. Instead, it states that allocation "continues to be founded on the principle that Pacific salmon belong to the people of Canada as a common property resource and must be sustainably managed by government for the benefit of present and future generations" (DFO 1999). The policy's provisions apply specifically to Pacific salmon fisheries and populations in BC, which include five salmon species: sockeye (*Oncorhynchus nerka*), coho (*O. kisutch*), Chinook (*O. tshawytscha*), pink (*O. gorbuscha*), and chum (*O. keta*). Steelhead (*O. mykiss*) and cutthroat (*O. clarkii*) trout are not explicitly included in the 1999 SAP, as they fall under management jurisdiction of the Province of British Columbia.

Indigenous Peoples along the Pacific west coast of North America have maintained long-standing connections to wild Pacific salmon, stewarding these vital species for millennia (Carothers et al. 2021; Nesbitt & Moore 2016; Reid et al. 2022; Silver et al. 2022). Despite recognition of the constitutional priority of Indigenous fishing rights in Canadian law and policy, many First Nations continue to face significant inequities in salmon allocation and barriers to accessing their salmon fisheries, compelling them to pursue legal action against Fisheries and Oceans Canada. For example, in 2006, five First Nations on Vancouver Island (Ahousaht, Hesquiaht, Tla-o-qui-aht, Ehattesaht, and Mowachaht/Muchalaht, known as Nuu-chah-nulth Nations) initiated legal action against the Canadian government, as they stated that the SAP unjustifiably infringed on their constitutionally protected rights to fish and sell their catch, particularly by prioritizing the recreational fishery over their rights-based commercial sale fishery for Chinook and coho salmon (Ahousaht Indian Band and Nation v. Canada 2006-2009). A final court decision in 2009 proved the plaintiffs have constitutionally protected commercial aboriginal fishing rights. In 2018, the five First Nations initiated a second court case with appeals relating to the 2009 ruling. The 2018 court case decisions proved the unjust infringement of the SAP on their constitutionally protected aboriginal commercial fishery rights to fish and sell their catch. This decision also prompted an official review of the 1999 SAP, a process that remains ongoing (DFO 2023).

Similar to the Ahousaht, Hesquiaht, Tla-o-qui-aht, Ehattesaht, and Mowachaht/Muchalaht Nations on Vancouver Island, many other First Nations communities throughout British Columbia are also unable to meet their food, social, economic, and ceremonial requirements for Pacific salmon, a challenge compounded by growing conservation concerns facing wild salmon populations across the Pacific region (Connors et al. 2019; Gavenus et al. 2023; Steel et al. 2021). These concerns are multifaceted and reflect the relative decline in abundance of wild salmon populations, which varies significantly by species and region. A lack of up-to-date and reliable data on distinct salmon populations exacerbates uncertainty in their status, increasing the potential for fisheries mismanagement and negative policy externalities further fueling distrust among many First Nations towards Canada's conservation and allocation decisions and ability to uphold legal management objectives (Atlas et al. 2023; Klain et al. 2014; Nguyen et al. 2016; Reid et al. 2022). For example, the recent State of Salmon report (Connors et al. 2024) found that the northern regions of BC are experiencing the most widespread declines for all five salmon species, with most populations falling well below long-term averages for either spawner abundance or total abundance (or both). Despite these declines, no wild Pacific salmon species are currently listed under the Species at Risk Act (SARA), reflecting a long-standing pattern: very few fished species have ever been listed under SARA, even when recommended for listing by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Although a few distinct populations such as Sakinaw Sockeye, Interior Fraser River coho and Chinook, and Okanagan Chinook are currently classified as endangered by COSEWIC, they are not formally listed under SARA (DFO 2020).

Many First Nations representatives from across BC have argued that the 1999 SAP has never fully reflected the priority of salmon allocation for FSC fisheries, the policy fails to adequetly meet the requirements of growing First Nations and Indigenous communities, or the changing context of contemporary fisheries reconciliation efforts in Canada -or perhaps never did (Ahousaht Indian Band and Nation v. Canada 2018). Notably as discussed above, the Canadian Supreme Court's Ahousaht decision affirmed the rights of the five Nuu-Chah-Nulth Nations to access Rights-based commercial salmon fisheries. This monumental court ruling underscored the need for Canadian fisheries policies to recognize and uphold Indigenous rights and importantly,

prompted DFO and the Minister of Fisheries and Oceans to commit to reviewing, updating, and renewing the 1999 SAP (DFO 2023).

The SAP review process involves formalized collaborations with five Nuu-chah-nulth Nations as well as broader engagement with other BC First Nations and stakeholders, including commercial and recreational fisheries users across the province. The formal SAP review process represents a critical opportunity to ensure that fisheries policies (like the SAP) are updated in Canada to better align with UNDRIP principles, recognition and prioritization of Indigenous rights and title, shared conservation priorities, and to address long-standing gaps in equity and representation of Indigenous Knowledges in colonial fisheries management and subsequent policies. The SAP review process presents a meaningful and practical opportunity to improve the management of Pacific salmon, their allocations and advancing fisheries reconciliation with First Nations in Canada. In BC, First Nations are rights holders, not stakeholders (Darling et al. 2023), who were largely excluded from the original development of the 1999 SAP. First Nations are the original stewards of their lands and waters, with inherent rights and responsibilities that long predate colonial fisheries governance. These rights are recognized and affirmed under Section 35(1) of the Canadian Constitution Act (1982).

Through workshops and interviews, we engaged First Nations from across BC in the co-development of assessment indicators and scoring metrics to create a Salmon Allocation Policy Assessment Tool. This research aims to support fisheries reconciliation efforts in Canada by providing a framework to evaluate the implementation of the SAP since its inception in 1999. The SAP Assessment Tool enables First Nations and Fisheries and Oceans Canada (DFO) to identify areas of the policy that may require revision, and to guide the future implementation and assessment of an updated SAP. Unlike most fisheries assessment frameworks -which typically focus on evaluating the state or conditions of an ecosystem(s), protected areas, or fishery outcome- this Tool is specifically designed to evaluate whether the SAP has been applied in practice as intended and whether it is meeting its stated legal allocation obligations under the Doctrine of Priority. Central to this research is the inclusion of 51 First Nations perspectives from across British Columbia, which is essential not only for advancing reconciliation and

upholding Indigenous rights in Canada, but also for developing more just, effective, and inclusive fisheries policy outcomes for all.

Methods

Positionality Statement

This research was invited by the First Nations Fisheries Council of British Columbia to support the development of an SAP Assessment Tool to ensure outcomes for salmon conservation and First Nations Priority Access are tracked and evaluated in an equitable way. We, the authors, represent a group of non-Indigenous academic researchers, graduate students, postdoctoral fellows, and professionals working with and for First Nations governments, organizations, and non-governmental organizations. Our shared goal is to support and uplift Indigenous governance in fisheries and advance meaningful changes to colonial fishery management and policies. Furthermore, we aim to be supportive allies in advancing reconciliation with First Nations in BC through improving policies that currently limit allocation and access to Pacific salmon.

We also wish to acknowledge the trust and responsibility placed in us by the many First Nations and Indigenous communities that we work for as well as FNFC. As non-Indigenous individuals, we understand our privileges and are committed to critical reflection and accountability to ensure our actions align with the guidance and priorities of the First Nations leaders and communities in which we serve. Thus, this research seeks to center Indigenous Knowledges and First Nations stewardship priorities for Pacific salmon whilst challenging the ongoing injustices inherent in current colonial management structures and policies implemented for fisheries in Canada.

Overview of SAP Assessment Tool Development Process & Key Partnerships

The co-development process for designing an assessment tool for the SAP was guided by close partnerships and collaborations with First Nations stewardship staff, Indigenous Knowledge holders, community leaders, salmon fisheries experts, academic researchers, as well as staff from the First Nations Fisheries Council. These partnerships, built on trust and long-standing relationships held between FNFC, BC First Nations, and the research team, ensuring that diverse perspectives from across BC were captured in the development of the indicators and overall policy evaluation framework design.

The research process followed several steps (Figure 4). Following the invitation of FNFC to collaborate on the development of the SAP Assessment Tool (Spring 2024), the lead researcher conducted a scoping literature review to explore existing policy evaluation tools relevant to salmon and for fisheries management. This process involved searching for and screening open-access journal articles through Google Scholar and the University of Victoria's library database, using a broad set of key search terms related to fisheries policy assessment, developing marine conservation evaluation frameworks and indicators. Given the exploratory nature of this screening exercise, we reviewed peer-reviewed journal articles and grey literature such as government reports, non-profit publications, and Indigenous-led resource management documents. The scope was intentionally broad, considering fisheries and conservation focused policy assessment approaches beyond salmon to identify any best practices for developing evaluations. In parallel, FNFC and the lead researcher also worked closely to convene and establish the research team and to develop plans for a virtual workshop and carry out the co-development of the SAP Assessment Tool. The research was conducted with ethics approval from the University of Victoria (Ethics Protocol #24-0363).

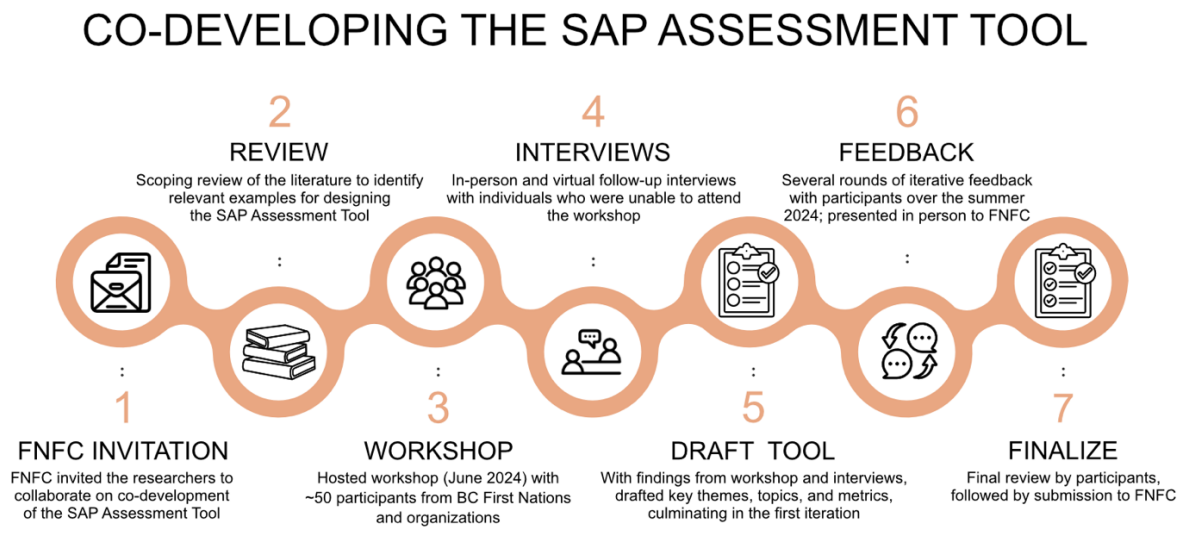

Figure 4. Timeline illustrating the overall research phases for co-developing the Salmon Allocation Policy Assessment Tool.

Workshop & Interviews

A virtual workshop, held on June 17th, 2024, convened 51 participants representing First Nations organizations and communities, such as fisheries managers and other technical staff, to identify key indicators that can be used to evaluate salmon conservation and First Nations Priority Access objectives as listed in the SAP. We structured the workshop to maximize input from participants and followed the steps laid out by Bennett et al (2021b) for co-developing good indicators for assessing fisheries outcomes. We shared the discussion questions (see Appendix A) in advance of the workshop. After an opening prayer by a Haíłzaqv Nation member and fisheries manager, and introductions, we began the workshop with a brief overview of the 1999 SAP, providing definitions of key terms utilized such as 'access', 'indicators', 'metrics', 'Indigenous rights', 'policy assessment'. We specified what was considered in and out of scope for the workshop breakout group conversations. We focused discussions on the perspectives of First Nations and did not include any discussion questions regarding recreational and commercial fisheries. To enable small-group discussions and allow everyone to share their insights, we divided participants into four breakout groups. Breakout group discussion iteratively focused on the two highest allocation priorities of the SAP: Conservation, and First Nations Priority Access. Each breakout group was facilitated by a research team member, with a dedicated note taker assigned to document discussions and participant feedback via a Miro (virtual note taking software) white board. Facilitators helped prompt discussion, maintained respectful dialogue, and supported their note taker as needed. Each breakout group addressed the same set of four discussion questions. The discussion questions were designed to focus and guide the conversations and were developed by the research team with input from FNFC staff.

Following each of the two breakout sessions, all participants reconvened as a large group to share and report on their discussions and add any additional comments to main themes covered. Participants then collaboratively organized themes for each discussion question under the Conservation and First Nations Priority Access categories (See Figure 5). We invited participants to share any additional thoughts or feedback after the workshop. In the weeks following the workshop, the research team hosted four additional virtual, structured group interviews with First Nations stewardship staff and fisheries experts who were unable to attend the workshop. Each interview lasted two to four hours and followed the same format as the workshop. After each interview, the team updated the main workshop Miro board, incorporating any new or emerging

ideas from the interview sessions and organized themes in the same manner as the workshop review session.

Analysis of Results, Drafting Indicators & Reporting Back

After the research team concluded the workshop and subsequent interviews, the entire research team collaboratively reviewed each discussion question answers from workshop and interview breakout groups for both Conservation and First Nation Priority Access. The team worked to group ideas into similar themes for each discussion question answer and identified the prevalent topics in alignment with the first two priorities of the 1999 SAP -i.e. Conservation and First Nations Priority Access (Figure 5). We then collaboratively consolidated the most prevalent themes and identified possible indicators (in the form of questions), and scores (answers) organized by categories of Conservation and First Nations Priority Access.

Figure 5. Example screenshot illustrating how the research team organized workshop and interview discussion questions and responses into thematic groupings in the platform, Miro board. Themes related to 'Conservation' are colour-codded green and displayed on the left,

while themes related to 'First Nations Priority Access' are colour-coded teal and displayed on the right, each with corresponding supplementary notes.

The research team then invited iterative feedback on the draft indicators and scoring metrics which were brought together in two distinct sections under the themes of Conservation and First Nations Priority Access, which created a draft SAP Assessment Tool. Iterative feedback included sharing the draft Tool and a summary document detailing the process with all workshop and interview participants, and the research team presenting three separate in-person presentations first to the FNFC, DFO, and First Nations SAP review group in Vancouver, British Columbia. After further conversations with both FNFC and DFO, the research team worked to align the indicators and assessment scores (metrics) as closely as possible with the contents of the 1999 SAP, again sharing it back to participants for their feedback and review. Additionally, FNFC circulated the draft SAP Assessment Tool via a BC First Nations listserv to gather broader input from other BC First Nations and representatives who may not have been able to attend the previous workshop or interviews. We received feedback in written format and through phone conversations from listserv recipients. Finally, the research team presented the updated draft indicators and metrics forming the SAP Assessment Tool via a summary document and in-person presentations to the FNFC, DFO and the official First Nations SAP review team in Vancouver, British Columbia during both the Summer and Fall of 2024.

Results

Scoping Review

Although co-developing indicators and metrics with a broad range of collaborators such as Indigenous Peoples, commercial and recreational fishers, government agencies, consultants, etc. to assess the state of ecosystems, protected areas, or fishery outcomes is not a new concept throughout the literature (e.g. Anderson et al. 2015; Engen et al. 2024; Kourantidou et al. 2020; Nash & Graham 2016; Rice & Rochet 2005); to the best of our knowledge, there is limited peer-reviewed, publicly accessible literature specifically focused on assessment tools or frameworks co-designed with or by Indigenous Peoples to evaluate fisheries policies and their applications in a North American context. Instead, existing fisheries assessment tools or frameworks primarily focus on evaluating specific performance measures or metrics through indicators tailored to

economic, biological, or social outcomes. For example, Price et al. (2017) developed a framework to assess Pacific salmon conservation progress in relation to Canada's Wild Salmon Policy. Additionally, Bennett et al (2021b) share their research process for successfully co-developing 'good' indicators for assessing socio-ecological outcomes in fisheries contexts. However, we found very few examples of relevant fishery policy assessment tools or frameworks that could inform our research approach. The few fisheries-related policy assessment or evaluation examples we identified were international and not specific to Pacific salmon.

From the international examples identified from our review, one notable approach was documented by Lin et al. (2014), who co-developed a distant-water fisheries policy indicator system in Taiwan. This policy assessment framework addressed the lack of evaluation tools available for newly created fisheries policies and assessed policy performance across ecological, social, economic, and institutional dimensions. Lin et al. (2014) worked with key stakeholders - such as scholars, government officials, and industry representatives- using structured surveys to establish meaningful indicators for the evaluation tool however this was not conducted in partnership or led by Indigenous Peoples. Similarly, other international examples include a fisheries governance performance assessment tool developed by Hosch (2012) for the Eastern and Southern African and Indian Ocean region. This tool functions as a "barometer," providing country-level governance scores as a percentage out of 100. Another example comes from Belize, where an 11-step adaptive management framework was created to evaluate fishery policy implementation using model-free indicators. McDonald et al. (2017 & 2018) applied this framework in a case study of Belize lobster fisheries, assessing management policies from ecological, social, and economic perspectives. While these examples demonstrate innovative and collaborative approaches to developing fisheries policy evaluation tools, they were relevant, but not directly transferable to our methodological approach or scope, which was grounded in the context of Indigenous rights holders and Pacific salmon management.

Details of The SAP Assessment Tool

The SAP Assessment Tool is divided into two main sections: the first focused on Pacific salmon conservation and the second on First Nations Priority Access in BC. For this research, we define access as "the ability to use and benefit from a resource or an area. Access is influenced by

rights, but access is not solely a matter of rights. Access in a fisheries context can be broadly defined as the ability to use and benefit from available marine resources or areas of the ocean or coast." (Bennett et al. 2018 & 2021a). We also include fisheries in freshwater as part of our definition of fisheries access here. The SAP Assessment Tool comprises 40 indicators: 23 evaluating First Nations perspectives on the SAPs conservation allocation priority and 17 assessing the alignment of current fisheries allocation approaches with First Nations Priority Access (see Appendix for the SAP Assessment Tool). Each indicator is assessed using a five-point scoring system (metric; 0–4), with specific thresholds and performance criteria outlined in the tool. Indicators are defined as outcome statements or questions that enable evaluators to assess SAP implementation based on the stated performance criteria (Bennett et al. 2021b). In ensuring our indicators were 'good', we checked that the details were measurable, precise, consistent, sensitive, simple, and affordable (Margolius & Salafsky 1998).

Ultimately, the indicators and scoring metrics provide a structured approach for evaluators to assign scores and comments, reflecting their perspectives on the SAP's performance in meeting its Conservation and First Nations Priority Access allocations over the past ~25 years. We provide open access to our independently and co-developed SAP Assessment Tool for other groups who wish to use or adapt it (see Appendix B. for SAP Assessment Tool instructions and Supplementary Materials for the SAP Assessment Tool).

The SAP Assessment Tool includes indicators of which we identified key themes emerging from both the Conservation and First Nations Priority Access sections. Conservation related indicators centered on themes of 'Biological Monitoring', 'Catch Monitoring', 'Closures', 'Escapement', 'Habitat and Management', while First Nations Priority Access indicators focused on themes of 'Access Priority', 'Allocation Decisions', 'Fishing Opportunities', and 'Meeting FSC/Treaty Requirements' (Figure 6). Additionally, 'Data' and 'Indigenous Knowledge' emerged as shared themes across both sections of the SAP Assessment Tool indicators. Based on previous discussions with FNFC and some DFO staff currently involved in the 1999 SAP review process, we deliberately excluded certain topics from the workshop and interview discussions because they were considered out of scope of the SAP review process, despite their importance to many participants. Specifically, we did not include targeted questions relating to recreational or

commercial fisheries, community well-being, capacity required to engage in fisheries, or general themes around youth engagement. Importantly, although we did not include targeted questions around these themes, many participants shared their concerns related to these themes.

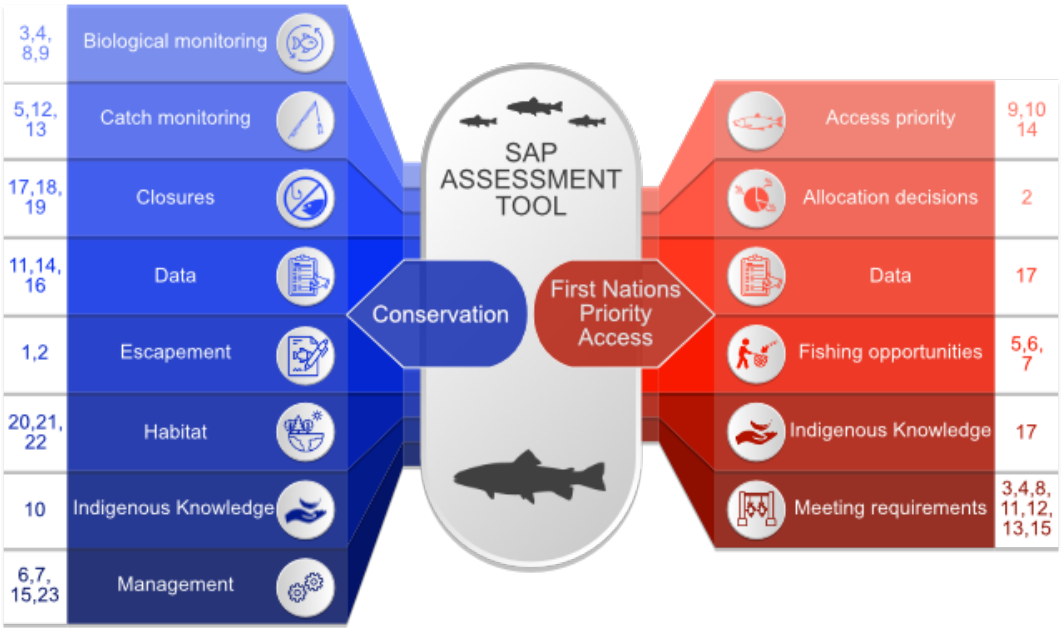

Figure 6. Key themes identified from the co-development of the SAP Assessment Tool & included as indicators. Indicators & scoring metrics are categorized into two main sections: Conservation (in blue on the left) & First Nations Priority Access (in red on the right). Each theme is linked to corresponding indicator numbers, displayed on either side of the figure. See Appendix B for Assessment instructions & Supplementary Materials for the full SAP Assessment Tool.

Workshop & Interview Results

Participants highlighted several pressing concerns regarding the conservation of and access to salmon fisheries in BC. For example, a key issue emphasized is the need for updated FSC allocations for First Nations, as existing FSC salmon allocations were originally created with minimal consultation with First Nations and generally do not reflect the past and present realities of growing Indigenous communities and populations. Many allocations have not changed since the SAP was established, and in some cases outdated FSC allocation exceeds the current total run size of salmon in most years since the adoption of the SAP in 1999 (e.g. Atnarko sockeye,

Beveridge et al. in review). There was strong support for conducting updated community needs assessments to realign allocations with contemporary requirements. Another recurring barrier to accessing allocations identified by participants is limited resources. Limited fishing knowledge, access to fishing equipment and boats, financial capacity, and imposed restrictions on time, along with broader community and individual well-being and declining salmon populations, were mentioned as some key obstacles for overcoming access and conservation barriers.

Participants also voiced strong concerns over the imbalance in current colonial decision-making authority, particularly regarding ministerial discretion and veto power by the Canadian Federal government agencies. While there has been progress toward co-governance agreements (e.g. the Maa-nulth Treaty Joint Technical Committee and the Fisheries Resource Reconciliation Agreement signed between eight BC First Nations and Canada), many First Nations remain unable to exercise their priority access rights due to systemic barriers embedded within both federal policies and international agreements like the Pacific Salmon Treaty. The perceived misalignment between conservation objectives and the management of recreational salmon fisheries- particularly for Chinook and coho salmon in BC was also raised by many workshop participants, who expressed frustration that the recreational sector continues to receive priority allocation from DFO, despite its substantial impact on salmon populations, in contravention of the Doctrine of Priority. This perception has further eroded trust in the fairness and effectiveness of the SAPs ability to meet stated conservation and First Nations Priority Access allocations. Low and variable salmon abundance were perceived to be major drivers of participants' inability to meet FSC requirements, and increased competition with other fishing sectors was mentioned as another major driver of this gap between FSC requirements and actualized salmon harvests.

Participants identified several critical steps that should be taken to strengthen conservation efforts and improve salmon access:

1. Shift to finer scale salmon management (watershed or salmon population level) to better reflect regional ecological and cultural requirements.

2. Enhance in-season salmon monitoring efforts to reduce conservation risks, build collaboration and better coordination between First Nations, DFO, and other stakeholders.

3. Build trust through improved communications and coordination efforts between First Nations, DFO, and regional management bodies. This could enable improved data sharing and transparency alongside improving salmon fisheries management decisions and co-governance processes.

4. Improve salmon habitat restoration, as salmon habitat health is widely recognized as essential for both conservation and for supporting First Nations' access to healthy salmon populations. Yet, we note that DFO currently excludes salmon habitat conditions and restoration efforts from the scope of the 1999 SAP, limiting the policy's ability to address some of the key drivers of declining salmon populations. This gap is further compounded by overlapping federal-provincial governance responsibilities for habitat management, where no single colonial authority is fully accountable for long-term protection, restoration, or monitoring. Many participants highlighted that significant conservation action and upholding First Nations priority access requires coordinated, sustained investment in salmon habitat restoration, protection, and ongoing monitoring across jurisdictions.

Discussion

The Salmon Allocation Policy Assessment Tool in Practice

We envision three potential pathways under which the SAP Assessment Tool may be implemented in BC. Firstly, First Nation communities can use and apply the tool as they see fit. For example, following the development of the SAP Assessment Tool, we conducted a regional review of the 1999 SAP with four Central Coast First Nations (CCFNs). CCFNs convened in December 2024 and applied the SAP Assessment Tool to their territories to provide feedback across the 40 indicators. The research team asked each Nation's representatives and salmon experts to apply a score, and to explain their rationales associated with their experiences related to each indicator. In cases where scores differed between Nations, the average score was reported. In addition to applying scores, the research team recorded detailed notes on background information and rationales provided to each score applied including key challenges and opportunities for meeting the stated Doctrine of Priority for Central Coast salmon populations and the fisheries they support. This effort took a retrospective view of salmon fisheries since 1999, evaluating the success of DFO in meeting the Doctrine of Priority since the SAP was initially implemented for CCFNs. To further illuminate the rationale behind the scores applied

during the evaluation by local experts, participants identified three fishery specific case studies for Pacific salmon species across the BC Central Coast region to demonstrate how each fishery has been managed over the last ~25 years and to what degree these decisions by federal managers have upheld the Doctrine of Priority as stated in the 1999 SAP.

Secondly, FNFC and BC First Nations may find value in incorporating the Tool into the United Nations Declaration on the Rights of Indigenous Peoples Action Plan (UNDA Action Plan) to help guide an evaluation of Act's implementation with respect to fisheries. And lastly, the current FNFC and First Nations SAP review group may choose to adopt a version of the SAP Assessment Tool as a formal policy evaluation framework within the updated SAP. We recommend that the SAP Assessment Tool be used as an evaluation framework to inform the current and ongoing SAP review and update, as well as in a formal five-year review process in partnership with BC First Nations and DFO. However, the decision of when and how the SAP Assessment Tool is utilized and applied is ultimately beyond the control of the research team and rests with those who are involved in the formalized SAP review process and the decision-making authority of the Minister of Fisheries and Oceans Canada.

Research Limitations & Lessons Learned

This research faced several challenges and limitations. A key limitation was the inability to engage with all First Nations and communities across British Columbia who are affected by the SAP. This was due in part to the time and capacity constraints of the research team and the limited availability of First Nations and Indigenous fisheries organizational staff, who often juggle multiple priorities and responsibilities. The scope of the research also posed limitations. While the development of the indicators, metrics, and SAP Assessment Tool itself were co-developed with First Nations throughout BC to focus on salmon Conservation and First Nations Priority Access, this scope excluded the third section of the SAP, Commercial and Recreational fisheries. The research team and FNFC agreed from the outset not to include indicators or scoring metrics related to recreational or commercial fisheries, in recognition that First Nations should not bear the responsibility for developing an evaluation for components of the policy from which they were historically excluded. Similarly, many participants also highlighted the critical role of youths, Elders, and broader community engagement in supporting salmon

conservation and increasing First Nations Priority Access, the importance of salmon access to well-being, and the capacity required to engage in the act of fishing along with fisheries management, yet these themes are currently considered out of scope of the SAP by DFO.

Additional challenges arose from the inherent difficulty of measuring complex and deeply meaningful relationships between First Nations and salmon through forms of indicators and scoring systems. Salmon hold great cultural, social, ecological, and economic significance for many First Nations, and we were mindful of the risk of oversimplifying or diminishing this importance. Additionally, there was concern that by evaluators potentially assigning high scores for certain indicators, this could be misinterpreted by DFO or the Canadian government as areas of the policy requiring less attention, potentially leading to complacency. Thus, we emphasize that this policy Assessment Tool is not intended to assign blame but rather to identify strengths and weaknesses in fishery policy (i.e. the SAP) and its application, to support constructive dialogue and improvements where necessary. Finally, the evolving nature of the SAP itself presents challenges in creating a tool for its assessment. This evaluation Tool was developed to assess the implementation of the SAP since 1999, but ongoing revisions to the policy may necessitate adjustments to the Tool in the future. Furthermore, how and by whom the Tool is ultimately used remains beyond our control, which may influence its effectiveness and impacts in the long-term. Despite this uncertainty, the research team and all workshop and interview participants feel strongly that the current version of the SAP Assessment Tool included in this research is a solid and reflective product of shared salmon Conservation and First Nations Priority Access objectives.

Beyond the challenges and limitations of this research, we feel that our research approach and outcomes offer valuable lessons that extend well beyond the co-creation of indicators and an assessment tool for the SAP. One of the most important takeaways was the critical importance of creating space for open and honest dialogue with First Nations from across BC on how to best assess policy. Instead of beginning the workshop and interviews with technical examples or prescribing direction, we started with candid conversations that allowed participants to share their goals, priorities, and critiques of colonial fisheries policies like the SAP. This approach led to strong mutual understanding and revealed broad alignment around conservation and First

Nations access -challenging the assumption that these priorities are in conflict and instead showing they can be complementary. The process underscored the need for flexibility, recognition of regional differences, and careful attention to language to ensure the work remained inclusive and respectful. Ultimately, the collaborative process of co-developing the assessment tool was just as meaningful as the tool itself -fostering trust, shared ownership, and a final product grounded in the priorities of all participants. The research team was intentional about building in time for back-and-forth dialogue, knowledge sharing, and ensuring multiple opportunities for feedback -through additional in-person sessions, presentations, emails, phone calls, and written responses -which helped shape a concise yet meaningful set of indicators that formed the foundation of the SAP Assessment Tool.

Importance of Evaluating Fisheries Policies

Globally, evaluations of resource management policies, including fisheries policies, can be utilized as a critical tool for assessing policy effectiveness, diagnosing implementation challenges, and informing adaptive management for improved governance in a formalized way (Pomeroy et al. 2022; Smith et al. 2019). Despite the recognized benefits of policy evaluation, little research has been conducted on co-developing indicators and scores (metrics) that can be used for collaborative policy assessment -particularly in ways that make space for knowledge pluralism and knowledge co-production such as Indigenous Knowledges and other ways of knowing beyond western sciences. Our SAP Assessment Tool is distinct in this regard, as the indicators and scoring metrics were co-developed with First Nations and the First Nations Fisheries Council (FNFC) in British Columbia. This approach creates a meaningful opportunity to challenge and improve colonial fisheries management by ensuring that First Nations perspectives and Knowledges are not only meaningfully included but are actively informing policy assessments. It also provides a mechanism for evaluating whether resource management policies -like the SAP- are effectively meeting their stated objectives and if not, identifying areas that may require further attention or revision.

Workshop and interview participants emphasized that the 1999 SAP lacks specificity in addressing both emerging and ongoing conservation priorities, as well as equitable access for First Nations to Pacific salmon in Canada through the current allocation structure. This

underscores the need for fisheries policy evaluation tools that reflect current ecological realities and First Nations rights in Canada (Beveridge et al. in review; Price et al. 2017). The collaborative development of indicators and metrics, alongside ongoing reviews and assessments conducted in true and meaningful partnerships with First Nations and DFO is one avenue through which Canada can advance reconciliation efforts. Further, by evaluating the SAP using a co-developed assessment tool, we can improve our collective understanding of whether Pacific salmon allocations align with policy objectives and identify strategies to address shortcomings. This process is essential for strengthening policy implementation, ensuring accountability, and adjusting management approaches as needed–key principles of adaptive fisheries management (Pomeroy et al. 2022).

Conclusions

The purpose of this research was to co-develop a fisheries policy assessment tool to critically evaluate the implementation of the 1999 Salmon Allocation Policy (SAP) in British Columbia (BC). We provide a transparent set of indicators and metrics co-developed in partnership with BC First Nations, to further assess how well the current and forthcoming updated SAP meets its stated allocation objectives in Sections 1 and 2: Conservation and First Nations Priority Access. We underscore the critical intersection of reconciliation and colonial fisheries policies, highlighting the need for updated, inclusive, and equitable resource management approaches. Evaluating and updating policies like the 1999 SAP is one way Canada can advance fisheries reconciliation efforts with Indigenous Peoples, who have historically and continue to be excluded from the creation, implementation, and evaluation of fisheries and resource management policies. The SAP Assessment Tool can help illuminate shortcomings in the implementation of the SAP since 1999, particularly in upholding the Doctrine of Priority for salmon allocations in Canada. This research also offers guidance to Fisheries and Oceans Canada on improving adaptive management strategies for Pacific salmon conservation and First Nations priority access in British Columbia. Beyond evaluating the SAP, the methods used to co-develop this tool provide valuable lessons for creating fisheries policy assessment tools more broadly across Canada and beyond that are inclusive of Indigenous perspectives and priorities. Lastly, we hope this research can contribute to the limited body of research available on collaborative fisheries

policy assessments and indicator development with Indigenous Peoples, particularly in the context of Pacific salmon and North American fisheries governance and policy application.

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Conflict of Interest Statement

Some members of the FNFC are included as co-authors. While the FNFC supported the research and co-authors were involved in the project, they did not influence the analysis or outcomes of the study. The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The views expressed in this manuscript are those of the author(s) and do not reflect the opinions of the institutions, organizations or aggregates for which the authors are affiliated. For example, the opinions of author's affiliated with FNFC, CCIRA, CFN, are not reflective of the perspectives of all the First Nations who are part of those organizations.

Chapter 3. Learning From Each Other: Indigenous-led Pacific Salmon Monitoring in Practice

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Introduction

Positionality Statement

We, the authorship team, span diverse life and career stages, including lifelong learners. We acknowledge our positionalities as Indigenous and non-Indigenous scholars, researchers, Knowledge Holders, students, and practitioners working within academic institutions and alongside Indigenous governments and organizations. Aware of the privilege inherent in our positions, we are committed to critically reflecting on our language, how we represent voices, both our own and others and the biases we bring to our work. As a team primarily composed of women working in fisheries conservation and management across Canada and the United States (a field historically dominated by men) we bring personal and professional experiences that shape our approach to advancing equity. Our experiences give us a deeper understanding of

systemic inequities and strengthen our commitment to amplifying underrepresented voices while fostering inclusivity, equity, and respect within all aspects of fisheries.

We also recognize the ongoing harms of colonialism throughout the regions where we live and work, particularly in fisheries conservation, monitoring, and management. This research seeks to challenge these dynamics by supporting Indigenous leadership, self-determination, and the elevation of Indigenous Knowledges and stewardship practices. Guided by the six R's of Indigenous research -relevance, respect, reciprocity, responsibility, relationships and redistribution (Harris & Wasilewski 2004; Kirkness & Barnhardt 2001; Menzies et al. 2024; Tessaro et al. 2018; Tsosie et al 2022)- we view meaningful and respectful decolonial research as non-extractive, embedded in accountability, and responsive to community and partner priorities. We believe this requires both personal and collective commitments to deep, ongoing learning and unlearning. By articulating our positionalities, we acknowledge how our identities and lived experiences shape our research perspectives and engagement (Cadman et al. 2024; Reid et al. 2024). We strive to foster genuine collaboration in fisheries by centering and uplifting Indigenous voices and stewardship practices as a start.

This research project was conceptualized during a 2022 workshop hosted by the Central Coast Indigenous Resource Alliance, which convened First Nations from across the Central and North Coasts of British Columbia. Workshop participants shared Knowledges, experiences, and insights about their Nations-led salmon monitoring programs. A predominant discussion focus was the shared worldview that fish, like all species, have the right to live and exist in harmony with all other beings. While salmon are generally viewed to be voiceless in western decision-making frameworks, many First Nations, Native Tribes, and Indigenous Peoples understand salmon to have agency, and therefore hold an inherent responsibility to advocate for them, steward them responsibly, and ensure their survival for future generations. These responsibilities stem from longstanding and ongoing relationships grounded in Indigenous laws and governance systems, which have and continue to guide salmon stewardship since time immemorial. Participants also emphasized First Nations' inherent rights to fish, and their responsibilities as stewards of vital marine species, such as wild Pacific salmon. First Nations leaders, managers, Knowledge Holders, and professional contractors working for First Nations thus expressed a

strong interest in learning about Indigenous-led salmon monitoring programs beyond the Central and North Coast of British Columbia, recognizing the role these programs play in supporting fishery rights, sovereignty, data ownership, and the advancement of cooperative fisheries management in their respective territories and regions. While our research focus is on Pacific salmon monitoring, we recognize that similar challenges exist for other species and ecosystems. This research aims to contribute potential solutions to current fisheries concerns and research priorities -with an emphasis on salmon- to align and support our research partners' objectives.

Indigenous Fisheries Monitoring & Management

Indigenous Peoples have sustained fisheries management for millennia, guided by ancestral Knowledge and adaptive stewardship practices (Ban et al. 2018; Lepofsky & Caldwell 2013; Mathews & Turner 2017; Turner et al. 2022). The deep connections between fisheries stewardship, monitoring, and sovereignty are evident in Indigenous practices (Goodman 2000; Kelly et al. 2024; McMillan & Prosper 2016; Silvano et al. 2023). For example, the Torres Strait Islander Peoples have governed coral reef ecosystems and fisheries for up to 120,000 years (Busilacchi 2008; Dudgeon et al. 2010). In Aotearoa, Māori stewardship of marine and freshwater species has continued for over 5,000+ years, and monitoring of key traditional species such as the longfin freshwater eel and two species of freshwater crayfish (Kusabs & Quinn 2009; Moller et al. 2004). In the South Pacific, Kānaka Maoli (Native Hawaiians) have sustained loko i‘a (fishponds) through intricate engineering and resource management practices (Richmond 2013; Schemmel et al. 2016; Winter et al. 2023).

In the Pacific Northwest - a region encompassing the lands and waters of the American states of Alaska, Washington, and northern Oregon, the Canadian Territory of Yukon and the province of British Columbia - where this research is focused, First Nations and Native Tribes of Canada and the United States have managed fisheries for over 14,000+ years including, monitoring, practices to limit overfishing risks, selective harvesting, and habitat enhancements (Carothers et al. 2021; Donkersloot et al. 2020; Lepofsky et al. 2021; Reid et al. 2021; White 2011). Marine fisheries remain central to all aspects of coastal First Nations and Native Tribal cultures, food systems, and economies (Esquible et al. 2024; Lepofsky & Caldwell 2013; Ojeda et al. 2022). Today, Indigenous systems of management continue to play a critical role in sustaining marine and

freshwater ecosystems, ensuring the health of fisheries for future generations (Atlas et al. 2021; Artelle et al. 2019; Rodes 2024; Schemmel et al. 2016; Wilson et al. 2018). These longstanding systems of management are codified through stories, ceremonies, harvesting practices, and family lineages that have formed the foundation of coastal First Nations and Native Tribes cultures and ways of life for millennia and continue to this day (Berkes et al. 2000; Berkes 2004 & 2012; Carothers et al. 2021; Eckert et al. 2018; Mathews & Turner 2017).

Disruptions of First Nations & Native Tribes Fisheries Governance

The sustained presence of colonial policies such as Canada's *Fisheries Act* (1868) and the American *Magnuson-Stevens Fishery Conservation and Management Act* (1976), criminalize Indigenous fishing practices, dispossess Indigenous communities of traditional fishing territories, and centralize decision-making authority within colonial governments and agencies (Atlas et al. 2021; Clay & Olson 2008; Harris 2001; Higgs 1982; Newell 1993; NOAA 2007; White 2011). This intentional shift in management, authority, decision-making and subsequent monitoring removes First Nations and Native Tribes from their roles as primary stewards of their lands and waters. This shift also continues to fundamentally alter fishing methods, replacing place-based, often highly selective and terminal fisheries, such as weirs, fish traps, and dip net fisheries, with high impact, mixed-stock industrial scale fisheries that prioritize economic interests above all else (Carothers et al. 2021; Donkersloot et al. 2020; Esquible et al. 2024a).

The ongoing displacement of Indigenous Peoples from their lands and waters -through colonial policies, resource management regimes, and forced consolidation into reserves or reservation systems, has significantly reduced opportunities for Indigenous-led monitoring (Silver et al. 2022). Concentrating First Nations and Native Tribal communities onto reserves or reservations in both Canada and the United States has physically removed people from their territories in which they monitor and steward, effectively taking "boots off the ground" and "eyes off the waters". This forced disconnection has not only undermined Indigenous monitoring practices but has also facilitated the expansion of industrial-scale developments across Indigenous lands and waters, further eroding ecosystem health, community well-being and the capacity for monitoring, stewardship, and governance (Esquible et al. 2024a; Lee et al. 2019; Richmond 2013). At the same time, loss of Indigenous presence across lands and waters has profound implications for

understanding our rapidly changing ecosystems. Local and Indigenous monitoring systems provide insights that western scientific monitoring alone cannot adequately generate, particularly in an era of accelerating climate change (Whitney et al. 2020).

Industrialized fishing methods have contributed to declines in Pacific salmon populations and further constrained First Nations' and Native Tribes' access to wild Pacific salmon (Atlas et al. 2021; Sakati 2023). However, the continued co-existence and application of Indigenous governance, monitoring practices, and Indigenous Knowledges demonstrate the success and sustainability of long-term coastal and marine management by Indigenous Peoples throughout the Pacific Northwest region (PNW) and elsewhere (Esquible et al. 2024b; Lepofsky et al. 2021). Only in recent decades have colonial governments across North America made formal commitments to addressing the past and ongoing harms inflicted on First Nations and Tribes through fisheries management. For example, in the United States, landmark Supreme Court rulings have affirmed inherent Native Tribal rights and restored legal authority to fisheries, recognizing that such authority was never extinguished -such as, *Sohappy v. Smith/United States v. Oregon* (1968), *Department of Game of Washington v. Puyallup Tribe* (1973), and the *United States v. Washington* (i.e. the Boldt Decision 1974). Similarly in Canada, key Supreme Court decisions affirming inherent Indigenous rights, title and authority over fisheries include *R v. Sparrow* (1990), *R v. Marshall* (1999) and *Ahousaht Indian Band v. Canada* (2021). However notably, this formalized recognition has not been applied to all Native Tribes and Indigenous Peoples, for example, Alaska Native fishing rights are considered extinguished under the Alaska Native Claims Settlement Act (Anderson 2016).

Declines of Pacific Salmon & Improved Monitoring for PNW Region

Wild Pacific salmon (anadromous fin fish known by a myriad of Indigenous names) and their respective fisheries across the PNW, are declining (Esquible et al. 2024a; Eckert et al. 2018; Reid et al. 2022a; Reid & Ban 2025). Salmon declines can be attributed to the cumulative effects of habitat loss, accelerating climatic and ocean changes, localized and international industrial pressures, and are further entrenched by ineffective state and federal-driven fisheries policies and management (Lee et al. 2019; Peterman & Dorner 2012; Price et al. 2008). Many salmon fisheries are now struggling to provide sustainable social, economic, and ecological benefits. In

Canada for example, reactive federal management responses aimed at reducing overfishing and addressing impacts to salmon declines have included decreasing the number of commercial licenses through federal buyback programs and initiatives and decreasing catch landings. However, many Pacific salmon populations continue to face conservation risks (Atlas et al. 2023; Price et al. 2017; Reid et al. 2021; Wilson et al. 2025). Colonial fisheries management also suffers from a lack of reliable, fine-scale salmon monitoring, particularly in mixed-stock fisheries, where underreported harvest and poor escapement data hinder conservation efforts and access to fisheries rights holders and stewards like First Nations and Native Tribes (Wilson et al. 2025). Given the failures of colonial fisheries monitoring and management efforts, there is an urgent need and growing recognition to support and advocate for First Nations and Native Tribal-led fisheries management and monitoring.

Current Research Gap

Effective fisheries management relies on robust monitoring, which provides critical information to assess population health, detect trends, and inform conservation strategies for long-term resilience (Berkes & Turner 2006; Cox et al. 2010; Ostrom 1990). This is increasingly important under climate change, where conditions that affect the survival of fish are constantly shifting, and in general, making conditions harder for salmon to survive in (Biela et al. 2022; Ohlberger et al. 2025; Wilson et al. 2025). Fisheries monitoring serves as the foundation for adaptive management, ensuring that decisions are based upon evolving ecological and fishery conditions rather than static policies (Boenish et al. 2020; Folke et al. 2010; Staton et al. 2025). Adaptive fisheries management is one such approach that has long been practiced by First Nations and Native Tribes that can be defined as management that embraces change and uncertainty, thereby fostering resilience in social and ecological systems (Lee et al. 2019). It is important to highlight that Indigenous fisheries have long practiced adaptive management, even if not defined under this westernized description (Berkes & Usher 2000). Generally, while management establishes the rules and regulations fishery users must adhere to, monitoring generates the evidence needed to adjust these strategies and advance conservation objectives through up-to-date information (DFO 2012). Without comprehensive and current monitoring, fisheries managers risk making uninformed decisions that could lead to overfishing, ecosystem imbalances, and inequitable

resource distribution and access (Atkinson et al. 2025; Berkes and Turner 2006; DFO 2012; Sleigh 2024).

Federal and state-led salmon monitoring programs, such as those implemented by Fisheries and Oceans Canada (DFO), the National Oceanic and Atmospheric Administration (NOAA), and the United States Fish and Wildlife Service, typically rely heavily on western scientific approaches to monitor salmon across all life history stages and their harvests. These programs often employ biological monitoring methods such as spawning surveys, genetic analyses, and tagging studies, all of which require significant technical expertise and resources (Sleigh 2024; Thompson et al. 2020). Estimates of total salmon populations are commonly generated using techniques like mark-recapture methods (e.g., tagging or fin clipping), escapement surveys (aerial, ground, snorkel), smolt outmigration counts (using smolt traps), acoustic or sonar technologies such as DIDSON or ARIS systems, and spawner-recruit modeling. Additional methods include coded wire tagging, ocean and trawl sampling, and reconstruction modeling based on harvest and catch data (Adkison 2022; Shaklee et al. 1999; Staton et al. 2020). Such programs may also collect data on biological characteristics such as fish length, weight, age, sex, and genetic population composition. Finally, western science approaches employed to monitor fisheries harvest typically focus on quantifiable metrics such as the number of fish retained and released, fishing locations, gear types, and timing of effort (Boenish et al. 2020; DFO 2012).

Western science-based approaches to monitoring salmon life histories and harvests are often reductionist, resource and capacity intensive, and highly centralized. These approaches tend to largely exclude Indigenous perspectives on monitoring priorities and methodologies, prioritizing Eurocentric paradigms (Reid et al. 2021; Sleigh 2024). The limitations inherent in these systems are especially pronounced in remote areas, where limited infrastructure, logistical constraints (such as boat or fly in access only communities), and reduced access to funding and technical support frequently lead to shortcomings in monitoring implementation -or even outright failures. Centralized, state or federal-led monitoring efforts utilizing western science approaches also suffer from inconsistent or patchy application across jurisdictions and limited coordination or communication between agencies, these limitations persist despite the growing urgency posed by accelerating climate change impacts on salmon populations and ecosystems. Moreover,

monitoring efforts often focus on populations associated with large commercial (industrial) or recreational fisheries, generally neglecting smaller, and more diverse salmon systems. This is concerning given that these smaller systems are critical to sustaining both ecological networks and local food security, and salmon biodiversity throughout the PNW region (Atkinson et al. 2025; Price et al. 2008; Wilson et al. 2025).

Research Objectives

Indigenous-led fisheries monitoring encompasses observation systems informed by traditional and localized Indigenous Knowledges, cultural values, worldviews, and management objectives, and often draws on western science-based approaches and tools (Danielsen et al. 2024; Thompson et al. 2020a). Indigenous-led monitoring generally prioritizes community participation, localized decision-making power, and holistic approaches that integrate harvest, ecological, cultural, reciprocal, and spiritual objectives (Garcia & Lescuyer 2008; Steel et al. 2021; Thompson et al. 2020b; Wilson et al. 2018). Emerging research suggests that Indigenous leadership in environmental monitoring, particularly in coastal and marine environments, fosters more inclusive decision-making, enhances conservation efforts and outcomes, and strengthens social-ecological resilience (Beveridge et al. 2020; Kimmerer 2000; Reid et al. 2022b; Reid & Ban 2025). However, despite the strengths of Indigenous-led monitoring and the growing formalized recognition of Indigenous rights and sovereignty over fisheries such as wild Pacific salmon, significant knowledge gaps remain (Thompson et al. 2020a).

Specifically, there is limited understanding and representation within western scientific discourse on the extent of Indigenous leadership in salmon monitoring, as well as how First Nations and Tribal Nation-led monitoring is defined, practiced, applied, and supported within cooperative fisheries management in the PNW region. This study aims to address these gaps by highlighting some First Nations and Tribal Nations perspectives on salmon monitoring and their respective contributions to adaptive and cooperative management in practice throughout Alaska, Yukon, British Columbia, Washington and Oregon. We also identify current monitoring gaps and offer potential solutions on how salmon fisheries monitoring efforts can be collectively improved to ensure long-term resilience of Pacific salmon for current and future generations.

Methods

Methodological Approaches

To achieve the multifaceted objectives of this research, we conducted semi-structured, in-depth interviews. All interview participants were directly engaged in salmon fisheries monitoring as either salmon harvesters, members of First Nations or Tribal Nations fishing families/communities, fisheries staff, managers, directors and/or some combination of roles. We used in-depth interviews to (i) gain insights into existing monitoring activities relevant to salmon fisheries; (ii) understand and measure perceptions among First Nation and Tribal communities towards current Indigenous-led salmon monitoring programs effectiveness; and (iii), assess the outcomes associated with Tribal and First Nations respective salmon fisheries monitoring programs within the framework of supporting cooperative and adaptive management.

In-depth Interview Participant Recruitment

We applied a stepwise approach to our research, beginning with an literature scoping review, followed by a broader web search to identify potential Indigenous-led salmon monitoring programs and contacts to solicit for interviews. To identify relevant literature, we utilized the Web of Science search engine and Google Scholar and followed the literature search methods described in Thompson et al. (2020a). We screened the title and abstract for relevance (i.e. described a salmon fisheries monitoring initiative, monitoring led by Indigenous Peoples, and monitoring over a period greater than one year) and further reviewed at full text. The limited available peer reviewed literature we identified did not specifically cite salmon monitoring program staff or provide any contact information to further explore. We then broadened our search to include First Nation and Tribal websites and consulted the wider research team for potential contacts and/or salmon monitoring programs. Once we established a large list of programs and potential contact details based on our search efforts, we invited potential participants from each program for interviews via email (in total, 143 Indigenous-led salmon monitoring programs were identified across the PNW region and invitations sent to all identified). We also used a chain referral sampling approach to identify additional interview participants i.e. interviewing people who had been recommended by previous interview participants (Heckathorn 2011; Thompson et al. 2019; Voyer et al. 2017). The research was carried out with human ethics approval from the University of Victoria (Ethics Protocol #23-

0117) and as noted above with guiding R's ethical principles from Indigenous approaches to research (Tsosie et al. 2022).

In-depth Interviews

Initial contact with interview participants was made in a variety of ways, including first reaching out to known contacts previously identified by our research team's connections and by chain referral sampling approaches. These approaches facilitated open communication, allowing potential interview participants to engage with the research team, prior to arranging online interviews. Interview participants were emailed a verbal consent form, interview questions, and a summary document outlining the research intent prior to agreeing to meet with us.

From November 2023 to April 2024, we conducted a total of 24 group and individual interviews with 31 individuals from First Nations and Tribal Stewardship Departments and Indigenous-led fisheries organizations from across the PNW region (see Figure 7 for map). Prior to each semi-structured interview, all participants received a copy of the interview questions and were asked to provide verbal, free, prior, and informed consent. Interview participants were free to choose to remain anonymous and/or to keep their information confidential, however all participants provided consent to be identified by name. It is important to note that some participants explicitly stated that, while they were honoured to participate, they could only share their personal views and did not speak on behalf of their community or employer. This was particularly emphasized by the 12 non-Indigenous participants, who clarified that their perspectives were based on personal experiences gained through their work experiences for First Nations and Native Tribes through their employment. Each interview lasted between 1 to 2 hours and was conducted via Zoom. Interviews were audio recorded for the sole purpose of transcription with permissions granted by all participants. During the interview, we asked 14 predetermined discussion questions, ranging from participants' histories in participating in salmon monitoring to their perceptions of current management and their thoughts towards the collaborative future (see Appendix B.2).

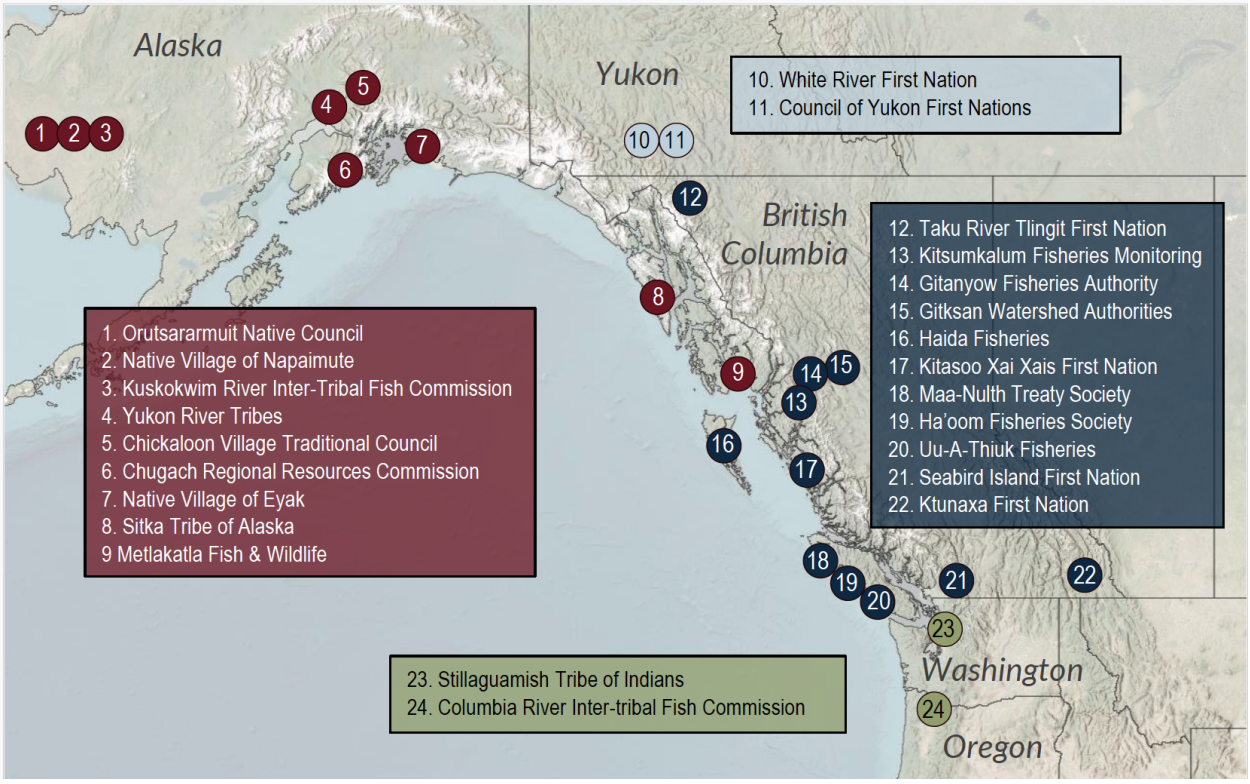

Figure 7. General locations & regions of the First Nations & Tribal-led salmon monitoring programs we connected with during this research.

Interview participants were not selected to represent entire populations of First Nations, Tribal Stewardship Departments, or Indigenous-led fisheries organizations. Instead, our goal was to capture a broad range of perceptions and perspectives across a wide geographical region (Figure 7). We sought diversity amongst participants in terms of age and gender and invited participants to extend their interview invitation to others to join their interview if they wished. As a result, many interview participants chose to include colleagues with extensive experience in salmon monitoring, contributing to a wide range of ages and gender identities among those interviewed. The structured, in-depth interviews offered valuable insights into the contributions of some First Nations and Native Tribes in leading salmon fisheries monitoring programs. Participants brought diverse ways of knowing shaped by their unique cultural and professional backgrounds, life experiences, professional roles, and monitoring approaches.

Interview Analysis & Reporting

Interview transcripts were generated using the secure transcription software, Sonix (https://sonix.ai/), and then manually verified. Transcripts were coded using a thematic analysis approach by a single observer (JS) using NVivo 16 software (Menzies et al. 2024; Voyer et al. 2017). Transcript analysis and coding involved several steps and tasks, including a combination of iterative inductive coding, sorting, and categorization, which allowed for the identification of major themes (i.e. codes), key concepts, and participant insights (Menzies et al. 2022). Using an inductive approach, we identified and generated fourteen overarching codes (major themes) with 70 subcodes (subthemes) identified (see Appendix B.3 for Codebook). Following the methods outlined in DerCuir-Gunby et al (2011), many of the sub-codes incorporated measurable descriptions and could be represented under multiple relevant themes. Sub-codes were then organized into hierarchical lists within each theme, with the most frequently referenced codes placed at the top, and those with fewer references within the transcripts at the bottom. Once the coding process was complete, we linked the main themes back to the research objectives for final review and analysis.

Following the interviews, all participants were provided with a copy of their respective transcripts for review within a timely manner to ensure clarity and accuracy. At this time, participants could also choose to remove any information from their answers or add any additional information that they may have forgotten to include at the time of recording. To ensure the themes and overall message of this paper resonated with interview participants, we also created and shared a preliminary report with a subsequent presentation to ensure the way participants' responders were interpreted and grouped into themes was appropriate and correctly represented. Finally, we circulated a draft manuscript to all interview participants, allowing them to review, provide feedback, and invite all to become co-authors. This process ensured that all participants' knowledge shared is presented accurately, in a good way, and for a broad audience.

Results

The following results section is organized into the main themes that emerged from our analysis. Each numbered section represents a key theme with a detailed overview that reflects the perspectives and experiences shared by the interview participants. The four themes highlight the diversity of Indigenous-led salmon monitoring programs, their distinctions from and coexistence

with western science-based approaches, connections to cooperative fisheries management and some of the ongoing challenges faced along with potential solutions.

Indigenous-led Fisheries Monitoring Descriptions & Approaches by Participants

Participants emphasized that Indigenous-led salmon monitoring takes many different forms in practice (Figure 8); however, a common approach involves using mixed qualitative methods. All 31 interview participants highlighted the importance of continuing efforts to highlight the importance of Indigenous Knowledge and western science coexistence to enhance monitoring outcomes for both salmon and people. From all our participants responses, the following seven examples of Knowledge coexistence in salmon monitoring emerged as shown in Figure 8.

Figure 8. Examples of how Indigenous Knowledges & western sciences co-exist in salmon monitoring programs, as described by interview participants. While the figure visually highlights areas of knowledge co-existence in practice, it is not an exhaustive representation. Participants also emphasized that Indigenous Knowledges & western sciences are often used together, yet each also exists & holds value independently.

By highlighting these co-existing monitoring methods in practice, participants discussed how such efforts enhance both salmon conservation outcomes and community involvement in stewarding and increasing access to salmon populations. While these examples focus on salmon monitoring, similar approaches are widely applied to other important marine, coastal, and terrestrial species. First Nations and Native Tribes also monitor a wide range of key plants and animals, further highlighting the broader relevance of these methods for fisheries and resource management beyond Pacific salmon, thus this is not an extensive list.

Participants shared that Indigenous-led salmon fisheries monitoring prioritizes cross-season data collection, is typically place-based (focusing on specific watersheds, rivers, or territories), and is often guided by multiple ways of knowing that center community food access objectives as well as conservation. These programs play a vital role in maintaining deep understandings of salmon run timing, local and regional population health, habitat and ecosystem needs, and the food, social, ceremonial, and economic requirements of community members.

> *"...A long time ago and even today, monitoring was and is done by just being present on the land and by engaging in fishing, or other activities along the streams in the lakes, rivers, etc. for thousands of years. When there's a dependence on the relationship with fish, you pay a lot of attention to it." -Environmental Stewardship Director, Jessica Winnestaffer*

> *"Indigenous-led monitoring means that the research is driven by Nation objectives and values, and that its design is to support the Nation's priorities and objectives." -Marine Planner, Laurel Sleigh*

There was strong emphasis on the fact that Indigenous-led monitoring methods significantly differ from western science approaches, wherein monitoring design, application, and findings are directly implemented and owned by Indigenous governments, organizations, and communities- rather than colonial governments, state agencies, or private consulting firms. A key aspect of Indigenous-led salmon monitoring programs highlighted by interview participants is the

intergenerational transmission of Knowledges, with all participants stating a strong emphasis on including both youth and Elders in their monitoring approaches.

> *"The Elders bring so much history and knowledge. At our season management table, these Elders, they are listened to very much. When they make recommendations…people listen to those recommendations coming from Elders or their observations of the salmon runs, how it's doing in season, and staff members and people from [the U.S] Fish and Wildlife Service and Kuskokwim River Inter-Tribal Fish Commission who are part of the season management team, definitely listen to the Elders when they speak up." -Executive Director, Kevin Whitworth (Figure 9).*

Figure 9. The Takotna River weir, pictured above, is a Tribally operated salmon monitoring project in Alaska located in the headwaters of the Kuskokwim River, run by local Alaska Native crew through a partnership between the Takotna Tribal Council and the Kuskokwim River Inter-Tribal Fish Commission (Kevin Whitworth/KRITFC).

> *"...Through the monitoring program, we've been able to get a lot of youth at the fisheries management meetings, too. Some of the concerns from the community are that local youth are not in these biologist roles. They're all people coming from the outside in, they*

don't have an understanding of Tribal management, values, etc. There are no younger people on these advisory councils and that's what the community wants to see. I think giving youth an opportunity from high school where they're captivated, engaged, and they're on route to pursue school is where they can continue this path and be a leader." - Fisheries Biologist, Janessa Esquible

Participants identified further key distinctions between Indigenous-led and western based salmon monitoring approaches. In their opinions, a defining feature of Indigenous fisheries monitoring is the concept of monitoring by use- in contrast to colonial monitoring practices, which separate fisheries management from salmon access. In Indigenous-led approaches, active fishers often serve as compliance monitors, not just sources of stock assessment data. Many First Nations and Tribal monitoring efforts are a part of everyday activities, such as fishing and being out on the lands and waters, while others operate as intentional and organized programs such as fishing weirs, dockside monitoring programs, and interviews with fishers. Such ongoing monitoring efforts are increasingly recognized as vital for asserting Indigenous sovereignty, exercising jurisdiction, and informing long-term decision-making processes across territories (Sleigh 2024; Thompson et al. 2020a; Wilson et al. 2018).

"It's a big community thing too, monitoring. For example, when the salmon are running, everyone's talking about the number of fish they're seeing. They're saying 'oh, the bluebacks' are in, sockeye deep in the holes'. There's just so many scientific metrics being shared around in conversations between community members, which holds a lot of really important information. When our people go to Kisgegas -our biggest fishing village-I take a lot of advice from the people that fish Kisgegas, all of us take a lot of advice from the fishers that are in the mid Skeena region. There's also a lot of people that take their own notes about the fish they're seeing; I get messages almost every day in the summer saying 'hey, I saw this fish at this spot. Is that typical?' People are always collecting their own information and trying to trace back the history of the populations in those streams and their territories, which is super cool… that piece of information, like the 'blue backs are running' or you can see the 'sockeye are green', indicates different populations, those physiological attributes, are just so valuable." -Fisheries Biologist, Taylor Wale

All interview participants from across the PNW region also highlighted the important distinction in that Indigenous-led salmon monitoring is often viewed as an act of reciprocity and a responsibility, as salmon cannot speak for themselves, and it is conducted for reasons beyond profit. As well, the capacity Indigenous-led monitoring programs bring for local verification, interpretation, and uplifting multiple sources of information, ensures that findings are contextualized within a holistic understanding of environmental factors, as informed by Knowledge Holders and First Nation and Tribal experts.

> *"...Having long term data is incredibly important and they [the Tribe] wants to keep the weir going even if English Bay isn't as commercially profitable as it once was. I guess that's also one of the benefits of salmon monitoring that's Indigenous led is that they monitor for the sake of monitoring rather than monitoring because it's profitable." - Tribal Fisheries Biologist, Maddy Lee (Figure 10).*

Figure 10. Tribal fisheries technicians from the Native Village of Nanwalek mobilize a fixed picket weir in early June to initiate sockeye salmon escapement monitoring, a key component of community-driven fisheries management in Nanwalek (Maddy Lee).

> *"To me, one of the main reasons why I think this is so important for Tribes to continue to monitor salmon is because we can think on a different time scale. We don't think on a four-year election cycle, we're thinking generations. That's a unique role that you don't always see in State and Federal governments, and I think that's a unique role that Tribes can play and continue to collect this important data." -Natural Resources Coordinator and Fisheries Biologist, Matt Piché*

Indigenous-led Monitoring & Links to Cooperative Management

Most interview participants emphasized that Indigenous-led salmon monitoring empowers their respective First Nation and/or Tribal Nations governments, entities, and communities to collect and use their data and information for internal purposes or to share it with external or state-led agencies fisheries managers as they deem necessary and on their own terms. This information is gathered and shared both across fishing seasons and over long timeframes, supporting adaptive decision making. A few participants further noted that monitoring information strengthens data sovereignty, enabling more cooperative fishery management with colonial governments and agencies.

> *"…We're not only looking at western science, but we're also looking at Indigenous Knowledge and incorporating it into salmon management decisions. It's really different when you actually have Indigenous Knowledge holders at the decision-making table, instead of going out and doing interviews and then trying to bring information back into the decision-making table. You have Indigenous Knowledge holders at the management table, making decisions, using their Knowledge. So that's really unique." -Executive Director, Kevin Whitworth*

> *"I lived through the days when we [Columbia River Intertribal Fish Commission] were constantly in court. We don't do that much anymore, and I think that's a credit to all the various agencies and Tribes involved in this that were able to use the system, be able to talk about the data, share the data, to be able to talk about our differences and to come to*

mutual conclusions. I think things have really changed over the last 40 years that I've been doing this, and I think for the better". -Fisheries Management Department Director, Mike Matylewich

"Historically, there hasn't been an open data sharing relationship, even though there is a ton of data that's being collected by DFO [Fisheries and Oceans Canada] on this species (salmon)...so, the monitoring program is bringing the Knowledge back into the Nation's hands, which really helps us make decisions and on future restoration goals as well. We have a lot of ideas for how we want to improve salmon habitat in our Territory. I think having real time data of what's going on with the different populations will be really helpful." -Fisheries Biologist, Mia Stratton

Although some isolated examples were provided, most interview participants expressed mixed views on whether Indigenous-led salmon monitoring directly supports fisheries co-management in their regions. Many emphasized that fundamental changes to fisheries management in North America are required, including stronger actions rather than just symbolic commitments. Meaningful action including the transfer of power by colonial governments is required to restore and strengthen First Nations and Tribal authority over decision-making and the management of territorial lands and waters (Bodwitch et al. 2022; Silver et al. 2022; Thompson et al. 2020b).

"I think the Tribe certainly wishes it had more autonomy, more sovereignty in being able to make those types of decisions about resources in their customary and traditional Territory. But I do think because we've been collecting these [monitoring] data, we are having a little bit better of a relationship with the state and federal managers. The Tribe doesn't get final say on anything, but certainly gets input into it, which I think is important…Trying to look at the bright side, the Tribe's role in some of those regulatory decision-making discussions has increased as a result of the monitoring project, but there's still a lot of room for improvement." Fisheries Biologist, Kyle Rosendale

Key Challenges & Solutions Identified

Indigenous-led salmon monitoring occurs across multiple life stages of Pacific salmon and continues year after year, despite numerous ongoing and realized challenges. All interview participants identified similar barriers to implementing their monitoring programs, which we grouped into seven main themes. The most salient challenge is the absence of stable, long-term funding for monitoring efforts. This issue is particularly pronounced for remote communities, where operational costs are much higher, and funding streams are often inconsistent, inflexible, and inadequate. As a result, Indigenous-led organizations, First Nations, and/or Native Tribal governments or entities must piece together funding from multiple sources. Additionally, retaining staffing capacity remains a significant challenge, with issues related to staff retention and Indigenous monitors struggling to balance their work responsibilities with traditional practices such as fishing for their families during peak season coinciding with salmon fisheries monitoring windows.

> *"The Tribes always stewarded this land and now we have to write grants to do it. But we're still stewarding the land and the fish by trying to improve their habitat to what it was pre-contact, pre-development." -Environmental Stewardship Director, Jessica Winnestaffer*

Secondly, many participants expressed frustration over ongoing tensions between First Nations, Native Tribes, and colonial governments and agencies and the challenges of navigating turbulent relationships. Historical and ongoing harms have led to mistrust, and in many regions, fractured working relationships between Indigenous communities and government agencies remain strained leading to poor collaboration and desire to work together on monitoring initiatives. In more cases than not, ultimate authority over salmon management remains within colonial management frameworks, such as Canada's Minister of Fisheries and Oceans and state and federal managers in the United States. Many participants noted that despite their communities conducting extensive monitoring, final management decisions are still made by distant government officials who hold fundamentally different worldviews, values, and priorities. Navigating colonial bureaucratic processes, such as obtaining monitoring permits, also presents significant challenges.

"...For instance, we have our Memorandum of Understanding (MoU) with the U.S Fish and Wildlife Service and a couple of years ago, the Yukon Delta National Wildlife refuge manager who was the manager for the Kuskokwim, he was really, really hard. Then we got the next refuge manager. He was even worse. But then this last manager, even though he's working under the same MoU, this most recent manager, he promoted the partnership to a true collaboration where both entities are working to better each other's government relations. It really all depended on the one, on the person, even though it's the same MoU, it's just some people interpret the MoU so differently than the next person, which is really awful and challenging." *-Executive Director, Kevin Whitworth*

Participants also raised concerns about the challenges of non-Indigenous fishers disregarding Indigenous laws and stewardship practices, particularly in relation to catch-and-release fishing, access to preferred fishing grounds, and heightened competition over salmon stocks. Furthermore, jurisdictional complexities imposed by colonial management structures heighten tensions between Indigenous fishers and other non-Indigenous salmon users. Many Indigenous-led monitoring programs must navigate overlapping and often contradictory jurisdictional frameworks imposed by colonial governments and stakeholders, complicating their ability to implement effective monitoring and management strategies.

"...Another challenging element of having a fishery with five unique Nations is that each Nation has a different outlook on monitoring and what it should look like. So having one monitoring objective [prescribed from Fisheries and Oceans Canada] that applies to all five Nations for salmon is very challenging to get a consensus and bring that to the table." -Senior Biologist, Candice Picco

"...Even though my treaty right is 50%, 50% of zero is still zero, so we need to have fish that we can catch". -Fisheries Manager, Mike Matylewich

"Sockeye typically returned to Gitanyow Lake, in the tens of thousands, but have not returned in these numbers over the past few decades. Currently, they return in the hundreds to a couple of thousand annually. Gitanyow hasn't harvested sockeye from the

Kitwanga in well over 50 years so it's difficult to witness recreational harvests in the Skeena take place." -Fisheries Biologist, Melissa Shirley

A major challenge remains in the reluctance of colonial agencies to accept Indigenous-led monitoring systems and information. Many federal and state-led governmental agencies (such as Canada's federal Fisheries and Oceans agency, DFO, and the United States state-led Fish and Wildlife Service or NOAA) continue to view data collected by First Nations and Tribal communities as purely qualitative and insufficient compared to western science methodologies, leading to its dismissal or underutilization in colonial policy and fisheries management decisions.

"But unfortunately, when you put a research proposal to the board of fish or even the federal subsistence board, that is just based on Local Knowledge, they want numbers, they want hard numbers. We're trying, and one of my jobs is to try to marry those two worlds. I've been at it a long time, it's hard, it really is hard. There's value in both knowledge systems and I think you could have a very, very robust decision-making framework by incorporating both those knowledge systems equally. But are we there? No. Are we going to get there? Probably not in my lifetime, but eventually we may." - Environmental Director, Dan Gillikin

"Another really difficult challenge that we face in working with Fisheries and Oceans Canada (DFO) is that there is a real power imbalance. There's a real dynamic of punitive action by DFO to First Nations fisheries monitoring programs and efforts, even when they [First Nations] receive funding by the Pacific Salmon Commission and Nations have jumped through all the hoops, we've demonstrated the legitimacy of our methods and results. But we still get crappy treatment from DFO staff and have to continuously answer questions regarding the legitimacy and validity of our information…" - Fisheries Program Director, Angela Addison

Lastly, all participants identified accelerating climate change and increasing ecological uncertainties as significant environmental challenges facing Indigenous-led salmon monitoring programs. For instance, extreme water levels -whether unusually high or low- can restrict or

prevent access to monitoring sites, while floods and severe weather events can damage monitoring equipment and infrastructure.

> *"One of the concerns that our Tribal members have, and it's a shared concern throughout all the Tribes on the Copper River watershed, is, in the face of climate change and everything happening, is our management going to be responsible enough, responsive enough to adapt quick enough to these changes? And could potential harvest ever jeopardize the sustainability of the resource? -Natural Resources Coordinator and Fisheries Biologist, Matt Piché*

> *..."The spring melt comes right around the time that the Chinook are running and then with climate change, it turns from a snow dominated system to a rain dominated system, and our systems are just getting blown out right during the time of the Chinook migration. So, it's really hard to see through the waters to see what kind of fish are in there. It's really hard to have fences in (weirs) because the debris comes down the river and knocks them out. Just overall really disappointing situations for enumeration." - Fisheries Biologist, Taylor Wale*

However, despite these challenges, all participants shared that their respective Indigenous-led salmon monitoring programs persist, demonstrating resilience and commitment to both salmon conservation and their community's well-being. Although we did not directly ask participants about solutions to the challenges facing Indigenous-led salmon fisheries monitoring programs, many were eager to share their insights and suggestions based on their knowledge and experiences. Five main areas of action emerged: 1. Colonial governments must increase and diversify flexible, long-term funding for Indigenous-led monitoring; 2. Indigenous communities must continue to support and engage youth within fisheries monitoring and reporting; 3. Adopting new technologies in ways that honor Indigenous Knowledge Systems and methods is helpful for people and salmon. 4. Improving relations between Indigenous and non-Indigenous governments through mechanisms such as robust data sharing agreements, updated memorandums of understanding, or formal recognition of sovereignty and rights and title is critical. This can be achieved through co-governance agreements that include process funding,

adequate time to develop interpretation and clearly articulated terms of references, as well as getting people out on the lands and waters. And 5. Involving community members in all aspects of salmon monitoring is central to successful fisheries monitoring. These solutions are discussed in detail below in the Further Calls to Action section of the discussion.

Discussion

Perceptions of Cooperative Fisheries Management Throughout The PNW

Indigenous-led salmon monitoring plays a crucial role in advancing adaptive fisheries management by centering Indigenous Knowledge Systems, empowering local communities through inclusive decision-making, and providing holistic salmon information (Adams et al. 2021; Thompson et al. 2020b; Schemmel et al. 2016; Wilson et al. 2018). Several interview participants noted that their monitoring programs now generate cross-season fisheries data, drawing from both Indigenous Knowledges and western sciences approaches and perspectives, which aligns with emerging scholarship documenting complementary strengths of these approaches (Bowels et al. 2022; Moller et al. 2004; Thompson et al. 2019; Sleigh 2024; Stanton et al. 2025). In describing these contributions, participants also shared ideas for how such efforts could continue in good ways, offering unprompted recommendations that we highlight as further calls to action.

Participants further emphasized that Indigenous-led monitoring efforts are not just about collecting data but can also facilitate powerful ways to reconnect First Nation and Tribal communities with their lands, waters, and territories through acts of fishing and being together. This resonates with broader literature which also highlights the cultural, spiritual, and relational importance of monitoring and greater well-being (Atlas et al. 2021; Beveridge et al. 2020; Eckert et al. 2018; Happynook 2022; Sleigh 2024). At the same time, participants further stressed that Indigenous-led monitoring can identify critical conservation status of salmon populations while also tracking vital cross-season fishery-specific impacts through the coexistence and application of both Indigenous and western sciences. These insights reflect calls in the literature to strengthen and uplift Indigenous-led salmon monitoring as a pathway for long-term salmon resilience and improving coastal community well-being (Cadman et al. 2022; Carothers et al. 2021; Thompson et al. 2019).

A significant message emerging from this research is that while Indigenous-led salmon monitoring is informing adaptive fisheries management, true co-management for Pacific salmon is rare (Swerdfager & Armitage 2023). As highlighted by interview participants and supported by peer-reviewed literature, data collected through Indigenous-led monitoring programs often informs adaptive and cooperative fisheries management. Yet, despite these contributions, First Nations and Native Tribes are not consistently recognized as equal managers in fisheries management (Goodman 2000; Kelly et al. 2024; McDevitt 2018; Williamson et al. 2023). True government-to-government (i.e., co-management) arrangements between Indigenous and colonial governments remain uncommon in the context of fisheries throughout the PNW (Swerdfager & Armitage 2023). Notable exceptions in the United States include Washington's 1974 *Boldt Decision*, which legally affirmed the treaty rights of Northwest Tribes and as legal salmon co-managers through the Northwest Indian Fisheries Commission, and *U.S. v. Oregon*, which led to the creation of the Columbia River Inter-Tribal Fish Commission to facilitate salmon co-management between four Native Tribes in the region (Fisher 2012; Wilkinson 2024). In contrast, no comparable, true fisheries co-management currently exists in Canada for salmon fisheries because the Minister of Fisheries and Oceans still have final decision-making authority (Parsons 2010; Swerdfager & Armitage 2023).

Further complicating the recognition of Indigenous-led monitoring efforts is the inconsistent acceptance and interpretation of these programs by colonial fisheries managers and policymakers. Formal agreements, such as treaties, court cases, Memorandums of Understanding (MoUs), and partnerships, vary widely across states, provinces, regions, and countries (Swerdfager & Armitage 2023). Consequently, reliance upon individual 'champions' within colonial management agencies to facilitate co-management frameworks is precarious, emotionally taxing, financially burdensome, and unjustified in an era of fisheries reconciliation (Cannon et al. 2024; Lee et al. 2019; Steel et al. 2021). Despite these challenges, our findings affirm that data collected and owned by First Nations and Native Tribes remains powerful. It strengthens data sovereignty, advances salmon conservation objectives, and supports First Nations and Tribes' access to Pacific salmon, building on both lived experiences and knowledge co-production (Cooke et al. 2021; Frid et al. 2023; Muhl et al. 2023).

Calls to Action

Interview participants were eager to discuss the ongoing challenges their salmon fisheries monitoring programs face. Although participants were not specifically asked to provide potential solutions, many shared ideas and recommendations for addressing the challenges through calls to action. Participants identified five key solutions to support Indigenous-led salmon monitoring efforts moving forward, which closely align with existing calls to action in conservation and fisheries-focused literature (e.g. Cannon et al. 2024; Frid et al. 2023; Lee et al. 2019; Menzies et al. 2024; Winter et al. 2023; Stein et al. 2024; Reid et al. 2024; Reid & Ban 2025; Silver et al. 2022; Sparrow et al. 2020).

Action 1. Funding

The first call to action highlighted by interview participants is the urgent need to increase and diversify flexible, long-term funding from colonial governments and agencies. Many First Nations and Tribal communities remain at a disadvantage in accessing the same funding opportunities available to governmental or non-Indigenous organizations (Frid et al. 2023; Wiber et al. 2009). Participants emphasized that this funding and its funders must be grounded in recognition of Indigenous value systems and ways of life as legitimate, meaningful and effective approaches to monitoring, conservation and stewardship (Frid et al. 2023; Menzies et al. 2024; Sleigh 2024; Winter et al. 2023). Without this recognition, First Nations and Tribal communities often face systemic barriers when applying for competitive grants, particularly in comparison to non-Indigenous monitoring proposals which may have greater access to institutional resources. To overcome these challenges, participants called for dedicated, long-term, non-competitive and flexible funding streams specifically dedicated to support First Nations and Tribal Nations salmon monitoring programs. This distinction is essential, as successful monitoring -and the valuable data it generates- requires sustained investment over time to succeed (Sparrow et al. 2020).

At the same time, participants also highlighted that there is growing emphasis from colonial governments on promoting economic resilience within Indigenous communities. This push is increasingly tied to conservation and stewardship initiatives. For example, at the 2024 *Estuary to Old Growth* gathering in British Columbia, Canada, a full day was dedicated to exploring how

Indigenous Protected and Conserved Areas (IPCAs) can serve as both tools of advancing Indigenous governance and mediums for economic opportunity. Speakers at the gathering highlighted innovation through IPCAs as avenues for First Nations in British Columbia to leverage and generate their own flexible funds, building long-term economic resilience on their own terms (Wilbur-Collins 2024). However, interview participants noted that colonial funding support must go beyond one-off initiatives and be rooted in long-term commitments that align with First Nations and Tribal Nations stewardship priorities and management objectives.

Action 2 & 3. Increase youth capacity & new technologies

The second call to action highlighted by interview participants is to increase investment in Indigenous youth and build their capacity within their First Nation or Tribal-led salmon monitoring programs. Participants emphasized that youth engagement is particularly critical, as youth serve as vital 'knowledge bridges', helping to connect Indigenous Knowledge with emerging technologies and innovative approaches to create more effective and empowered monitoring programs (Adams et al. 2021; Atlas et al. 2017; Schemmel et al. 2016; Wiber et al. 2009). Participants further stressed the importance of adopting new technologies to address workforce challenges such as employee retention and the physically demanding nature of salmon monitoring work. For instance, installing autonomous weir-counting cameras can reduce the need for round-the-clock human surveillance, easing staffing pressures while maintaining effective monitoring (Atlas et al. 2023). Utilizing such technologies not only strengthens monitoring efforts but also engages younger generations, who may be particularly interested in traditional fishing practices and monitoring along with western science innovations (Esquible et al. 2024b; Reo et al. 2017).

Action 4. Improve Relationships

Thirdly, interview participants call for immediate actions to improve working relations between Indigenous and non-Indigenous governments in fisheries. Many participants emphasized the need for colonial governments to improve internal working relationships—both among their own staff and in their collaborations with First Nations and Native Tribes. They specifically called for a shift away from reliance on 'champion individuals' within government agencies and toward more systemic, long-term relationship-building. One proposed approach to repairing relations, is

the co-development of ‘Knowledge Hubs’, where scientists, Knowledge Holders, Elders, youth, and government managers and staff can engage in reciprocal learning together out on the land and waters (Hauser et al. 2023).

Participants emphasized that rebuilding trust and strengthening collaboration with colonial governments and agencies requires creating informal spaces for relationship-building outside of formal boardrooms or virtual meetings, where people can connect more openly and honestly (Esquible et al. 2024b). They also pointed to the importance of improved data-sharing agreements between First Nations, Native Tribes, and colonial governments that uphold Indigenous ownership, control, and governance of their data as foundational for restoring trust and enabling equitable partnerships (Cannon et al. 2024; Menzies et al. 2024). These relational steps align closely with strategies outlined by Menzies et al. (2024) for addressing the growing disconnect between humans and the non-human world. Such strategies include engaging in everyday acts of care, supporting locally grounded monitoring, and strengthening governance systems rooted in reciprocal responsibilities. Participants noted that these approaches are directly relevant to bridging the persistent divide between Indigenous and non-Indigenous salmon fisheries monitoring staff and fisheries managers. Menzies et al. (2024) further encourages intentional reflection on personal and institutional values, including how individuals and organizations understand their responsibilities to salmon and their habitats. Participants similarly emphasized that by articulating and sharing these values, can help identify common ground and fosters more cooperative, respectful approaches to stewardship.

Action 5. Involve Community

The final call to action identified by interview participants emphasizes the value of involving community members in all aspects of fisheries monitoring efforts, to enhance collaboration, knowledge sharing, and stewardship effectiveness. Menzies et al. (2024) similarly advocate for uplifting and supporting initiatives rooted in Indigenous values and approaches to environmental stewardship. Participants noted that achieving this often requires non-Indigenous fisheries managers, scientists, consultants, and decision-makers to step back and support First Nations and Tribal Nations leadership beyond the confines of western scientific frameworks and institutions (Cadman et al. 2022). At other times, it involves advocacy, funding, time and flexibility for

capacity-building, and collaboration from within western institutions to help mend the divides (Menzies et al. 2024; Reid & Ban 2025). In this regard, participants emphasized the importance of, and the unique opportunities presented by, deep community engagement and capacity-building initiatives developed through fisheries monitoring.

Investing in school programs, mentorship opportunities, and summer training positions for youth is seen as a valuable way to strengthen salmon monitoring efforts within Indigenous communities (Laver et al. 2024; Steel et al. 2021). They further stressed the need for community involvement throughout the entire monitoring process- from study design and data collection to data dissemination and decision-making. Engaging youth, Elders, and fishers together in these processes ensures that communities remain informed, engaged, and involved, ultimately fostering greater awareness of data sovereignty and its role in adaptive and cooperative fisheries management (Adams et al. 2021; Beveridge et al. 2020; McMillian et al. 2016; Rhodes 2024).

Research Limitations

Like all research, this study has its limitations. Our research scope is narrowly focused within the PNW region and in a North American context. As the intention of this research was not to conduct a complete survey of all Indigenous-led salmon monitoring programs, we further recognize that this research also does not offer a comprehensive representation of all perspectives on Indigenous-led salmon monitoring (despite our best efforts to identify as many programs as possible). Instead, it relied on a form of convenience sampling, where individuals opted in to share their experiences with us. We typically spoke with one to three individuals from each program, as a result, the perspectives captured reflect individual insights rather than the full breadth of views from entire communities involved in salmon monitoring. Additionally, all interviews and data collection were conducted in English, which may have limited participation or the perspectives shared.

Conclusion

Our research highlights the essential roles of Indigenous-led salmon monitoring programs in providing comprehensive, cross-season monitoring data that can support cooperative management and First Nations and Tribal Nations fishery objectives, whilst ensuring the long-

term sustainability of salmon populations for future generations. Interview participants further highlight that Indigenous-led fisheries monitoring programs often fill critical capacity gaps left by colonial management and agencies, yet their contributions and benefits are infrequently acknowledged by colonial managers, governmental institutions, or decision-makers. Beyond their immediate impact, Indigenous-led monitoring efforts foster both theoretical and practical opportunities for learning and knowledge exchange. Our findings underscore the importance of ongoing Indigenous leadership in fisheries monitoring and suggest that these insights are applicable to other regions pursuing similar efforts in cooperative management and advancing fisheries reconciliation.

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Data Availability Statement

Interview transcripts are not publicly available as they were shared directly with interview participants and are owned by their respective First Nation, Tribal, or Indigenous organizations. Access to these transcripts is governed by their respective community protocols and agreements.

All other data used in this study are available in Appendix, which includes relevant summary materials and supporting data.

Conflict of Interest Statement

The authors declare no conflicts of interest related to the research, authorship, or publication of this manuscript.

Chapter 4. Prioritizing Coho Conservation & First Nation's Fisheries Access Through Haíłzaqv Monitoring

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Introduction

Positionality Statement

This research was initiated in 2019 by the Haíłzaqv Nation, an Indigenous community located in what is now known as the Central Coast of British Columbia, Canada, through the Heiltsuk Integrated Resource Management Department (HIRMD). The research team includes Haíłzaqv resource managers and fisheries staff, alongside non-Indigenous academics and fisheries scientists from the University of Victoria, Simon Fraser University, the Wild Salmon Center, and the Central Coast Indigenous Resource Alliance. The team has been actively engaged throughout the research process, from identifying monitoring objectives to overall study design, supporting data collection, analysis, and data verification, to writing results and dissemination. Our professional relationships and collaborations span many years and across numerous ongoing fisheries-related research projects throughout British Columbia. Collectively and as individuals, we aim to support research that is grounded in strong relationships built on respect, trust, and reciprocity. We share a steadfast commitment to engaging in meaningful, reciprocal, community-driven research that aligns with the priorities of the Haíłzaqv Nation. Beyond academic discourse, we hope this research can contribute to realized change in fisheries science, by demonstrating the power of Indigenous-led salmon monitoring in strengthening adaptive fisheries management. By centering our collaborations with local Haíłzaqv fishers, personal

connections, and diverse ways of knowing, this research highlights approaches to salmon monitoring that extend past western science frameworks and methods that support Indigenous data sovereignty (Walter et al. 2020).

Current Salmon Crisis in British Columbia, Canada

Wild Pacific salmon (*Oncorhynchus* spp.) are experiencing decline across most of Canada's Pacific region. A recent State of Salmon Report (Connors et al. 2024) documents widespread declines in the abundance of five species of Pacific salmon found throughout British Columbia (BC), including sockeye (*Oncorhynchus nerka*), chum (*Oncorhynchus keta*), Chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), and pink (*Oncorhynchus gorbuscha*). The report further states that 70% of wild Pacific salmon populations are currently well below their long-term averages, raising significant conservation concerns across their ranges (Connors et al. 2024). Persistent declines are driven by interrelated and compounding factors, including climate change, habitat loss, and cumulative human development pressures that negatively impact Pacific salmon productivity and abundance (Crozier & Siegal 2023; Munsch et al. 2022; Schoen et al. 2017; Wilson et al. 2022). Historically, commercial overfishing, both locally and internationally, has played a major role and continues to contribute to declining salmon populations (Price et al. 2017). More recently, recreational fishing is contributing to these declines, along with dramatic climate changes (De Valle et al. 2024; Price et al. 2017; Steel et al. 2021; Walters et al. 2019).

Salmon Fisheries & Management in British Columbia

Today, Pacific salmon in British Columbia (BC) are harvested by three main sectors: commercial fisheries, recreational fisheries and Indigenous fisheries (Food, Social, and Ceremonial or FSC fisheries). FSC fisheries are protected under Section 35 of the Canadian Constitution and are legally prioritized for Pacific salmon allocation after conservation needs are met (Castaneda et al. 2020; Gavenus et al. 2023), as affirmed in BC's *Salmon Allocation Policy* (DFO 2019; Gavenus 2024; SAP 1999). Indigenous Peoples have sustainably managed their salmon fisheries for millennia, using selective gear, limiting harvest pressures, and fishing terminally at the end of migration routes and only once population health is assessed (Atlas et al. 2017, 2021; White 2006). These systems of governance were and continue to be severely disrupted by colonial

policies such as the *1868 Fisheries Act*, which further displace Indigenous governance, economies, and laws in favour of centralized state control (Carothers et al. 2021; Harris 2009; Reid et al. 2022). Commercial salmon fisheries, which emerged in the late 1700s and expanded during the cannery era (Castaneda et al. 2020; Harris 2009), are now composed of a limited number of licensed fishers and vessels operating under strict regulations (DFO 2019). They typically target mixed-stock aggregations -fish from multiple populations migrating through an area at the same time- and are managed through species-specific quotas, area-based restrictions (Pacific Fisheries Management Areas or PFMAs), and gear regulations (Parsons 2010). Recreational fisheries also target mixed populations of salmon and are subject to licensing and seasonal regulations, including species-specific catch and possession limits, regional fishing gear restrictions, and seasonal closures (DFO 2025a).

While often perceived by the public as lower impact, research shows that recreational fishing pressures now rival or exceed those of the commercial sector, particularly for high-value species like coho and Chinook salmon in BC (Bendriem et al. 2019; Nguyen et al. 2013; Morrow et al. 2022). Yet monitoring of the recreational sector remains inconsistent, relying heavily on self-reporting, which is far less reliable than current monitoring applied in commercial fisheries (Morrow et al. 2022; Mackenzie & Cox 2013). At the same time, significant monitoring gaps persist in many Indigenous and remote communities FSC fisheries. These gaps are not coincidental; they reflect ongoing impacts of colonial structures that limit some First Nations' capacity to monitor fisheries effectively, and mistrust between First Nations and DFO that limits opportunities for data sharing and collaboration. For instance, Fisheries and Oceans Canada (DFO), the federal agency responsible for fisheries management, has consistently failed to provide adequate and sustained investment in Indigenous-led and community-based fisheries monitoring (Atkinson et al. 2025; Beveridge et al. in review; Sleigh 2024). Chronic federal underfunding both perpetuates harm and creates a paradox: while DFO policies and priorities demand robust data, and the "best available science" for management decisions, the agency withholds resources and capacity required to produce it. Moreover, DFO routinely privileges western scientific approaches while dismissing Indigenous Knowledge and often failing to recognize Indigenous Knowledge Systems as 'data' despite thousands of years of guiding marine and coastal monitoring, stewardship, and governance (Artelle et al. 2019; Atlas et al. 2021; Reid

et al. 2022). As a result, many Indigenous fisheries managers and community leaders lack the information required to assess whether FSC requirements or conservation objectives for Pacific salmon are being met or evaluate the status of salmon populations within their territories. Addressing these inequities and strengthening monitoring across all fisheries sectors is critical to advancing more effective, accountable, and just salmon management in BC (Claxton 2019).

Canada's federal response to Pacific salmon declines, often framed as part of the broader "salmon crisis", has been largely reactive (Atkinson et al. 2025; Lefrançois 2024). DFO has typically relied on in-season responses such as emergency harvest reductions or fishery closures in reaction to low salmon returns or acute conservation concerns (e.g., drought, floods, landslides). While such measures may be necessary in the short term, they reflect a narrow, crisis-driven management paradigm that falls short of addressing long-term ecological change and systemic access inequities. DFO is mandated to prioritize conservation through foundational policies such as the *Wild Salmon Policy* (2005), the *Salmon Allocation Policy (1999)*, and the application of DFO's *Precautionary Approach* (DFO 2009; Lemieux et al. 2019). These policies, alongside constitutional and legal obligations to uphold First Nations' rights to fish for Food, Social, and Ceremonial (FSC) purposes (DFO 1999; DFO 2005; Steel et al. 2021), provide a framework for more proactive and equitable decision-making. However, the consistent realized failures to implement such policies in practice -particularly in relation to monitoring and enforcement- limits their effectiveness (Frid et al. 2023; CCFN workshop report 2025).

Furthermore, the continued and systematic exclusion of Indigenous Knowledge Systems, along with the lack of robust catch monitoring data -driven in part by DFO's lack of financial investment in monitoring capacity- are key obstacles to implementing precautionary and conservation-focused salmon management in Canada. While DFO previously maintained a more extensive presence throughout BC with many local fisheries officers and creek walkers based in remote, coastal communities (1970s-1990s), budget cuts have shifted management to being centralized with widespread reductions in population and fishery monitoring (e.g. Atkinson et al. 2025; Price et al. 2017). The impact of this monitoring decline is further compounded by sectoral pressures from commercial and recreational stakeholders, and the complexities of managing transboundary salmon populations, such as those shared with Alaska (Atlas et al. 2021).

Monitoring Mixed-Stock Salmon Fisheries

One of several key challenges to monitoring salmon catch is determining which salmon populations are being caught in mixed-stock fisheries. This is especially difficult because salmon populations often vary greatly in their productivity, abundance, and population dynamics -factors that elevate conservation risks when populations with low productivity or small numbers are inadvertently overharvested alongside more abundant stocks (Burgess et al. 2013; Hilborn 1985; Moore et al. 2021; Ricker 1958). Unevenness among productivity and high synchrony among salmon populations can lead to reduced stability of harvest outcomes and increase the risk of overfishing low productivity or small populations, making it critical to identify stock compositions of catches in large marine regions like the Central Coast of BC (Connors et al. 2020a,b; Moore et al. 2021).

Coded wire tagging (CWT) and Genetic Stock Identification (GSI) represent two distinct approaches to monitoring salmon populations. These methods are powerful and increasingly accessible monitoring tools that can provide estimates of the population composition of fish caught within a given area or region (Bendriem et al. 2019; Beacham et al. 2022). CWT relies on implanting coded wires into juvenile hatchery fish and later recovering the tags from adults caught in fisheries or on spawning grounds (Morishima & Henry 2000; Welch et al. 2021). This provides precise information about hatchery-origin fish from specific release groups but is limited to tagged populations (Bendriem et al. 2019; Shaklee et al. 1999). In contrast, GSI relies on naturally occurring differences in allele frequences across populations or regions, to assign fish to their populations or regional origins (i.e. their distinct Conservation Unit, CU) by collecting small, non-lethal tissue samples (e.g. fin clips) and analyzing samples against a reference library of genetic baselines (Beacham et al. 2021; Flannery et al. 2025).

Unlike conventional CWT systems, which rely on the recovery of marked hatchery fish from a limited number of indicator populations, GSI can be applied broadly to both wild and hatchery origin fish, offering population-level identification without the need to genotype every spawner (Beacham et al. 2021; Shaklee et al. 1999). Both methods provide valuable insights, with CWT being especially useful for estimating hatchery survival and exploitation rates, while GSI can reveal the stock composition of mixed-stock fisheries, including the presence of vulnerable

populations (Beacham et al. 2021, 2022; McKinney et al. 2017). Timely and accurate information on salmon population composition in mixed-stock fisheries is increasingly important for applying precautionary and adaptive management strategies. Such information enables managers to adjust fisheries openings or closures to reduce bycatch of endangered populations while supporting harvest opportunities of more abundant populations (Beacham et al. 2019, 2021; Flannery et al. 2025; McKinney et al. 2017; Shaklee et al. 1999).

Coho Salmon & British Columbia's Central Coast

Coho salmon are important to many First Nations' FSC and economic fisheries in Canada. Beyond their persistent cultural significance, coho also play a crucial role in BC's marine and coastal ecosystems and hold substantial economic value for recreational and commercial fisheries (Bendriem et al. 2019; Hallin 2022). Across BC, there are 44 distinct CUs of coho, comprising an estimated 2,600 distinct spawning populations (localized groups of salmon that return to spawn in their natal river system), which are distributed among approximately 10,000 documented spawning sites (Bendriem et al. 2019). This genetic and ecological diversity previously made BC's Pacific region a prolific spawning and rearing ground for the species (Bendriem et al. 2019, 2022). Of particular concern to First Nations throughout the Central Coast region of BC (CCFNs) is the declining trend witnessed among most Pacific salmon populations, with abundances below their long-term averages (Atlas et al. 2022; CCFNs workshop report 2025; Connors et al. 2019; Wilson et al. 2025). However, limited salmon population and fishery monitoring data and lack of consensus by federal fisheries managers at DFO regarding salmon population status in this region, has hindered action to address the declines. Persisting data gaps for Central Coast coho (as well as other salmon species throughout the Pacific region) exacerbates uncertainty regarding conservation status of these populations and whether First Nations can meet their current and future food security needs (Connors et al. 2024; PSF 2022; Valle et al. 2024; Walters et al. 2019).

Following the marine and coastal heatwave conditions witnessed across the Central and North Pacific that began in early 2014 and continued through most of the latter half of the decade, most coho populations (and other salmon and marine species) experienced a severe short-term decline, and populations across much of the Central Coast of BC have remained well below their long-

term averages (Wilson et al. 2025), even with reduced harvest efforts across various fisheries. Central Coast coho have recently been prioritized by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a Group One candidate for conservation assessment and potential endangered species designation, underscoring the urgency of implementing precautionary, conservation-focused fisheries management (COSEWIC 2025).

Coho Salmon & The Haíłzaqv Nation's Fisheries Monitoring Program

Dramatic declines in salmon abundance in recent decades have transformed life for CCFNs, including the Haíłzaqv Nation. In response to years of inadequate monitoring by DFO in their respective and shared Territories, the Heiltsuk Integrated Resource Management Department (HIRMD) launched a salmon fisheries monitoring program in 2019. This program monitors both recreational and Haíłzaqv FSC salmon fisheries to improve estimates of fishing effort and catch, and samples DNA from harvested salmon for GSI. HIRMDs salmon monitoring program aims to provide consistent data on salmon catches, fisher perceptions, and fishing effort to support conservation of salmon fisheries with management guided by Haíłzaqv principles and laws. This effort grew from concerns by Haíłzaqv fishers, community members, and managers regarding declining salmon abundance. Ongoing recreational and commercial fisheries are seen as significant barriers contributing to limited access and preventing many Haíłzaqv community members from meeting their salmon food security (FSC) requirements (Steel 2021). Additional reported barriers include but are not limited to declining salmon populations, competition with other fisheries -particularly the recreational sector- shifting salmon migration patterns and reduced fisher capacity, including financial resources, boats, time, and fishing knowledge (Beveridge et al. in review; Steel et al. 2021). Improved fishery monitoring can help estimate impacts from all fishery sectors, improve population monitoring for salmon species, and provide HIRMD with data to support precautionary management approaches and conservation objectives.

The purpose of this research is to support the Haíłzaqv Nation's ongoing efforts to assert and revitalize their inherent authority to monitor, steward, and manage fisheries within their Territory. Central to this work is the ability to monitor salmon fisheries directly and understand how changing environmental and management conditions impact local access to important marine

species such as Pacific salmon. Drawing on Haíłzaqv fishery catch monitoring data collected by HIRMD and GSI results from 2019 to 2024, this paper provides a snapshot of FSC fishery dynamics -particularly for coho- throughout marine areas of Haíłzaqv Territory (i.e. PFMAs 7 and 8). We identify estimates of when, where, and how many coho are being harvested, including fish from populations of concern such as those in the Hecate Lowlands Conservation Unit, and assess the challenges currently faced by FSC fishers in meeting their seasonal harvest requirements. By analyzing catch data, GSI findings, and the perspectives of Haíłzaqv fishers, this work seeks to ground coho conservation and FSC priority access in local realities and to inform more equitable and effective fisheries management aligned with Haíłzaqv values and governance.

Methods

Research Area & Methodological Approach to Monitoring

This research was led by the Heiltsuk Integrated Resource Management Department (HIRMD), in partnership with the co-authors of this paper. This research takes place in Haíłzaqv Territory in the Central Coast region of BC, specifically within the community of Bella Bella. Bella Bella is a remote, island community with roughly 2,500 residents (comprising mostly Haíłzaqv membership and some non-Indigenous residents) and draws an influx of non-Indigenous visitors during the peak summer months (Heiltsuk Tribal Council 2025).

Our work builds upon the salmon catch monitoring program run by HIRMD, which provides ongoing estimates of recreational and FSC fishing effort, as well as the catch of Chinook, sockeye, chum, pink, and coho salmon since 2019 (Steel et al. 2021; Wilson et al. 2025). Given the diversity of fishers in the Central Coast marine area and the range of salmon fishing methods used, this research employed a mixed methods sampling approach to engage with both recreational and Haíłzaqv FSC fishers. In this study, mixed methods refer to deliberate use and investigation using both quantitative data (e.g. effort and catch statistics, genetic stock identification) and qualitative insights (e.g. fisher creel-style surveys, fisher perspectives, and Haíłzaqv Knowledge). Mixed methods approaches' that bring together quantitative and qualitative data have been shown to provide a more comprehensive understanding of fisheries dynamics than either method alone, capturing both measurable trends and lived experiences that

shape fishing practices and access (Harvey et al. 2025; Young et al. 2019). The raw data and fishery knowledge are owned and managed by HIRMD and are not included in this paper. This research received ethics approval from the University of Victoria (Ethics protocol #19-0186) and has also undergone review and received approval from HIRMD managers, directors, and the Heiltsuk Tribal Council.

Salmon Genetic Stock Identification (GSI) Data Collection

During dockside surveys, HIRMD technicians collected genetic samples from fishers' salmon catches. Small clips from salmon adipose or tail fins were fixed to pre-numbered Whatman sheets organized by species and mailed to the DFO Molecular Genetics Lab (MGL) in Nanaimo, BC, for analysis. Methods for DNA extraction and genotyping followed the procedure described in Beacham et al. (2017) using an established panel of 304 single nucleotide polymorphisms (SNPs) and fish were assigned back to baseline collections from 502 coho salmon populations and their associated CUs in British Columbia, Washington, and Alaska (Whitmore 2023). These samples were analyzed using Genetic Stock Identification (GSI), which allows the ability to determine the population (Conservation Unit, CU) of origin. By comparing the genetic profiles of salmon caught in different locations and times, GSI can reveal migration patterns and seasonal movements of salmon populations across marine and freshwater environments (Hess et al. 2014; Jensen et al. 2023).

Samples were gathered from both Haíłzaqv FSC and recreational fishers returning to Bella Bella across five fishing seasons (2019–2023). However, due to COVID-related travel restrictions and area closures in 2020, no recreational fishing dockside surveys or GSI samples were collected that year. Instead, a sub-group of Haíłzaqv FSC fishers were provided DNA sampling kits to continue salmon GSI data collection using their personal catches. From 2021 onward, HIRMD technicians collected DNA samples from harvested adult salmon and recorded catch locations, which were later mapped to DFO PFMAs to protect sensitive fishing information. In alignment with HIRMDs data management and priorities for public sharing, we present only the coho GSI results in this research.

Salmon Genetic Stock Identification (GSI) Analysis[8]

Results from GSI analyses conducted by the DFO molecular genetics labs were reported as probabilities of assignment to a given Conservation Unit or reporting group, in this case geographically distinct populations with sufficient representation in the current genetic baseline. Each individual salmon sample was assigned a set of probabilities across multiple CUs, which always sum to 1. Reporting from genotyping included up to five CUs with an associated probability that an individual salmon (coho for this research) originated in that geographic area, although for samples with high probability of assignment to a smaller number of CUs, fewer are reported (e.g. if probability of the first or second sums to 1). In total, 472 coho salmon samples were successfully genotyped and assigned to their respective CUs and collection locations. Across these samples, 20 CUs were identified as having some probability of assignment.

To account for the probabilistic nature of genetic assignments, we used a Dirichlet regression approach, implemented in the R-package DirichletReg (Maier 2021) to model the proportion probability data for each individually genotyped fish. Results for the five CUs reported for each fish were rounded proportional to their probability of assignment to meet the assumption of multinomial regression that values sum to one. We then fit a Dirichlet regression relating CU-level proportions for each fish to year modeled as a categorical variable, to evaluate annual variation in the composition of mixed-stock coho catches landed in PFMAs 7 and 8 combined. To evaluate seasonality of catches across these CUs, we fit a second model relating CU-level proportions to month as a categorical variable.

To interrogate differences in CU-level catch proportions across specific sub areas of PFMA 7 and 8 for coho salmon, we subsampled population identification data from the five PFMAs with the largest number of catch samples (range per sub area: 46 to 127) in the HIRMD dockside collections. This subsample from sub-areas 7-12, 7-17, 7-25, 7-32, and 8-5 constituted 381 of the total 472 samples. We then fit a Dirichlet regression relating the CU-level proportions to sub area, to estimate differences in the contributions of each CU to catches in each sub area, to generate spatial predictions of catch proportions for coho salmon in the most regularly visited

[8] Authorship note: The GSI analysis methods described in this subsection were developed by Will Atlas, with Central Coast coho GSI analysis led by Will Atlas and Kyle Wilson.

fishing areas across Haíłzaqv Territory in PFMAs 7 & 8. Finally, we fit a model that included the effects of sub area, day of year and their interaction, to generate seasonal predictions of catch proportions across the same five PFMAs.

Dockside Fisher Surveys

To better understand salmon fishery dynamics and fishers' perceptions in PFMAs 7 and 8, we conducted dockside surveys to quantify fishing effort, catch, spatial and temporal activity patterns and overall satisfaction of catch among both FSC fishers (Haíłzaqv or Indigenous-status fishers harvesting for FSC purposes) and recreational fishers (non-status fishers holding a recreational license, either as BC residents or non-residents). Dockside surveys (often referred to as 'creel surveys') are widely used in fisheries monitoring approaches to obtain information on a fishery, often using an interview with returning fishers and in the field (Beauchamp et al. 2019; Morrow et al. 2022; Nieman et al. 2021). Creel surveys are also widely used in recreational fisheries around the world as a tool to estimate total catch and fishing effort, including in British Columbia and across Canada (Jenkins et al. 2020; Lowry et al. 2015; Nieman et al. 2021; Morrow et al. 2022). Creel surveys can typically be defined as a survey of the timing and location of fishing effort and catch, and the biological composition (sex, size, age) of fish harvested during or after a fishing trip (Jenkins et al. 2020; Nieman et al. 2021).

Creel surveys may also combine voluntary genetic sampling with surveys, allowing surveyors to gather both social and biological data at the same time. For example, while fishers respond to creel-survey questions, technicians often measure and sex the fish and collect biological samples for GSI testing (Beauchamp et al. 2019). The resulting data are analyzed using a combination of quantitative and qualitative methods to estimate catch and release numbers, boat counts (fishing effort as reported by fishers), and other key fishery indicators. These metrics help improve understanding of the fishery dynamics and fish populations within specific regions (Bendriem et al. 2019; Mackenzie & Cox 2013).

From 2019-2024, HIRMD fishery monitoring technicians conducted in-person, volunteer dockside surveys throughout Haíłzaqv Territory in Bella Bella, operating daily from May 15 to September 15 each year. Technicians survey as many returning fishers as possible at high-use

public areas such as gas docks, marinas, and boat ramps, collecting both quantitative and qualitative data using standardized survey sampling methods (Beauchamp et al. 2019; Morrow et al. 2022). The 13-question survey was co-developed by HIRMD managers and the research team and gathers information on fishing methods, locations, timing, catch details, intended harvest use, and observations of other fishers in the area. HIRMD also added additional questions not currently included in DFO's IRec Program to capture human dimensions of fishing. These questions addressed fishery perceptions, socio-economic information (e.g., values, beliefs, attitudes), demographic data (e.g., age, gender), and estimates of total fish releases by species.

In contrast, DFO's IRec Program relies on self-reporting completed by recreational fishers (DFO 2025b). This system collects information on recreational fishing effort and catches from tidal water license holders, through periodic email and mailout invitations, and randomly selected recreational anglers to complete survey reporting on trip details and species retained. This approach has significant limitations: although reporting is mandatory, there are no penalties for non-compliance, and the resulting data often lack accuracy, completeness, and representativeness (Bendriem et al. 2019; Mackenzie & Cox 2013; Post & Parkinson 2012; Morrow et al. 2022). Furthermore, because recreational fishers self-report online, they may omit precise fishing locations, reduce the spatial resolution of the data and potentially limit the ability to assess impacts on specific salmon populations or fishing areas. Moreover, IRec does not collect qualitative data such as fisher observations, perceptions of abundance, or broader socio-cultural contexts (Lunzmann-Cooke et al. 2024; Nieman et al. 2021), further limiting its usefulness for local or Nation-specific fisheries management. DFO does not routinely share detailed catch information with First Nations or the public, reducing transparency of the IRec program and hindering collaborative monitoring efforts.

HIRMDs fisheries monitoring program employs a systematic sampling approach to ensure that survey effort is proportional to the size of the known Haíłzaqv FSC fishery in the region (Benoît & Allard 2009; Beauchamp et al. 2019). Throughout the fishing season, we survey the majority of Haíłzaqv FSC fishers, leading us to draw meaningful inferences about the local FSC fishery, by conducting daily dockside and phone surveys between 12:00 and 22:00 (Beauchamp et al. 2019). We also ensure representative survey coverage across all days of the week to reduce any

potential sampling bias and increase survey effort during known high-activity periods such as holidays, community events, optimal tidal windows and peak salmon run times. While HIRMD technicians make every effort to survey as many fishers as possible, it is logistically impossible to reach every recreational fisher in the region. Some are not willing to participate in surveys, while others may not physically stop in Bella Bella -choosing instead to remain self-contained on their boats or to dock in other communities. As a result, the data presented here does not support robust inferences about the entire recreational fisher population within the region. However, expanding survey coverage and monitoring methods in future years may enable more conclusive assessments of this sector.

Dockside Survey Analysis

An exploratory statistical analysis was conducted to better understand HIRMDs dockside fisher survey data from 2019-2024. Due to limitations in HIRMDs current monitoring program, sampling does not capture all recreational fishers across the broader Territory and region, and therefore this analysis does not represent an expanded creel estimate for the recreational sector and should not be interpreted as such.

To support consistent analysis of the dockside survey data, survey questions were standardized by combining structured, measurable response formats with limited open-ended questions. For example, numerical inputs (e.g., number of salmon caught, hours fished) and categorical choices categories (e.g., gear type, fishing location, fisher type) were used to ensure comparability across responses and survey years (see Appendix C. Supplemental Materials Ch 4 for dockside survey questions). Survey data were prepared and analyzed using R and RStudio (ggplot2, dplyr), focusing on trips where one or more coho salmon were reported caught or trips where fishers reported targeting coho, across all gear types (gillnet, trolling, rod and reel, etc.) and for both recorded FSC and recreational fishers captured in the dockside surveys. We examined spatial and temporal patterns across PFMAs and interpreted coho catch reported in the surveys to GSI results from genotyped fish collected during the same trips. Each genotyped fish was assigned to its respective CU, allowing us to evaluate potential population specific trends in catch composition across time and space. Fishing trips occurring outside of PFMAs 6 though 9, or

listed as N/A, were excluded from this specific analysis. The master dataset comprised 1,849 recorded trips (1,368 FSC trips and 481 recreational trips).

To evaluate fisher perceptions of daily trip success and overall seasonal success among Haíłzaqv FSC fishers (2019-2024), we analyzed survey responses using R (ggplot2 and dplyr packages). We fit linear models with fixed effects, where the response variables were 1. Trip success perceptions ratings and 2. Seasonal success perception ratings. Predictor variables included year, month, DFO PFMA, fuel costs, and total salmon caught per trip. All FSC-designated trips were included in the analysis, regardless of whether any coho were caught. This approach allowed us to capture the full range of recorded fishers' experiences. For perception analysis we excluded 181 FSC trips that did not provide a response to the trip success or season perceptions questions, as well as all surveys with recreational designated fishers. All gear types used by FSC fishers were included in the analysis (i.e. gillnet, seine, trolling/rod and reel, casting, etc.). In total, 259 FSC individuals surveyed from 2019-2024 in 1,412 total trips were included. We also calculated annual mean trip success scores to summarize temporal trends in fisher experiences.

To estimate Haíłzaqv FSC fisher trip-level costs per salmon, we divided each fisher's reported fuel expenditure by the total number of salmon harvested on that trip (i.e., cost per salmon = fuel cost standardized across the season/total salmon harvested). Reported fuel costs were standardized using the average, season-specific tax-exempt fuel price paid by Haíłzaqv fishers at Lama Pass Fuel in Bella Bella, which allowed us to adjust for fuel price fluctuation across the season. This approach provides a conservative estimate of harvest costs, as it accounts only for fuel expenses. We did not incorporate any costs associated with the purchase, maintenance, insurance, or moorage fees of boats, nor any fishing gear expenses. Thus, resulting values reflect fuel-based operating costs rather than full socio-economic costs of participating in the fishery.

Results

Results of Coho GSI Analysis (2019-2023)

Across the 2019-2023 fishing seasons, 472 coho salmon GSI samples were collected from recreational and FSC fishers in PFMAs 7 and 8 who landed their catch in Bella Bella. Of these, 88.6% originated from Central Coast CUs (Figure 11). On average, the Hecate Lowlands and

Straits CU represented the largest share of coho salmon catch (37.92% SD 13.89) in our sample from PFMAs 7 & 8, followed by the Bella Coola Dean (23.17% SD 2.94), Rivers Inlet (11.99% SD 2.98), Douglas Channel (7.79% SD 9.98), and Northern Coastal Streams (7.27% SD 8.15) CUs. Modest contributions were also recorded for Homathko-Kliniklini (3.5% SD 1.89), Southern Coastal Fjords (3.59% SD 2.41), and Howe Sound CUs (1.39% SD 1.54). While additional North and South Coast CUs were detected from our samples, they comprised <1% of the total recorded catch (See Table C.3.1 in Appendix).

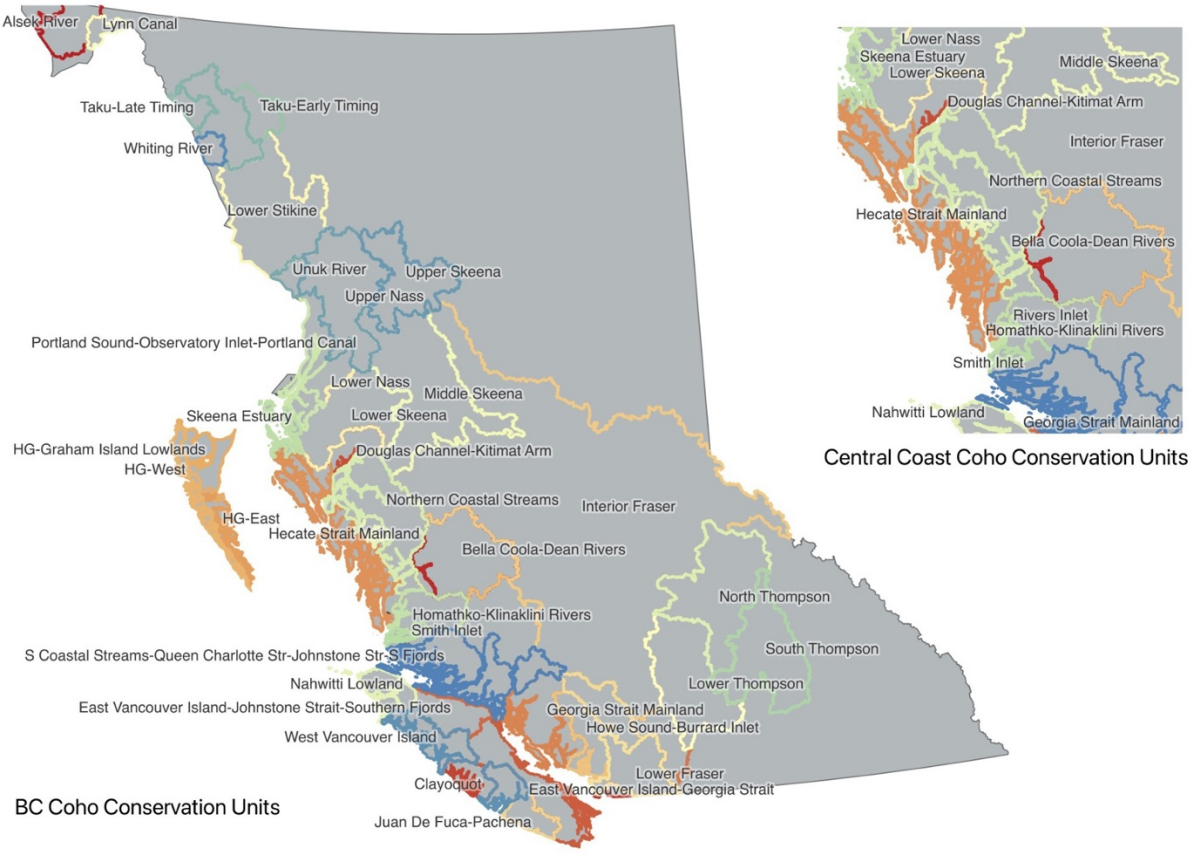


Figure 11. Map of British Columbia coho salmon Conservation Units (left) & Central Coast coho salmon Conservation Units (right).

Seasonal & Interannual Composition of Coho Conservation Units Distribution & Variability of Genetic Assignment Certainty

While the genetic assignments of coho samples to their respective CUs are not absolute, our results show generally high assignment probabilities, but with notable variation in certainty

across CUs and years. There were also apparent differences in the average probability of assignment to each unique CU, likely due to the completeness of baseline collections within a given region, and the degree of genetic uniqueness within the CU. For example, samples assigned to the Hecate Lowlands and Straits CU were assigned with an average probability of 94.78%, while samples from Bella Coola Dean (79.4%) and Rivers Inlet (78.4%) CUs were assigned with lower average probability.

Analysis of coho catches across the five most heavily fished PFMAs (Hecate Strait and Lowlands, Bella Coola Dean, Rivers Inlet, Douglas Channel, and North Coastal Streams) reveal spatial and temporal differences in the contribution of Central Coast coho CUs (see Appendix Table C.3.1). Monthly variability in the contributions of coho catch from specific CUs was also apparent. While all seven CUs of Central Coast coho salmon, except for the small northerly Mussel-Kynoch CU, were present in marine fisheries in all months of sampling (May through September) and all years (2019-2023), some CUs had notable seasonality in their contributions to coho catches across the fishing season. Specifically, catches of coho from the Hecate Lowlands and Straits CU had a strong seasonal peak in August (beta coeff. = 0.698; Pr(>|z|) = 0.0028). By contrast, catches of Bella Coola-Dean appeared to decline throughout the fishing season, with marginally significant reductions in their contribution to catch for August (beta coeff. = -0.417; Pr(>|z|) = 0.066) and September (beta coeff. = -0.678; Pr(>|z|) = 0.086).

Dockside Survey Analysis (2019-2024)

A total of 2,127 dockside surveys were employed from 2019-2024, including 1,412 from Haíłzaqv FSC fishers and 715 from recreational fishers. The results presented reflect patterns observed primarily from Haíłzaqv FSC fisher survey responses and for coho salmon catch. Results suggest that most fishing activity (by FSC and recreational fishers for all salmon species) is concentrated during the peak summer months, from late June to late August. Among local FSC fishers, a small number continue to fish for Pacific salmon year-round, but overall winter effort remains low due to inconsistent catch rates and challenging weather conditions. FSC fishing generally ramps up in mid to late April, increasing through May depending on weather and fish arrival to the area. Summer marks the height of FSC fishing effort, though participation can dip during stretches of poor weather or slow fishing. By mid-September, FSC effort drops sharply,

aligning with the start of the school year and shifting community priorities. Recreational fishing typically begins later than FSC fishing, with the first major influx recorded in early June and peak activity in July and August. In 2020 and 2021, effort patterns were significantly impacted by COVID-19 travel restrictions. Most private fishing lodges in the region remained closed throughout 2020 and reopened later than usual in 2021. Similarly, independent recreational fishers were largely absent from the region in 2020, and although recorded effort was low in June of 2021, it increased noticeably by mid-summer as restrictions eased. From 2021 onward, recorded recreational fishing efforts have greatly surpassed pre-pandemic recorded patterns, with activity building through June and peaking in August as captured in our survey data (see Figure 12).

Dockside survey data suggests a steady increase in the proportion of recreational fishers since the easing of COVID-19 travel restrictions, alongside a notable decline in both the number of individual FSC fishers and FSC trips. Dockside survey efforts have been generally consistent across years in terms of the number of sampled days (see Table 2). Inferences on fisher trips and individual participation in the FSC fishery are based on survey counts and results may reflect both actual changes in effort and variations in sampling intensity. For example, 2020 recorded the highest number of recorded FSC trips in a single season, followed by 2019 (Table 2), whereas 2024 recorded the lowest number of FSC trips, coinciding with the highest marine fuel prices on record (~$2.35CND/litre), which represents a substantial increase even when adjusted for inflation compared to 2019 prices (~$1.20CND/litre). At the same time, 2024 marked the highest number of recreational trips recorded, with 2023 being the second highest. Overall, from 2019 to 2024, the proportion of FSC trips captured in dockside surveys has declined, while recreational trips have steadily increased as captured in the dockside surveys, despite increasing seasonal survey effort across the Bella Bella area (Table 2).

Table 2. Individual Haíłzaqv fishers captured within annual fisheries monitoring program & trips recorded through surveys

Year	# of days sampled	FSC Individuals Recorded	FSC Trips Recorded
2019	66	105	261
2020	52	55	307
2021	54	79	227
2022	78	89	251
2023	76	82	208
2024	83	63	158
2019 - 2024	Total: 409	Total: 259	Total: 1,412

Shifting Coho Catch Areas & Rise of Catch & Release Fishing

Dockside survey analysis suggests that Haíłzaqv FSC fishing effort may be shifting closer to Bella Bella, with fewer FSC trips recorded over time in more distant areas such as Area 8, despite higher recorded catch-per-unit-effort (CPUE, calculated by the number of fish caught per hour, per trip) for both recreational and FSC fishers in more distant areas, including for coho. From 2019 to 2024, most coho recorded through surveys were caught in August, with the highest seasonal and annual catches recorded occurring in PFMAs 7 across both fisher groups. The strongest coho seasons recorded through the dockside surveys were 2019, 2022, and 2024, while 2020, 2021 (impacted by Covid-19 restrictions) and 2023 saw the lowest recorded catches.

Table 3. Estimates of coho CPUE for Haíłzaqv fishers captured in fisheries monitoring surveys across all gear types & trips within PFMA 7 & 8

Year	Coho CPUE	Standard Error	CI_low	CI_high
2019	3.34	1.32	0.73	5.95
2020	1.12	0.17	0.77	1.47
2021	1.85	0.24	1.36	2.34
2022	2.58	0.46	1.67	3.50
2023	1.11	0.15	0.81	1.40
2024	2.25	0.38	1.49	3.01

Except for 2020, dockside survey data suggest a potential decline in coho CPUE in PFMA 7 for FSC fishers since 2019. In 2019, 250+ coho were recorded caught in a single PFMA subarea,

whereas by 2024, coho catches recorded in the same subarea ranged from 0-50. This is interesting, as 2019 was not considered a strong coho return year for the Central Coast region (Wilson et al. 2025) and data collected shows the greatest statistical variability (Table 3). In contrast, 2023 recorded the lowest overall coho CPUE and lowest statistical variability. Since 2020 onwards, recorded coho catches in PFMA 7 and 8 are declining- a notable shift from 2019, when CPUE in PFMA 7 exceeded that of PFMA 8 and is the highest coho CPUE year recorded. In 2024, recreational fishers report higher CPUE per trip in Area 8 than FSC fishers. The results from the dockside surveys also indicate an increase in voluntarily reported catch-and-release activity across both fisher groups, particularly among recreational fishers. This trend suggests growing changes in fisher behavior and reporting. Notably, in 2024, a higher proportion of caught salmon were released, compared to 2023. Some recreational fishers have reported releasing upwards of 30 coho per daily trip to HIRMD dockside technicians.

From 2019 to 2024, there were 373 Haíłzaqv FSC trips recorded with zero salmon caught, representing 26.4% of the total 1,412 FSC trips (Figure 12). The worst year recorded for no-salmon catch FSC trips was 2022 at 32.2%, followed by 2020 at 30.6%.

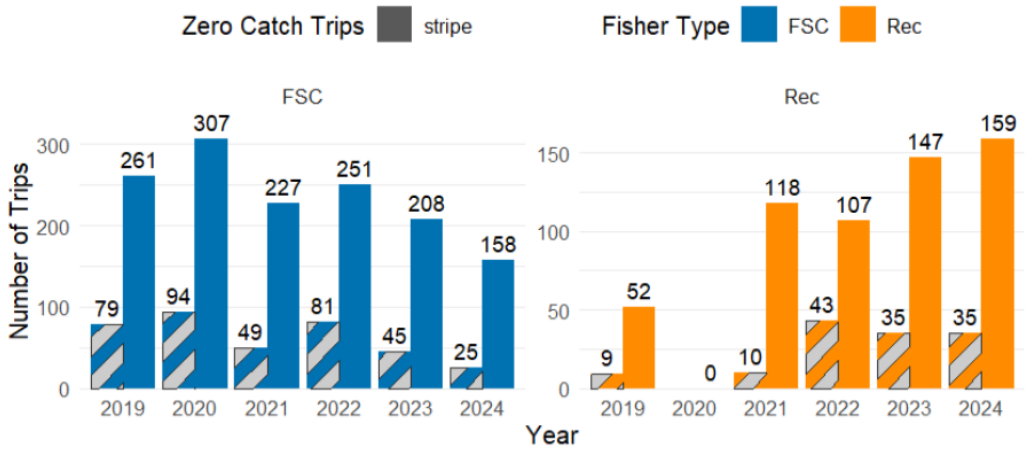


Figure 12. Zero salmon landed trips recorded in Haíłzaqv fisheries monitoring surveys from 2019-2024 by Haíłzaqv fishers (blue) and recreational fishers (orange).

Salmon Harvest Costs Increasing for Haíłzaqv Fishers

Dockside survey results indicate that the estimated cost for Haíłzaqv FSC fishers to harvest salmon has steadily increased from 2019 to 2024. In 2019, the average estimated cost per salmon (based on fuel prices) was $23.33 for Haíłzaqv fishers, while by 2024, it had nearly tripled to $67.60 and across all gear types. Trolling consistently emerged as the most expensive fishing method, with costs rising from $27.03 per salmon in 2019 to $73.28 in 2024. In contrast, gillnetting remained a significantly more cost-effective method for harvesting salmon, with prices per salmon increasing only slightly from $7.76 in 2019 to $10.39 in 2024. Fuel prices remain a major contributor to rising costs of salmon, with marine gas prices increasing each year -further straining the economic feasibility of FSC fishing, along with increasing costs for purchasing, maintaining, and insuring boats. For example, in 2019 marine fuel on reserve in Bella Bella (tax exempt) was ~$1.20CND/litre versus in 2024 it was ~$2.35CND/litre.

Notably, HIRMD survey data also shows a marked increase in the use of trolling gear by FSC fishers over time, alongside a significant decline in the use of gillnets. These shifts in gear choice may reflect both changing access to equipment, finances, larger boats, salmon species availability, as well as adaptation to increasingly variable fishing conditions and an aging FSC fisher population who can no longer operate larger vessels or employ physically strenuous gear. Additionally, the average effort (hours) spent per FSC trip also declined since 2019. For example the average Haíłzaqv FSC fishing trip in 2019 was recorded at 7.9 hours, and 2024 at 4.6 hours (Table 4).

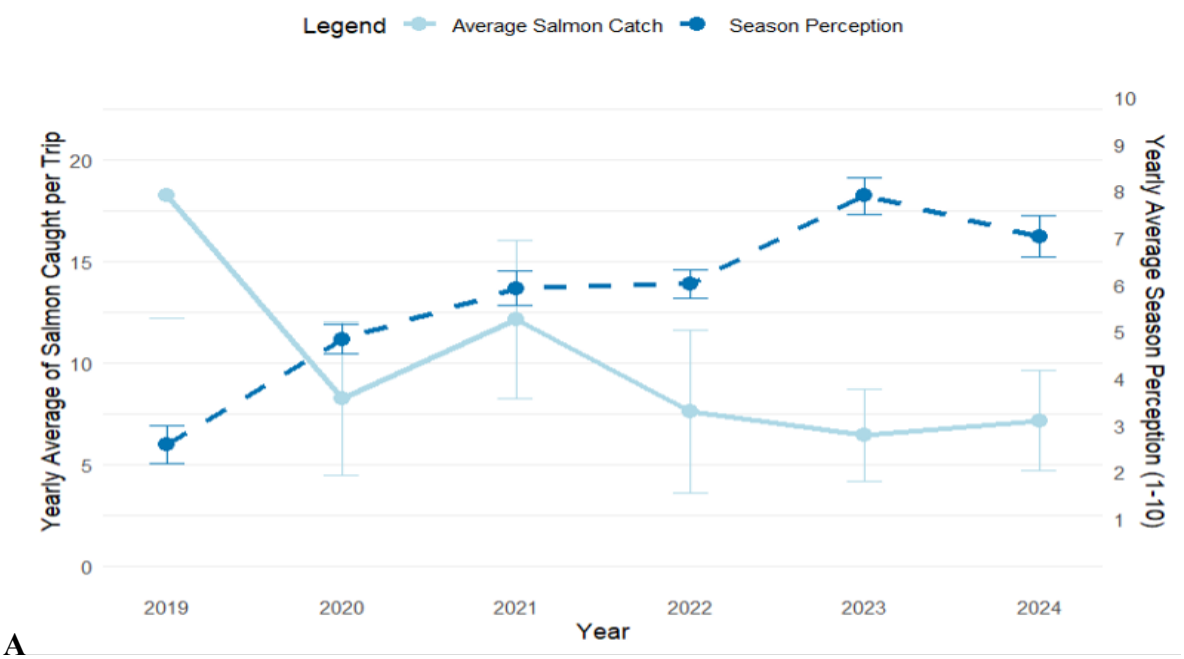
Table 4. Average annual recorded Haíłzaqv fisher trip duration across surveyed years

Year	Average hours per trip (FSC)
2019	7.9
2020	7.6
2021	5.4
2022	4.5
2023	4.1
2024	4.6

Perceptions of Fishing Trip & Season Success Shifting for Haíłzaqv Fishers

Haíłzaqv FSC survey responses indicate that while the average number of salmon caught per FSC trip has declined over time, fisher perceptions of daily trip success have remained relatively consistent. Interestingly, FSC fishers were more likely to describe their daily trips in Area 8 as successful compared to those in Area 7. This is likely due to higher average salmon CPUE in Area 8 but may also reflect other valued aspects of the fishing experience, such as spending time out on the water in the Territory with family and friends, fishing for other fish or marine species, or being further out in the Territory. Overall, perceptions of what makes a daily fishing trip successful appear to be shifting across survey years and fisher age groups based on general PFMA. These evolving perceptions of trip success reflect a combination of shifting coho catch outcomes, cultural and social values, and changing conditions on the water.

Interestingly, surveyed Haíłzaqv FSC fishers' results suggest a potential shifting baseline in how FSC fishers define a "successful" fishing season and trip. While the average number of salmon caught per FSC trip (CPUE) has seemingly declined over the years for gillnet trips, fisher perceptions of overall season success have increased for both FSC fishers using gillnetting and trolling gear (Figure 12). For example, in 2019 (when coho CPUE is highest recorded in our data set) fishers rated their season perception success the lowest, with an average score of just 3.75 out of 10. In contrast, 2023 had the lowest average coho CPUE recorded, yet fishers reported the highest average season success rating score of 8 out of 10. This divergence points to a potential shift in how fishery success is evaluated, suggesting that while FSC fishers may view individual trips as less productive in terms of coho or salmon species catch, they are finding greater satisfaction in broader seasonal experiences. This could also reflect changing expectations, resilience, or a stronger emphasis on cultural, social, or personal fulfillment beyond salmon harvest numbers.



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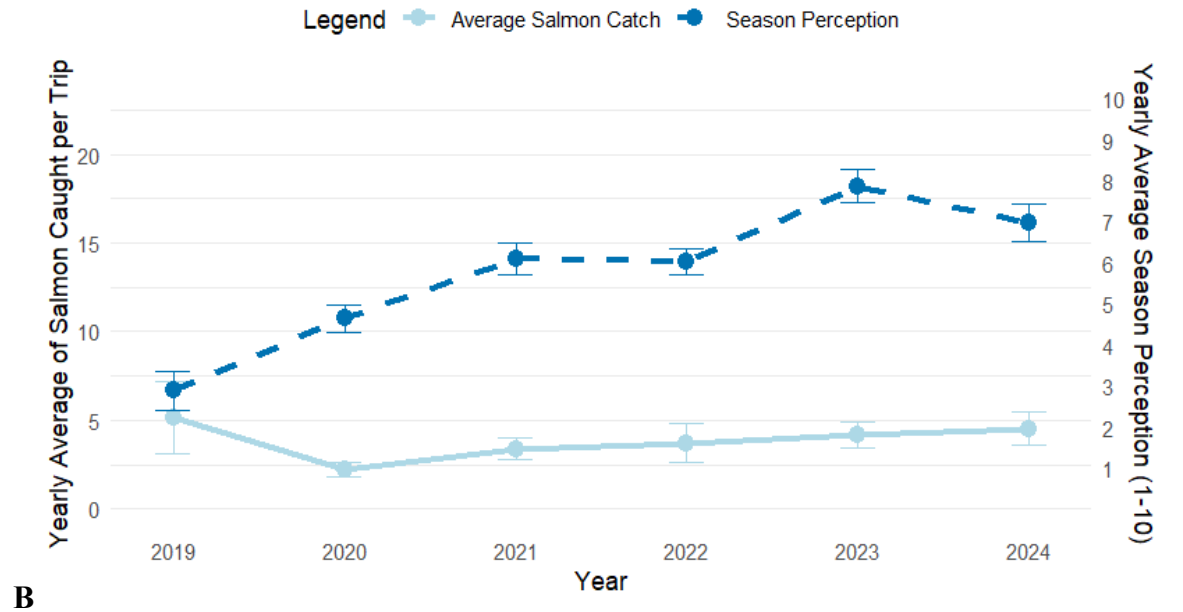

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Figure 13. Average perceptions of overall fishing season success by Haíłzaqv fishers between 2019 to 2024 (rated on a scale from 1 = worst to 10 = best). The top panel A includes all recorded Haíłzaqv trips across all gear types (1,412), while the bottom panel B excludes gillnet trips (1,222).

Additionally, we observed variation in fishing trip participation based on the self-reported age of FSC fishers captured in our surveys. The widest age range of FSC participants occurred in 2020, possibly driven by outcomes of the Covid-19 pandemic, and largely by increased involvement from younger individuals who were out of school, but this has since declined in the following

years. In contrast, older age groups (particularly those aged 61 and over) have shown more stable participation across all recorded years. For example, the average age of FSC fishers recorded in 2019 was 44.65, rising to 51.61 by 2024 (Table 5). This trend suggests that the overall age of participating Haíłzaqv FSC fishers is increasing over time, possibly indicating limited recruitment of younger or new fishers into the FSC fishery, while existing fishers continue to age season by season and their perceptions may be normalizing lower catch levels, CPUE, or perhaps FSC fishers are adjusting their expectations year after year (further suggesting shifting baselines or recency bias) (Medeiors et al. 2024; Papworth et al. 2009). Our survey results further indicate that the type of gear used by Haíłzaqv FSC fishers (e.g., gillnetting or trolling) does not appear to directly influence fishers' reported perceptions of trip success. Instead, factors such as fishing duration, specific location of the fishing trip and the number of salmon harvested seem to play more substantial roles in shaping how fishers evaluate their overall successes.

Table 5. Average age of Haíłzaqv fishers recorded from 2019 to 2024 (n=1,210 trips with age provided)

Year	Average Fisher Age	SE	95% CI Lower	95% CI Upper
2019	44.65	1.26	42.15	47.15
2020	46.64	0.73	45.19	48.09
2021	46.59	0.96	44.70	48.49
2022	47.99	0.94	46.12	49.86
2023	47.60	0.93	45.75	49.46
2024	51.61	1.07	49.48	53.73

Discussion

Key Findings

Many Pacific salmon populations across BC's coastal systems and marine environments have declined significantly in recent decades (Connors et al. 2024; Nesbitt & Moore 2016; Rahr et al. 2025; Reid et al. 2022; Schoen et al. 2017). Since 2017, average coho spawner abundance in the

Central and North Coasts have dropped by 39% relative to contemporary baselines (Wilson et al. 2025*)*, and many coho populations are now considered in "critical conservation zones," or their population status remains unknown reflecting broader CU status trends across the region (Atkinson et al. 2025; Price et al. 2017). The Hecate Strait and Lowlands coho CU is experiencing the steepest declines (Wilson et al. 2025). Our coho GSI and dockside survey results support and build upon these findings. Most recorded coho harvested in both recreational and Haíłzaqv FSC fisheries during peak season (particularly August) were traced to local populations of origin -especially within the Hecate Strait and Lowlands CU. This indicates that fishing activity is likely closely linked to vulnerable and variable salmon populations, and that any harvest pressure including recreational, commercial, or FSC, can have immediate conservation impacts. As such, place-based and localized monitoring and management approaches offer a practical path forward to achieving stronger conservation outcomes.

From 2019 to 2024, recorded coho catches by Haíłzaqv FSC fishers have become increasingly unpredictable, making it harder to plan and achieve successful harvest opportunities. This unpredictability is reflected in more frequent zero-catch trips and correlated with both increasing fuel costs and shifted fisher behaviours and views among local Haíłzaqv fishers about what defines a successful trip or fishing season. Some older fishers describe their perceptions of season success more positively, perhaps reflecting "shifting baseline syndrome," where personal perceptions of fisheries abundance or health adjust over time with memory (Medeiros et al. 2024; Papworth et al. 2009). These perceptual shifts, also observed elsewhere along the Pacific coast (e.g. Medeiros et al. 2024; Rhodes 2024; Ringer et al. 2018), can mask the urgency of conservation requirements and downplay the severity of declining fisheries access and abundance. Overall, these trends signal the growing instability of harvesting salmon in mixed-stock fisheries and have direct implications for First Nations food security (Gavenus 2024; Marushka et al. 2019; Nesbitt & Moore 2016; Winbourne 2001).

Insights produced from dockside survey results are also highly relevant in the context of growing calls across the Central Coast First Nations to distinguish between industrial-scale recreational fisheries, such as lodges and guide outfitters, and private individual recreational fishers (Central Coast Harmonized Marine Use Plan 2015; Fowler et al. 2023; Haíłzaqv Marine Use Plan 2024).

Under BC's current *Salmon Allocation Policy (1999)*, lodge-based fishing operations are grouped with private recreational fishers despite operating for profit and generating high fishing pressure in some areas. Differentiating these sectors would greatly improve transparency in allocation and better reflect actualized effort and fisheries access. De Valle et al. (2024) similarly found that Indigenous respondents to a BC wide survey expressed concerns about declining access to FSC fisheries -concerns that align closely with those shared by Haíłzaqv fishers during dockside surveys. Respondents from De Valle et al (2024) survey emphasized that reduced access, driven in part by declining fish populations, lack of monitoring and localized management, and climate changes are undermining their food security and called for further research into the links between fishery access and food sovereignty across BC for First Nations. Our findings echo these concerns. Declining local coho populations, such as those from the Hecate Strait and Lowlands CU, combined with increasing variability in CPUE, are directly limiting access to Haíłzaqv FSC fishers.

These trends coupled with coast-wide salmon declines are threatening food security for communities like the Haíłzaqv Nation, where salmon remains a vital cultural and nutritional foundation (Gavenus 2023; Marushka et al. 2019; Nesbitt & Moore 2016; Wilson et al. 2025; Winbourne 2001). Limited access to traditional foods and food systems has serious implications for Indigenous health and well-being. Pacific salmon are not only rich in protein, micronutrients, and omega-3 fatty acids (Blanchet et al. 2021; Marushka et al. 2021; Sheehy et al. 2015) but are also deeply rooted in all aspects of Indigenous Knowledge Systems, culture, social life, and spiritual identity (Garibaldi & Turner 2004; Kuhnlein et al. 2013). The act of fishing supports intergenerational knowledge transfer, physical activity, family and community connection - contributing to overall wellness (Egeland et al. 2009; Gavenus 2024; Marushka et al. 2021). Food insecurity remains disproportionately highest among Indigenous households in Canada. In BC, 41% of Indigenous households are reportedly food insecure, while across the country, over half (54.2%) of First Nations households living on-reserve report food insecurity, compared to just 12.3% of Canadian households overall (Marushka et al. 2021). Our results indicate declining coho catch success and reduced salmon CPUE among Haíłzaqv FSC fishers, including ~30% of trips ending in zero-salmon catch, directly reduce access to salmon. This exacerbates challenges in First Nations meeting household and community requirements for traditional foods, such as

Pacific salmon. Combined with the cultural, nutritional, and social importance of Pacific salmon, these trends further highlight the compounding effects of ecological changes and inconsistent fisheries access on the health, well-being, and food security of coastal First Nations.

Importance of Localized Salmon Monitoring

For millennia, First Nations communities have developed long-standing knowledge of Pacific salmon passed down through generations, informed by diverse approaches to monitoring local populations through harvest, ceremonial protocols, stewardship and governance (Atkinson et al. 2025; Atlas et al. 2021; Reid et al. 2022). Since time immemorial, observations out on the lands and waters by harvesters subsequently inform Indigenous governance and management decisions (Eckert et al. 2018; Esquible et al. 2024; Housty et al. 2016; Steel et al. 2021; Thompson et al. 2019). In the Central Coast of BC, Kitasoo Xai'xais Nation members describe both past and present salmon monitoring methods employed by harvesters and fisheries managers alike, emphasizing that the practice of harvesting itself is both monitoring and management (Sleigh 2024). These in situ monitoring methods as well as formalized methods are widely practiced today by First Nations community members up and down, across, and beyond the coast of BC (Sleigh 2024). However, as climate change is now forcing salmon, people, and ecosystems to adapt at rates never previously experienced before in our lifetimes, monitoring changes in salmon distribution, diversity, health, and contributions to fisheries has never been more critical (Atkinson et al. 2025; Bradford & Irvine 2000; Esquible et al. 2024). Rapid shifts in ocean temperatures, altered freshwater flow regimes, increasing frequency of extreme weather events, and widespread habitat degradation are driving unprecedented changes in Pacific salmon migratory pathways, survival rates, and population composition (Connors et al. 2025; Schoen et al. 2017). At the same time, these ecological shifts are intensifying pressures on communities that rely on salmon for food security, local economics, and cultural continuity, underscoring the urgent need for timely and finer-scale data to support adaptive and precautionary decision-making (Gavenus et al. 2023; Nesbitt & Moore 2016).

Localized fisheries monitoring can better inform precautionary management to improve outcomes for Pacific salmon. However, it requires effective communication, coordination, and collaboration between multiple sectors and jurisdictions including Indigenous (e.g. First Nations

governments like the Haíłzaqv Nation), Federal (e.g. Fisheries and Oceans Canada), State (e.g. Alaska Board of Fisheries and/or Alaska Department of Fish and Game, and international governing bodies (e.g. the Pacific Salmon Commission (Wilson et al. 2025). While a truly collaborative governance arrangement for salmon fisheries within BC is hard enough, it also requires radical change in harvest management from both Canadian and Alaskan fisheries (Atlas et al. 2024, 2025).

Formal recognition and support for Indigenous-led salmon monitoring is a tangible step toward fisheries reconciliation. Such efforts affirm Indigenous rights, governance, self-determination, and data sovereignty, while underscoring the irreplaceable value of Indigenous Knowledge (Gauvreau et al. 2017; Jones et al. 2024; Reid & Ban 2025; Sleigh 2024). Support by DFO and other non-Indigenous managers, researchers, and fisheries practitioners (by way of accepting monitoring data as credible, providing financial support, capacity, etc.) can help rebuild trust and strengthen coastwide salmon conservation efforts (Sleigh 2024; Steel et al. 2021). Our findings highlight the strong correlation between local salmon populations and local harvest in Haíłzaqv Territory, emphasizing the urgent need for collaborative strategies that prioritize both conservation and equitable access for Indigenous fishers.

Calls to Action & Recommendations

Compared to other fisheries sectors in BC, recreational fisheries are often poorly monitored, with limited information on total harvest impacts for many remote areas of the province (Atkinson et al. 2025). Without access to a reliable time series of recreational fishing data, DFO managers are often limited in their ability to accurately estimate recreational catches, harvests, and post-release mortality across BC, resulting in fisheries management decisions that fail to reflect real time changes in salmon population status. This reliance on potentially biased and/or limited data has often led to decisions entrenched and reinforcing the status quo, despite ongoing concerns from First Nations and conservation organizations (Bendriem et al. 2019; Lunzmann-Cooke et al. 2024; Mackenzie & Cox 2013; McCormick et al. 2013). Ultimately, ongoing challenges in effectively and equitably monitoring BC's recreational fisheries are undermining efforts to conserve salmon populations, resulting in inconsistent management approaches across regions (Morrow et al. 2022). This is further limiting First Nations' access to healthy fish populations for

FSC purposes, compromising communities and fishers' ability to sustainably exercise their constitutionally protected Indigenous rights (CCFN SAP workshop report 2025; Steel et al. 2021). There is a pressing need to improve monitoring of the recreational fishing sector, including the adoption of technologies and methodologies that can support more accurate and transparent data collection (including GSI analysis) across BC for Pacific salmon.

Bringing together fisheries catch monitoring data with salmon GSI offers a powerful approach to improving estimates of fishery trends in Haíłzaqv Territory, particularly within PFMAs 7 and 8 (Beauchamp et al. 2019). For example, August is the busiest month for fishing and harvesting coho among both FSC fishers and recreational fishers throughout the area, and this effort also coincides with the peak migration period for Central Coast coho CUs into the region. This overlap underscores the importance of adaptive, in-season management decisions that prioritize and apply precautionary measures during this critical time. Analysis of five seasons of GSI data (2019–2023) and six seasons of dockside creel surveys (2019–2024) indicates a clear relationship between CU-level coho abundance and fishery catch, particularly for the Hecate Strait–Lowland CU. Reducing fishing pressure and limiting harmful practices such as catch and release fishing in summer months could help lower conservation risks to vulnerable coho populations -such as those from the Hecate Straits and Lowlands populations and other known populations of concern.

To better align Central Coast salmon fisheries with the principles of precautionary and adaptive fisheries management to ensure long-term conservation of Pacific salmon for all fisher groups, we propose the following management recommendations to be considered for potential implementation during the 2026 fishing season throughout PFMAs 6-9. The following recommendations aim to reduce harvest risks for data-limited salmon populations (such as the Hecate Strait–Lowlands CU) while also protecting other depressed salmon populations that migrate through the Central Coast during peak harvest periods.

No Catch & Release Fishing: Mandatory retention of all legal-sized salmon in marine fisheries to reduce catch and release mortality

Evidence from HIRMD dockside surveys (2019-2024) suggests that recreational fishers, and to a lesser extent Haíłzaqv FSC fishers, routinely release large numbers of legally harvestable coho salmon caught in the Central Coast marine fishery. This pattern is evident in their self-reported harvest and release information. This practice raises serious conservation concerns, as it likely contributes to substantial undocumented post-release mortality among local Central Coast coho populations. Given the recent declines and variability in coho productivity, and research demonstrating post-release mortality in coho may exceed 50%, reducing or eliminating catch and release practices in marine fisheries presents a key opportunity to lower undue conservation risks while still allowing for harvest opportunities (Cook & Schramm 2007; Hinch et al. 2024; Patterson et al. 2017; Van Leeuwen et al. 2020). Hinch and Lunzmann-Cooke et al (2024) recommend allowing fishers to retain undersized salmon as part of their daily quota, since many of these fish will unlikely survive release or remain fit enough to reach the spawning grounds and successfully reproduce. In addition to negative population impacts, catch-and-release fishing practices remain deeply misaligned with Haíłzaqv values, laws, and stewardship responsibilities (Atlas 2019; Gauvreau et al. 2017; Heiltsuk Marine Use Plan 2024; Lee et al. 2019; Steel et al. 2021; White 2011). These concerns have been clearly expressed in the updated Heiltsuk Marine Use Plan (2024) as well as the harmonized Central Coast First Nations Marine Use Plan (2015), further highlighting catch-and-release fishing as a threat to conservation and future access to salmon.

Lowering Harvest Limits: When necessary, reduce the daily limit of coho salmon to 2, with a maximum 4 in possession for recreational fishers

In recent years the productivity and abundance of Central Coast coho salmon populations have varied significantly, creating a need for precautionary management approaches that aim to reduce conservation risks during years of low returns (Wilson et al. 2025). However, due to limited systematic escapement, spawner abundance, and fisheries catch monitoring led by DFO, reliable information on coho salmon abundance is unavailable for many CUs, and the information that is collected is generally not accessible until well after the fishing season ends (Atkinson et al. 2025). These data limitations pose serious challenges to timely and informed decision-making. To reduce these challenges, we recommend maintaining a conservative daily and possession limits for coho salmon, specifically a daily limit of 2 and possession limit of 4 for recreational

fishers, until improved monitoring systems, pre-season forecasting, and in-season indexes of abundance are in place and co-governance processes underway at the Central Coast Management Council have established agreed upon benchmarks for adaptive management. As CCFNs and DFO continue working together and in parallel to strengthen salmon population and fishery monitoring for coho salmon, HIRMD will continue accessing opportunities to support more accurate pre-season forecasting and responsive in-season management. In future years, these improvements could allow for increased harvest opportunities when run sizes warrant them. We suggest that August may be the most appropriate month for implementing this regulation, as it coincides with the highest fishing effort and greatest likelihood of encountering coho from local CUs returning to the area.

Long-term Funding for Monitoring

One of the most salient challenges facing Indigenous-led fisheries monitoring is the absence of stable, long-term funding dedicated specifically to fisheries monitoring. This issue is particularly acute for remote communities, where operational costs are higher, and any available funding is often inconsistent, inflexible, and inadequate to meet current realities and needs (Frid et al. 2023; Seidler et al. 2024; Sleigh 2024). Consequently, Indigenous-led organizations and First Nations governments' must piece together funding from multiple sources, sacrifice other stewardship initiatives or priorities, or limit their monitoring activities. One way to advance fisheries reconciliation through direct action in Canada is by the federal government providing stable, long-term funding that supports Indigenous-led fisheries monitoring and management programs (Jones et al. 2024; Sleigh 2024). This includes increasing and diversifying flexible, long-term, and non-competitive funding opportunities accessible to First Nations to support their salmon monitoring programs by the Canadian federal government and agencies such as Fisheries and Oceans Canada.

Research Limitations

While this research has strengthened our collective understandings of local coho salmon populations and their contributions within Haíłzaqv Territory, and the broader Central Coast of British Columbia, it has some inherent limitations. Firstly, there are several potential sampling biases associated with conducting creel-style surveys and dockside monitoring methods in

fisheries research (Beauchamp et al. 2019; Ditton & Hunt 2008). For example, most fishers survey answers and subsequent salmon GSI samples are obtained from individuals fishing near or originating their trip from Bella Bella, thus recreational fishers fishing in other PFMAs nearby may not be accurately accounted for in the survey data. The HIRMD dockside surveys in Bella Bella are conducted generally between the hours of 12:00 to 22:00. Accordingly, fishers fishing from shore or early in the morning or late at night are not captured in the surveys. Moreover, one of the greatest limitations of creel-style surveys is sampling error due to potential fisher avidity bias: i.e. some fishers fish more frequently (and hence have a greater chance of being intercepted), consequently they are sampled more frequently (Johnston et al. 2022; Nieman et al. 2021). To achieve a cross section of angler behaviors, attitudes and expenditures, anglers need to be sampled with an equal probability. Attempts were made to minimize avidity bias by surveying fishers from all three public docks around Bella Bella, as well as conducting surveys over the phone and asking private recreational fishing guides to provide surveys to HIRMD.

More broadly, our ability to interpret GSI results is reduced particularly because genetic baselines for coho salmon in the Central Coast -and more broadly across BC- remain patchy and limited. This uncertainty is compounded by the inherent associated variability in coho population productivity and climate change impacts to marine ecosystems. Research in the Pacific Northwest region indicates that future coho population recoveries will greatly depend upon both productivity trends as well as harvest management (Adkinson et al. 2024; Beacham et al. 2020; Bradford & Irvine 2000; Wilson et al. 2025). Given these limitations, GSI results and understandings should be interpreted with caution. To help mitigate this uncertainty, GSI results are reported as probabilities across five potential CU assignments, summing to 100%.

Our findings from HIRMDs dockside surveys are limited in terms of what the results can and cannot reveal regarding the recreational fishing sector. This is due in part to the fact that we cannot currently account for all the potential individual recreational fishers passing through the region, as our sampling design only allows us to speak with fishers who choose to stop in Bella Bella or surrounding docks given the current study design. To better estimate recreational fishers CPUE, we sample at the largest recreational fishing lodge in Area 7 on a weekly basis throughout the fishing season. Moreover, while our focus on Haíłzaqv FSC fishers' knowledge and data

provided rich, place-based insights but did not fully capture the breadth of perspectives or harvest patterns of private recreational fisheries and lodge-based operations -groups that also exert considerable influence on local salmon populations throughout the region. This caveat highlights the need for additional and more comprehensive monitoring throughout the region. We suggest that future work expand to include analysis on other salmon species and integrate additional data sources, such as overflights surveys and boat counts, to strengthen creel estimates and provide a more complete picture of harvest estimates and activity across the broader Central Coast.

Lastly, our research and analysis centered primarily on coho salmon, even though the Haíłzaqv fisheries monitoring program collects valuable information on other salmon and marine species. Strengthening collaborations with other First Nations, Indigenous-led organizations such as the Central Coast Indigenous Resource Alliance, and fisheries researchers throughout the year (not only during summer months) could further strengthen regional-scale understandings of fisheries dynamics. Incorporating data from recreational and lodge operations would further support a holistic understanding of harvest pressures across all active fishers, year-round. This expanded, yet still collaborative monitoring effort is urgently needed to support equitable, precautionary, and adaptive management of Pacific salmon in British Columbia, guided by the values, knowledge systems, and management priorities of Indigenous Peoples and their communities.

Conclusion

To move beyond the current reactive crisis management regime, we argue for a true shift toward longer-term, systems-based approaches that recognize the value of Indigenous Knowledges alongside western scientific data (e.g. transformation). This includes sustained financial investment in Indigenous-led fisheries catch monitoring, and the appropriate application and uptake of DFO managers of ‘alternative data sources’ to western sciences (Moffat et al. 2025) such as fisher knowledge, place-based and seasonal observation patterns, Indigenous ways of knowing, and governing whole salmon systems. This information offers holistic understanding of ecological and social change and can support management decisions that are grounded, anticipatory, and just (Artelle et al. 2019; Esquible et al. 2024; Gauvreau et al. 2017; Reid & Ban 2025). Without this necessary shift, DFO managers continue to reactively respond to crises

without the fundamental information or relationships required to mitigate them and continue to marginalize Indigenous conservation priorities and knowledge systems in the process, as reflected through the development of the five-year Pacific Salmon Strategy Initiative (PSSI) in 2021 and the funding mechanisms launched through the joint Salmon Restoration and Innovation Fund (BCSRIF) in 2019.

Using data from HIRMD's salmon catch monitoring surveys (2019–2024) and salmon Genetic Stock Identification results (2019–2023), we estimate the contributions of Central Coast coho CUs to harvests in Pacific Fisheries Management Areas 7 and 8 and examine seasonal and interannual trends in CU-specific catch. These findings enhance our understanding of current coho population dynamics, their role in Haíłzaqv fisheries, and how local fishers access and experience these fisheries in the context of increasing climate-related uncertainty. This research demonstrates how producing reliable, community-driven data through programs like the Haíłzaqv Fisheries Monitoring Program, can enable precautionary, adaptive management approaches that support salmon conservation, Indigenous governance, and improved fisheries access through monitoring. Ultimately, in the face of escalating climatic and environmental pressures, strengthening Indigenous leadership in fisheries monitoring and management offers a promising pathway toward equitable, culturally grounded salmon governance that benefits ecosystems, communities, and fishers now and into the future.

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Salmon Commission's Northern Fund (to CCIRA), and the Heiltsuk Integrated Resource Management Department. Fisheries and Oceans Canada also provided direct support for salmon Genetic Stock Identification analysis costs.

Chapter 5. Conclusions

Dissertation Overview

Pacific salmon, along with the coastal marine ecosystems they inhabit, face an increasingly uncertain future (Reid et al. 2022; Wilson et al. 2025; Zurba et al. 2021). Multiple, compounding stressors (ranging from climate change and habitat degradation to overharvest) threaten the long-term viability of salmon populations and associated fisheries. These pressures have profound impactions on the wellbeing of Indigenous Peoples, their cultures, and their Knowledge Systems (Carothers et al. 2021; Whitney et al. 2020). Confronting these challenges requires more than reactive crisis management by colonial governments. It requires truly new ways of thinking (e.g. proactive, innovative, holistic, and transformative) about how we collectively manage and govern salmon fisheries in an unprecedented and rapidly changing world. One certainty is that Indigenous Knowledges Systems, which include stewardship values and practices, have sustained fisheries across the Pacific region for millennia -and will continue to do so (Atlas et al. 2021; Campbell & Butler 2010; Castaneda et al. 2020; Reid et al. 2022; Reid & Ban 2025). Yet, these relational, place-based Knowledges are often overlooked in current colonial governance frameworks dominated by federal agencies and western science (Cook et al. 2021; Reid et al. 2021).

Compounding threats to wild Pacific salmon and their conservation throughout British Columbia, Canada and the broader Pacific Northwest region, are exacerbated by significant data gaps. Many salmon fisheries remain data-deficient, and mixed-stock marine fisheries continue to complicate efforts to conserve vulnerable populations. Public fisheries catch data for Indigenous Food, Social, and Ceremonial (FSC) fisheries, as well as commercial and recreational sectors, are often limited or in some cases, simply nonexistent, constraining both conservation and management responses (Inman et al. 2021; Walters et al. 2019). Through use of interviews, surveys, workshops, dockside surveys and data analysis, this dissertation demonstrates how Indigenous-led fisheries monitoring efforts and methods of knowledge co-production are helping to close these gaps for Pacific salmon. This dissertation contributes to three core areas of literature: firstly, scholarship on Indigenous Knowledge and First Nations governance of lands and waters, secondly, knowledge co-production for Pacific salmon fisheries monitoring led by

Indigenous Peoples, and thirdly, conceptualizations of Pacific salmon fisheries management and policy reform from First Nations throughout British Columbia.

The research presented through this dissertation shines light upon examples of knowledge co-production in relation to Pacific salmon monitoring, management, and policy assessment in the Pacific Northwest, focusing on the region within which Pacific salmon primarily migrate (Alaska, British Columbia, Yukon, Washington, and northern Oregon). Together these research findings emphasizes that effective and equitable salmon conservation and management, both now and into the future, depend on our collective ability to draw upon all the very best available tools, knowledge systems, and insights (Reid et al. 2020, 2021). This requires time, effort, and above all, meaningful relationships (Cadman et al. 2024; Reid 2020; Ellam Yua et al. 2022). In the face of mounting pressures on coastal ecosystems and fisheries worldwide, we argue that it is now more pertinent than ever to support and uplift Indigenous governance and stewardship while centering principles of knowledge co-production, as this is increasingly recognized as one of the most effective pathways to addressing biodiversity loss and advancing sustainable fisheries management (Artelle et al. 2019; Armitage et al. 2024; Connors et al. 2025; Norström et al. 2020; Price & Claxton 2020; Popken et al. 2023; Reid & Ban 2025; Zurba et al. 2021).

Dissertation Objective & Guiding Research Questions

This dissertation centers on themes of knowledge co-production for Pacific salmon, emphasizing Indigenous perspectives and knowledges to strengthen salmon fisheries monitoring, management, and policy assessment. Our research illustrates the current opportunities, challenges, and synergies involved in co-producing research that brings together multiple ways of knowing (Indigenous Knowledge and western science), for monitoring and stewarding Pacific salmon fisheries in the Pacific Northwest. Specifically, Chapter 1 introduced the historical and contemporary context of Pacific salmon stewardship and management across the Pacific Northwest, establishing the research problems addressed by this dissertation. Chapter 2 details the co-development process of a Salmon Allocation Policy assessment tool. Chapter 3 reviews some examples of Indigenous-led salmon monitoring programs, highlighting their applications, outcomes, management priorities, and conservation objectives. Chapter 4 builds on these themes through a case study of the Haíłzaqv Nation's salmon fisheries monitoring program, focusing on

coho fisheries and recommendations for improved conservation and management outcomes in the Central Coast of BC. All research presented in Chapters 2 through 4 was conducted in partnership and collaborations with Indigenous and non-Indigenous fisheries managers, staff, community representatives, leaders, and knowledge holders.

The overarching aim of this dissertation is to center Pacific salmon, Indigenous Peoples, and Indigenous Knowledges, to offer recommendations for transforming colonial fisheries policies that continue to shape Pacific salmon fisheries in Canada, so they are more inclusive of and guided by multiple knowledge systems and knowledge that is co-produced. To achieve this objective, I applied both theoretical and empirical approaches from natural and social sciences, focusing our research through case studies across the Pacific Northwest region of North America, with particular attention on the Central Coast of British Columbia. Specifically, I address three core research questions which support the dissertations' central objective. Below, I summarize the main findings for each of these research questions, including recommendations, followed by a discussion of research limitations, lessons learned, and potential directions for future research.

Research Question 1, Chapter 2:

The first research question of this dissertation asked was: "*How can an assessment tool be co-developed with First Nations to reflect Indigenous perspectives on the implementation of Canada's 1999 Salmon Allocation Policy (SAP), particularly regarding conservation objectives and Canada's stated commitment to priority access for Indigenous Nations to salmon fisheries in British Columbia?*" To address this question, we collaborated with the First Nations Fisheries Council of British Columbia (FNFC) and representatives from 51 First Nations across British Columbia to co-create a Salmon Allocation Policy Assessment Tool (framework). The tool was designed to evaluate the SAPs effectiveness in meeting two of its stated objectives: prioritizing salmon conservation and ensuring First Nations priority access. While the focus on this chapter details the development process of the tool itself, it is important to note that we also conducted an additional follow up workshop and interviews with four Central Coast First Nations to pilot the tool and identify specific regional concerns with the 1999 SAP implementation from inception to current. This additional research led to the creation of a Regional Central Coast First Nations SAP Assessment Report, which is confidential in nature and not shared within this PhD

dissertation. We also created a Salmon Allocation Policy Assessment Tool Development Workshop Summary Report, and provided this to all partners and collaborators, which is also confidential and not included within this PhD dissertation.

During the co-development process of the SAP assessment tool, we found that there were consistent results revealed among the First Nations partners and collaborators regarding the implementation of the 1999 SAP in relation to upholding salmon conservation and First Nation priority allocations. In particular, workshop and interview participants continually identified the failure of the federal government of Canada to uphold the Doctrine of Priority, which requires the First Nations' Food, Social, and Ceremonial (FSC) fisheries be given priority after conservation needs are met in British Columbia. Participants from both the co-development workshop and the subsequent regional Central Coast pilot workshop also pointed to barriers including inadequate stock assessments, the absence of biological escapement goals and data, and continued competition with commercial and recreational harvesters despite declining salmon abundance as key challenges to the implementation of the SAP.

This research makes several important contributions to salmon management and fisheries policy assessment theoretical discourse. It advances understandings of knowledge co-production by demonstrating how collaborative, Indigenous-led processes and ways of knowing can reshape fisheries policy evaluation frameworks so that they more accurately reflect Indigenous fisheries conservation and management priorities. It also broadens fisheries policy scholarship, which has often focused narrowly on reviewing biological or technical outcomes, by situating the SAP within broader questions of equity, governance, and reconciliation. Finally, it contributes methodological innovation by demonstrating how qualitative, regional, and rights-based perspectives can shape policy assessment reform through collaboratively developed indicators and tools. These contributions help highlight how fisheries policy evaluation can move beyond western scientific models to approaches that meaningfully engage with the values and knowledge systems of Indigenous Peoples. Currently, this chapter is under peer review at Facets.

At the same time, this work also offers tangible and practical contributions to fisheries management and policy review in British Columbia. The SAP assessment tool can provide

governments, fisheries managers, and Indigenous organizations an applied framework for evaluating whether the SAP is achieving its stated objectives or at least provide a starting point. The pilot application of the SAP assessment tool further demonstrates that the tool can help surface regionally specific shortcomings and generate evidence to support reforms, particularly ensuring that Indigenous salmon Food, Social, and Ceremonial requirements are met, and conservation objectives are upheld. More broadly, the process of co-developing the tool along with the indicators and metrics that make up the tool, represents a model for reconciliation in practice, offering a potential pathway to ensure Indigenous voices and Knowledges are not only included but are central in the future evaluations and updates to fisheries policies that continue to dictate fisheries governance in Canada. Perhaps this model may be adapted to other fisheries policy assessments in Canada and beyond.

Looking forward, there are clear opportunities for future research and application in relation to this chapter. Expanding the SAP assessment tool to include indicators for the commercial and recreational sector of the SAP, developed in partnership with representatives from those sectors, would allow for a more comprehensive evaluation. Continuing to pilot the tool with additional First Nations across British Columbia will also strengthen legitimacy and highlight regional patterns in policy impacts. Most importantly, the findings generated by these forthcoming assessments can help shape the forthcoming review of the SAP, to ensure that policy reform is representative of the lived experiences and priorities of the Indigenous Peoples in which the policy directly impacts.

Citation: Steel, J., Whitney, C., Ban, N., Atlas, W., Adams, M., Cannon, S., Beveridge, R., Gavenus, E., Connoy, J., Mason, T., Mahon, M., Mills, M., Wong, J., Blakley, A., & Harper, S. (in review). Co-developing a fisheries policy assessment tool: Evaluating British Columbia's Salmon Allocation Policy. Submitted to Facets Journal.

Research Question 2, Chapter 3:

The second research question this dissertation asks was: "*What are some of the motivations, challenges, and outcomes of active Indigenous-led salmon monitoring programs throughout the Pacific Northwest and how does Indigenous-led monitoring support collaborative fisheries*

management arrangements?" As a first step in answering this question, I reviewed available peer-reviewed and gray literature on Indigenous-led salmon monitoring programs from across the Pacific Northwest region. While this scoping review exercise provided important background, it also revealed significant gaps in what has been documented in peer-reviewed literature to date. I found that much of the existing scholarship surrounding Indigenous-led salmon monitoring describes monitoring programs structures or technical methods, but rarely centers the perspectives of Indigenous fishers, managers, stewardship staff, leaders, and Knowledge holders. Nor does much of the literature discuss the motivations that drive Indigenous monitoring efforts, or the ways in which monitoring influences fisheries governance, albeit collaborative or not.

In an effort to answer the research question, and under the guidance of our research partners from the Tamamta Program in Alaska, the Centre for Indigenous Fisheries in Vancouver, and the Central Coast Indigenous Resource Alliance, I conducted in-depth interviews with 31 Indigenous and non-Indigenous fisheries managers, staff, and Knowledge holders from across the Pacific Northwest region, including Alaska, Yukon, British Columbia, Washington, and northern Oregon. The findings solicited from the interviews offered a unique opportunity to better understand and learn about how some Indigenous-led salmon monitoring programs are envisioned, practiced, sustained, and importantly, how they contribute to First Nation and Native Tribal communities' well-being and collaborative salmon management.

We found that Indigenous-led salmon monitoring programs are motivated by multiple, yet often interconnected priorities. For example, the research revealed that there was a strong need to generate data based on multiple knowledge systems to ensure conservation measures reflect local conditions, uphold responsibilities to salmon, and respect Indigenous data sovereignty. Results also highlighted the importance of monitoring as a means of exercising governance authority, strengthening cultural continuity, and supporting decision making that utilizes multiple knowledge systems. At the same time, this research also identified significant challenges currently facing Indigenous-led salmon monitoring programs, including chronic underfunding through the dependence on short-term project-based grants and limited recognition from state and federal governments on the validity of data. These barriers -along with others as identified

through our research- undermine the stability of monitoring programs and reinforce current power imbalances in Pacific salmon fisheries monitoring and management. Importantly, our findings stress that Indigenous-led salmon monitoring cannot be solely understood as data collection. Rather, monitoring is often an expression of Indigenous sovereignty and stewardship responsibilities, rooted in intergenerational care for salmon and future generations to come.

This chapter makes both broad theoretical and practical contributions. Theoretically, it contributes to fisheries management and monitoring discourse by demonstrating how Indigenous-led monitoring co-creates knowledge, supporting authority and informs decision making. We contribute understandings that monitoring is not simply a technical exercise but a political, and cultural practice that reflects and advances Indigenous governance and stewardship priorities for Pacific salmon. Methodologically, this research also contributes to knowledge co-production scholarship by centering Indigenous voices in understanding program designs, implementations, and outcomes, challenging dominant fisheries narratives that have historically and continue to marginalize Indigenous perspectives and Indigenous Knowledge Systems within western science and fisheries discourse.

Practically, this research provides valuable insights for fisheries monitoring and management, as it highlights current gaps in funding and colonial institutional support, the need to recognize Indigenous-led monitoring as an essential component of fisheries governance, and how collaborative fisheries management arrangements could be strengthened when these programs and their information are rightfully acknowledged and upheld at management tables. Our research findings for this chapter have been disseminated in multiple formats to ensure their usefulness to both academic and community audiences. A confidential research findings report was shared to all interview and research partners, containing detailed findings and examples not included in this dissertation out of respect and sensitivity of some information. In addition, this chapter is currently in peer review at the journal of Ecology and Society, extending the academic contributions of this work. The success of this research relied in part on the partnership with Tamamta collaborators in Alaska, whose leadership and networks were crucial for providing guidance and support throughout the research process.

Our research points to several directions for future study and expansion of the work. We suggest that further research is needed to better understand how colonial institutional structures, such as funding models and policy frameworks shape the effectiveness and stability of Indigenous-led salmon monitoring programs and fisheries co-governance arrangements in general. There has also been strong interest from collaborators and partners in coming together to build upon the Central Coast Indigenous Resource Alliance's fisheries monitoring workshop previously hosted in 2022, to host an additional, larger in-person workshop to share experiences, strengthen knowledge co-production in fisheries monitoring and to advance cross boarder Indigenous salmon collaborative monitoring and governance throughout the Pacific Northwest.

Citation: Steel, J., Ban, N., Carothers, C., Reid, A., Whitney, C., Adams, M., Esquible, J., Lee, M., Cunningham, R., Reid, M., Sleigh, L., Walkus, J., Trembly-Boyer, S., Service, C., & Mack, T. (in review). Learning From Each Other: Indigenous-led Pacific Salmon Monitoring. Submitted to Ecology and Society

Research Question 3, Chapter 4:

The third research question this dissertation asks is: "*How can an Indigenous-led salmon monitoring program strengthen knowledge of local salmon populations while supporting management priorities and community requirements for Food, Social, and Ceremonial (FCS) fisheries?"* The fourth chapter of this PhD dissertation -completed in close collaboration with the Heiltsuk Integrated Resource Management Department (HIRMD)- was initiated in part as a response to lessons learned during my master's research (Steel et al. 2021) and in service to the Haíłzaqv Nation. To answer the guiding question, we started by drawing on and analyzing data collected through the Heiltsuk Integrated Resource Management Department Fisheries Monitoring Program. Specifically, we drew upon dockside survey data (2019–2024) and salmon Genetic Stock Identification (GSI) results (2019–2023) to better understand coho salmon contributions to marine fisheries within Haíłzaqv Territory. Building on these findings and in close collaboration with Haíłzaqv partners, we also co-developed fisheries management recommendations for the Central Coast region (Pacific Fisheries Management Areas 6-9).

Our analysis of Haíłzaqv FSC fishers' reported catches and perceptions of the salmon fishery over six years revealed persistent variability in coho Catch Per Unit Effort (CPUE), alongside spatial variations in areas of high catch. Results from the dockside surveys with local fishers illuminated insights into the fishery changes and perceptions experienced by Haíłzaqv salmon fishers, along with fisher demographic changes, and shifting catch and effort for Pacific salmon over time and space. GSI results further illuminated that approximately 90% of coho harvested and sampled in the program near the Haíłzaqv community of Bella Bella originate from Central Coast Conservation Units (CUs), though their relative contributions fluctuated annually, likely reflecting variations in abundance. These findings suggest that fisheries management has significant potential to either reduce or amplify risks to local Central Coast coho populations, especially since multiple CUs with asynchronous returns contribute to regional harvests. We also found a strong relationship between CU-level abundance and catch, particularly for the Hecate Straight-Lowlands CU, which is currently listed as a population of conservation concern.

In response to these findings, we worked with Haíłzaqv partners to co-develop precautionary management recommendations aimed at reducing mixed-stock harvest risks and to better align Central Coast salmon fisheries with both conservation and First Nations priority access at the forefront. Although initially focused on coho, these recommendations were deliberately expanded to include Chinook, pink, chum, sockeye, and steelhead, given the widespread declines in salmon populations across coastal British Columbia and the fact that all salmon species are vital to the Haíłzaqv Nation and neighbouring Central Coast Nations for Food, Social, Ceremonial (FSC), cultural, and economic purposes. A confidential research findings report was shared to HIRMD, containing detailed findings and expanded examples not included in this dissertation out of respect and sensitivity of the FSC catch monitoring information. In addition, a peer reviewed journal article mirroring the details within Chapter 4 is in preparation for publication submission, extending the academic contributions of this work. The Heiltsuk Integrated Resource Management Department views this as an important extension of exercising the Haíłzaqv Nation's rights to steward and manage their fisheries through knowledge co-production in research.

This research and subsequent data analysis centered on coho salmon, despite the Haíłzaqv fisheries monitoring program collecting valuable information on other salmon and marine species. Spatially, we also restricted our analysis to centre Haíłzaqv Territory (Pacific Fisheries Management Areas 7 and 8), leaving broader Central Coast patterns and salmon species less examined. Moreover, our focus on Haíłzaqv FSC fishers' knowledge and data provided rich, place-based insights but did not fully capture the breadth of perspectives or harvest patterns of private recreational fisheries and lodge-based operations, who also exert considerable influence on local salmon populations throughout the region. We suggest therefore, that future work should extend to include analysis on other salmon species and review other monitoring data sets, such as overflights surveys and boat counts, to improve creel estimates and expand coverage across the broader Central Coast. Collaborations and partnerships with other First Nations, Indigenous-led organizations such as the Central Coast Indigenous Resource Alliance, and fisheries researchers could also strengthen regional-scale understandings of fisheries dynamics, while incorporating data from recreational and lodge operations to provide a holistic understanding of harvest pressures from all active fishers. This expanded, yet still collaborative monitoring effort is urgently needed to support equitable, precautionary, and adaptive management of Pacific salmon in British Columbia, guided by the values, knowledge systems, and management priorities of Indigenous Peoples and their communities.

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Research Realities & Limitations

The reality of Pacific salmon fisheries monitoring and management is that these areas of study are inherently complex and multifaceted. Therefore, there were many possible directions to which this PhD dissertation could have taken to address the research questions. Reflecting on this work through the theme of knowledge co-production, I identify three broad limitations facing this dissertation: 1. Scale of research, 2. The challenges of employing knowledge co-production as a framework, and 3. The scope of knowledge and perspectives included throughout

our research. I also think it's important to highlight limitations that expand beyond this PhD research, which continue to fundamentally shape the ability of Indigenous Knowledges and Indigenous-led fisheries research outcomes to influence salmon governance in Canada today.

1. Scales of research: The first challenge and limitation of this PhD research pertain to research scale. Across the Pacific Northwest there are many distinct salmon runs, salmon populations, and fisheries, often harvested in mixed-stock contexts (Groot & Margolis 1991; Schindler et al. 2003). Yet, since colonization, Pacific salmon management has often operated at mismatched scales -local, provincial, state, or Pacific coast wide- which has led to disconnects between the scale of ecological processes, social-cultural dimensions, and the scale of decision-making. To focus this dissertation on the challenge of scale, I conducted research to expand across three geographical and governance scales: first through a Pacific Northwest-wide analysis on Indigenous-led salmon monitoring, second, Canadian focused research on co-developing a Salmon Allocation Policy assessment tool, and third, a First Nation and salmon species specific case study within the Central Coast of British Columbia. However, while this multi-scaled research approach was intentional, it evidentially left out hundreds of other scales of salmon populations, species, and fisheries.

2. Knowledge co-production: The second overarching limitation stems from the challenges of applying knowledge co-production as a research method framework (Rölfer et al. 2022). There are ongoing scepticisms from researchers regarding the distinction between collaborative research and genuine knowledge co-production (Cooke et al. 2021). For example, simplified framings of "integrating", "weaving", "paring" or more problematically, "validating" local or Indigenous Knowledges remain common in fisheries governance, despite critiques of these approaches (Nadasdy 1999; Muhl et al. 2023; Tengo et al. 2014; Reid et al. 2021). Indeed, within existing colonial fisheries management frameworks and systems, research risks becoming a vehicle for co-opting Indigenous Knowledge rather than facilitating meaningful partnerships, knowledge and data sovereignty or self-determination (Mazzocchi 2018). Knowledge co-production also requires an investment of time that far exceeds conventional western-scientific research timelines (Cooke et al. 2021; Mills et al. 2023). Investing the necessary time and capacity to truly work in partnership requires resources to support partners over the duration of

the collaboration (Cadman et al. 2024; Cannon et al. 2024; Jones et al. 2024; Zurba et al. 2021). However, grant funding levels are often not able to provide sufficient time or funding necessary within a single grant, and grant cycles are often short relative to the time needed for iterative science-to-action processes (Mills et al. 2023; Rölfer et al. 2022; Seidler et al. 2024). While recent shifts and efforts within academic discourse mark important progress, without parallel reforms in federal or colonial agencies these efforts may remain limited in impact.

There are also personal limitations to how well I'm positioned as a PhD student to apply knowledge co-production frameworks throughout the research process. I do not currently live within the communities of my research partners and thus relied heavily on communication from a distance. I was fortunate, however, to have previously lived within the Haíłzaqv community of Bella Bella in the Central Coast of British Columbia during my master's research and to have maintained both professional and personal relationships with many incredible people, lands, and waters there. These long-standing connections were integral to the success and outcomes of this dissertation. I cannot stress enough how important it is to make and continue to put in the work to foster in-person connection for undertaking methods of knowledge co-production, especially in collaborative fisheries research.

3. Scope of knowledge included: The third limitation relates to the scope of knowledge and perspectives represented within this dissertation. Our research and the research methods employed aimed to amplify Indigenous voices, perspectives, and knowledges in salmon fisheries monitoring, management, and policy assessment development. However, it was not possible, nor appropriate to attempt to engage with all Indigenous Peoples who monitor, steward, and fish for Pacific salmon, nor can our research be interpreted as speaking on behalf of all Indigenous Peoples or ways of knowing about Pacific salmon. In addition, Pacific salmon are also central to many non-Indigenous commercial and recreational fishers, whose perspectives were not directly included in this dissertation. Their knowledges and experiences could have enriched Chapter 2, in co-developing a third section within the Salmon Allocation Policy Assessment Tool for commercial and recreational salmon fisheries. However, constraints of time, funding, and capacity prevented this inclusion. I'm confident that future research could extend the assessment

tool and co-development process to incorporate perspectives from fishers from these sectors, alongside considerations for salmon fisheries management reform.

These challenges reflect limitations of this dissertation, yet they are also shaped by a broader governance constraint, the current colonial governance system of Canadian fisheries itself. Despite growing legal recognition of Indigenous Knowledges and governance authority, the Minister of Fisheries continues to retain ultimate decision-making power over all fisheries (and salmon) management decisions in this country (Fisheries Act 1986). This centralized authority fundamentally constrains the extent to which Indigenous Knowledges, co-produced knowledge, and research can influence policy and practice. Indigenous and non-Indigenous scholars and practitioners alike have argued that meaningful reconciliation in fisheries requires transferring decision-making power back from centralized colonial agencies to Indigenous governance systems and local communities (Adams 2019; Atlas et al. 2021; Armitage et al. 2012, 2024; Popken et al. 2023; Reid & Ban 2025; Steel et al. 2021). Without such structural changes, the impacts of Indigenous-led research and knowledge co-production will remain limited in their ability to effect transformational change that is deeply needed (Bodwitch et al. 2024; Silver et al. 2022; Zurba et al. 2021).

Future Directions

In this dissertation, we assert that the decline of Pacific salmon, alongside the erosion of traditional ways of life for coastal Indigenous Peoples throughout the Pacific Northwest, is in part attributable to the displacement of Indigenous values and knowledge systems that have long underpinned stewardship practices (chapters 3 and 4). In their place, western science-based practices and Eurocentric values and knowledge systems have come to dominate fisheries management (chapter 2) (Carothers et al. 2021; Esquible 2024; Silver et al. 2022). This shift has produced centralized management systems with limited accountability and continues to threaten both the health of Pacific salmon and Indigenous Peoples who depend upon them for Food, Social, and Ceremonial purposes. The findings presented across Chapter 2 through 4 point to the urgent need for transformation in fisheries monitoring, management, and policy reform that acknowledges and centers Indigenous Knowledge Systems, advances relational accountability, and reorients conservation away from profit, greed, and capitalism (Esquible 2024).

Over the past four years, I have come to understand more profoundly that non-Indigenous researchers and fisheries managers working alongside and for Indigenous Peoples must begin from a place of love, care, respect, and trust. At its core, this means asking oneself: who is the research serving? What principles and knowledge systems are guiding the decisions that are being made? In my own research journey, I have learned first-hand the importance of process over product, prioritizing partnerships over projects, and understanding current realities over hypothetical outcomes. A concern that surfaced repeatedly through this work is the danger of doing research without action. As Esquible (2024) reminds us, reciprocity in research demands more than just knowledge sharing; it requires a responsibility to act. It is my hope that this dissertation -and the additional practical contributions stemming from this work- can offer value to Indigenous governments, university researchers and students, fisheries managers, and broader governance bodies concerned with the future of Pacific salmon.

While the writing of this dissertation marks the closing of my doctoral journey, the work itself is far from complete. The Pacific salmon crisis remains unresolved, intensified by climate change other cumulative impacts and pressures amplifying uncertainty and division. We continue to live through unprecedented political, environmental, and social times. In general, this is not a time of salmon abundance; it is a time of survival. In conversations discussing what may lie beyond this research, I am humbly reminded that there is always more work to be done, more listening, more learning, more unlearning, and more sharing of lessons learned -i.e. what is working, and what is not- in advancing Indigenous rights and collaborative management of Pacific salmon fisheries.

I feel strongly that this dissertation reinforces that the theory and practices of knowledge co-production remain underrepresented in fisheries research, particularly in relation to supporting collaborative management across regions and boarders. Theoretically, I suggest that future research should explore how knowledge co-production in salmon fisheries monitoring can contribute not only to improving ecological outcomes but also the governance relationships that underpin effective collaborative fisheries management. Advancing this work thus means grappling with additional questions of power, accountability, and ethics, ensuring frameworks of co-production do not simply re-enforce colonial systems (Bodwitch et al. 2024; Cooke et al.

2021; Ellam Yua et al. 2022; Muhl et al. 2023; Norström et al. 2020; Rölfer et al. 2022; Schuttenberg & Guth 2015; Zurba et al. 2022). Practically, future research could also focus on documenting and supporting the substantial contributions of Indigenous-led monitoring efforts and how such efforts are indeed affecting change for collaborative fisheries management. Specifically, there is a need for cross-border and regional studies that highlight how Indigenous fisheries monitoring programs for Pacific salmon can co-create knowledge, address conservation concerns, strengthen and advance shared decision making for fisheries. In closing, if researchers are "genuinely concerned with the ecological consequences of human activities, then engaging in applied, reciprocal work with Indigenous Peoples offers a direct pathway for science and co-created knowledge to inform and potentially transform policy" (Adams 2019).

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Appendix A. Supplementary Materials Chapter 2.

Appendix A.1 Salmon Allocation Policy Assessment Tool & Indicator Development Workshop: Breakout Group Discussion Questions

Part 1: Conservation

Salmon Stewardship

1. What information is currently lacking to inform stewardship and conservation of salmon species/populations within your Territory? What kinds of information could improve salmon conservation, at what scale?

2. Do you think federal management (~25 years) has been successful in prioritizing conservation for salmon species/populations in your Territory? How can you tell if it is successful or not?

3. Are there current agreements between your Nation and DFO for conservation goals/fishery reference points/fishery openings for salmon? What kind of information is needed to set and/or assess reference points? Please explain.

4. What information should we (FNs, DFO, researchers) use to tell us whether conservation goals for salmon are being met? What would you expect to see if federal managers prioritized salmon conservation in your Territory?

Part 2: First Nations Priority Access

Food Access, Social & Cultural Connections to Salmon

1. How do you know whether your personal and community salmon (food) requirements are being met or not met? Discuss specific ways of knowing or measuring that your salmon food requirements are met.

2. What is needed for your community to maintain and restore cultural knowledge and practices related to salmon? Are there current barriers for you/your community in maintaining cultural connections to salmon? What are they?

3. Do you have recommendations for changes in fishery management that can increase opportunities for community members to access salmon?

4. What information should we (FNs, DFO, researchers) use to tell us whether First Nations Priority Access for salmon is being met? What would you expect to see if First Nations access for salmon is prioritized in your community?

Appendix A.2. Salmon Allocation Policy Assessment Tool Instructions

Date:

Name(s) of evaluators:

Contact information:

First Nation(s) or Organization(s):

Region(s) for assessment *(For this Assessment Tool, region(s) can be defined as a geographically distinct area characterized by ecological, cultural, administrative, or a combination of boundaries. Region(s) can include First Nations Territories, DFO Pacific Management Fisheries Areas, and/or Bioregion, etc.):*

Salmon Specie(s) for assessment *(Please list all salmon species in your region for assessment, however if you would like to note if and how a specific or single salmon species differs, please provide detailed notes within the appropriate 'detailed comments' column for each indicator):*

Instructions for evaluator(s)
The Salmon Allocation Policy (SAP) Assessment Tool consists of two sections: Part 1, focusing on evaluating the Salmon Allocation Policy's ability to meet stated 'Conservation' allocation objectives and Part 2, to meet stated 'First Nations Priority Access' allocation objectives.

1. Please complete all cover page information.
2. Be sure to begin by reading each question (Indicator) carefully and fully. Ensure you understand the indicator being evaluated. If you are unsure, please contact the research team for support. Please consider all relevant information, context, and perspectives for wild pacific salmon in your region of assessment.
3. Based on your reflections for each indicator, select a score from the provided 0-4 scale that best aligns with your assessment of the related indicator. The scoring scale (0-4) is described as follows:
   0- Needs not met, substantive concerns and changes are required to address issues.
   1- Needs are partially met, significant concerns and improvements needed to address issues.
   2- Needs are somewhat met; concerns could be relieved with refinements.
   3- Needs are mostly met, with minor concerns that could be relieved with a few refinements.
   4- Needs are met with no concerns; no further action is required.
4. For each indicator, please also provide a written response explaining why you selected the specific corresponding score. Include any supporting rationale, evidence, or details that help clarify your scoring choice. Written responses should directly relate to the specific indicator. The written responses are critical for helping to better understand the rationale behind each selected score and for ensuring the assessments transparency. Please be sure to include them.

5. Continue this process for all indicators listed in Part 1. Conservation, and Part 2. First Nations Priority Access. Ensure each indicator has an assigned score and corresponding written response.
6. Once all indicators have been evaluated, sum the individual indicator scores for Part 1 and Part 2 to obtain the total Assessment Tool score. Write the total section scores in the designated areas at the bottom of each section of the Tool, and again at the very end of the Tool.
7. After completing the evaluation using the SAP Assessment Tool, please sign your name(s) in the space provided at the bottom of Part 2. If the evaluation was completed collaboratively, all evaluators involved should provide their signatures to acknowledge their participation and agreement with the scores and written answers provided.
8. Upon completion of these steps, please submit the completed SAP Assessment Tool back to the research team.

Appendix A.3. Salmon Allocation Policy Assessment Tool

Table 6. Salmon Allocation Policy Assessment Tool – Conservation Part 1.

Section (within 1999 SAP)	Indicators	Score (0-4) (Metrics)	Written Responses	Your Score
Conservation	**1.** Have salmon escapement goals been set across your region?	0: No escapement goals are established for any salmon populations in my region. 1: Escapement goals are minimally established with significant gaps. Escapement goals still need improvement or further development in the region. 2: Several populations have defined escapement goals, but application in the region is inconsistent. Some areas need improvement or further development of escapement goals. 3: Escapement goals are established for most salmon populations, covering the most important populations in the region. Escapement goals are defined but may need further development. 4: Escapement goals are fully established for all salmon populations in the region.		**Score: /4**
Conservation	**2.** Have salmon escapement goals been co-developed with First Nations in your region?	0: Salmon escapement goals do not exist or were created by DFO without participation from First Nations. 1: There is minimal partnership with First Nations in creating salmon escapement goals, improvement is needed. Indigenous Knowledge is minimally considered when setting salmon escapement goals. 2: Some salmon escapement goals are created in partnership with First Nations, but partnerships could be improved. Indigenous Knowledge is informing salmon escapement goals but there are gaps. 3: Most salmon escapement goals are created in partnership with First Nations, with substantial collaborative input.	**Written Responses**	**Score: /4**

		Indigenous Knowledge is actively informing salmon escapement goals, and efforts are made by DFO to utilize other forms of knowledge in setting escapement goals. 4: All salmon escapement goals are co-created with First Nations. Indigenous Knowledge is fully and equally informing salmon escapement goals.		
Conservation	**3.** Is there accessible in-season salmon monitoring information available to inform whether salmon escapement goals are met in your region?	0: No in-season salmon monitoring information is available in the region. Overall insufficient in-season information is available to assess whether escapement goals are met. 1: Minimal in-season monitoring information is available to inform whether escapement goals are met. 2: Some in-season monitoring information is available to inform whether escapement goals are being met, and some information is available to First Nations in the region in-season. 3: In-season monitoring information is available to assess whether escapement goals are being met. Most in-season salmon monitoring information is available to First Nations in the region. 4: Comprehensive in-season monitoring information is available for First Nations and DFO in the region, covering all necessary areas and salmon populations.	**Written Responses**	**Score: /4**
Conservation	**4.** Are annual spawner surveys (i.e. creek walking) used to estimate the spawning abundance of salmon populations that are important to First Nations in your region?	0: There is no annual spawner surveys conducted, and no spawner surveys are used to estimate salmon population abundance over time. 1: Limited spawner surveys are used to estimate salmon abundance over time, but overall insufficient data to estimate annual salmon spawning abundance.	**Written Responses**	**Score: /4**

		2: Annual spawner surveys are used to estimate salmon population abundance over time, but some data gaps remain. 3: Annual spawner surveys are regularly conducted to estimate abundance for most of the populations that are important to First Nations, however there may be some data gaps. 4: Annual spawner surveys are used consistently to provide reliable estimates of abundance for populations that are important to First Nations.		
Conservation	**5.** Are salmon fisheries catch monitoring program(s) operating in partnership with First Nations in your region?	0: No in-season salmon fisheries catch monitoring programs and no partnerships. 1: There are minimal in-season salmon fisheries catch monitoring programs, but no partnerships between First Nations and DFO in the region. 2: There are some in-season salmon fisheries catch monitoring programs, with some partnerships between First Nations and DFO in the region. 3: There are in-season salmon fisheries catch monitoring programs, with many partnerships between First Nations and DFO in the region. 4: There are in-season salmon fisheries catch monitoring programs throughout the region, all in partnership with First Nations and DFO.	**Written Responses**	**Score: /4**
Conservation	**6.** In your region, are there in-season fisheries management triggers in place for instances when escapement goals for salmon are not being met?	0: Salmon fisheries management decisions (triggers) are not driven by escapement goals and are not made in-season. 1: Salmon fisheries management decisions (triggers) are minimally influenced by escapement goals but are not made in-season. 2: Escapement goals are considered in season for salmon fisheries management	**Written Responses**	**Score: /4**

		decisions (triggers), but other factors take precedence. 3: Salmon fisheries management decisions (triggers) are mostly driven by escapement goals and in-season. 4: Escapement goals are the primary driver of salmon fisheries management decisions (triggers) in season.		
Conservation	**7.** Do First Nations in your region agree that the data used to make salmon conservation decisions are data driven and transparent?	0: First Nations do not agree with or trust the quality of data used for salmon conservation decisions. Data quality is unacceptable and insufficient for making informed decisions. The decision-making process is not transparently communicated. 1: First Nations have significant concerns that the quality of data used for salmon conservation decisions is inaccurate or insufficient. Major improvements required. The decision-making process is poorly communicated. 2: The quality of the data used for salmon conservation decisions is somewhat acceptable, with some limitations, improvements required. The decision-making process is somewhat communicated. 3: The quality of the data used is good and sufficient for making informed conservation decisions, minor improvements needed. The decision-making process is communicated. 4: The quality of the data used to make salmon conservation decisions is excellent, reliable, and First Nations trust the accuracy of the data. The decision-making process is well communicated.	**Written Responses**	**Score: /4**
Conservation	**8.** In your region, what percentage of salmon populations have escapement monitoring?	0: 0% There is no salmon population escapement monitoring in the region. 1: 1% - 30% 2: 30% - 60% 3: 60% - 90%	**Written Responses**	**Score: /4**

		4: 90% - 100%		
Conservation	**9.** Are there salmon indicator stock(s) within your region?	0: There are no salmon indicator stock(s) established in the region. 1: There are some salmon indicator stock(s) established in the region, but the stock(s) used are not representative of populations in the region. 2: Salmon indicator stock(s) are established in the region, but the stock(s) used are not always representative of populations in the region. 3: Salmon indicator stock(s) are established and are representative of most populations in the area. 4: Salmon indicator stock(s) are established in the area and are strongly representative of populations in the region.	**Written Responses**	**Score: /4**
Conservation	**10.** In your region, is Indigenous Knowledge informing salmon conservation?	0: There is no consideration of Indigenous Knowledge, it does not inform salmon conservation efforts. Significant improvements required. 1: Indigenous Knowledge is minimally informing salmon conservation efforts, significant improvements required. 2: Indigenous Knowledge is somewhat informing salmon conservation efforts, but there is room for improvement. 3: Indigenous Knowledge is actively informing salmon conservation efforts. 4: Indigenous Knowledge is fully and equally informing salmon conservation efforts.	**Written Responses**	**Score: /4**
Conservation	**11**. Is there a pre-season salmon forecast set by DFO for your region?	0: There are no pre-season salmon forecasts for the region. 1: There are some pre-season salmon forecasts, but they are unreliable and are not used to support planning and management for the region.	**Written Responses**	**Score: /4**

		2: There are pre-season forecasts for some salmon species, but they are of limited utility for management planning in the region. 3: There are pre-season forecasts, but additional information is required for some populations in the region. 4: There are pre-season salmon forecasts for all species that are targeted in directed fisheries within the region.		
Conservation	**12**. In your region, are recreational fishery catches monitored to inform estimates of annual salmon harvest across the sector?	0: Recreational fishery catches are not monitored and estimates of annual salmon harvest from this sector are not known for the region. 1: Recreational fishery catches are minimally monitored and estimates of annual salmon harvest for this sector are unreliable for the region, extensive gaps are present. 2: Recreational fishery catches are partially monitored, and estimates of annual salmon harvest are somewhat known for the region, but large gaps remain. 3: Recreational fishery catches are mostly monitored, and estimates of annual salmon harvest are generally known and mostly reliable for the region. 4: Recreational fishery catches are monitored, and estimates of annual salmon harvest are comprehensive for the region.	**Written Responses**	**Score: /4**
Conservation	**13**. In your region, are commercial fishery catches monitored to provide estimates of annual salmon harvest across the sector?	0: Commercial fishery catches are not monitored and estimates of annual salmon harvest from this sector are not known for the region. 1: Commercial fishery catches are minimally monitored and estimates of annual salmon harvest for this sector are unreliable for the region. 2: Commercial fishery catches are monitored, and estimates of annual salmon	**Written Responses**	**Score: /4**

		harvest are generally known for the region, but gaps remain. 3: Commercial fishery catches are monitored, and estimates of annual salmon harvest are known and mostly reliable for the region. 4: Commercial fishery catches are monitored, and estimates of annual salmon harvest are comprehensive for the region.		
Conservation	**14**. Have First Nations in your region witnessed salmon population declines in the last 25 years?	0: Dramatic and severe salmon population declines have been witnessed across the region. 1: Significant salmon population declines have been witnessed across most areas in the region. 2: Noticeable salmon population declines have been witnessed across certain areas in the region. 3: Minimal salmon population declines have been witnessed in the region, with few isolated instances of decline noted. 4: Salmon populations have remained stable throughout the region, no declines witnessed.	**Written Responses**	**Score: /4**
Conservation	**15**. In your region, is DFOs 'Precautionary Approach' being appropriately applied to support salmon conservation?	0: DFOs precautionary approach is not implemented and does not support salmon conservation efforts in the region. 1: DFOs precautionary approach is occasionally considered but application is inconsistent in supporting salmon conservation efforts in the region. 2: Some aspects of DFOs precautionary approach are applied to support some salmon conservation efforts in the region. 3: DFOs precautionary approach is a significant component of salmon conservation efforts in the region. 4: DFOs precautionary approach is fully applied to support salmon conservation efforts throughout the region.	**Written Responses**	**Score: /4**

Conservation	**16.** If there are declining salmon stocks in your region, do these stocks continue to be harvested in mixed-stock fisheries?	0: Regardless of the status of salmon stocks, mixed-stock fisheries remain open for all sectors. 1: Mixed-stock fisheries generally remain open, with occasional closures or restrictions for some sectors to reduce impacts on declining stocks. 2: Mixed-stock fisheries are sometimes closed or restricted when declines in stocks are identified, closures and regulations remain inconsistent. 3: Mixed-stock fisheries are typically closed or heavily restricted to reduce risks to declining stocks. If there are openings, strict regulations and conditions are in place. 4: Mixed-stock fisheries are fully closed in years and locations where fishery impacts pose risks to conservation and recovery of identified declining stocks.	**Written Responses**	**Score: /4**
Conservation	**17.** Have First Nations in your region voluntarily closed or restricted FSC and/or treaty designated fisheries for salmon for conservation purposes in the last 25 years?	0: First Nations consistently voluntarily close and/or restrict the FSC and/or treaty designated salmon fishery, and full closures are a common and consistent exercise in the region. 1: Frequently, First Nations voluntarily close and/or restrict the salmon FSC and/or treaty designated fishery, with numerous occurrences in the region. 2: There are occasional voluntary FSC and/or treaty designated salmon fishery closures or restrictions led by First Nations in the region, with moderate number of occurrences. 3: There have been few isolated occurrences of voluntary FSC and/or treaty designated salmon fishery closures or restrictions led by First Nations in the region, with some exceptions. 4: First Nations have never had to close or restrict the FSC and/or treaty designated	**Written Responses**	**Score: /4**

		salmon fishery in the region due to conservation concerns.		
Conservation	**18.** Has DFO closed or restricted FSC and/or treaty designated salmon fisheries for conservation purposes in the last 25 years in your region?	0: DFO consistently closes or restricts the FSC and/or treaty designated salmon fishery, and FSC and/or treaty designated salmon fishery closures are a common occurrence in the region. 1: Frequently, DFO closes the salmon the FSC and/or treaty designated salmon fishery, with numerous instances in the region. Often the FSC and/or treaty designated fishery are restricted. 2: There are occasional DFO-mandated FSC and/or treaty designated salmon fishery closures and/or restrictions led by DFO in the region. 3: There have been a few isolated instances of DFO-mandated FSC and/or treaty designated salmon fishery closures and/or restrictions in the region. 4: DFO never closes or restricts the FSC and/or treaty designated salmon fishery in the region, little to no exceptions.	**Written Responses**	**Score: /4**
Conservation	**19.** If yes, were First Nations in your region appropriately consulted by DFO on the FSC and/or treaty designated salmon fisheries closure(s)?	0: First Nations in the region are never appropriately consulted. 1: First Nations in the region are infrequently consulted. 2: First Nations in the region are intermittently consulted. 3: First Nations in the region are frequently consulted. 4: First Nations in the region are appropriately consulted.	**Written Responses**	**Score: /4**
Conservation	**20**. Are there salmon habitat restoration programs occurring in your region?	0: There are no salmon habitat restoration programs in the region and there is no financial support allocated for such programs. 1: There are only a few salmon habitat restoration programs occurring in the region and funds are insufficient. Financial support	**Written Responses**	**Score: /4**

		comes from other sources that are not dedicated to restoration efforts. 2: There are some salmon habitat restoration programs occurring in the region with dedicated funds allocated to the programs. However, the financial support is short-term and infrequent. 3: There are salmon habitat restoration programs occurring in the region, with dedicated funding, however the financial support is not long term. 4: There are salmon habitat restoration programs occurring in the region with dedicated, stable, and long-term funds.		
Conservation	**21**. If yes, do First Nations in your region perceive the salmon habitat restoration program(s) to be effective for conservation of salmon populations?	0: There are no salmon habitat restoration programs occurring in the region. 1: First Nations in the region do not think the salmon habitat restoration program(s) are effective for conservation of salmon populations, and the program(s) fail to restore salmon habitat. 2: First Nations in the region somewhat think the salmon habitat restoration program(s) are effective for conservation of salmon populations but there are significant concerns that the program(s) have many gaps and are insufficient. 3: First Nations in the region think that the salmon habitat restoration program(s) are effective for conservation of salmon populations, but some gaps remain in the program(s) ability to fully restore salmon habitat. 4: First Nations in the region think the salmon habitat restoration program(s) are effective for conservation of salmon populations, and the program(s) successfully restore salmon habitat.	**Written Responses**	**Score: /4**
Conservation	**22.** Are salmon habitat indicators being monitored throughout your	0: Salmon habitat indicators are never monitored and conservation risks in the	**Written Responses**	**Score: /4**

	region to track conservation risks? (e.g. water quality, stream obstructions, etc.).	region remain unknown due to lack of assessment and tracking. 1: Salmon habitat indicators are inconsistently monitored and conservation risks in the region remain unknown due to a lack of consistent assessment and tracking. 2: Salmon habitat indicators are somewhat monitored and conservation risks in the region remain somewhat known. Assessment and tracking are irregular. 3: Salmon habitat indicators are monitored and conservation risks in the region are known. Assessment and tracking occur semi-regularly. 4: Salmon habitat indicators are fully monitored and regularly assessed to track and understand conservation risks for the region.		
Conservation	**23.** In your region, are the quantitative data (e.g. stock recruit models in measures of MSY, etc.) used by DFO to inform salmon fisheries management decisions inclusive of longer time horizons? (e.g. more than 20 years).	0: No long-term data is used; only short term (<20 years) information is used by DFO to make salmon management decisions in the region. 1: Most salmon management decisions by DFO are made based on short-term information (<20 years), but occasionally DFO references long term data in the region. 2: Long-term (>20 years) data is considered, but short-term information is mostly used by DFO to make salmon management decisions in the region. 3: Long-term (>20) data is regularly used by DFO to make salmon management decisions, but too much reliance on shorter term information in the region remains. 4: Long-term (>20 years) data are fundamental components of management decisions made by DFO in the region, both short and long-term data are used.	**Written Responses**	**Score: /4**
Conservation	**23 Indicators**	**Total Section Score: /92**		

Table 7. Salmon Allocation Policy Assessment Tool – First Nations Priority Access Part 2.

Section (within 1999 SAP)	Indicators	Score (0-4) (Metrics)	Written Responses	Your Score
FNs Priority Access	**1.** Are FSC, rights-based sales fisheries, and/or treaty allocations for salmon meeting the current requirements for First Nations communities in your region?	0: Current FSC and/or treaty allocations for salmon are extremely insufficient for First Nation communities in the region to meet their food requirements and communities are food insecure. Allocation adjustments are required. 1: Current FSC and/or treaty allocations for salmon are generally insufficient for First Nation communities in the region to meet their food requirements and are overall food insecure. Allocation adjustments are required. 2. Current FSC and/or treaty allocations for salmon are largely sufficient for First Nations in the region to meet their food requirements, but some are food insecure. Some allocation adjustments are required. 3: Current FSC and/or treaty allocations for salmon are sufficient for First Nations in the region to meet their food requirements and most are food secure. Allocation adjustments may be required. 4: Current FSC and/or treaty allocations for salmon are fully sufficient for First Nations in the region to meet their food requirements and are food secure. No allocation adjustments are required currently.		**Score: /4**
FNs Priority Access	**2.** Are First Nations in your region involved in informing and updating salmon rights-based fisheries and/or treaty allocations as salmon requirements change for communities?	0: First Nations are not involved in salmon allocation decisions and/or updates. Salmon allocation amounts are significantly out of step with current community realities and requirements. 1: First Nations are rarely involved in salmon allocation decisions and/or updates. Salmon	**Written Responses**	**Score: /4**

		allocation amounts do not reflect current community realities and requirements. 2: First Nations are sometimes involved in salmon allocation decisions and/or updates. Salmon allocation amounts somewhat reflect current community realities and requirements. 3: First Nations are often included in the salmon allocation decisions and updates. Salmon allocation amounts mostly reflect current community realities and requirements. 4: First Nations are always included in salmon allocation decisions and updates. Current salmon allocation amounts reflect community realities and requirements.		
FNs Priority Access	**3.** In your region, do FSC and/or treaty designated fishers have to travel outside of the region to fish for salmon to meet FSC and/or treaty requirements?	0: FSC and/or treaty designated fishers always travel outside the region to fish for salmon and rarely meet their FSC and/or treaty allocation requirements. 1: FSC and/or treaty designated fishers often travel outside the region to fish for salmon as local salmon fishing is insufficient to meet FSC and/or treaty allocation requirements. 2: FSC and/or treaty designated fishers sometimes travel outside of the region to fish for salmon and usually meet their FSC and/or treaty allocation requirements. 3: FSC and/or treaty designated fishers rarely travel outside of the region to fish for salmon and often meet their FSC and/or treaty allocation requirements by fishing locally. 4: FSC and/or treaty designated fishers never have to travel outside of the region to fish for salmon and have access to salmon locally to fulfill FSC and/or treaty allocation requirements.	**Written Responses**	**Score: /4**
FNs Priority Access	**4.** In your region, do First Nation communities have to	0: First Nation communities always trade and barter or purchase salmon from outside the region	**Written Responses**	**Score: /4**

	trade and barter or purchase salmon (or less preferred alternatives) from outside of the region to meet FSC and/or rights-based requirements?	and never meet their FSC and/or rights-based requirements with local salmon. 1: First Nation communities often barter and trade or purchase salmon from outside their region and rarely meet their FSC and/or rights-based requirements from local salmon. 2: First Nation communities sometimes barter and trade or purchase salmon from outside their region and usually meet their FSC and/or rights-based requirements from accessing local salmon. 3: First Nation communities rarely barter and trade or purchase salmon from outside their region and often meet their FSC and/or rights-based requirements by accessing local salmon. 4: First Nation communities never have to barter and trade or purchase salmon from outside their region and always have access to local salmon to fill FSC and/or rights-based requirements.		
FNs Priority Access	**5.** In your region, do First Nations have access to dual salmon fishing opportunities (e.g. commercial and FSC and/or treaty designated)?	0: No dual fishing opportunities exist and barriers (e.g. lack of access to boats, fishing gear, fishing licences, finances etc.) completely prevent access. 1: Limited dual fishing opportunities exist, with significant barriers (e.g. lack of access to boats, fishing gear, fishing licences, finances etc.) to access. 2: Some dual fishing opportunities exist, but with many barriers (e.g. lack of access to boats, fishing gear, fishing licences, finances etc.) to access occurring. 3: Dual fishing opportunities are present, with occasional barriers to access. 4: Dual fishing opportunities exist with no barriers to access.	**Written Responses**	**Score: /4**

FNs Priority Access	**6.** In your region, are there opportunities for new FSC and/or Treaty designated fishers to participate in salmon fisheries?	0: There are no opportunities for new FSC and/or treaty designated fishers to participate in salmon fishing in the region. 1: There are limited opportunities for new FSC and/or treaty designated fishers to participate in salmon fishing in the region, but barriers exist (e.g. full fishing area closures or fishing area reductions for conservation measures etc.). 2: There are some opportunities for new FSC and/or treaty designated fishers to participate in salmon fishing in the region, but there are many restrictions and limitations (e.g. full fishing area closures or fishing area reductions for conservation measures etc.). 3: There are opportunities for new FSC and/or treaty designated fishers to participate in salmon fishing in the region, but there are some restrictions and limitations (e.g. full fishing area closures or fishing area reductions for conservation measures etc.). 4: There are ample opportunities for new FSC and/or treaty designated fishers to participate in salmon fishing in the region, with little to no restrictions or barriers.	**Written Responses**	**Score: /4**
FNs Priority Access	**7.** In the last 25 years, how has the number of fishers participating in salmon FSC and/or treaty designated fisheries changed in your region?	0: The number of active FSC and/or treaty designated fishers participating in salmon fishing has severely declined in the last 25 years. 1: The number of active FSC and/or treaty designated fishers participating in salmon fishing has declined in the last 25 years. 2: The number of active FSC and/or treaty designated fishers participating in salmon fishing has stayed the same in the last 25 years. 3: The number of active FSC and/or treaty designated fishers participating in salmon fishing has increased in the last 25 years.	**Written Responses**	**Score: /4**

		4: The number of active FSC and/or treaty designated fishers participating in salmon fishing has substantially increased in the last 25 years.		
FNs Priority Access	**8.** Are FSC, rights-based and/or treaty designated fishers able to access salmon fishing area(s) to fulfill salmon allocations without impediment from other stakeholder fisheries in your region?	0: Rights-based fisheries and/or treaty designated fishers never have access to priority fishing areas due to consistent and significant impediment from other stakeholder fisheries and cannot fill salmon allocation as a result. 1: Rights-based fisheries and/or treaty designated fishers have reduced access to priority fishing areas and routinely experience impediments from other stakeholder fisheries. FSC fishers usually cannot fill salmon allocation as a result. 2: Rights-based fisheries and/or treaty designated fishers have partial access to priority fishing areas but often still experience impediments from other rights-based fisheries. FSC fishers sometimes fill their salmon allocation as a result. 3: Rights-based fisheries and/or treaty designated fishers have access to priority fishing areas but sometimes experience some form of impediment from other fishery users/sectors. FSC fishers generally fill their salmon allocation. 4: Rights-based fisheries and/or treaty designated fishers have full access to priority fishing areas and never experience impediments from other fishery users/sectors. FSC fishers can fill their salmon allocation free from access impediments from other stakeholder fisheries.	**Written Responses**	**Score: /4**
FNs Priority Access	**9.** If there are active recreational salmon fisheries in your region, do First Nations perceive this sector to receive harvest and/or access priority to salmon populations before FSC and/or treaty designated	0: There is strong perception by First Nations in the region that recreational fisheries receive priority harvest and/or access to salmon populations before FSC and/or treaty designated salmon allocation requirements are met. 1: There is a notable perception among First Nations in the region that recreational fisheries	**Written Responses**	**Score: /4**

	salmon allocation requirements are met?	receive priority harvest and/or access to salmon populations before FSC and/or treaty designated salmon allocation requirements are met. 2: First Nations in the region have mixed perceptions on whether they believe the recreational fisheries to have priority salmon harvest and/or access to salmon populations before FSC and/or treaty designated allocation requirements are met or not. 3: Generally, First Nations in the region do not believe that recreational fisheries receive priority for harvest and/or access to salmon populations before FSC and/or treaty allocation requirements are met. 4: First Nations in the region do not perceive recreational fisheries receive priority for salmon harvest and/or access over FSC and/or treaty designated allocations. Recreational fishery harvest licences are granted only when FSC and/or treaty designated allocations are fully met.		
FNs Priority Access	**10.** In the last 25 years, have First Nations in your region closed and/or limited FSC and/or treaty designated salmon fisheries while other fishing sectors for salmon remained open?	0: Yes, First Nations regularly close FSC and/or treaty designated salmon fisheries, while all other fishing sectors in the region remain open. 1: First Nations often close or limit FSC and/or treaty designated salmon fisheries while some other fishing sectors remain open. 2: First Nations occasionally close or limit FSC and/or treaty salmon fisheries, while other fishing sectors generally remain open, possibly with lower bag limits or lower allocation. 3: First Nations rarely voluntarily close or limit FSC and/or treaty designated salmon fisheries, but if they do, other fishing sectors usually close, limit their salmon harvest and/or lower allocation.	**Written Responses**	**Score: /4**

		4: First Nations rarely voluntarily close or limit FSC and/or treaty designated salmon fisheries, but if they do, all other fishing sectors close or limit their salmon allocation as well.		
FNs Priority Access	**11.** In your region, are environmental changes negatively impacting First Nation's ability to access FSC and/or treaty designated salmon fisheries?	0: Environmental changes are severely impacting the region and negatively impact First Nations abilities to access FSC and/or treaty designated salmon fisheries. 1: Environmental changes are significantly impacting the region and often negatively impact First Nations abilities to access FSC and/or treaty designated salmon fisheries. 2: Environmental changes are somewhat impacting the region and sometimes negatively impact First Nations abilities to access FSC and/or treaty designated salmon fisheries. 3: Environmental changes are minimally impacting the region and rarely negatively impact First Nations abilities to access FSC and/or treaty designated salmon fisheries. 4: Environmental changes are not occurring in the region and are not negatively impacting First Nations abilities to access FSC and/or treaty designated salmon fisheries.	**Written Responses**	**Score: /4**
FNs Priority Access	**12.** Is aggregate management of mixed-stock salmon fisheries that affect your region, perceived to be compromising First Nations ability to sustainably fish single stock or terminal fisheries?	0: Aggregate management severely compromises FNs ability to sustainably fish single or terminal stock salmon fisheries in the region. 1: Aggregate management significantly compromises FNs ability to sustainably fish single or terminal stock salmon fisheries in the region. 2: Aggregate management generally compromises FNs ability to sustainably fish single or terminal stock salmon fisheries in the region. 3: Aggregate management occasionally compromises FNs ability to sustainably fish	**Written Responses**	**Score: /4**

		single or terminal stock salmon fisheries in the region. 4: Aggregate management is not used or does not compromise FNs ability to sustainably fish single or terminal stock salmon fisheries in the region.		
FNs Priority Access	**13.** In your region, are First Nations able to harvest their full FSC and/or treaty salmon allocations?	0: First Nations in the region are never able to achieve their designated allocations; salmon management is never successful in ensuring allocations are met. 1: First Nations in the region are generally unable to achieve their designated allocations; salmon management is usually unsuccessful in ensuring allocations are met. 2: First Nations in the region are sometimes able to achieve their designated allocations; salmon management occasionally ensures allocations are met. 3: First Nations in the region usually achieve their designated allocations, salmon management is generally successful in ensuring allocations are met for First Nations. 4: First Nations in the region always achieve their designated allocations, salmon management is successful in ensuring allocations are met for First Nations.	**Written Responses**	**Score: /4**
FNs Priority Access	**14.** In your region, are current salmon FSC and/or treaty allocations formally included in DFO salmon management objectives?	0: FSC and/or treaty allocations are never included in DFO management objectives for salmon in the region. 1: FSC and/or treaty allocations are rarely included in DFO salmon management objectives for the region. 2: FSC and/or treaty allocations are occasionally included in DFO management objectives for salmon in the region.	**Written Responses**	**Score: /4**

		3: FSC and/or treaty allocations are often included in DFO salmon management objectives for the region. 4: FSC and/or treaty allocations are always included in DFO salmon management objectives for the region.		
FNs Priority Access	**15.** Do salmon fisheries outside of Canada collectively hinder First Nations ability to meet their salmon FSC, rights-based sales fisheries, and/or treaty allocation in your region?	0: Salmon fisheries outside of Canada severely hinder First Nations ability to meet their salmon FSC, rights-based sales fisheries, and/or treaty allocation, and drastically impact salmon availability throughout all areas in the region. 1: Salmon fisheries outside of Canada significantly hinder First Nations ability to meet their salmon FSC, rights-based sales fisheries, and/or treaty allocation, and impact salmon availability in most areas of the region. 2: Salmon fisheries outside of Canada somewhat hinder First Nations ability to meet their salmon FSC, rights-based sales fisheries, and/or treaty allocation, and marginally impact salmon availability in the region. 3: Salmon fisheries outside of Canada slightly hinder First Nations ability to meet their salmon FSC, rights-based sales fisheries, and/or treaty allocation, and slightly impact salmon availability in some areas of the region. 4: Salmon fisheries outside of Canada do not hinder First Nations ability to meet their salmon FSC, rights-based sales fisheries, and/or treaty allocation, and do not impact salmon availability in the region.	**Written Responses**	**Score: /4**
FNs Priority Access	**16.** Is Indigenous Knowledge informing salmon fisheries management in a formalized and meaningful way with DFO in your region?	0: Indigenous Knowledge never informs salmon fisheries management and there are no formalized agreements with DFO in the region.	**Written Responses**	**Score: /4**

		1: Indigenous Knowledge minimally informs salmon fisheries management but there are no formalized agreements with DFO in the region. 2: Indigenous Knowledge sometimes informs salmon fisheries management, and there may be formalized agreements with DFO in the region. 3: Indigenous Knowledge informs salmon fisheries management in a meaningful way, and there are some formalized agreements with DFO in the region. 4: Indigenous Knowledge always informs salmon fisheries management and there are formalized agreements with DFO to ensure Indigenous Knowledge meaningfully informs management in the region.		
FNs Priority Access	**17.** Does DFO regularly share data and justification for their salmon management decisions with First Nations in your region?	0: Salmon population data is not shared between DFO or First Nations in the region. No justification of the salmon management decisions is provided by DFO to First Nations in the region. 1: Minimal salmon population data sharing occurs between DFO and First Nations in the region. Some justifications of the salmon management decisions are provided by DFO to First Nations in the region. 2: Some salmon population data is shared between DFO and First Nations in the region, but data sharing is irregular and not formalized. DFO generally provides justification of salmon management decisions to First Nations in the region. 3: Most salmon population data is shared between DFO and First Nations in the region, with formalized data sharing processes in place. Often, DFO provides justification of salmon	**Written Responses**	**Score: /4**

		management decisions to First Nations in the region. 4: All salmon population data is shared between DFO and First Nations in the region and formalized data sharing processes are in place. DFO always provides justification of salmon management decisions to First Nations in the region.		
FNs Priority Access	**17 Indicators**	**Total Section Score: /68**		

Total Conservation Score: /92

Total FNs Priority Access Score: /68

Evaluator(s) signature(s):

Appendix B. Supplemental Materials Chapter 3.

Appendix B.1. Verbal Consent Form Interview Participants

Overview.
Jade Steel is a PhD Candidate in the School of Environmental Studies at the University of Victoria, and as a graduate student, Jade Steel is required to conduct research as part of the requirements for a doctoral degree in the field of Ethnoecology. Her work is being conducted under the co-supervision of Drs Natalie Ban and Charlotte Whitney. You may contact her supervisors at **nban@uvic.ca or charwhitney@gmail.com.**
This research is funded by the national nonprofit organization Mitacs and the Social Sciences and Humanities Research Council of Canada.

Purpose & Objectives.
To document Indigenous-led salmon monitoring programs (e.g., creel & biological programs) throughout the Pacific Northwest (PNW) to better understand how such programs support First Nations and/or Tribal management of important foods and resources, such as wild Pacific salmon. We hope to understand how different governments and agencies (i.e., Indigenous, and non-Indigenous governments) can work together to effectively monitor salmon fisheries and assess salmon conservation issues, as well as highlight what fundamentals might be necessary to change.

Research Rationale.
Documenting examples of Indigenous-led salmon monitoring programs, their specific program outcomes and highlighting program applications for adaptive management, reconciliation, and fisheries co-management can provide helpful understandings of contemporary fisheries management gaps throughout the PNW. Findings from this research can also demonstrate how Indigenous leaders are moving forward with fisheries monitoring efforts that best fit their communities' needs and/or management and conservation objectives for salmon.

Participants Selection.
You are being asked to participate in this study because you either work in a role as, or similar to, a stewardship manager, staff or catch monitoring technician and hold significant knowledge and understandings of salmon fisheries monitoring, and Indigenous-led governance of salmon respective to your workplace.

What is involved?
Your voluntary participation will include participating in a short video conferencing interview with Jade Steel. It is anticipated that this interview will last between 60-90 minutes, and you may participate in your own desired location. With your verbal permission, audiotapes/and-written notes will be taken during our interview, and a transcription of our interview will be provided to you.

Inconvenience, risks, & benefits.
Participation in this study may cause some inconvenience, including taking time during work or business hours; however, we are flexible and can meet whenever most convenient for you. There

are no known or anticipated risks to you by participating in this research. The potential benefits of your participation in this research include being able to share your knowledge to help inform fisheries conservation and marine management in PNW and beyond.

Compensation.
To compensate you for any inconvenience related to your participation, you will be given a financial honorarium of $100 CND/hour in the form of a prepaid visa gift card. Participants will receive a minimum $100CND prepaid visa gift card even if their participation is less than 35 minutes.

Voluntary Participation.
Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will remain anonymous and used with permission, or your data will be removed completely from our database as directed. Participants will also still receive full compensation should you choose to withdraw.

Anonymity and Confidentiality.
All research participants will have the opportunity to remain anonymous if they wish. If anonymity is requested, we will code all information with a specific number and will not publish any possible identifiable information. Your name will remain unlisted, and data provided anonymous unless you otherwise consent to the use of your name in research outputs. Your confidentiality and the confidentiality of the data will be protected by password protected computers and encryption.

Contacts.
Jade Steel, the primary researcher, or co-supervisors as listed at the beginning of this consent form. You may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 / ethics@uvic.ca).

Your verbal consent indicates that you understand the above conditions of participation in this study, that you have had the opportunity to have your questions answered by the researchers, and that you consent to participate in this research project.

_____	_____	_____
Name of Participant	Signature of Jade Steel	Date

PLEASE SELECT STATEMENT: Only if you consent:

I consent to have my responses attributed to me by name in the results: _____
(Participant to provide verbal consent)

PLEASE SELECT STATEMENT: Future Use of Data

I consent to the use of my data in future research: _____ (Participant to provide verbal consent)

I consent to be contacted in the event my data is requested for future research: _____ (Participant to provide verbal consent)

A copy of this consent form will be provided to you over email and a copy will be digitalized by the researcher for their records.

Appendix B.2. In-depth Interview Questions: Review of Indigenous-led Salmon Monitoring Programs Across The Pacific Northwest

The interview questions below inquire about your Nation/Tribes/Organizations specific salmon fisheries monitoring program.

1. Can you please tell me what your specific position is and the name of the organization/Nation/Tribe that you work for/support?

2. What salmon species does the organization/Nation/Tribe you work for monitor? Do you monitor any other marine fisheries?

3. Can you please tell me a little bit about your organization/Nation/Tribes' salmon fisheries monitoring program(s)?

4. Why does the organization/Nation/Tribe you work for conduct salmon fisheries monitoring?

5. At the organization/Nation/Tribe, who conducts the salmon fisheries monitoring?

6. How long has the salmon fisheries monitoring program been in place?

7. How is the salmon fisheries monitoring program funded?

8. What are some salmon fishery monitoring methods that have worked well in the past for your organization/Nation/Tribe?

9. Do you consider the salmon fisheries monitoring program to be 'Indigenous led?'. If so, what does 'Indigenous led' mean for your organization/Nation/Tribe?

10. Is salmon monitoring happening in ways that aren't apart of the specific monitoring program? E.g., "We are monitoring by living here" (Thompson et al. 2019).

11. What are the outputs of the salmon fisheries monitoring program? E.g., Who uses the resulting data & how?

12. What have been the intended or unintended outcomes of your organization/Nation/Tribe's salmon fishery monitoring program?

13. Does the salmon monitoring program support co-management of fisheries? If yes, how?

14. Are you aware of any other Indigenous-led salmon fisheries monitoring programs within or beyond your Nation/Tribe/Organizations Territory? Would you be willing to share any information (such as contact information, or the name of the program) with us?

15. Can you please provide us with a mailing address? Thank you kindly for your support & participation

Appendix B.3. In-depth Interview Analysis - Codebook

Table 8. In-depth Interview Thematic Analysis Codebook

Code Name	Sub Codes	Code Description
Commercial/Industrial Fishing	N/A	Generally industrial or commercialized in-scale, profit-driven fishing operations, includes discussions about industrialized fishing impacts on salmon populations, Indigenous fisheries access and power dynamics and regulatory concerns.
Interest in research findings	General research interest Workshop interest	Captures expressions of interest, curiosity, or engagement of this research and it's findings by interview participants.
Fisheries Governance/ Management	Alaska British Columbia Washington Co-management Colonial management In-season management Indigenous management Shifting governance Permit System	References to systems, structures, and processes involved in managing fisheries, including who makes decisions, how authority is distributed, and what policies or practices are in place. Includes discussion of regional governance contexts, management approaches, and shifts in power or responsibility over time.
Funding	Federal Funding timelines Grant/proposals Inequity NGOs Private donors State and Provincial Incentives	Financial resources used to support fisheries-related monitoring, including how funding is accessed, distributed, and sustained. Challenges, opportunities, and implications tied to different funding sources and structures covered.
Hatcheries	N/A	Salmon hatchery programs, including roles in enhancement for recreational or commercial sectors, conservation, or improving salmon access to Indigenous fishers. Benefits, concerns, and impacts of hatcheries discussed.
Outcomes & Applications	Data gaps Capacity gaps Indigenous Peoples driving change	Participant reflections on the results, impacts, or practical uses of salmon monitoring programs, including both positive and negative outcomes, as well as

	Negative outcomes Positive outcomes Restoration Unintended outcomes Youth involvement Collaborations	insights into how findings or initiatives are applied in real-world contexts.
Personal Perceptions	Historic Identity Positive feelings Negative feelings/interpersonal conflicts Anger/sadness Colonialism	How participants perceive, reflect and attribute emotions to salmon monitoring in/for their community.
Monitoring Program Methods	Biological Challenges Fish Wheel/Weir In-season data collection Other species Qualitative Salmon Species Job descriptions Monitoring locations Multiple objectives Timelines	General descriptions of how salmon monitoring programs are designed and implemented, both technical and logistical elements. Participants highlight challenges and innovations involved in monitoring efforts.
Relationships	Building partnerships Fostering trust Conflicts Data sharing Elder & youth Relatives Colonial government	The dynamics of interpersonal, community, and institutional relationships involved in salmon monitoring. Further includes how connections are built, maintained, or challenged among individuals, groups, and governing bodies.
Knowledge Coexistence	Technology Monitoring by being	How different knowledge systems -such as Indigenous Knowledges, western sciences methods are brought together in fisheries monitoring. Participant reflections on approaches that honor multiple ways of knowing.
Who's Monitoring	Collaborations Colonial governments Contractors Indigenous led	Who is involved in conducting fisheries monitoring, highlighting the diversity in roles, contributions, and authority in monitoring programs.

	First Nation/Tribal techs Youth	
Monitoring Rationales	Build partnerships Climate change Conservation concerns Data sovereignty Impacts of other sectors (Commercial, Recreational, Fish farms) FSC monitoring Improve management Colonial government/agencies not doing their job Increase community access Interest by leadership/responsibility Legal reasons Not meeting FSC requirements Playing colonial games	Reasons and motivations behind fisheries monitoring programs, including ecological, cultural, political, and legal drivers.

Appendix C. Supplemental Materials Chapter 4.

Appendix C.1. Participant Verbal Consent Form: HIRMD Dockside Surveys

Description of the Research
This research aims to improve understanding of fishing activity throughout Haíłzaqv Territory by collecting both biological data and knowledge and perceptions of local fishers. As a recognized salmon fishery, your insights are an important part of this work. The research is being carried out by the Heiltsuk Integrated Resource Management Department to ensure the findings directly support community-led management of Pacific salmon fisheries.

What is Involved:
If you choose to participate, we will conduct a short survey with you now, which will take approximately five minutes. You'll be asked 13 questions about your recent fishing trip(s) throughout Haíłzaqv Territory. To accurately record the information you share, we will take notes during the survey and write down your responses. If you would like a copy of the survey and your responses, please feel free to let us know at any time before, during, or after our conversation.

Risks & Benefits of Participating:
There are no known or expected risks associated with participating in this study. While you may feel some discomfort being surveyed in person, we will make every effort to conduct the survey in a way that is comfortable and convenient for you. A potential benefit of participating is the opportunity to share your knowledge in support of coastal management efforts in Haíłzaqv Territory.

Confidentiality:
Any information we collect today will not be linked with your name without further verbal permission. The data derived from this study may be used in reports, presentations, and publications but you will not be individually identified. We will further protect your confidentiality by coding information with a number so no one can trace your provided answers to your name. As well, password-protected computers will protect your confidentiality and the confidentiality of collected data.

Dissemination of Results:
The results of this study will be shared in a variety of ways, including scientific journal publications, scholarly presentations, community meetings, HIRMD and public websites, community newsletters, presentations to fisheries managers, social media, and community educational materials.

Disposal of Data:
All data is owned and stored indefinitely at the Heiltsuk Integrated Resource Management Department.

Voluntary Nature of the Study:
Your participation in this research study is entirely voluntary. You may choose not to take part, or

you can withdraw at any time during the fishing season or afterward. If you decide to withdraw, you may also request that any notes or data we have collected from you be deleted.

Contacts & Questions:
Individuals that may be contacted regarding this study include Jade Steel and Zakoiya Peel of the Heiltsuk Integrated Resource Management Department (catch.monitoring@heiltsuk.ca). You may also verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

Anonymity:
PLEASE PROVIDE VERBAL AGREEMENT only if you do consent:

I do consent to be identified by name/credited in the results
I do consent to have my responses attributed to me by name in the results

Future Use of Data:
PLEASE PROVIDE VERBAL AGREEMENT only if you do consent:

I do consent to having a copy of my data shared with the Haíłzaqv First Nation for the following:

- HIRMD (i.e. Rights and Title Litigation, internal documents, stored indefinitely)
- Indigenous controlled publications (ie. Student research projects, CCIRA publications, researchers who have a protocol agreement with HIRMD):

Statement of Consent:
On this date X, verbal consent indicates that you understand the above conditions of participation in this study, that you have had the opportunity to have your questions answered by the researchers, and that you consent to participate in this research project.

A digital copy of this consent form will be available to you if you wish to further review the terms and conditions of this study, at any time.

Appendix C.2. 2025 HIRMD Fisheries Catch Monitoring Survey Questions

Date:
Fisher Name & Age:
Time In/Out:
Surveyor Name:

1. Generally, where did you fish today?
2. How many boats were fishing at each location (FSC, Commercial, Rec, Other)
3. Gear used?
4. How many hours did you fish at each location?
5. Fisher boat type
6. Number of salmon caught & species (Kept and released)
7. How was fishing today (1-10)
8. How has fishing been this season (1-10)
9. Fuel cost for fishing today
10. Who will eat the catch?
11. Trip Success (yes/no, why or why not)
12. Fisher type (Guided/unguided) & number of licensed fishers
13. Have you been prawning? Where? Are you catching enough?

1-10 scores	Perceptions
1	terrible/horrible/worst
2	bad
3	poor
4	slow/quiet/below average
5	skimp/spotty
6	mediocre/intermittent
7	ok/decent/picking up/better than last
8	good/steady
9	great/really nice/pretty bang on
10	awesome/excellent/fantastic

Appendix C.3. Coho Genetic Stock Identification Contributions 2019-2023

Table 9. (C.3.1) Coho Genetic Stock Identification Contributions Haíłzaqv Territory 2019-2023

CU	2019	2020	2021	2022	2023	Mean	SD
HecLow+HStr^	22.25	22.37	40.22*	50.33	28.15	32.66	12.29
BCD^	20.62	25.07	25.91	20.25	46.58	27.69	10.87
DOUG^	10.53	26.65	3.99*	7.74	12.61	12.30	8.64
Rivers^	14.52	15.33	12.30	8.67	5.38	11.24	4.17
NCS^	18.94	2.90	6.01*	0.78	1.83	6.09	7.45
HK	3.81	0.00	4.16	2.94	1.30	2.44	1.75
SC+SFj	1.07	0.30	4.25	5.27	0.50	2.28	2.31
Nahwitti	1.22	6.82	0.02	0.18	0.31	1.71	2.89
Howe-Burrard	3.55	0.00	0.81	0.91	0.38	1.13	1.40
EVI+GStr	1.61	0.08	0.09	0.37	0.02	0.43	0.67
MusKyn^	0.17	0.00	0.96	0.00	0.96	0.42	0.50
JdF	0.00	0.00	0.02	1.28	0.63	0.39	0.57
LFR	0.73	0.01	0.00	0.86	0.07	0.33	0.42
SC+GStr	0.20	0.00	0.40	0.00	0.00	0.12	0.18
USKNA	0.00	0.00	0.40	0.00	0.00	0.08	0.18
Smith^	0.00	0.00	0.00	0.00	0.34	0.07	0.15
LILL	0.23	0.00	0.00	0.00	0.00	0.05	0.11
LNASS	0.00	0.01	0.02	0.13	0.00	0.03	0.06
LSKNA	0.03	0.02	0.01	0.04	0.00	0.02	0.02
SEAK	0.00	0.00	0.00	0.01	0.03	0.01	0.01

Table C.3.1. Contributions (represented as percentage of total sampled catch) of British Columbia coho salmon conservation units (CU) to mixed-stock catches landed in Bella Bella from 2019 to 2023, as well as average annual contribution and annual SD for each CU. Asterisks denote statistically significant annual differences from the Dirichlet regression evaluating annual variation in CU-level contributions to coho catches. Central Coast CUs are denoted with a circumflex (^). CU place name abbreviations (as listed in order): Hecate Lowlands & Straights, Bella Coola Dean, Douglas Channel, Rivers Inlet, Northern Coastal Streams, Homathko-Klinaklini, South Coast & Southern Coastal Fjords, Nahwitti (Saanich Inlet), Howe-Burrard, East Coast Vancouver Island & Georgia Straight, Muskyn, Juan De Fuca, Lower Fraser River, South Coast & Georgia Straight, Upper Skeena, Smith River, Lillooet, Lower Nass, Lower Skeena, South East Alaska

Appendix C.4. Supplementary Central Coast Coho Salmon Genetic Stock Identification Information

Catches of coho salmon assigned to the Bella Coola-Dean CU were remarkably consistent across years, with no annual differences detected in our analysis. Catches of Rivers Inlet coho salmon were relatively stable, but their contribution to PFMA 7 and 8 catches sampled in Bella Bella and Shearwater was significantly lower in 2022 than in the preceding years ($Pr(>|z|) = 0.0485$). Catches of coho from the Douglas Channel – Kitimat CU were relatively higher in the first two years of sampling (2019 and 2020), although 2020 numbers should be interpreted with caution given the relatively small sample size for that COVID-impacted season, with significantly lower catches of the Douglas Channel – Kitimat CU in 2021 ($Pr(>|z|) = 0.045$) and 2022 ($Pr(>|z|) = 0.039$). Likewise, the proportional share of catch for the Northern Coastal Streams CU were lower in 2021 ($Pr(>|z|) = 0.026$) and 2022 ($Pr(>|z|) <0.0005$).

For Bella Coola Dean coho, a larger share of catches recorded in the GSI results occurred in subareas 8-5 (beta coeff. = 0.889; $Pr(>|z|) <0.0005$) and 7-32 (beta coeff. = 0.295; $Pr(>|z|) =0.0467$). For Hecate Lowlands and Straits CU coho, catches were highest in sub area 7-17 (beta coeff. = 0.438; $Pr(>|z|) = 0.0007$) and 7-12, relatively lower in subareas 7-32 (beta coeff. = -0. 462; $Pr(>|z|) = 0.0019$), 7-25 (beta coeff. = -0. 510; $Pr(>|z|) = 0.0019$), and lowest in subarea 8-5 (beta coeff. = -0. 671; $Pr(>|z|) <0.0005$). Coho from the Rivers Inlet CU made a significantly larger contribution to catches in subarea 8-5 (beta coeff. = 0.407; $Pr(>|z|) <0.0152$), however parameter estimates for subarea differences in catch contributions from the Northern Coastal Streams CUs were non-significant, with a modest trend towards higher contributions to the catch in PFMA 8-5.