Co-production of knowledge for indicators, otters and ecosystem-based management

by
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AUTHOR'S DECLARATION

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

STATEMENT OF CONTRIBUTIONS

I am the sole author for Chapters One and Five which were written under the supervision of Derek Armitage. Chapter Two, Three and Four are developed as co-authored manuscripts for publication, with myself as the lead author. Chapter Two was co-authored with Jennifer Silver, Trevor Swerdfager, Hilary Thorpe and Derek Armitage. Chapter Three was co-authored with Derek Armitage, Kevin Anderson, Cindy Boyko, Sara Busilacchi, James Butler, Chris Cvitanovic, Linda Faulkner, Julie Hall, Geoffrey Martynuik, Kura Paul-Burke, Trevor Swerdfager, Hilary Thorpe, and Ingrid van Putten and is submitted to Ecology & Society. Chapter Four is currently under preparation for journal submission. Bibliographic citations for the chapters are given below.

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ABSTRACT

Co-production of knowledge for indicators, otters and coastal-marine ecosystem-based management

My dissertation examines the interplay of knowledge processes and power in relation to ecosystem-based management for equitable and ecologically sustainable governance of coastal marine resources (e.g., fisheries). Knowledge co-production (KCP) is presented as one effective strategy to generate the understanding needed to inform responses to complex coastal and marine social-ecological challenges. KCP is defined here as the collaborative process of bringing a plurality of knowledge sources and types together to formulate and address a specific problem and build an aligned and systems-oriented understanding of that problem for an actionable outcome. KCP also reflects the collaborative identification of barriers, gaps and processes to complex problems across a wide range of 'value rationalities'. However, KCP is not a panacea, and much uncertainty remains surrounding its development and implementation, and in particular, the broader governance contexts in which the interplay of knowledge, power and decision-making emerge.

Three specific objectives guide my research: (1) to critically examine the opportunities, limitations and impact of KCP in the application of indicator approaches for coastal-marine resource management and governance initiatives globally; (2) to examine more specifically the interplay of governance and KCP by drawing upon a detailed reflection of selected international examples of ecosystem-based management (e.g., Canada, New Zealand and Papua New Guinea); and (3) to co-produce place-based, visual scenarios of alternative sea otter (*Enhydra lutris*) return futures in Haida Gwaii, British Columbia (Canada) as a means to engage diverse knowledges and co-examine opportunities for the ongoing restoration of coastal-marine systems. To address these objectives, I have adopted a mixed methods approach which includes a systematic scoping review (n=67) on the relationship between indicator development and KCP. This scoping review helps to set up more grounded research and analysis in Haida Gwaii and other contexts. In this regard, my research adopts an inductive and transdisciplinary approach to allow for flexibility in identifying and understanding issues of relevance within the examples examined in this dissertation (e.g., Haida Gwaii). An inductive approach is appropriate for this research as it allows for an analysis of the themes that arise through engagement with rightsholders and key stakeholders associated within the context of: (1) engagement with selected global examples (n=4) of KCP and coastal-marine EBM through a critical and reflective process with key

collaborators (n=13); and (2) the co-development of four place-based visual scenarios and accompanying narratives of alternative sea otter futures in Haida Gwaii through a series of workshops (n=4), working group meetings (n=3), and a wide range of discussions and conversations with Elders, Haida youth, and various representatives from diverse organisations (e.g., Council of Haida Nation, Parks Canada, Fisheries and Oceans Canada).

The outcomes of my research challenge conventional approaches to ecosystem-based management of coastal-marine resources. For example, this includes taking a more relational perspective that reveals how choices about indicators for coastal-marine governance are embedded within knowledge/power processes. Such choices shape what is documented and measured in ecosystem-based management. In addition, this research highlights the value of a more intentional and 'deep knowledge co-production' which recognises how certain forms of governance, and especially those rooted in systems of colonization, may marginalize Indigenous and other place-based ways of knowing despite best intentions. In questioning and challenging such systems of governance, KCP can disrupt inequitable patterns of social and institutional practices. Finally, in the context of Haida Gwaii, this research offers a series of co-produced and place-based insights on sea otter return and the potential implications for governance and co-management in ways that are inclusive and centre reconciliation.

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"When you've gained so much success
You'll be filled with happiness.
But know that unconditional love
Connects you to the power above"

The final stanza of the last poem I received from Gran, gifted to me before she passed on. Everything my grandmother did, she did with unconditional love, it is her love, and the love that she wove into my childhood that flows through me. It is woven into my work, gives me strength and surrounds everything I do in my life.

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List of Abbreviations

CHN	Council of the Haida Nation
DFO	Department of Fisheries and Oceans
EBM	Ecosystem-based Management
HGMP	Haida Gwaii Marine Plan
IOG	Institute of Governance
KCP	Knowledge Co-production
LSPP	Gwaii Haanas ‘Waadluxan KilGuhlGa Land-Sea-People Plan
MPA	Marine Protected Area
PC	Parks Canada
PNG	Papua New Guinea
S&TS	Science and Technology Studies
SHIP	Skidegate Haida Immersion Program
SS	Sustainability Sciences
SSNSC	Sustainable Seas National Challenge

Chapter 1 Introduction

1.1 Introduction and problem context

My dissertation examines the interplay of knowledge processes and power in relation to ecosystem-based management for equitable and ecologically sustainable governance of coastal marine resources (e.g., fisheries). Western forms of knowledge expressed through evaluative indicators and quantitative models (we refer to those here as decision-making tools) often drive management of fisheries and marine mammal conservation and governance. These decision-making tools (i.e., indicators and models) and the knowledge that informs them emphasize primarily ecological and/or narrow economic efficiency objectives at aggregate scales, and can perpetuate decisions that dispossess and marginalise local communities (Cash et al., 2006a; Tengo et al., 2014; Berkes, 2017). Further, they have often been applied in the context of more 'command-and-control' or sectoral decision-making and management (Hilborn et al., 2015; Armitage et al., 2019; Elsawah et al., 2020). Yet, local and Indigenous knowledges, experience and values are needed to make place-based or context-sensitive decisions, and especially where efforts are required to address trade-offs among diverse objectives (e.g., cultural, economic and ecological) (Bentley et al., 2019; Steffen et al., 2018; Wyborn et al., 2019; Williams et al., 2020). For example, indicator initiatives typically mask the complexity of social-ecological (including governance) interactions, and focus instead on more easily measurable variables (see Chapter 2; Muhl et al. 2022). The challenges associated with knowledge and the application of tools for decision-making take us into the realm of 'knowledge co-production' (KCP), or the collaborative generation of new insights and perspectives. KCP reflects the collaborative identification of barriers, gaps and processes to complex problems across a wide range of 'value rationalities' (Armitage et al., 2011; Clark, 2016, Nörstrom et al., 2020; Apetrei et al., 2021). KCP can thus have a key role in achieving better governance outcomes in coastal-marine contexts. However, direct evidence to show success or correlate knowledge co-production with better social or ecological outcomes is still emerging, and finding counterfactuals is challenging. Yet, continuing with status quo approaches in resource management and conservation context remains problematic, and therefore, there is emerging evidence that co-production processes are more likely to yield better outcomes for all parties involved. This conceptual and methodological challenge of linking a process to better governance outcomes is explored further in Chapter 2 and 3.

,

‘Governance’ here refers to how society or groups within society make, communicate and are held accountable for decisions and associated decision-making processes. In this sense, governance is an integrated social and institutional process that considers and is fundamentally based on some reasonably shared set of values, beliefs and principles within a specific context (Kooiman and Bavinck, 2005). There are many ways that governance is operationalized (see Partelow et al. 2018), and one of those ways is through the practice of ecosystem-based management (EBM). EBM is defined here as “an integrated adaptive management approach to help marine managers consider trade-offs to protect and sustain diverse and productive ecosystems and the services they provide. Informed by science, it incorporates the entire ecosystem, including humans, into management decisions” (AORA, 2019). More simply, it aims to balance “human activities and environmental stewardship in a multiple-use context’ (Smith et al. 2017). As noted above, EBM is often considered a ‘governance approach’ (Olsson et al., 2008; Berkes, 2012), but is also a context in which specific decisions about resources (e.g., harvest controls, quota allocations, model development, etc) are made. Therefore, careful attention to knowledge systems and values driving such processes may foster better governance and management outcomes (social and ecological), and offer support for improved decision-making (e.g., in the context of oceans and coastal communities). KCP thus provide a lens and approach through which to examine how knowledge and coastal and marine governance are linked for collaborative action-based solutions (Lemos and Morehouse, 2005; Metz et al., 2019; Norström et al., 2020; Cooke et al., 2021; Mach et al., 2020).

In the context of Haida Gwaii, for example (and a key site of research in this dissertation-see Chapter 4 for more information on the Haida context), the Council of the Haida Nation has collaborated with the provincial and federal government to develop plans to protect, conserve and ‘co-manage’ land and sea resources. For example, the Haida Gwaii Marine Plan (HGMP, 2015) and the Gwaii Haanas ‘Waadlu<u>x</u>an Kil<u>G</u>uhl<u>G</u>a Land-Sea-People Plan (LSPP, 2018) are centred on Haida principles that emerge from Haida Law and scientific EBM perspectives. These principles (see Table 1-1) are an example that demonstrates how Indigenous views and scientific knowledge may align to strengthen decision-making and governance.

Table 1-1: Haida principles and ecosystem-based management (EBM) principles

Haida Principles	**EBM Principles**
Yahguudang—*Respect*	Precautionary approach
‘Laa guu ga <u>k</u>anhllns—*Responsibility*	Inclusive and participatory

Gina ‘waadluxan gud ad kwaagid—*Interconnectedness*	Integrated management
Giid tlljuus—*Balance*	Sustainable use
Gina k’aadang.nga gii uu tll k’anguudang—*Seeking Wise Counsel*	Adaptive management
Isda ad dii gii isda—*Giving and Receiving*	Equitable sharing

Source: Council of the Haida Nation and Government of Canada (2018)

Coastal and marine governance in Haida Gwaii and the Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site is unique in terms of depth of engagement with rightsholders and community groups, collaboration and knowledge sharing. As such, this setting (see Figure 1-1) provides a critically important context in which to consider how the cultural values and multiple objectives (e.g., social, economic and ecological) in fisheries and marine resource management can be more effectively integrated into the quantitative evaluation methods, indicator processes and future scenarios that drive conservation, fisheries and other resource decision-making (e.g., management plans, harvest rules, allocation decisions). However, not all contexts have the institutional and cultural legacy of Haida Gwaii, and there is merit in exploring how knowledge/power processes and co-production emerge in other governance contexts where Indigenous rightsholders and other stakeholders (e.g., commercial interests, governments, civil society) are seeking to address complex coastal-marine challenges (e.g., New Zealand).

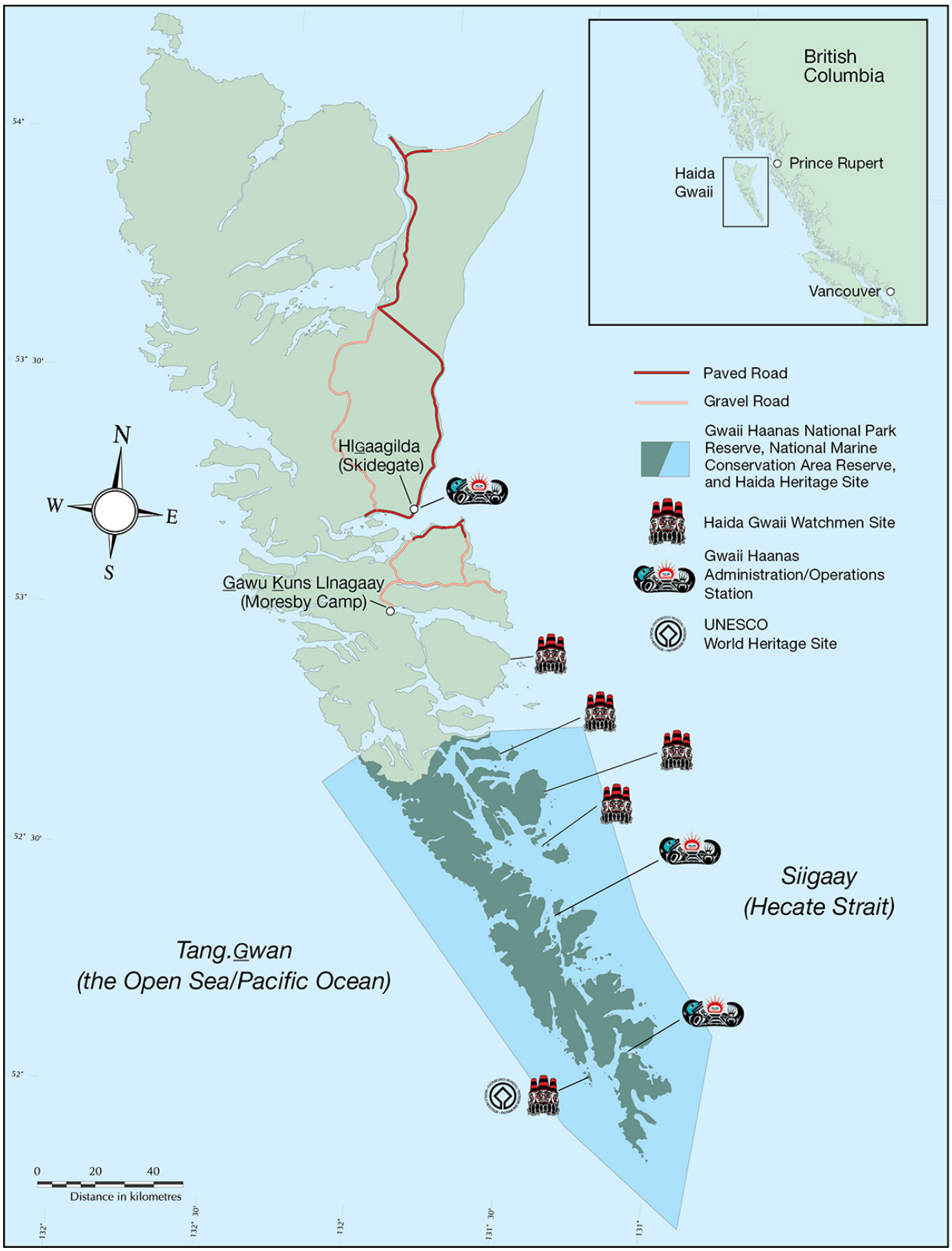


Figure 1-1 Location of the Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site (outlined in blue)

Innovative decision-making processes and forms of co-management through which multiple types and sources of knowledge can be co-developed are central to achieving desirable outcomes (e.g., access to local marine-based food resources). In Haida Gwaii, the Land-Sea-People Plan aims to support these aspirations and draw attention to fisheries of particular interest to Haida for cultural and commercial reasons (e.g., herring, abalone, urchin). However, one key species of interest is the sea otter (*Enhydra lutris*). The return of sea otter, after having been hunted for the fur-trade and extirpated in the 19th century, is generating new management questions and governance challenges with regard to food security (e.g., overconsumption of shellfish) and conservation priorities (see Chapter 4). Historically, sea otters kept sea urchin numbers low and allowed for kelp habitat to flourish (Salomon et al., 2007; Larson et al., 2013; Carswel et al., 2015) However, if otter populations expand, shellfish and other invertebrate species are likely to experience significant population declines (Estes and Palmisano, 1974; Burt et al., 2020) with significant implications for commercial harvest. Sea otters are culturally important in Haida Gwaii, but their return will impact people's access to marine-based food resources including urchins, clams, and abalone, with further implications for the availability of culturally important food resources for Haida communities. The access to marine-based food resources is compromised because sea otters compete for the same food source (i.e., shellfish, urchins etc) as people. As a result, sea otter return intersects with local community food security needs as well as commercial harvesting interests and is catalysing a re-emergence of Indigenous knowledge and principles of governance to ensure place-based decision-making. The management and governance of sea otter recovery is thus of significant interest to Haida and other B.C. coastal First Nations (see Salomon et al. 2023).

1.2 Research goal, objectives and study context

The goal of my research is to examine the interplay of knowledge processes, power and ecosystem-based management in the context of coastal-marine resources management with a view to improve sustainability outcomes. Western forms of knowledge about coastal-marine systems expressed through indicators and quantitative models typically drive management of fisheries and marine mammal conservation. Western science refers here to those sciences conventionally associated with academic intuitions that have been shaped by Western ontologies and value systems (Alexander et al., 2019; Henri et al., 2021). Our use of the terms 'Western science / knowledge' and related phrases is not confined to only STEM (Science, Technology, Engineering and Mathematics) disciplines, but is applicable to all disciplines within the academy. This perspective aligns with Aikenhead and Ogawas' (2007) definition of

'Eurocentric sciences' which notes that, "Eurocentric sciences possess a powerful way of knowing about nature, and this includes knowledge appropriated over the ages from many other cultures (e.g., Islam, India and China). Such knowledge was modified sufficiently to fit Eurocentric worldviews, metaphysics, epistemologies, and value systems. Eurocentric science is also known as the culture of Western science in some fields of cultural anthropology [. . .] to emphasize the group's shared norms, values, beliefs, expectations, technologies, and conventional actions (Aikenhead and Ogawa, 2007:543)".

Further, decision-making tools (like indicator approaches and models) and the knowledges that inform them are often situated in colonial systems of governance and objectives that perpetuate decision-making processes in which local communities (e.g., Indigenous nations) may be dispossessed and marginalised. As noted above, KCP is increasingly framed as a strategy to generate the understanding needed to inform responses to complex coastal and marine social-ecological challenges. However, KCP generates a number of questions and challenges, in addition to opportunities. Central among these challenges is the manner in which broader governance contexts significantly determine the interplay of knowledge, power and decision-making, and the decision processes that emerge as a result (see section 1.4.5 for more detail). As a result, I have chosen to focus on indicators and scenarios specifically as decision-making tools to support better governance outcomes.

Three specific objectives guide my research: (1) to critically examine the opportunities, limitations and impact of KCP in the application of indicator approaches for coastal-marine resource management and governance initiatives globally (manuscript 1); (2) to examine more specifically, the interplay of governance and KCP by drawing upon a detailed reflection of selected international cases of coastal-marine ecosystem-based management (e.g., Canada, New Zealand and Papua New Guinea) (manuscript 2); and (3) to co-produce place-based, visual scenarios of alternative sea otter (*Enhydra lutris*) futures in Haida Gwaii, British Columbia (Canada) as a means to engage diverse knowledges and co-examine opportunities for the ongoing restoration of coastal-marine systems (manuscript 3). Addressing these three objectives is one pathway to move from an examination of the interplay of knowledge processes and power to support better outcomes through EBM implementation (see Table 1-2 for a summary of objectives, research questions, theoretical/conceptual framing and data collection methods).

With reference to these objectives, my research has been embedded in several key initiatives and processes, and my insights in this dissertation have been extended by my engagement in

a number of related activities. For example, my research on indicators (manuscript 1) emerged as part of my role in the Gwaii Haanas Ecosystem Based Management Implementation Working Group (Council of the Haida Nation, Parks Canada and Fisheries and Oceans Canada), Additionally, the insights from my engagement with knowledge/power and indicators was further extended through my role as a consultant on a Fisheries and Oceans Canada contract on evaluating human dimensions and advancing thinking on monitoring for Canada's *Oceans Act* Marine Protected Areas (MPAs). Both of these initiatives have shaped how I understand and seek to apply indicators for coastal-marine governance and EBM.

With regard to manuscripts 2 and 3, KCP is recognized as key concept that links processes of indicator and scenario development with the ongoing implementation of the Land-Sea-People Plan. In particular, my research on sea otter return is nested within the 'X̲aayda Gwaay.yaay K̲uugaay Gwii Sdiihltl'lx̲a: The Sea Otters Return to Haida Gwaii' project which is led by the Council of Haida Nation and Parks Canada. This initiative is also linked to the Coastal Voices project (http://coastalvoices.net/) nested within Resnet. These two projects are seeking to understand and prepare for the return of sea otter and provided an opportunity to engage with a wide range of individuals and organizations while I developed a particular decision-making tool (i.e., future scenarios) to help contribute to an ongoing management plan process.

Beyond the Haida Gwaii specific initiatives in which I have played particular roles, I have had an opportunity to learn from a diverse range of scholars on initiatives that directly inform my work. For example, I was part of a group of scholars reflecting on science, power and disrupting colonialization (see Silver et al., 2022). As well, I had an opportunity to participate in several meetings and a writing process with a wide range of Indigenous and non-Indigenous scholars seeking to diversify how biodiversity is managed by centering Indigenous governance principles and values (see Salomon et al. 2023). Notably, I also sought to extend my insights from these learning opportunities and apply some of this thinking on knowledge, power, marine conservation and governance into the South African context (my home country) with a different group of colleagues and scholars (see Peer et al., 2022).

1.3 Undertaking research in the context of a global pandemic

As reflected above, I have been embedded in a series of project and study contexts. However, this is a thesis that was fundamentally shaped by the COVID-19 pandemic. Community work

needs to be grounded in place. Prior to the pandemic, in November 2019, I visited Haida Gwaii for the first time. My entry into Haida Gwaii was facilitated by Professor Dan McCarthy who had long-standing connections with the community, and Dr Carlos Ormond, who was the Director for the Haida Gwaii Institute, a centre based in Skidegate, Haida Gwaii, associated with UBC's Faculty of Forestry that offers university-level programming inspired by the lessons learned in Haida Gwaii. Both Carlos and Dan facilitated conversations and created connections that shaped my PhD. Along with support from my supervisor (Derek Armitage) who had previously visited Haida Gwaii as a researcher with the Ocean Modelling Forum, I was able to start crafting a space for doctoral research, with a focus on co-development of governance indicators. Unfortunately, as I was completing my coursework, in February 2020, the pandemic hit and what was initially a temporary hiccup and something we all thought would be resolved relatively quickly, became something that stopped my return to Haida Gwaii until November 2021. The subsequent ethics and COVID-travel limitations required by the University of Waterloo made it difficult to return and as a result, the earliest time I could move to Haida Gwaii was in May 2022, in my third year of my PhD. The subsequent timeline for my field research was ultimately compressed into seven months, and while many relationships had been built via Zoom, there is no replacement for in-person contact, especially in communities.

Communicating online closes the door to so many voices in many ways and in seven months I tried to recapture that sense of place and being part of a unique and special space. In some ways I was successful. I was invited to teach at the Haida Gwaii Institute and participated in numerous community events. But post-COVID, events were slow to restart, and people were more nervous with integration back into 'normal' community processes and experiences were very limited. COVID-19 is a lens that has to be considered in the context of my methodology and the manner in which papers subsequently emerged. These papers reflect the best choices possible in a context where field work was limited and opportunities to engage in person were constrained for almost two years. The experience with the pandemic fundamentally shaped and changed me both professionally and personally.

1.4 Conceptual overview and guiding framework

My dissertation examines the interplay of knowledge processes and power in relation to ecosystem-based management for equitable and ecologically sustainable governance of coastal marine resources (e.g., fisheries). To address this goal, my research engages with a series of concepts and theories (e.g., co-production, forms of governance, decision-making

tools), and ultimately, employs a conceptual framework. The framework informs my overall research design and methodological approach. In the following section, I seek to draw connections across a series of these ideas and illustrate their links to the core manuscripts in my thesis, including an analysis of the role of knowledge and power process in the develop of indicators for coastal-marine governance (manuscript 1), the practice of co-production for EBM and its relationship to governance in particular places (manuscript 2), and the manner in which co-production can help us understand ecosystem-based management and governance associated with the return of a keystone species (manuscript 3).

1.4.1 Political ecology as an entry point

My understanding of KCP and governance has been shaped by political ecological scholarship and its critiques of management and conservation (Muhl and Sowman, 2020). In particular, I have drawn on political ecological perspectives (Robbins, 2000; Watts, 2000; Walker, 2005 and 2006; Robbins, 2011) as a hybrid body of social theory and cross-cutting lens to understand and explore the intersecting issues of knowledge and power as they relate to and shape management efforts (e.g., indicator processes, sea otter management) and coastal-marine governance more broadly. Specifically, political ecology provides a lens through which I can understand the issues that determine how different knowledges and ways of understanding the world can influence management and governance (Fairhead and Leach, 1995; Escobar, 1998; Robbins, 2020) how meaning and understanding about the natural world are co-produced (Jasanoff, 2004; Forsyth, 2008; Bennett, 2019), and the importance of critiquing the systems of institutions and governance (e.g., colonialism) within which coastal-marine management takes place (Berdej et al., 2019; Silver et al., 2022).

With respect to this dissertation, political ecology as an entry point also points to the role of power and its intersection with knowledge processes and knowledge systems (Turnbull, 1997; Nadasdy, 1999; Carolan, 2008). The institutional relationships governing power and knowledge, and the subsequent relationships between science and society, state and citizen (Shapin and Schaffer, 1985; Jasanoff, 2004; Bremer and Meisch, 2017) emerge in different ways across the manuscripts in this dissertation. In addition, the connection of knowledge to culture and power, with knowledge as a representation of societal function (Forsyth, 2004) is an important insight and one that would be beneficial to ongoing ecosystem-based management efforts in coastal-marine settings. For example, these relationships call into question whose knowledge is prioritized, who decides what knowledge is used and for what purpose.

As such, political ecological research helps draw attention to the manner in which the foundations and narratives of different knowledge systems yield different claims about reality and nature-society relationships (see Rathwell et al. 2015). In particular, political ecologists and Indigenous scholars of knowledge and science have highlighted how dominant knowledge systems embody the power of particular groups, with negative implications for other ways of seeing the world (Fairhead and Leach 1995; Batterbury et al. 1997; Forsyth 2003; Dryzek 2005; Kimmerer, 2013; Abu et al., 2019; Reid et al., 2021). This theorizing of knowledge/power processes is an important foundation for the emergence of and critiques of 'knowledge co-production'.

1.4.2 Knowledge co-production, power and the implications for governance

Knowledge co-production (KCP) as an applied outcome of knowledge/power theory draws attention to the social-relational processes and application of decision-making tools for coastal-marine ecosystem-based management and governance. Here, I critique KCP for its lack of explicit consideration of power dynamics or the overtly colonial institutional context in which feedbacks among knowledge, power and governance emerge. KCP is defined as the collaborative process of bringing a plurality of knowledge sources and types together to formulate and address a defined problem and build an aligned and systems-oriented understanding of that problem for an actionable outcome (Armitage et al., 2011; Norström et al., 2020). Researchers and practitioners are gravitating towards KCP as a pathway forwards that incorporates participatory and transdisciplinary approaches for improved outcomes (e.g., social-ecological sustainability) (Clark, 2016). As reflected in the literature, most coastal-marine systems are influenced by a range of complex vertical and horizontal feedback mechanisms and cross-scale drivers (Steffen et al., 2018). To address these challenges, multiple groups of people with different forms of knowledge relative to governance issues are needed to successfully address the resulting social, political, ecological and behavioural uncertainty (Cash et al., 2006a).

KCP has been interpreted and analysed differently within two main academic literatures: 1) sustainability sciences (SS); and 2) science and technology studies (S&TS). Specifically, the definitions and concepts draw attention to a range of processes and principles that provide a foundation for understanding and assessing KCP. In this regard, these different literatures on KCP have drawn attention to a number of features and principles. For example, KCP is perceived by SS scholars as a conscious partnership among different groups of people to achieve shared objectives (Clark and Dickson, 2003). Such partnerships involve participants

choosing to work together on an issue and in a way in which different forms of knowledge are integrated into decision-making to produce new and varied outcomes and ways of producing science (Miller and Wyborn, 2018).

Sustainability science scholars have also argued that that co-production can be a potentially transformative by shifting the institutional relationships governing power and knowledge, and the subsequent relationships between society and science, and state and citizen (Ostrom, 1996; Lemos and Morehouse, 2005; Cash et al., 2006b; Wyborn, 2019). Prefacing some of these insights, S&TS scholars have examined and critiqued how science and society shape one another. This critique supposes that knowledge is a product of society which simultaneously shapes and informs it, leading to mutually reinforcing feedback loops (Jasanoff, 2004). This 'iterative interaction' describes the way knowledge is shaped and moulded through repeated interactions between scientists and the culture contexts they work in (Arnott et al., 2020). Thus, S&TS scholars have been concerned with the connection of knowledge to culture and power, with knowledge as a representation of societal function (Forsyth, 2004), and subsequently, the invisible role of knowledges and expertise in shaping and transforming authority. As such, the historical and social construction of knowledge shapes the way we perceive, use and interpret societal identities, norms, and institutions (Jasanoff, 2004), and the contested political, social and cultural issues that underlie governance decisions.

Ultimately, the scholarship on KCP encourages critical reflection on a range of issues (see Cvitanovic et al., 2015; Djenontin and Meadows, 2018; Wyborn et al., 2019), such as: (1) usability of knowledge; (2) participation and representation; (3); consideration of power (4) accounting for complexity; (5) the importance of communication and strategies for engagement; and (6) the links to application and implementation (e.g., in ecosystem-based management). New forms and examples of KCP have emerged in response to changing contexts (i.e., climate change, social and cultural barriers). This requires engagement across multiple actors who can contribute varied perspectives and help address problems (Norström et al., 2020). For example, place-based knowledge can be beneficial when understanding how climate has changed over time. Specifically, by drawing on the emerging literature on knowledge systems and co-production, this dissertation shows how different forms of knowledge can enhance and reveal novel pathways to understand and manage fisheries and -coastal-marine ecosystems (e.g., sea otters) (Kershner et al., 2011; Ferreira et al., 2018; Ingram et al., 2018).

Still, there are significant criticisms of KCP as an analytical lens and as a methodological orientation (see below). One core criticism of KCP is related to the inability to fully account for power and its dynamics in sustainability science initiatives (Lövbrand, 2011). Certain veins of co-production scholarship do consider material and discursive power in a more comprehensive manner, yet it is predominantly in theory rather than practice (Wyborn et al., 2019). Such critiques of power raise important questions of who is benefitting from processes of KCP, what issues are being addressed, and who is deciding how and what knowledge to use to inform policy and generate impact (Abson et al., 2017). Specifically, the role of institutions (as rules in use) and the networks which emerge through complex relationships have been a focus of much analysis (see Latour, 1993), and in regard to how power and knowledge perpetuate certain norms (Forsyth, 2004). For example, in many processes people are expected to participate in processes without being compensated for their time and this perpetuates certain relationships of power. Therefore, those engaged in co-production need to account for the time and costs of diverse groups of people, so that wealthier individuals and/or 'elite' knowledge holders are not prioritized.

Indeed, these forms of power in KCP manifest practically in many different ways (Raik et al. 2008). For example, issues regarding the costs of time and resources for participants reflect issues of power that require more consideration (Oliver et al., 2019). The people who can willingly give their time and have the capacity to engage are more likely to already hold power and have access to more material resources (i.e., the economic advantage of cars for travelling or the emotional advantages of a stable space to work from) than those who are disadvantaged. As a result, individuals with less power (material, discursive) or alternative perspectives can be excluded from 'collaborative' processes all too easily (Stirling, 2008; Leach et al., 2010; Klenk et al., 2015). Furthermore, the value of Indigenous knowledges is often place-specific and is not easily replicated in other contexts. This tends to undermine the influence it may have (see Sutherland et al., 2017), although there are examples in which the value of Indigenous perspectives is gaining traction (e.g., the IPBES process, or Indigenous controlled conservation areas).

Despite the emphasis on collaboration and partnerships, there remains significant room for KCP as a methodology and as an analytical framework to be more cognisant of power if it is to successfully disrupt conventional ways of understanding complex systems and produce actionable outcomes (Jasanoff, 2004). With regard to this dissertation, there are two critiques that emerged from a politically informed KCP that warrant some consideration. First, what is missing in much of the current KCP scholarship (and especially in places like Canada,

Australia and New Zealand), is a critical reflection of the fundamental shifts in governance power that are currently being navigated between Indigenous peoples and formal nation states. In Canada, for example, the restitution of rights and reconciliation and start of a conversation involving nation-to-nation governance and management of fisheries (e.g., the Changing Tides agreement in Haida Gwaii) will (or should) have a profound influence on how we think about KCP processes. A nation-to-nation relationship will fundamentally challenge existing governance and decision-making processes, as well as questioning what collaborative processes are and what they mean. Such process are reflected in both manuscripts 2 and 3.

Second, it is essential to acknowledge that co-production exists and is pursued in a political-economic system that is capitalist. The structures, incentives, and norms of capitalism profoundly influence how many organizations and even researchers approach ecosystem-based management and coastal-marine governance. For example, Büscher and Fletcher (2020) argue that the orientation of science for conservation and resource management is inherently capitalist which undermines outcomes and ultimately influences the process of how knowledge is produced. For instance, marine zoning is largely based on the 'fences and fines' approach, which has (re)surged into popularity in addition to capitalist forms of new conservation such as payment for ecosystem services (Chan et al., 2017; Büscher and Fletcher, 2020). To address this context, practices of conservation, management and governance need to more effectively integrate place-based knowledge and Indigenous and local perspectives (Salomon et al., 2018; Alexander et al., 2019). I turn next to this management and governance challenge and the theories of coastal-marine governance and ecosystem-based management which frame my dissertation chapters.

1.4.3 Coastal-marine governance and ecosystem-based management

Governance is as an integrated social and institutional process that considers values, beliefs and principles, while also reflecting diverse stakeholders' interests and contexts for more transparent and legitimate decision-making (see Kooiman and Bavinck, 2005). Governance can also refer to a way of steering or governing that is manifested in different types of policy arrangements (Van Tatenhove, 2011). Policy arrangements are "an expression of new interrelations between state, civil society and market" (Van Tatenhove et al. 2006). Van Tatenhove (2011) defines marine governance as the process of coastal and marine policy making shared between different stakeholders. These stakeholders mobilize discourses and debate solutions depending on the problem context (Van Tatenhove 2008; Van Leeuwen and

Van Tatenhove 2010). Negotiation occurs between nested governmental institutions at multiple levels (international, (supra) national, sub-national), and between actors and organizations of different coastal/maritime activities in order to govern activities at sea and their consequences.

Ecosystem-based management is EBM is often considered a 'governance approach' (Olsson et al., 2008; Berkes, 2012). However, EBM is also a context in which specific decisions about resources are made (e.g., harvest controls, quota allocations, model development, etc). This ecosystem-based perspective emerged most directly during the 1990s (see Slocombe 1993), and in Canada was reflected in the Canada's Oceans Act preamble (1996 c. 31), which states that "conservation, based on an ecosystem approach, is of fundamental importance to maintaining biological diversity and productivity in the marine environment". In Europe, EBM has been codified in the common fisheries policy and has been implemented as the Marine Strategy Framework Directive (MSFD; ICES, 2005; EU 2008). EBM has been codified in other governance contexts as well, including South Africa's Marine Living Resources Act (No. 18 of 1996) and Australia's Ocean policy (1998).

There are a number of strengths and weaknesses of EBM as a governance approach. For example, EBM is hypothesized to offer a more holistic, inclusive and participatory approach for multiple-use contexts (Smith et al., 2017). Further, it is meant to inherently recognise coupled social-ecological systems involving stakeholders in an integrated and adaptive management process where decisions reflect societal choice. At the same time, EBM has encouraged a shift away from the sole focus on 'predictability' model for decision-making by reflecting on the importance of social processes. Still much EBM maintains a central emphasis on knowledge created through the natural sciences, and is characterized in implementation efforts by conflicting interests, a lack of organizational/legal framework in many jurisdictions, and a lack of communication (Marshak et al. 2017). It is important to note in these contexts the "power relations between these actors and how power balances between the actors in a coalition influence participation (inclusion and exclusion) within the institutional setting (or system of rules of the game) in which maritime policies take place" (Van Tatenhove, 2011:95)

There are several perspectives on coastal-marine governance and ecosystem-based management that emerge in the literature and that require further consideration. For example, coastal-marine management should incorporate principles of 'good' governance. At a minimum, effective governance should include local communities in decision-making

processes in order to meet their social, environmental and economic goals (Osherenko, 1988; Nadasdy, 2005; Christie et al., 2017; Nguyen et al., 2019). There are interrelated barriers to achieving good governance that intersect with knowledge/power processes (Lemieux et al., 2021). Specifically, these barriers include the presence of different views on authority (where it comes from and who ought to have it), process dimensions (the role of state science, role of local and Indigenous knowledge, collaborative modelling, how values and objectives are measured and represented), and when/how different stakeholders and rightsholders are held accountable for decisions (past and present).

Current approaches to coastal-marine governance and ecosystem-based management are often based on the Western-scientific illusion of one objective truth (Charles, 2001; Dehens and Fanning, 2018; Silver et al. 2022). State-led coastal-marine governance has often been characterised by a 'command and control' approach in which ecosystems are perceived as both predictable and controllable (Holling and Meffe, 1996). Despite some efforts in ecosystem-based management to adopt a more linked and complex approach, decision-making is still framed in the context of conventional scientific information. This application of scientific knowledge is critical but is incomplete if it excludes local stakeholders who have different perspectives and knowledge systems (Mazzocchi, 2006; Berkes et al., 2007; Huntington et al., 2011; Lemieux et al., 2018). These gaps provide a clear link to the importance of KCP and more general efforts to democratize the governance of coastal-marine resources and fisheries.

Approaches and frameworks of governance have emerged to support more equitable and ecologically sustainable outcomes (Merchant, 1989; Sutherland et al., 2011; Lemos et al., 2018), including co-management (Armitage et al., 2011). Indeed, such efforts highlight a need to reflect on the tensions and possibilities of the: (1) regulatory or occasional 'command and control' functions of the state; (2) the neoliberal role of markets (i.e., fishing rights and economic incentives) (Silver et al., 2015; Pinkerton, 2017); and (3) perspectives that reflect more decentralized forms of authority and decision-making that in theory better reflect the values, needs and roles of local people (i.e., use, access and participation) (Nguyen et al., 2016; Bennett et al., 2017) (see manuscripts 2 and 3). For example, Ostrom (1990) emphasized the idea of community-based management and building local institutions (e.g., the rights, rules and norms that dictate how local people access and use resources), and this aligns with what many scholars of Indigenous governance consider priority principles.

However, underpinning the context of coastal-marine governance and ecosystem-based management is the influence of power. Power, in its many forms (e.g., structural, discursive, relational, and/or visible, invisible and hidden) runs through all aspects of governance (i.e., who makes decisions, how they are made, implemented etc) (Gaventa, 2005; Avelino and Rotmans, 2009). Yet, many governance frameworks and management approaches are not explicit in how they treat power. For example, much of the scholarship on EBM does not explicitly tackle power, and as noted, still emphasizes knowledge created through the natural sciences, despite advocating for more participation. Moreover, most governance theories and frameworks are silent on the emergence of Indigenous and/or non-western processes of governance and decision-making. I turn next to a reflection on the insights from Indigenous governance, noting that these perspectives are a key part of the interplay between knowledge/power and indicators (manuscript 1), and the specific examples of co-production reflected upon (manuscript 2) and implemented (manuscript 3).

1.4.4 Indigenous governance principles and practice

Indigenous governance is founded in place-based principles and is informed by multi-generational knowledge that is relational and context-specific. There are no universal set of Indigenous values. However, Salomon and colleagues (2023) highlight how at the core of many Indigenous governance systems are a set of values that perceive 'resources' as part of their everyday lived experience (Absolon, 2011). Diverse Indigenous governance perspectives thus emphasize the importance of place and the relational connectivity between people and their environments. Indigenous experiences and governance systems are thus increasingly positioned as a way to advance efforts to improve coastal and marine outcomes (Johannes, 2002; Ban and Frid, 2018; Reid et al., 2021). This is especially so in the context of Canada. In this section, I aim to briefly explore the definition and core principles of Indigenous governance.

There is an emerging literature on Indigenous governance systems, but it remains inappropriate to reduce these systems to a common set of formalised practices given that they are linked to place. However, Indigenous governance is defined here as the customary systems of decision-making that have been utilised across generations, such as resource sharing processes (e.g., potlatches in the coastal Pacific Northwest). The Institute of Governance (IOG, 2018) also provides a helpful framework to define Indigenous governance (see Figure 1-2). At the core of the IOG (2018) perspective is the notion that Indigenous governance is defined by cultures, traditional values and worldviews, and further framed by

the importance of autonomy (e.g., fiscal and jurisdictional), capabilities (e.g., leadership and community well-being) and relationships (e.g., Nation-to-Nation and community cohesion).

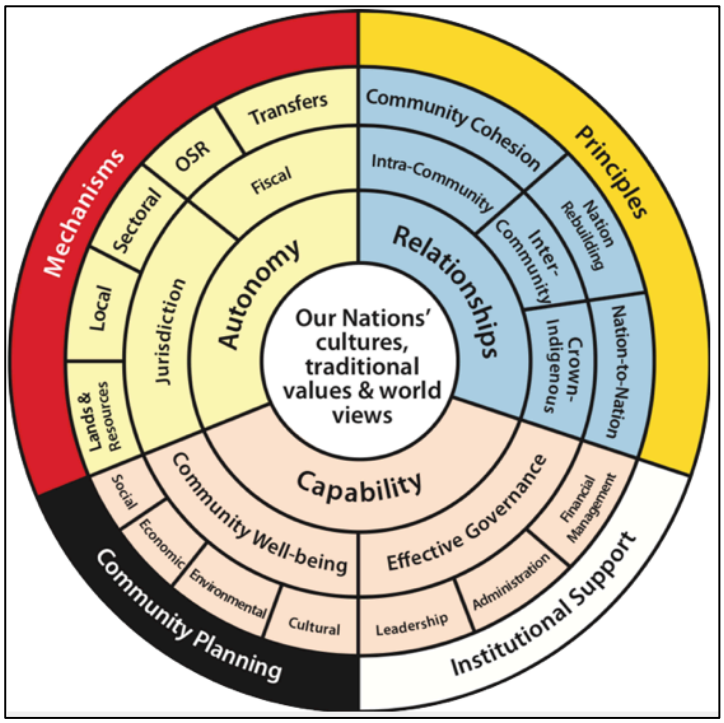


Figure 1-2 An example of an Indigenous governance framework

Source: IOG, 2018

Scholars of Indigenous governance are currently challenging the status quo in coastal-marine resource management and calling for new arrangements and engagement with/resistance to the state (Menzies, 2010; Denny and Fanning, 2016; von der Porten et al., 2016; Claxton and de France, 2018; Todd, 2018; von der Porten et al., 2019a; Reid, 2021; Todd, 2018). The cultural identity, social and political organizations of Indigenous peoples are connected directly to natural resources and environmental conservation (Jones et al., 2010; Jones et al., 2017; von der Porten et al., 2019b). For example, Indigenous-led conservation is emerging as one manifestation of Indigenous governance in contexts where place-specific knowledges are needed and as a means to support the regeneration of cultural, political and spiritual practices (Simpson, 2011; Salomon et al., 2023).

Indigenous governance is based on the underlying supposition that natural areas and people have co-existed prior to an area being designated as 'protected' and that conservation is part of a way of living (Roberts et al., 1995; Prosper et al., 2011; Augustine and Dearden, 2014;

McMillan and Prosper, 2016). The perspectives and lived realities of Indigenous people are fundamental for effective governance of coastal-marine resources in Canada (von der Porten and de Loë, 2014; Moola and Roth, 2019), yet Indigenous governance requires further recognition to foster coastal-marine resource stewardship and to promote conservation (Pinkerton et al., 2014; von der Porten et al., 2019b; Burt et al., 2019; M'sit No'kmaq et al., 2021).

Although I offer a basic definition above, Indigenous governance is actually difficult to adequately characterize as Indigenous peoples are not homogenous (i.e., there are some 600 First Nations, Inuit and Metis in Canada). Like all communities, different perspectives will be held by different people in First Nations, Inuit and Metis contexts. However, there are some collective principles and values that inform how Indigenous governance scholars and practitioners view pathways forward (Tully, 1995). These principles are summarized by von der Porten (2012) and reflect the insights of other Indigenous governance scholars: (1) involving indigenous voices in political discussions (Henricksen, 2001; Preston, 2009); (2) strengthening Indigenous-Indigenous partnerships (Simpson, 2008); (3) strengthening Indigenous-non-Indigenous partnerships (Turner, 2006; Price, 2008); (4) addressing colonialism (Alfred, 2005 and 2009; Bryan, 2009); (5) supporting and applying reconciliation processes between the state and Indigenous nations; and (6) asserting and championing Indigenous nationhood (Simpson, 2008).

There are operational challenges associated with the application of these principles in the context of coastal-marine governance and ecosystem-based management. For instance, these principles appear and/or are interpreted as an operational challenge because they exist in the context of legal and political structures and norms of the settler colonial state. When it comes to applying principles, factors such as time, self-governance, inertia and reticence of other state actors have been a challenge. There are political, institutional and state mandates that act as substantial barriers (see Battiste, 2011), and systems of power entrenched in governmental institutions and practices privilege western epistemologies and knowledge (Absolon, 2011; Murray and Burrows, 2017). Indigenous knowledge and values are often 'fit' into the approaches and frameworks as a box to be ticked. For example, local residents and Indigenous people are often required to adopt a specific economic production activity (i.e., intensive shellfish aquaculture) (Pinkerton and Silver, 2011; Silver, 2013). Shifting governance systems rooted in capitalist and colonial objectives and worldviews, and which are designed to maintain the status quo, reflects a fundamental challenge (Murray et al.,

2006; Castleden et al., 2018; Reid, 2021; Stein et al., 2020) and one which is considered in later chapters of this dissertation (Chapters 3 and 4).

Implementing and following Indigenous principles requires shifting systems for governance in ways that embody equity and justice, and which align with fundamental human rights (i.e., see the United Nations Declaration on the Rights of Indigenous Peoples) (Turner, 2006). For example, the revitalization of customary governance systems is linked to self-determination and provides guidance for improved decision-making (Natcher and Davis, 2007). Indeed, the involvement of local and Indigenous communities and the incorporation of their values and knowledges is more than a moral imperative (Agrawal, 1995; Salomon et al. 2023). These values and the knowledge systems they are founded upon are crucial inputs into understanding the complexity of coastal-marine systems, how those systems have changed through time, and the historical and institutional practices available to help manage those systems (see Nadasdy, 2003; Bryan, 2009).

In this regard, there are emerging frameworks and practices that reflect the actualization of Indigenous governance. For example, the concept of 'Two-Eyed Seeing' is one such approach, although its uptake across Canada varies (Bartlett et al., 2012; Peltier, 2018). Two-eyed seeing is the concept of recognising two knowledge systems existing in parallel (Indigenous and Western science) and using them to meet a challenge (Aikenhead and Michell, 2011; Barlett, 2012). Reid and colleagues (2021) explain that Two-Eyed Seeing "provides a pathway to a plural coexistence, where time-tested Indigenous knowledge systems can be paired with, not subsumed by, Western scientific insights for an equitable and sustainable future" (Reid et al., 2021:1). Reid et al. (2021) apply this concept in the context of a research process, co-developing a participatory modelling approach in a case study (e.g., the Slave River Delta, Canada). The idea of 'Two-Eyed Seeing' is also acknowledged in other places, such as New Zealand (King, 2013; Marshall et al, 2016; Abu et al., 2019).

Another emerging metaphor is the Indigenous concept of 'braiding knowledge' (Jimmy et al., 2019). Braiding is an ongoing, emergent process that respectfully brings Indigenous and conventional scientific governance processes side-by side and reflects a holistic way that both Western and Indigenous perspectives can frame coastal-marine governance (Bartlett et al., 2012; Kimmerer, 2013; Abu et al., 2019; Reid et al., 2021). Jimmy and colleagues (2019: 34) define braiding as "…decisions made together in a mutually defined process that centres the people impacted (in terms of decision and power)." Ultimately the key principles of braiding include: 1) creating space for creative, unconventional social transformation, 2)

moving slowly and healing settler-indigenous relations; and 3) making decisions mutually and respectfully (Jimmy et al., 2019). The challenge with braiding which is emphasized in the literature is not that it is combining two different knowledge forms, or cherry picking the best options, instead it is about maintaining the integrity of both knowledge systems while allowing for transformation. Many of these 'braiding knowledge' principles are consistent with the perspectives of Indigenous governance in Figure 1-2.

Indigenous forms of governance processes, rules and practices will yield new perspectives and may prevent 'break points' in decision-making and undesirable social and ecological outcomes (Stevenson, 2006; Berkes, 2009; Tengö et al., 2014; Mistry and Berardi, 2016; Ban et al., 2018; Francis et al., 2018). For example, Indigenous governance perspectives can further frame how sea otter return and the re-emergence of customary rules, principles and decision processes may intersect with access to marine food resources, with implications for food security and commercial harvesting of other valued species (see manuscript 3). As such, understanding governance (including Indigenous and customary forms of governance) and how it supports or undermines local values and place-based knowledges is an important theme. Governance approaches are needed that are culturally appropriate and that help to measure, assess and generate desirable social and ecological outcomes (see manuscripts 1 and 2). The consideration of Indigenous governance principles and values is particularly important in relation to the decision tools that are used to implement diverse objectives, and the manner in which those decision tools are linked to processes of knowledge co-production.

1.4.5 Knowledge/power and decision-making tools

Coastal-marine governance and ecosystem-based management provide the context within which to consider processes of knowledge, power and decision-making. However, situated within these broader contexts are the specific tools used to support those decision processes. Specifically, decision-making tools are used to help investigate problems arising from social-ecological interactions and can help (or hinder) efforts to navigate multiple objectives in collaborative ways (Schimel et al., 2015; Elsawah et al., 2020). Decision-making tools also help to achieve explicit goals through documented, structured processes (Groves and Game, 2015). In the context of coastal-marine governance and EBM, decision-making tools are useful for linking knowledge to action (Sunderland et al., 2009; Walsh et al., 2015).

There are varied and extensive tools to support decision-making practices in coastal-marine governance (Cook et al., 2014). Tools are defined by Schwartz et al. (2017: 2) as "…a structured set of specific activities used to accomplish one or more critical planning steps". This definition distinguishes tools from the array of databases and information sources that can be described as tools (i.e., International Union for Conservation of Nature redlists) (Mace et al., 2008). For example, indicators are a particular type of decision-making tool because they can provide insights on issues of importance that can be tracked over time and thus yield insights that support decision processes (e.g., tracking levels of trust over time can provide insight into acceptance of decisions). Other relevant or similar examples of decision-making tools used to help guide decision-makers include: models of various types, assorted scenarios, GIS applications/software; and synthesis efforts (e.g., systematic reviews). For the purpose of my work, I recognise that decision-making tools are broad in scope, but I have focused specifically on indicators (see manuscript 1) and scenarios (see manuscript 3).

Freudenberg (2003) defines an indicator as the "quantitative or qualitative measure derived from observed facts that simplify and communicate the reality of a complex situation." Indicators approaches are valuable in understanding social-ecological systems and provide measures that can help achieve and track social and ecological targets nested within broader objectives and goals. A more comprehensive overview of indicators as a decision tool is presented in the next chapter, but Rinne et al. (2013) have outlined how indicators are mainly used for three specific purposes: (1) an instrumental purpose to determine decision outcomes; (2) a conceptual purpose used for new ideas, learning and understanding; and (3) as a political purpose to justify decisions already taken. Such purposes illustrate how knowledge/power processes inevitably intersect with this particular tool and highlight the importance of critiquing and discussing the relational variables that determine how indicators are developed and applied (see Chapter 2; Muhl et al. 2022). In addition, there is value in acknowledging that indicators as discussed here (see Chapter 2) emerge from a western science perspective (see above) that may decontextualize or deconstruct complex systems as a pathway to understanding. This western science perspective and may not always comfortably fit with Indigenous worldviews in which relationships and connectedness are often more explicitly prioritized. As a counterpoint to this potential tension associated with indicators as a decision making tool, Chapter 3 draws attention to the use of participatory scenarios as an alternate form of viewing the system as connected, while creating further opportunity for genuine consideration and engagement with Indigenous and other place-based worldviews.

As noted above, this dissertation also engages with scenarios as an important decision tool (see Chapter 4). Here, visual, place-based scenarios have been used to engage people about the natural return of sea otter in Haida Gwaii. Scenarios again reflect choices about what knowledges to include to reflect relationships of interest and can feed into governance and ecosystem-based management processes. The co-produced scenarios add value and create buy-in linking management to place-based economic opportunities and food security, and situating management choices within a broader commitment to Haida-led research. The visual and narrative provided a creative and accessible strategy to understand otter-human relations and to engage participants in discussions about sea otter management and governance.

1.4.6 A working conceptual framework for my research

Figure 1-3 reflects a summary conceptual framework to link the various dimensions and concepts associated with my dissertation. As reflected in this framework, one of the most important features of ecosystem-based management and coastal-marine governance is the relationship with KCP and subsequently the social-relational dynamics of power within these processes. Political ecology insights help to connect knowledge and power and draws attention specifically to how governance processes are fundamentally shaped by social and institutional realities. Insights from political ecology are thus an entry point into a more critical perspective on the other bodies of literature and draw upon (e.g., EBM and decision-making tools) and influence how I analyse and interpret their application in complex coastal-marine contexts (e.g., like sea otter return in Haida Gwaii). In the context of this dissertation, I view KCP as a mechanism through which power can be more carefully considered, and Indigenous and place-based knowledges can be centred. Such processes thus help to build relationships (as illustrated by the interconnected arrows and feedbacks) among different organizations, foster social learning (defined here as learning that goes beyond the individual – see Reed et al. 2010), and encourage more adaptive responses (see Gutiérrez et al., 2011). This conceptual framework provides a foundation as well for the methodological approach and methods used in this research.

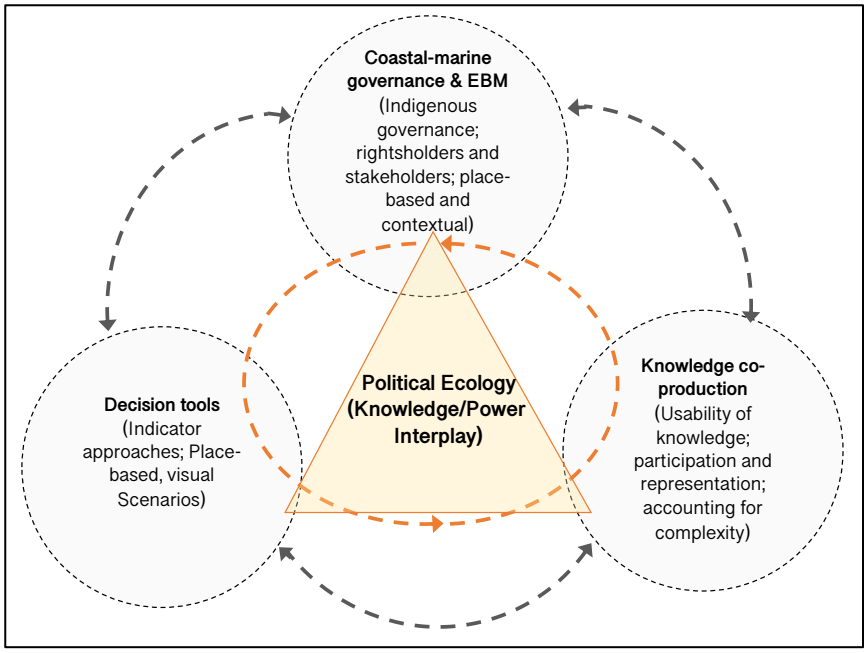


Figure 1-3 Conceptual Framework

1.5 Methodological approach and methods

My research aspires to be transdisciplinary (Pohl, 2010; Bettencourt and Kaur, 2011; Folke et al., 2016; Nash et al. 2017; Coen, 2018). I define transdisciplinarity here as "different academic disciplines working together with non-academic collaborators to integrate knowledge and methods to meet shared research goals achieving a real synthesis of approaches" (Kelly et al., 2019: 150). KCP is a crucial feature of a transdisciplinary research approach and refers to collaboration, mutual learning and engagement with diverse knowledges for actionable outcomes by balancing societal relevance with academic rigour (Polk and Knutsson, 2008; Angelstam et al., 2013; Payne and Shepardon, 2015).

My methodological approach and research emerge from the partnerships I have developed with Indigenous and federal governance organizations, and specifically, in the context of my roles in two initiatives: (1) the Gwaii Haanas Ecosystem Based Management Implementation Working Group (Council of the Haida Nation, Parks Canada and Fisheries and Oceans Canada); and (2) the Haida Gwaii 'Kuu' (Sea Otter) Ecosystem Model Project Team (led primarily by the Council of the Haida Nation/ Fisheries and Oceans Canada/ Parks Canada) and allied Coastal Voices initiative. My research has adhered to the Tri-Council Policy on Research Involving the First Nations, Inuit and Métis Peoples of Canada (see ethics section

below), and I have endeavoured to respectfully partner with and meaningfully engage with Indigenous communities. My approach, therefore, was also participatory.

Within the context of my aspirations to do transdisciplinary research I adopted a primarily inductive approach upon which I sought to draw insights based on place-based observations and experiences. The inductive orientation of my work ultimately influenced my choice of methods. By adopting an inductive and transdisciplinary approach, I allowed for flexibility in identifying and understanding issues of relevance to my research objectives within Haida Gwaii (manuscript 3), and in reference to other examples (manuscript 2). For example, the inductive perspective taken here was appropriate as it has allowed for an analysis of the themes that arose through engagement with rightsholders and key stakeholders associated with sea otter return in Haida Gwaii (manuscript 3). In the following sections I summarize the particular methods associated with each manuscript and dissertation objective. Further details on these methods can be found in the relevant manuscript. However, a. key message to emphasize is that the methods and approach taken are generally consistent across the manuscripts and all reflect a specific strategy to engage with the interplay of knowledge/power processes for coastal-marine governance and ecosystem-based management.

With regard to manuscript 1, I first undertook a systematic scoping review (see Chapter 2) to critically examine the opportunities, limitations and impact of KCP in the development of indicator approaches (while also reflecting on the models within which these indicators can be situated) for coastal-marine resource management and governance. I supplemented this systematic review (n=67) with a targeted review of other bodies of grey scholarship and literature that will help me address this objective, as well as drawing on grounded reflections with co-authors who are engaged in this space. My aim was to synthesise key issues associated with KCP and indicators and to provide a guide and identify pathways forward that help to frame and inform subsequent dimensions of my research (i.e., theorizing knowledge/power processes with regard to decision tools and approaches).

For manuscript 2, I engaged with selected global examples (n=4) of KCP in coastal-marine EBM initiatives through a critical and reflective process with key collaborators (n=13) (see Chapter 3). The four contexts in which we engage with KCP and governance include: (1) coastal ecosystem-based management initiatives in Haida Gwaii, Canada; (2) experiences with coastal governance and ecosystem management in New Zealand; (3) a knowledge brokering support program in Papua New Guinea aimed at fostering coastal livelihoods; and

(4) the historic and present day management experiences with the in-shore (coastal) cod fishery in Newfoundland and Labrador, Canada. Our critical analysis of these examples adopted a reflexive (Fazey et al. 2018) and qualitative assessment (see Starman, 2013) of co-production opportunities in which the co-authors were involved as a way to catalyze in-depth discussions and collaboratively identify specific lessons for successful KCP. In doing so, this research also benefited from a modified 'organizational ethnography' approach (Yanow et al., 2012) because most of the co-authors were reflecting on organizational and project contexts in which they were embedded. As a result, the project team was able to tap into the sensitivity of hidden dimensions within different organizations and co-create questions and discussion designed to draw out often overlooked but tacitly known dimensions for successful KCP.

My final manuscript (see Chapter 4) includes a community-driven and place-based assessment to understand and identify essential management and governance issues related to the return of sea otter in Haida Gwaii. The broader context here is the extent to which management and governance efforts can be used to collaboratively restore and sustain coastal ecologies, cultural practices and just economies given the significant implications of sea otter return (e.g., potential impacts to commercial shellfish harvests, uncertainties associated with food security - see Chapter 4). To do so, the central method of my research was to co-produce visual, place-based scenarios of alternative sea otter futures and accompanying narratives outlining the detailed social and ecological relationships associated with their return. I define scenarios here as "…plausible example(s) of what could happen under particular assumptions and conditions" (Peterson et al. 2003: 2). In this way, scenarios provide a novel tool in which relationships and tensions among alternative futures can be explored. Scenarios are an effective method in the context of sea otter return because they help to account for complexity and are useful for understanding and grappling with unknown futures, and the manner in which those futures reflect the principles, values and priorities of Haida and stakeholders. In addition, using both visual and narrative scenarios was more accessible and interesting to non-academics and were useful for framing community needs and revealing governance and management concerns.

The process of co-developing the scenarios and then using them to elicit management and governance insights was intense. First, I catalyzed the establishment of an eight-person scenario working group consisting of Haida Elders, youth, archaeologists, and other experts on sea otters and marine management. Once the working group was established, I facilitated three workshops to build, interpret and clarify the place-based scenarios and accompanying narratives. The workshops were appropriate in this context as they enabled iterative

development of insights and co-production. The approach of using a diverse working group of knowledge holders was a unique process and inverted the 'business as usual' model which sees researchers come in and do the work they are interested in, without considering the local communities, management authorities and/or their needs. Instead, my scenario co-development approach prioritised local needs and sought to do research for people, rather than for the sake of my own personal interests. Once the scenarios were developed, I worked with a local research partner to engage further on issues of management and governance through a series of four workshops and one interview across a total of 30 participants.

Specifically, the workshops included Haida youth from X̲aad Kíl Née (the Haida Language Office), Elders from the Skidegate Haida Immersion Program (SHIP), the Archipelago Management Board and a workshop/meeting with the Council of the Haida Nation executive committee. Ultimately, I collaborated with the Council of the Haida Nation to do community-based research that is directly engaged with sea otter return. Working closely with community-based researchers has generated multiple benefits, including mentorship, training and capacity building for future projects. These processes of learning and sharing experiences and knowledge flow in both directions. Full details on the scenario co-production and implementation process are available in manuscript 3 (Chapter 4).

My research design does intersect with methodological concerns of generalizability, replicability, and rigour (Yin, 2009; Creswell 2017). Yin (2009: 37) draws attention to issues of generalizability and the applicability of research findings to other contexts beyond those that have been the focus here. However, I make no specific claims about generalizability and replicability of my research because part of my work is grounded in the unique example of Haida Gwaii and circumstances like sea otter return. There are lessons to be drawn from the examples and experiences examined in manuscripts 2 and 3, yet the importance of context and the specifics of place are a more fundamental concern. There is scope to connect with theory (see Chapter 5), but my focus is as much on the practical application of insights. For instance, coastal communities are not homogenous, and the social, political, ecological, economic and cultural contexts influencing coastal-marine governance and EBM vary greatly across regions (see manuscript 2). Still, by examining processes of KCP in a range of cases and applying these ideas in Haida Gwaii, I am able to further build the theory and practice of KCP and highlight crucial lessons from experience that are relevant to a wider range of jurisdictions and problem contexts.

While generalizability and replicability are not a paramount concern, the rigour and validity of the work (e.g., doing my research in a way that is accountable to others and respectful) was a fundamental priority. For example, my own biases and the effect of my presence on the people I engaged and process I was involved in are points of reflections (see my positionality statement). To address these challenges, I grounded my work and approach in KCP and frequently engaged with a range of voices for feedback on my process. I was also careful to ensure that power was always balanced in a room when I did work and that I made myself approachable and available.

As reflected above, my dissertation was a rigorous multi-phase project that linked a systematic scoping literature review (manuscript 1) and reflective analysis (manuscript 2) activities with a place-based and engaged scenario approach in Haida Gwaii to understand sea otter return (manuscript 3). This multi-phased approach illustrates the interactions with the development of decision-making tools (i.e., indicators) and in particular through the lens of KCP. The insights from the indicator development analysis – and especially those related to governance, culture and economy – along with the insights from the reflexive and organisational ethnography of KCP examples, helped inform alternative future scenarios of sea otter return and their application. The information that emerged from indicator development (Objective 1), a synthesis and analysis of KCP cases (Objective 2) and scenario processes (Objective 3) can all be used to inform transdisciplinary KCP for better coastal-marine governance and ecosystem-based management. Principles and processes of KCP have provided a common methodological (and analytical) approach across these efforts and can help to bridge different ways of knowing and diverse experiences. The specific data collection methods and approach of my research are synthesized below (see Table 1-2).

Table 1-2: Objectives, research questions, theoretical/conceptual framing and data collection methods

Research objective	Example of related questions	Theoretical and conceptual framing	Data collection methods and approach
Manuscript 1: Critically examine the opportunities, limitations and impact of KCP in the	How are indicators developed, by whom? To what extent do practitioners and decision-makers want	Knowledge co-production Participatory indicator development in	• Scoping review (n=67) • Supplemental review and consideration of

application of indicator approaches for marine resource management and governance.	and use indicators? How do indicators inform decision-making once developed?	natural resource management.	gray literature related to indicator initiatives. • Grounded co-author reflections • Meta-synthesis approach
Manuscript 2: Examine the interplay of governance and KCP by drawing upon a detailed reflection of selected international cases for ecosystem-based management (e.g., Canada, New Zealand and Papua New Guinea);	What motivates people to participate in different KCP processes? How does identity, positionality and power dynamics inform engagement? What specific institutional arrangements have catalysed success?	Knowledge co-production Ecosystem-based management Governance	• Series of structured virtual workshops • Follow-up individual or small group semi-structured Interviews • Reflexive approach as part of a modified 'organizational ethnography'
Manuscript 3: Co-produce place-based, visual scenarios of alternative sea otter (*Enhydra lutris*) recovery futures in Haida Gwaii, British Columbia (Canada) as a means to engage diverse knowledges and co-examine opportunities for the ongoing restoration of coastal-marine systems	How do you see the governance of sea otter return linked to Haida Gwaii marine harvest practices that align with Haida values? How can we co-exist with sea otters in relationships where we honour our own rights to harvest while also honouring sea otters right to be here?	Knowledge co-production Scenario development Governance (Indigenous)	• Working group discussion for scenario development – place-specific qualitative and visual scenarios of sea otter recovery futures • Workshops and supplementary interview with a total of 30 participants

1.6 Research positionality

Matching my aspirations for transdisciplinary research with what I might feasibly and meaningfully accomplish in the defined time limits of a doctoral research project was difficult, and especially so given challenges posed by the COVID-19 pandemic. I had to balance disciplinary depth with the social and ecological complexity of the issues I sought to address. While completing my PhD, I acknowledged the challenges associated with transdisciplinary research, my own biases and interests, and reflected on my own identity in all its ever-changing complexity (see final reflections in Chapter 5).

When doing community-oriented research in particular (manuscript 3) or engaging with colleagues in a reflective process based on our shared examples (manuscript 2), I had to reflect on my identities within and outside of these processes. I am a white, English-speaking, able-bodied female. However, I identify as South African and was raised by my grandmother in an Ashrama, a space of interfaith worship. My experience in South Africa was not one of privilege, but how I appear in Canada as an international PhD student carries the assumption of privilege. I had to grapple with an outward perception from others that influenced how they related to me and viewed my work. While in my heart I am an African and tied to the land I was often mistaken as a person from England. My positionality as an outsider in a community setting and especially one that is First Nation is something that I reflect upon further below, and the complexity that this held for me.

In addition, my positionality within the community as a researcher shaped my approach. I situated myself as an action-oriented, transdisciplinary researcher. I think one of the greatest compliments I received was when I went back to visit a member of the sea otter working group, and the individual's father was asking what I did. While I attempted to provide an 'academic' and 'appropriate' answer, I heard a call from the other room: "she's on our side!". The complex psychology of identities and how that exists with research shapes how we perceive ourselves. But in conclusion, I will always see myself as an activist and on the 'side' of people living and stewarding their lands and waters. Throughout this research I have seen myself as an outsider, and as someone who needs to listen, learn and help with the skills I have been given, where I can, and with respect for those around me.

1.7 Ethics

The field research associated with this dissertation complied with the guidelines of the latest edition of Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans (TCPS2) that guide Canadian researchers. Ethics clearance for this research was obtained through the University of Waterloo's Office of Research Ethics (ORE) in accordance with the guidelines. The approved ethics protocol for the field research (ORE # 31165) addressed all relevant considerations and risk mitigation including, informed consent during participants recruitment; protecting privacy, anonymity, and confidentiality; data storage and password protection; reciprocity, trust, and relationships; and associated responsibilities of the researcher and research assistants (See Appendix E for the approval and consent forms). The initial ethics protocol was amended twice during the study period to ensure compliance with COVID-19 related safety measures, and to include the research ethics permission from the Council of the Haida Nation.

As per the second amendment, this research is part of a larger project on sea otter return (X̲aayda Gwaay.yaay K̲uugaay Gwii Sdiihltl'lx̲a – *The Sea Otters Return to Haida Gwaii*) that is supported by the Council of Haida Nation (CHN) and Parks Canada. This project includes Haida researchers and staff from both the CHN and Parks Canada, as well as a wide range of academic researchers and others, and is informing the Archipelago Co-Management Board (a joint Haida, Government of Canada decision-making body). My application for research permission was approved by the Council of the Haida Nation's on August 27th, 2021. The project associated with manuscript 3 met the Council of the Haida Nation's standards for research conducted in Haida territory.

My research contributes directly to this effort and also involves working with local/community researchers in doing so. This research thus adheres to the Tri-Council Policy on Research Involving the First Nations, Inuit and Métis Peoples of Canada (Chapter 9 of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans). As such, principles of OCAP (Ownership, Control, Access, Possession) are recognized as an important condition in which this research has taken place to ensure data sovereignty. We follow the principles and intent of a model research agreement developed at Memorial University and which emphasizes the following features: 1) the CHN retains ownership of any data collected, while the researcher will collect, store, retain, return, maintain confidentiality and/or destroy the data as per the standards and requirements of the institutional research ethics board (in this case the University of Waterloo Office of Research Ethics) and agreements with CHN; 2) the

researcher, in collaboration with research partners in the Kuu initiative may publish (i.e., in a peer-reviewed journal) the results of the research but prior to that will provide drafts for review to relevant parties with due time to identify suggested changes. Should requests for modifications be made, the researcher would seek do so where feasible and before subsequently submitting the research for peer-reviewed publication. In all circumstances, guidance from relevant parties as to wise practices would be sought.

My field research was also conducted in compliance with a COVID-19 Safety Plan to minimize potential exposure to COVID-19 during in-person field activities and was approved by the University of Waterloo's Office of Research (See Appendix E). In addition, public health guidelines and advisories issued by the health authorities in Canada were closely monitored during the fieldwork period and additional precautionary measures were implemented in collaboration with local research partners.

1.8 Thesis organization and linkages across chapters

Following this introductory chapter, the forthcoming chapters of this dissertation include three standalone manuscripts (Chapters 2, 3 and 4) and a concluding chapter (Chapter 5). As reflected above, these three manuscripts address distinct questions and contexts, but they are designed to build on each other and to achieve a broader interrogation of knowledge/power processes in the context of decision tools (i.e., scenarios, indicators) and the interplay with coastal-marine governance and ecosystem-based management. The concluding chapter revisits the objectives of this dissertation and summarizes the key findings from the three manuscripts. Next, the chapter highlights the significant and original contributions made to the advance knowledge and seeks to emphasise theoretical/conceptual and empirical or applied insights. The chapter concludes with a section on study limitations and a brief discussion about areas for future research. All work cited in this dissertation is presented as a list of references at the end of the dissertation and are itemized alphabetically. The appendices referred to within this introductory chapter are included at the end of the dissertation.

Chapter 2

Indicators are relational: Navigating knowledge and power in the development and implementation of coastal-marine indicators

2.1 Chapter Summary

In many environment and resource management contexts (e.g., integrated coastal management, ecosystem-based fisheries management), indicator selection and development are perceived as a largely technical, bureaucratic, and scientific challenge. As such, choices about indicators and their application are often treated as external from everyday politics and dynamics of social power. Our aim here is to highlight the value of a relational perspective that weaves power and knowledge together in the context of indicator development and implementation. We highlight four critical dimensions of this relational perspective that may lead to better indicator process outcomes: 1) centering identity and positionality to reflect power differentials; 2) emphasizing the importance of indicator 'fit' and the politics of scale; 3) engaging rather than erasing social-ecological complexity; and 4) reflecting on social norms and relationships to foster adaptation and learning. These four dimensions are rarely considered in most indicator initiatives, including those that are more participatory in design and implementation. The dimensions we outline here emerge from the grounded experience of managers and practitioners, including indicator processes in which we are currently engaged, as well as a scoping review of the literature on indicators for coastal and marine governance and conservation specifically. However, the four dimensions and relational focus are relevant to a wide range of resource and environmental management contexts and provide a pathway to catalyze more effective indicator processes for decision-making and governance more generally.

2.2 Introduction

Our aim here is to highlight the value of a relational perspective (e.g., as opposed to purely pragmatic and/or positivist framing) that weaves power and knowledge together in the context of indicator development and implementation. Indicators and their development play a crucial role in accurate assessments of social-ecological change and outcomes of coastal governance and conservation initiatives (Jennings et al., 2005; Sterling et al., 2017; Armitage et al., 2019; Latulippe and Klenk, 2020). Further, they are used to monitor and track changes over time, provide sources of information about ocean health and socio-economic effects of

resource use, and inform regulatory decision-making and policy (Fletcher et al., 2005; Rice and Rochet, 2005; Boyd and Charles, 2006). As such, indicators (and related measures) are meant to foster accountability, evaluate decision outcomes against intended objectives, and to assess change in social and ecological systems through time and space. Yet, in many resource and environmental management contexts, indicator selection and development are largely perceived as technical, bureaucratic, and scientific.

Increasingly, however, assessments of change and the monitoring and evaluation of management strategies must meet growing expectations for decision-making paradigms that disrupt solely Western science-based ways of measuring change, that more effectively consider local issues, reflect the incorporation of Indigenous and local ways of knowing, and that are sensitive to a wider set of values associated with human-nature interactions (see Wong et al. 2020; Beausoleil et al. 2021; Zurba and Papadopoulos, 2021). These expectations do not replace indicator efforts to assess economic benefits or ecological sustainability based largely on Western-science models, but rather encourage more attention to their historical-institutional contexts and knowledge claims (see Beausoleil et al. 2021).

Limitations associated with indicators often emerge as a result of a mismatch between how they are developed and how those engaged (actively or passively) assume they should be developed. Here, the hard dichotomy of an expert-driven approach versus a 'participatory' approach rarely exists in practice. There is usually some measure of 'community' input in most indicator development processes and/or engagement with 'scientists' and Western-science/conventionally defined experts in more community-oriented processes. For example, Beausoleil et al. (2021) highlight the nuances between Indigenous-led (in Canada), collaborative (those that engage Indigenous and western scientists) and participatory (those that are western science driven but involve some engagement) approaches. Indeed, there are certainly variations in approach and emphasis. In some situations, 'expert knowledge' (i.e., those trained in Western science) is privileged (Silver et al., 2022). Such processes tend to draw on secondary data or involve quantitative data collection aligned to a largely predetermined framework and perspectives about knowledge rooted in a western science paradigm (Cutter et al., 2010). Indicators that fit this approach tend to "follow theory and models, to integrate large volumes of data, and reveal unexpected analytical insights" (Tyler et al., 2016:421; Steiniger et al., 2020).

Indicators, moreover, may be framed by policy makers to address internal political directives (e.g., measuring the Sustainable Development Goals) (see also King 2016), and in that

regard, may be somewhat narrow or constrained. For example, with reference to the Aichi targets, Meehan et al. (2020) have noted how indicators predominantly focus on ecological measures, but they also note that equitable management requires a greater focus on knowledge sharing to address conflicting values and priorities. Processes that are more participatory or inclusive might seem 'better', but they too can lack (or be perceived to lack) rigor, or grapple with issues of representation (Reed et al., 2008). For example, Rosenström and Kyllönen (2007) found that participatory indicator development led to better buy-in of indicators in decision-making but noted that the process to develop indicators did not necessarily facilitate social learning, or shared learning about the system and outcomes (see also King 2016). Yet even when supported through more participatory design, indicators are often constructed without attention to the deliberative governance processes they might be meant to inform, and may become redundant or inapplicable due to associated costs for data collection and long-term reporting. Individuals responsible for evaluation and monitoring of coastal activities or management interventions may also be reluctant to track outcomes of programs if they are not going well or if they reveal tensions in the context of decision-making or inability to engage meaningfully with non-western knowledge systems (see Ban et al., 2013). Difficult relationships and differences in power (see Avelino et al., 2021; Tafon et al., 2021) among actor groups can thus introduce biases and affect choices about appropriate indicators.

Effective approaches to indicator development can generate opportunity for respectful engagement between different interest groups (e.g., commercial harvesters, communities), and potentially catalyze partnerships. In this sense, Kourantidou et al. (2020) position marine-based indicators as 'boundary objects' to engage with different knowledge systems, and to consider the role of indicators in tracking ecosystem change, as well as integrating knowledge in collaborative decision-making contexts in Canada's north. Here they define boundary objects as concepts that serve to bridge multiple types of knowledge and action, and to facilitate interactions between the two (see also Star and Griesemer, 1989; White et al., 2010; and van Pelt et al., 2015). Kourantidou et al. (2020) thus suggest that successful indicators will emerge when they reflect political and relational realities and when their role as 'boundary objects' (used to navigate normative claims and meet certain objectives) are emphasized. This is in fact rare in practice, and further attention is warranted on the ways in which indicators reflect the social-relational contexts in which they are embedded.

In the following section, we further theorize the relationships between power, knowledge and indicator development. We then highlight the main processes and methods through which

our ideas have been developed, including a scoping review of relevant literature (with an emphasis on coastal and marine settings). Next, we examine four critical dimensions of indicator development that highlight the value of a relational perspective that weaves power and knowledge together: 1) centering identity and positionality to reflect power differentials and links to underlying values; 2) emphasizing the importance of indicator 'fit' and the politics of scale; 3) engaging rather than erasing social-ecological complexity; and 4) reflecting on social norms and relationships to foster adaptation and learning. The insights we offer and critical dimensions we discuss are not a panacea for the historical and institutionalized challenges of indicator development for environmental decision-making (e.g., evaluating alternative harvest strategies) or monitoring social-ecological change. However, the insights do point to the value of expanding efforts to 'co-produce indicators' in ways that meaningfully grapple with power/knowledge relations and that can help to nudge indicator processes in directions that encourage more transdisciplinary and place-based governance.

2.3 Indicators, Power and Knowledge

Power refers to the capacity to influence the actions, beliefs or conduct of others (Foucault, 1980; Van Assche et al., 2017; Avelino; 2021). However, relationships of power are not explicitly addressed in most environmental management settings. In particular, few processes acknowledge the structural/material and discursive forms of power and knowledge production (see Van Assche et al. 2017), or the manner in which visible, invisible and hidden forms of power (Gaventa, 2005) influence how, where and with whom indicators may be developed and applied. For example, indicators used to track coastal and marine change or outcomes of coastal management interventions often reflect dominant systems of knowledge (i.e., Western science), institutionalized forms of power (i.e., centralized government agencies), and particular experiences of managers and decision makers (Silver et al., 2022). To frame our analysis and to reflect on power/knowledge relations, we draw in particular from the literature on knowledge co-production (KCP), defined here as the collaborative process of consciously bringing a plurality of knowledge sources and types together to address a defined problem and build an integrated or systems-oriented understanding of that problem for an actionable outcome (Armitage et al., 2011; Nordstrom et al. 2020). Specifically, we use experiences with KCP as a way to think about what is needed to disrupt one-way flows of information, and place more emphasis on the social-relational dimensions (Bodin and Prell, 2011; Alexander and Armitage, 2015) that can influence indicator processes.

KCP provides a useful lens to reflect on knowledge and power because it emphasizes relationships among different organizations, fosters knowledge generation, encourages social learning (defined here as learning that goes beyond the individual – see Reed et al. 2010), and promotes adaptive responses (Cvitanovic et al., 2016) (see below). Additionally, co-production processes are hypothesized to help establish a suite of objectives and measures that better 'fit' the needs of managers, community interests and resources users across multiple scales (Djenontin and Meadows, 2018; Metz et al., 2019). Such collaborative or cooperative processes are assumed then to better support the development of indicators needed to measure and document key outcomes of resource and environmental management initiatives (e.g., ecological, governance, community benefits) (Haynes et al., 2020; Kourantidou et al., 2020). Accordingly, there is a strong argument for approaches that identify, develop and apply indicators and measures from processes that centre Indigenous people, local communities, and more marginalized groups, and that better reflect their ontologies, worldviews and values in ways that challenge (and not just 'add to') Western academic knowledge (see Henry and Pene, 2001; Todd, 2016; Reid et al. 2021; Gewin, 2021). Yet, KCP is not a panacea and there are challenges to effective development of indicators and related processes that are largely unarticulated in the literature.

For example, critical scholars of science and society draw attention in particular to the legacy of colonialism that positions Western knowledge over Indigenous knowledges, and that creates entrenched barriers to the institutional changes required to decentre Eurocentric approaches (M's-it No'kmaq et al. 2021; Trisos et al. 2021). Critical theorists and scholars have long emphasized how knowledge influences and is influenced by the system within which it manifests (Jasanoff, 2004), and further recognize that co-production does little if it does not challenge in some manner the dominant political-economic system and growth model that constrain transformative efforts (see Saloman et al., 2018; Alexander et al., 2019; Büscher and Fletcher 2020; Reid et al., 2021; Atlas et al., 2021). As Moon et al (2021:7) note, "we must acknowledge that different epistemic communities generate or hold credible and legitimate knowledge [that] can aid in overcoming…power imbalances and ensure respectful and appropriate inclusion of different knowledge systems". However, there remain many challenges for indicator development process given the way actors (e.g., government representatives, community knowledge holders) position their different knowledges and diverse epistemological foundations (see Elsawah et al., 2020), what they consider or perceive to be legitimate knowledge (see also Maynard, 1994), and how that knowledge is evaluated within those different epistemologies (see Moon et al., 2019).

Incorporating diverse knowledges, and recognising the relational connectivity between local and Indigenous people and their environment can provide crucial insights, while helping to disrupt the 'pipeline' of colonial knowledge practices that often frame indicator development and objectives (see Ban and Frid, 2018; Reid et al., 2021; Atlas et al., 2021). There is clear evidence, for instance, that centering Indigenous and hereditary forms of knowledge and related processes is linked to improved social and ecological outcomes (Stevenson, 2006; Berkes, 2009; Tengö et al., 2014; Mistry and Berardi, 2016; Ban et al., 2018). Indigenous nations hold their own place-based knowledge of their environmental contexts (e.g., marine and coastal systems) (Leonard et al., 2020). Respecting the autonomy, laws and philosophies of Indigenous nations and local communities is thus crucial for equitable decision-making and governance. When it comes to indicator development this means avoiding a binomial flatland for indicators that is rooted in Western science, and instead make space for the inclusion of narratives and oral histories that reveal the complexity of the social and ecological space.

Despite shifts in framing, however, the flow of knowledge for indicator development (and application) still often starts with scientists externally identifying solutions to identified problems through predominantly quantitative methods, and delivering the results to society (Mach et al., 2020). The 'pipeline' or 'loading dock' model of science and policy interactions (Cash et al., 2006; Büscher et al., 2020) continues to drive the development of indicators in many jurisdictions. Following a brief overview of our methods, we engage more directly with several dimensions of knowledge/power and their relationships with indicator processes.

2.4 Methods

Our aim in this paper is to highlight the value of a relational perspective that weaves power and knowledge together in the context of indicator development and implementation. To support our analysis we drew upon three main sources of information: 1) a scoping review of 67 peer-reviewed literature of indicator approaches reflecting a more 'participatory' and inclusive perspective, with a particular focus on coastal and marine settings; 2) supplemental review and consideration of additional grey literature related to indicator initiatives centring coastal contexts; and 3) grounded reflections on experiences of co-authors involved in recent and ongoing indicator development (see Panel 1) and coastal resource management initiatives, two of whom have experience managing indicator processes for federal agencies in Canada. Our focus on coastal systems was intentional for two reasons: 1) some boundaries were needed to limit the scope of the literature we examined; and 2) our collective experiences and knowledge areas are primarily in coastal settings. However, the issues and

insights we document are relevant to a broader range of social-ecological settings, including in terrestrial domains (e.g., forestry, water management).

We conducted a scoping review of relevant literature to frame our synthesis and identify issues of emerging interest. To do so, we adopted a 'meta-synthesis approach' (see Rathwell et al. 2015) to ultimately identify a suite of core themes related to knowledge/power and their relationships. A meta-synthesis aims for a more integrated, qualitative and reflective perspective on an issue in the literature and is based on techniques primarily from health sciences (Thorne et al., 2004). In doing so, we contribute to the growing need for clarity on how diverse indicator process for regulatory decision-making, research and management evaluation can contribute to better outcomes. Our aim was to identify papers documenting practical examples where indicators were developed in participatory and inclusive ways.

We used a global perspective and time-scale of 2000-2020 to guide the search for relevant papers. Sixty-seven peer-reviewed papers were ultimately identified through a search protocol of keywords and relevant databases, including Scopus and Web of Science. We note here that the terms like 'participation' used to capture papers are contingent on how they are defined by authors and not necessarily reflective of how issues of inclusion and representation are actually experienced. To balance selectivity with comprehensiveness, three levels of search terms were used (see Table 2-1). 'Participation' was a central theme as searching only for knowledge/power or co-production yielded few results. Specifically, we ran a search for "participat* AND indicator" and limited the search to English peer reviewed articles only. We then searched within those articles for "marine OR fishery" to align with the system that we sought to analyse and then we searched within those papers for "develop* and process*. Even though the search terms were mostly marine some other similar resource contexts did emerge (e.g., agriculture). Limiting by 'develop' and 'process' was important as we want to see how indicators are developed rather than simply what indicators were chosen in a given situation. This only slightly reduced the number of articles. We limited the subject area to sociological and environmental sciences. This returned 410 documents.

These documents were then scanned by reading the abstracts and exported to Refworks to ensure that we had captured the full range of documents and were avoiding duplicates. The same search protocol was also subsequently used with Google scholar. We also drew on expert elicitation to capture additional papers of relevance that were examining issues of 'co-production' in indicator development. Once all papers were assessed, a total of 67 articles were deemed informative for the scoping and synthesis process. We organized the

information from the papers into an excel spreadsheet for further analysis using themes associated with our core concerns (e.g., strengths and weaknesses, links to science and policy, links to decision).

Table 2-1: Key search terms

Level 1	"Knowledge co?produc*" OR "Knowledge synthes*" OR "Knowledge integrat*" OR “knowledge exchange” OR "science-society" OR "Science for Societ*" OR “Knowledge exchange” OR “science-policy” OR “Co-produc* of know*” OR “participat*” OR “collaborat*”
Level 2	Indicator* OR criteri* OR Evaluat* OR Monitor* OR Measur*
Level 3	fish* OR marine* OR coastal OR ocean OR sea OR Aqua*

The vast majority of papers reviewed were based on cases and examples from Canada and North America (see Figure 2-1). Our analysis and examination of experiences in the literature was guided as much by what we did not find explicitly documented as much as it was identified as core issues in the cases examined. For example, few of the 67 papers reviewed explicitly identified or considered power dynamics within and between stakeholders and groups, with only eight of the 67 papers listing the participation of local stakeholders in the indicator process as being important for navigating knowledge and power. The conceptual and theoretical gaps in the literature on indicators emerged because indicator processes are framed largely as technical, bureaucratic, and scientific efforts. In this sense we were particularly interested in identifying the ‘counterfactuals’ apparent in experiences with indicator development, and particularly with reference to the relationship between knowledge and power. We did this by situating our scoping review and synthesis in a broader empirical context. Finally, we interpreted the insights from our analysis with reference to ongoing indicator processes in which authors E-K.M., D.A. and H.T. are currently engaged (see Panel 1 below for example), or that we have previously administered in our professional contexts. With reference to our own positionality (see material below) we are a team of applied scientists and practitioners (all settlers in a Canadian context) with different disciplinary and professional backgrounds (although we identify as interdisciplinary). The contributions of each author to the research and partnerships in which we are engaged does reflect our distinct experiences, privileges, and biases. These experiences (e.g., Panel 1) supplement this review and point to four critical dimensions for better indicator development reflecting the relational challenges of knowledge and power. These dimensions, therefore, emerged in an iterative manner that included a review of the papers and other materials, in the context of theories of knowledge/power, and a subsequent refinement of what we determined to be important gaps.

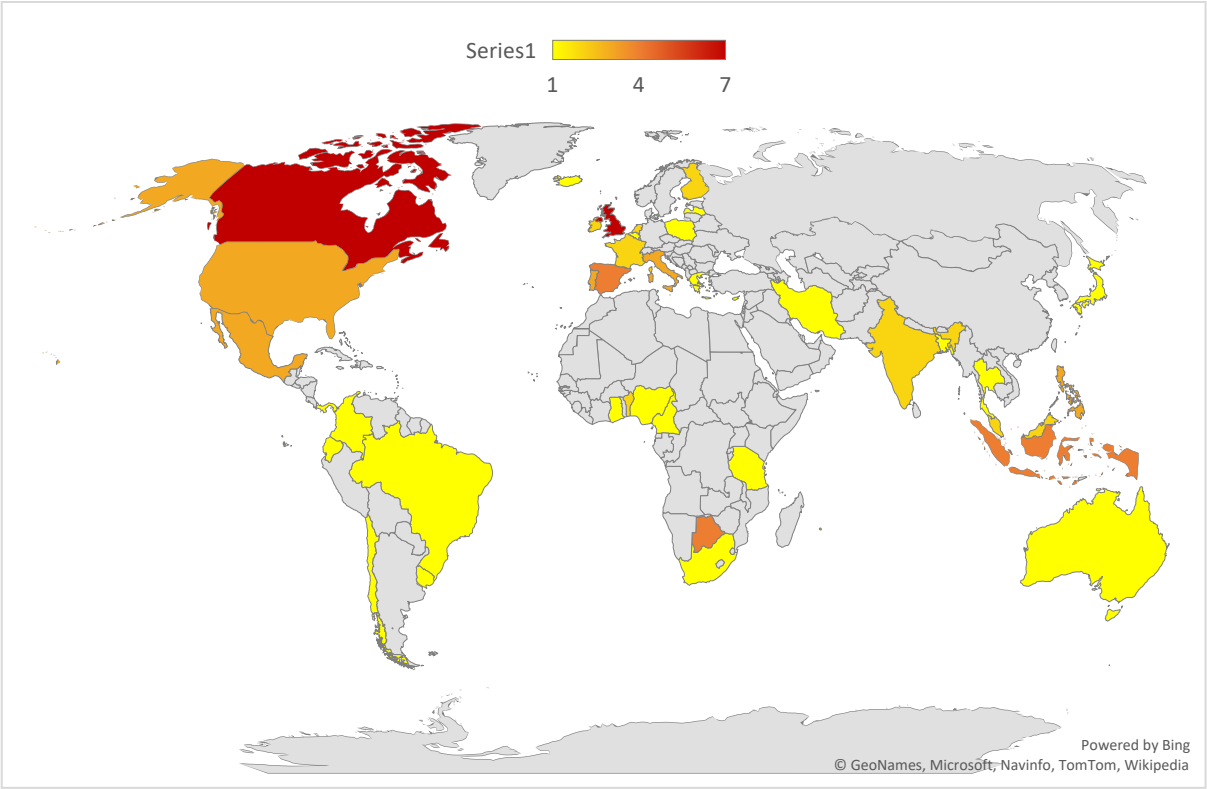


Figure 2-1 Geographic distribution of case-based studies (n=67)

2.5.1 Critical dimensions of indicator development and implementation

Indicators can very easily serve to reproduce particular practices or forms of decision-making that are inequitable in the absence of critical reflection on how and by whom those indicators are developed. In this section, we identify four critical dimensions to encourage indicator initiatives that are more relational, reflective, and engaged with their inevitable politics (see Figure 2-2): 1) centering identity and positionality to reflect power differentials and links to underlying values; 2) indicator 'fit' and the politics of scale; 3) engaging rather than erasing social-ecological complexity; and 4) critical reflection on social norms and relationships to foster adaptation and learning. We draw on examples from literature that reflect both the presence and absence of these dimensions. Attention to these relational dimensions can significantly improve opportunities for more robust and durable indicators processes.

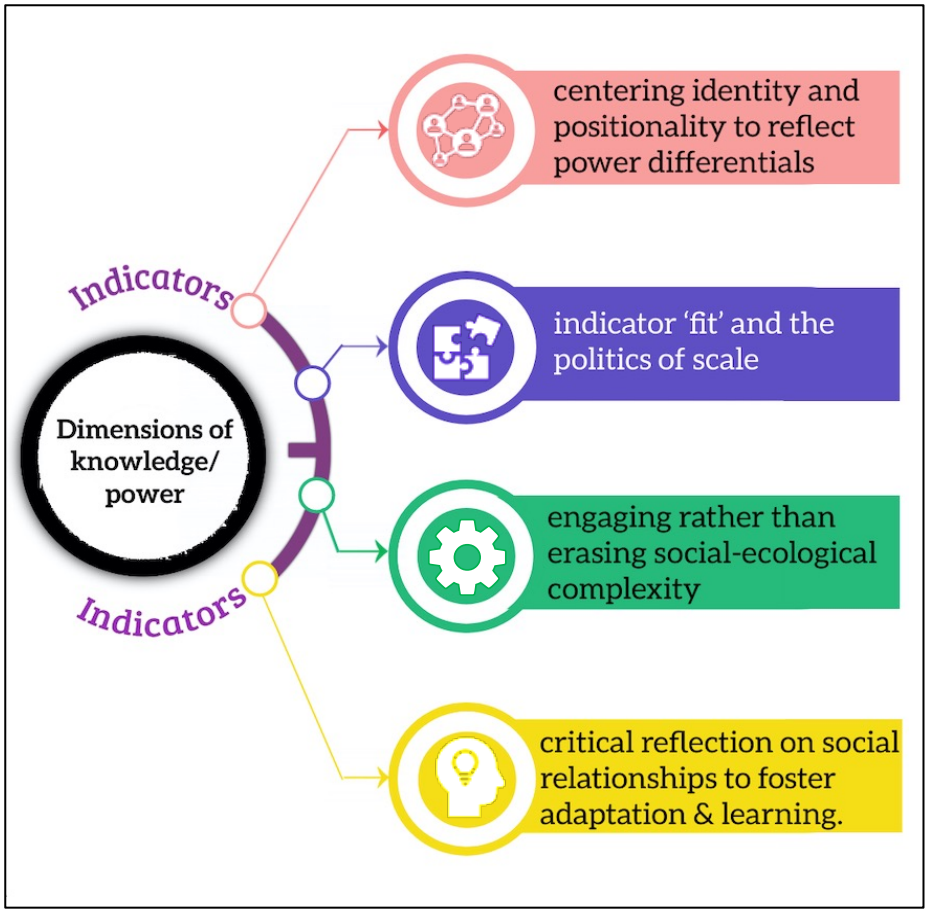


Figure 2-2 Critical dimensions of knowledge/power for indicator development

Panel 1: Indicator Development for Ecosystem Based Management in Haida Gwaii

The Gwaii Haanas Gina 'Waadluxan KilGuhlGa' Land-Sea-People Management Plan outlined a shared vision and sets direction for the protection and use of Gwaii Haanas National Park Reserve, National Marine Conservation Reserve, and Haida Heritage Site in Haida Gwaii, Canada. Notably, the Land-Sea-People Plan was co-developed over several years by the Haida Nation and Government of Canada in collaboration with communities and stakeholders, and it establishes the foundation for a range of management and implementation initiatives. One of these core initiatives is to develop and apply an evaluative framework (i.e., indicators and measures) to assess activities (e.g., fisheries) in Gwaii Haanas against Plan objectives. Indicator development, testing and application is guided by the Ecosystem Based Management Working Group (hereafter "working group"), formed by the partners implementing the Land-Sea-People Plan and reporting directly to the Archipelago Management Board (AMB), a co-management body comprised of three representatives of

the Haida Nation and three representatives of the Government of Canada (two Parks Canada, one Fisheries and Oceans Canada) to foster equal representation.
Activities of the working group are ongoing and include the development of a series of indicators and measures to assess governance, ecological, economic and social-cultural aspects of two pilot fisheries, Pacific herring (Clupea pallasi) and geoduck (Panopea generosa). Outcomes of the indicator initiative and evaluative framework will have important implications for how decisions are made and are linked to broader changes associated with nation-to-nation governance. As such, while there is a significant focus on the technical rigor and suitability of indicators, the knowledge/power dimensions framing this effort are a point of reflection in the process. For example, the composition of the working group illustrates the importance of *positionality, identity and representation* of diverse knowledge forms and peoples. Within the working group there are approximately 11 members representing the Council of the Haida Nation (CHN), Parks Canada (PC) and Fisheries and Oceans Canada (DFO), as well as three academics. Specifically, there are members with significant scope of understanding of the ecological dimensions of the key fisheries of interest (including a Haida knowledge holder), as well as those with rich insight on cultural values and the political context in which the evaluation framework is being developed. Collectively, the working group is trying to co-produce a suitable mix of evaluative indicators and measures drawn from the co-developed Land-Sea-People Plan – which are then vetted by the AMB - but which also involve a community engagement process to foster support. This ensures that the framework is informed by Haida knowledge and experience as well as western science inputs. Here, there are other knowledge systems that inform (and are being informed by) lived experience on the ground and values of participants in the process, including members of the AMB itself. Much of the process is about putting the 'right' people in a room (or zoom call) together to help balance institutionalised assumptions and structures and ensure that there are 'countervailing' relationships of power built into the indicator development process.

In addition, the composition of the working group reflects the diverse organizations that have responsibilities for the management of the area and implementing the indicators. The suite of indicators and measures are intended to be relatively straightforward and limited in scope (i.e., have a good '*fit'* for purpose) so that data/information can be triangulated, relatively easily collected over time, used to inform decisions by the AMB, and in the longer term allow the Haida Nation to exert more decision-making influence over key fisheries. As such, the AMB will be *learning and adapting* according to the reported state of the ecosystem illustrated by the indicators. A suite of indicators co-developed with attention to knowledge/power dimensions will *engage more deeply with complex* ecological, socio-economic and cultural

objectives reflected in the co-developed Land-Sea-People Plan. There may be drivers of change that have a significant effect on Gwaii Haanas but for which there is limited control (e.g., climate change).

Ultimately, the working group efforts are intended to improve decisions about ecosystems and fisheries and ensure benefits accrue to the Haida. In this regard, the focus on indicators is not so much technical as it is on aspects that reflect dimensions of knowledge/power and Haida aspirations around culture, food security and self-governance. In this sense the context for this indicator process is unique. The Haida have a unique political history and position in Canada as a First Nation that has asserted their rights, and this has led to innovative measures and plans (like the Land-Sea-People plan) which reflects a particular way of linking Haida knowledge, science inputs, Haida governance (including hereditary governance) and policy processes. Navigating dynamics of power and knowledge is as much an expectation in this process as it is a barrier, meaning the process is not smooth. Reflecting on the indicators and measures has revealed how complex these social-ecological systems are and why it is difficult to identity a technically rigorous, yet implementable and usable framework.

2.5.2 Centering identity and positionality to reflect power differentials

Scholars on knowledge/power increasingly highlight the value of more explicitly centering identity and positionality because of how these constructs influence resource management decisions (Todd, 2016; Moon et al., 2019). Identity refers to how people perceive themselves and the behaviours, norms and the subsequent actions people take in a given decision-making context in ways that align with their values. Identity is also learned/embodied as a result of social expectations that society places upon different people based on one or more signifiers (e.g., gender, class, ethnicity, religion) (Butler, 1999). Positionality refers to how people situate their identity (and values) in relation to other people in a broader societal context (Cheng and Randall-Parker, 2017). As such, values may guide decision-making more generally, while identity and positionality come into play more directly when seeking to navigate power/knowledge differences during indicator development processes.

There are two main ways in which the centering of identify and positionality (and underlying values) can inform indicator approaches. The first way is material and helps to draw attention to elements of representation and participation that can have significant influences on indicator development initiatives. For instance, indicator processes almost inevitably include certain groups and exclude others (see Figure 2-3). Which groups are included and excluded

often depends on who is leading a process and what knowledge they deem to be accessible and valuable. For example Maxim and colleagues (2012) combined expert and stakeholder knowledge to develop regional indicators to track the relationship between biodiversity and socio-economic activities, and found that the choice of indicators was dictated by who was in the room and what socio-political issues the participants found relevant.

Clearly, who participates in the development and implementation of indicators and how participation is defined and employed is a crucial issue, yet how participation is defined and how it manifests varies in relation to one's identity and positionality. Further, processes that do not recognize the complexities of identity and identity formation could reinforce problematic social constructions attributed to different signifiers (e.g. gender, class, ethnicity). Identity and positionality, and the extent to which there are opportunities for differentially positioned individuals is limited in most indicator processes (see also Beausoleil et al., 2021; Zurba and Papadopoulos, 2021). However, with reference to participation processes in the development of the Water Poverty Index (WPI), Wilk and Jonsson (2013) did identify a need for gender disaggregated workshops to counter positionality concerns (i.e., because of women deferring to men in the initial workshops).

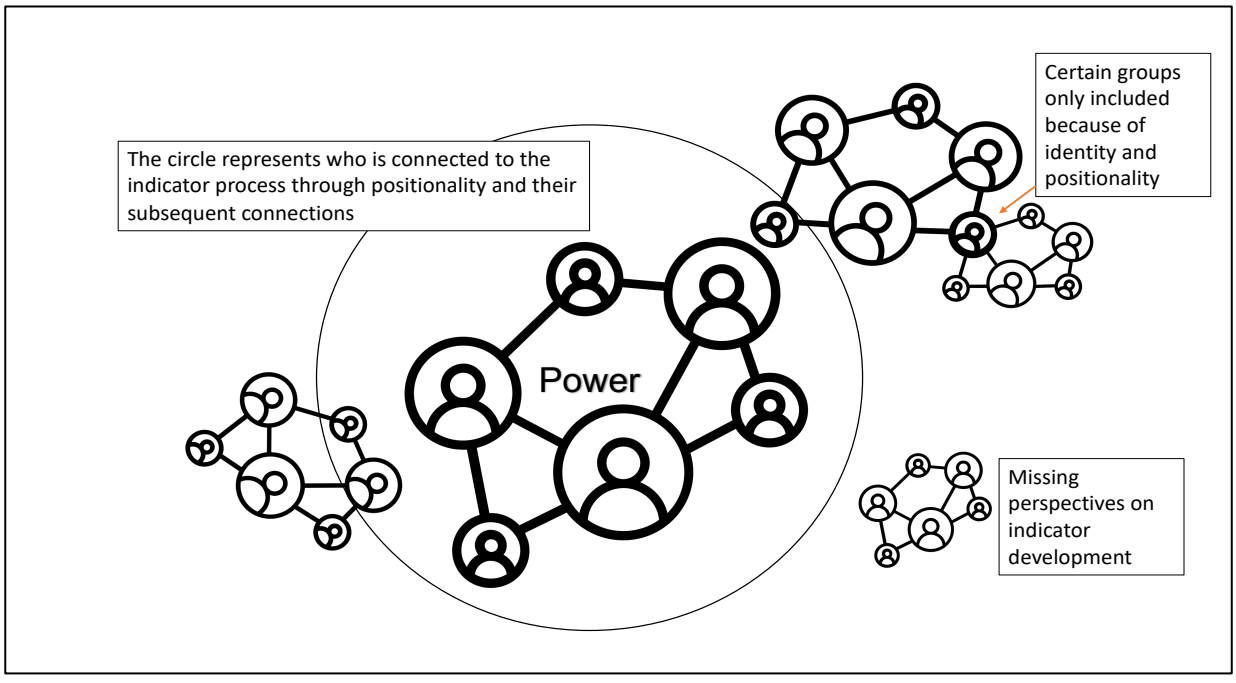


Figure 2-3 Positionality and identity shaping indicator development [the large circle indicates the indicator process and the networks indicate how people within the indicator process are influenced and connected to outside groups. One network not within the circle highlights how

there is a potential of some groups being excluded in the absence of meaningful representation].

As the papers reviewed here indicate, most indicator processes are not engaging with the implications of identity and positionality despite the high uncertainty and complexity of the systems – ecological and social – in which they are embedded. In fact, few papers offer even an explanation or definition of participation that is linked to well-established theories (e.g. see Arnstein's 1969 ladder) – theories of participation that are already relatively silent on these related constructs. Given the link between identity, positionality and participation, engaging with diverse knowledge holders or epistemologies thus becomes a 'moving target' (see Scott and Bell, 2013). Still, there are a number of examples that point to some effort in this regard (see Andalecio, 2011; Vugteveen et al., 2015; Sardain et al., 2016). Specifically, in drawing attention to the challenges of participation and engagement reflected in diverse identities and positionalities, these examples and others are aiming to clarify the relevant actors (across sectors, jurisdictions and places); reflect on how identity and positionality influence knowledge exchange needed to develop meaningful indicators; unpack the hierarchies and sub-groups of individuals and organizations; and consider how the social relationships they engender are driving outcomes of indicator processes (see Alexander et al. 2016).

A second way in which the centering of identity and positionality can inform indicator approaches is more tacit and hidden. Acknowledging the positionality of relevant actors (e.g., Indigenous knowledge holders, industry representatives, government representatives) in relation to one another can support better engagement and create opportunities for otherwise underrepresented epistemological 'voices'. However, attention to the influence of identity and positionality on participation does not necessarily ensure that issues of power and knowledge are addressed. This is particularly the case where particular actors and ways of knowing have long-standing or hegemonic roles in a decision-making context (see Jasanoff, 2003). For example, 'unseen' sources of identity and positionality can have profound outcomes on indicator initiatives because certain forms of knowledge, values and perspectives (e.g., dominant science) can be internalized by individuals and/or communities as the 'right' form of knowledge, even though their own experiences and understanding of a system may point to different concerns (see Agrawal, 2005).

Increasingly in a natural resource and management initiatives we need to be attentive to the colonial context in which knowledge systems are situated and the decisions that emerge from these contexts (M's-it No'kmaq et al. 2021; Trisos et al. 2021). As many of the papers

reviewed here show, choices about indicators, and the privileging of Western science knowledge systems in the development of most indicators draws attention to how indicators may easily serve particular agendas, or reflect particular ontologies. Most of the indicator processes and outcomes reviewed here emerged in a longer historical political-economic (i.e., colonial) context in which the relationship of particular groups (notably Indigenous peoples) to their territories has been forcefully severed and their multi-generational and place-based knowledges undermined (see Sterling et al. 2017). Indeed, what is missing in many of the papers and current indicators scholarship (and especially in places like Canada and Australia) reviewed here, is a fulsome reflection and critique of the shifts in power between Indigenous peoples and formal nation states. In Canada, for example, the assertion of rights and nation-to-nation governance relationships will (or should) have a profound influence on how we think about indicator processes for decision-making.

Finally, when indicators are developed with strong government support or emerge from institutions that are perceived as powerful, the apparent path to implementation reflects a more simplified version of reality (Hezri and Dovers, 2006). Yet, the undermining of particular identities either by force or through tacit messaging leads to an internalization of particular and homogenous ways of knowing. Moreover, the indicators that are prioritized can serve to emphasize and measure aspects of a system that participants come to believe are important because they are accepted to be right in the first place (see Agrawal 2005). Unsurprisingly, most papers documenting indicators processes do not engage with these phenomena, but there is room for inference as to how these tacit or hidden social processes are connected to situations where constrained outcomes or poor links between indicators and decision-making are documented (see Rosenström and Kyllönen, 2007; Tafon, 2018; Trimble and Plummer, 2018).

Ultimately, we must acknowledge how the 'material' and 'tacit' dimensions of identity and positionality (and the values they reflect) operate in tandem. Moreover, there are a variety of resource issues (e.g., funding), logistical or practical challenges (organizing meetings), competing epistemologies or ways of knowing, and relationships of power that all require attention, and that all operate together and influence how identity and positionality manifest in particular contexts. As a result, it is imperative that the gravity of the challenge is recognized, including those of participation and inclusion, grappling with diverse values and knowledge systems, and reflecting in particular on matters of representation of often disenfranchised groups. In this regard, a rich critical, theoretical and empirical literature on engagement is available to guide further reflection on intersecting issues of values,

identity/positionality and their implications for legitimate representation in the context of indicator processes (see Fudge et al. 2021). This includes more recent studies that draw greater attention to participation in marine governance using insights from political representation and decolonial theory (see Flannery et al. 2018; Bennett et al. 2019; Whyte 2018; Liboiran 2021).

2.5.3 Indicator 'fit' and the politics of scale

Operationally useful and meaningful indicators must 'fit' (see Epstein et al. 2015) their organizational and decision-making context, yet be sensitive to the politics of scale. Politics of scale is intended to challenge the notion that there is a distinct or even 'natural' or given hierarchy of scales (Marston 2000; Castree et al. 2008). Here there is an inevitable tension between the need for a politically sensitive yet coherent ways to think about scale (i.e., how does the knowledge/power create the temporal and spatial categories used to structure indicator processes) with a more functional or instrumental need to ensure indicators match the social and/or ecological objectives of managers (Swyngedouw in Blakey 2020). In this regard, we highlight several features of this challenge that are reflected in the literature and cases examined here, as well as other contexts reflected in our analysis (see Panel 1).

Indicators reflect a unique relationship between knowledge and power, and different forms and practices of indicator development have different yet often unaddressed scalar implications as a result. For example, in some organizational situations, indicator initiatives may be impeded (actively or passively) by practices involving the assignment (or not) of staff or resources, or by prioritizing more "urgent goals" that reflect priorities of one scale over another. A simple illustration of this is the top-down application of the Sustainable Development Goals (SDGs) and indicators to local contexts even though those indicators (and the aggregate goals they represent) are a poor match with the aspirations and experiences of particular groups. Indeed, this mismatch between goals articulated at one scale and desired outcomes at another scale was evident in a number of the cases reviewed here. For example, Aguardo and colleagues (2016) show the clear link between indicators incorporated into policy and management decisions concerning local fisheries for improved sustainability, but highlight the gaps in addressing and incorporating ethical and social concerns. Across the 67 papers, this scalar tension around goals and indicator 'fit' was reflected in several additional ways. Some examples illustrated this scalar tension in processes that seemingly focused on engaging effectively with particular groups, but in relation to expectations about adapting to a pre-existing list of indicators drawn from either

policy reviews or scientific/disciplinary literature (see Adrianto et al., 2005; Coelho et al., 2010; Andalecio et al., 2011; Ashok et al., 2017). Other examples highlighted the process of indicator development through 'expert elicitation' in which particular scalar perspectives are centred (see Diedrich et al., 2010; Danielsen et al., 2013: Asare-Kyei et al., 2015). However, the material and discursive foundations of scale are rarely surfaced in discussions about the 'method of engagement' or strategies for participation.

Challenges with spatial scale manifested in an organizational context as noted above, or in the politics and tensions embodied in methods of indicator development are significant. However, there are also temporal scale challenges that require further consideration. For instance, multi-stakeholder processes may be particularly effective momentum breakers because they stretch timelines beyond the mandate of particular governments or the leadership tenure of senior bureaucrats or others who might be required to 'champion' a particular initiative (Cvitanovich et al., 2021). Similarly, momentum can be constrained by endorsing the development of indicators but then failing to assign the necessary resources required for a data collection that requires time series inputs. For instance, Diedrich and colleagues (2010) found that while there was initial support for the development of indicators for the Balearic Islands in Spain, implementation of the indicators had to increasingly rely on agencies working voluntarily with no durable technical or financial support, thus constraining the ability of the project to scale up (spatially) and out (temporally). Additionally, because the power of most environmental datasets only becomes apparent after a significant time series is collected, most investments in this area require large present-term expenditures to generate medium to long-term benefits (i.e., temporal 'misfit'). For example, Biedenweg et al. (2014) found that after developing indicators, it was unclear how they would be financed or how data would be collected. Program managers may need to choose between hiring staff to benefit current programs or purchase monitoring equipment or survey time that generate benefits longer term (and possibly to someone else).

There are several other aspects of indicator development and implementation that pose risks for management agencies and programs, and that constrain efforts to improve social or ecological fit. For instance, in the absence of meaningful collaboration and engagement with different perspectives, indicators and the data they generate can create fears that program failures will be highlighted or that substantial problems will be identified. Here, an obvious tension across scales of governance emerge, as well as within organizational spaces where individuals engaged in localized or sub-regional initiatives must grapple with higher-level agency practices or cultures. As early as 2001, Stevenson and Lee noted that while

indicators could help judge the quality and progress towards sustainable agriculture, there was a risk that simpler and available indicators would be prioritised as they were easier to assess. In addition, drawing on an example from sustainability indicators in Marine Protected Areas (MPAs) Marques et al. (2013) found that unless stakeholders saw how their contributions affected strategic or operational actions, they would not be interested in further participation in indicator development. Moreover, in the context of national or regional organizations (e.g., federal government agencies), consistently adopted indicators can expose scalar differences in program performance within or across departments (e.g., fisheries, environment), or reveal better outcomes in one region over another. The implications of this are significant and can include unhelpful competition, decreased morale and conflict. In more local or regional processes, these same risks to fit can also manifest in conflict if processes are not meaningful, and exacerbate tensions among different authorities (e.g., federal-provincial, government-to-government). For example, in Malta, Cassar et al., (2013) assessed the use of sustainability indicators and found issues with a lack of political interest, supporting data, standardization in data compilation and variations in data provided by different departments, thus making implementation and use of these indicators complex and limited in their ability to inform policy.

Financial and resource risk is another key challenge that reveals tensions of scale and problems of fit. For instance, data collection can be labour intensive, monotonous, politically unimaginative and expensive, and therefore not always available in ways that are needed to support indicator efforts. In this regard, O'Ryan and Pereira (2015) found that despite the identification of appropriate indicators the inability to generate data undermined the effort overall. Similarly, biological and environmental indicators advocated in a study by Sardain and colleagues (2016) were found to be lacking available data, despite Panama being a biodiversity hotspot. The financial and performance risks associated with indicators may thus sometimes seem greater than any benefits that would arise from their adoption. Yet, this is not always the case and in situations where engagement was emphasized, some of these challenges to fit were addressed through involving local stakeholders in monitoring, not only raising awareness and participation but also through crucially-enhancing management response for operational outcomes (see Danielsen et al., 2013). There is emerging evidence that the processes of co-production in which knowledge/power is considered enhances the potential for more positive social and relational outcomes (e.g., trust building, recognizing alternative perspectives) and may help to alleviate some of these scalar tensions that undermine 'fit' (Chambers et al., 2021; Karcher et al., 2022a).

Finally, in some situations, it is important to highlight that indicator development and data collection is a legal requirement (e.g., fisheries stock surveys). In such processes, confidentiality or limitations on data access may be invoked (i.e., indicator data and information may only be provided under 'Access to Information' requests). There are instances where confidentiality is warranted, including situations in which Indigenous knowledges are used as part of indicator initiatives and as sources of data for tracking change. However, experiences where data is tightly controlled clearly undermines opportunities to enhance fit and can exacerbate tensions across scales (local, national) or within organizations because of a perceived or real lack of transparency about how information is being used. There are few simple solutions to any of these fit and scale challenges, and most solutions are inevitably context or place-specific. However, the recognition of spatial and temporal scale tensions, and associated financial and legal risk profiles associated with indicator processes outlined here serves as a foundation to better navigate the issues of power and knowledge that influence choices.

2.5.4. Engaging rather than erasing social-ecological complexity

Management of coastal and marine systems to address their diversity and complexity requires robust indicators that are scale sensitive and reflect more attention to relations of disciplinary knowledge and power. Social-ecological complexity refers here to the properties of a coastal-marine system that confound understanding or efforts to identify patterns and processes (see Duit and Galaz, 2008). However, in the context of environment and resource management efforts, making choices about what indicators of complex social-ecological systems change to prioritize remains a significant challenge. In many situations reviewed here, there is a tendency still to focus on single species or single resource contexts, and most indicator processes struggle to effectively deal with 'whole ecosystem' or linked social-ecological system perspectives (Berkes et al. 2003) (see also Panel 1). In particular, our review reflected three related challenges associated with system complexity that may limit the potential of indicators to meaningfully represent social-ecological systems as experienced by those 'within' the system of concern, and who are most likely to experience the consequences of decisions based on indicators of change. However, these three challenges are also potential solution spaces and serve as entry points for pathways forward.

First, many of the experiences with indicator development we reviewed reflect an inherent tendency toward simplification (i.e., focusing on a small subset of indicators) or the seemingly inevitable erasure of complexity. This may occur for several reasons that extend beyond more

obvious issues of resourcing and time constraints. For instance, in many contexts there are no legislative requirements to collect certain forms of data (e.g., beyond very specific fish populations). Therefore, given the absence of any requirement to develop indicators on more complex social-ecological systems, the reflexive action of government management systems to is develop indicators to fulfil their legislative mandate only. As well, choices about the scope and scale of methods to engage with stakeholders will inevitably influence how complexity is reflected in an indicator process. In some cases, processes that are more focused on quantitative measures of change can homogenise the experiences of local communities and mask the social and cultural complexity of place-based change. In this regard, Conway (2007) developed local sustainability indicators using the Driver-Pressure-State-Impact-Response model as a starting point for monitoring the state of the Solent strait in England. However, Conway found that while indicators could serve to focus public attention on key issues, unfortunately they could also serve to represent a simplification of reality and overlook relationships between social, ecological and economic systems. As well, Giordano and colleagues (2013) also found that stakeholders tend to oversimplify dimensions of a system, which led to a preference for indicators that respond in a reactive rather than proactive or preventative manner. To address this in part, Elsawah et al. (2020) have noted how the richness of social and cultural experiences can be surfaced more effectively where methods generate more qualitative narratives. There is a growing awareness of the power of 'narratives' to better capture complexity, and engage a wider range of actor groups (and their ontological and epistemological foundations) to reflect on system change.

Second, many examples of indicator processes reviewed here often reflect particular disciplinary perspectives. For instance, there is a tendency to focus primarily on or emphasize ecological parameters (Hornborg et al., 2019), in part because they may seem more tractable, or are more likely in a domain of knowledge that is privileged (e.g., fisheries biology in coastal/marine settings). Indeed, most ecological datasets used as a foundation for indicators will prioritize western forms of scientific knowledge because despite some variation in the papers reviewed here, indicator initiatives are still largely developed and driven by natural scientists or managers with natural science training (Antona et al., 2007; Aguardo et al., 2016; Ferreira et al., 2018). While the depth and rigour of these disciplinary processes is crucial, they may not reflect the full social and ecological complexity of the system, or in more troubling instances, consider particular social systems (e.g., the notion of community) as homogenous or reducible to units of analysis that mask complexity. For example, Fontalvo-Herazo and colleagues (2007) found that, when measuring the four dimensions (environmental, social, economic and governance) identified as important for integrated

coastal management, if one of the four dimensions was absent it would be difficult to measure and identify linkages between indicators to assess interconnected effects. Examples like this and others may point to the importance of avoiding the siloing of knowledge across domains.

Third, and in response to some of the challenges noted above, more integrated or interdisciplinary approaches to indicator development for decision-making are increasingly common (see Ascough et al, 2008; Levin et al., 2009; Samhouri et al., 2014). However, the evidence here suggests that these processes still do not always afford equal footing to social scientists and Indigenous knowledge holders (see also Sterling et al., 2017; Wheeler and Root-Bernstein, 2020). More attention to place-based knowledges and diverse perspectives can yield valuable insights on how people perceive and experience social-ecological feedback across scales as well as processes of rapid change (Ban et al., 2013; Todd, 2018; M'sit No'kmaq et al., 2021). Yet, even in situations where indicator processes actively engage with dimensions beyond the ecological, and where socio-cultural and wellbeing concerns are highlighted, the tendency to gravitate towards a limited suite of indicators is strong. For example, Antona et al., 2007 found that socio-economic indicators supporting integrated coastal management were largely ignored and their use was not considered important to MPA managers. Moreover, the ecological indicators that were generated in more depth were not shared for the benefit of relevant actors, limiting knowledge exchange, opportunities for co-production, and opportunities to reduce unproductive relationships of power. Ultimately, a shift to transdisciplinary efforts (see Pohl and Hadorn, 2008) will be needed to overcome deeply embedded knowledge/power relationships. As reflected in many examples considered here (and consistent with other experiences) indicator processes framed as interdisciplinary or integrative have difficulty navigating feedbacks among ecological attributes and social complexity, and particularly so in the context of change (see Lemos et al. 2018).

2.5.5 Critical reflection on social norms and processes to foster learning and adaptation for change

Indicator processes are often perceived as a means to link knowledge gathering practices, processes of information exchange and actionable outcomes (Mach et al., 2020). Learning, or 'social learning' in particular is an important although often unarticulated element of this relationship. Social learning is defined here as changes in understanding about a system or set of issues that go beyond the individual and that support some form of shared actionable response (e.g., shifts in rules and practices, new social organization) (see Reed et al. 2010). Despite a focus on participatory indicator approaches, limited research has examined the

interplay of social relations of knowledge/power, learning processes and the manner which indicator choices and their applications are negotiated or co-developed. Moreover, the process of social learning itself can represent an adaptive response to conditions of social-ecological change and uncertainty (see Pelling et al. 2008) that are the object of many indicator processes. Further consideration is warranted about of the role of indicators as a relational (knowledge/power) boundary object (e.g., Kourantidou et al. 2020) to catalyze learning and support more adaptive management efforts.

For example, as reflected above, indicators and the monitoring processes initially designed to improve understandings of social-ecological systems and their feedbacks are more likely to foster adaptive management, and particularly when they draw on diverse knowledge systems. However, as the papers reviewed here illustrated, the preconditions (e.g., willingness to experiment, supportive policy context for innovation, history of engagement) to enable social learning and navigate social relations of power in indicator processes, are not always in place. Most indicator initiatives, and the specific social and ecological indicators developed through them, are undertaken via a myriad of non-binding partnerships, ad hoc research programs or as special projects. As a result, the material or discursive power of these processes to effect change (i.e., better decisions that reflect actual conditions) are substantially constrained (see for example Antona et al., 2007; Asare-Kyei et al., 2015; Aguardo et al., 2016).

Still, there were also several innovative examples and mechanisms documented in the literature (see Reed and Dougill, 2002; Santana-Medina et al., 2013; Trimble and Plummer, 2018; Kourantidou et al., 2020) and in which managers responsible for moving indicator processes forward centred a learning process to achieve longer-term outcomes. To centre learning and adaptation more effectively, these cases foremost sought to ensure those most affected by change were involved in indicator development processes. While recognizing the limits of an emphasis solely on participation (see above), engagement of stakeholders remains crucial as a broader range of interests are able to document and observe changes over time, and are more likely incentivized to take action in response (Pomeroy et al., 2005). Ecological changes (e.g. climate change), economic changes (e.g. drops in tourism revenue due to COVID) or social changes (e.g. increase in local population, greater conflict) are more likely to feed into learning processes and subsequent responses if those most affected are involved. For instance, Paterson et al. (2010) emphasised the importance of transdisciplinarity as a way to foster trust and overcome political and cultural conflicts, thus contributing to a process of learning and more adaptive management. Similarly, Kourantidou et al. (2020) highlight how incorporating community views from the start was essential for

generating meaningful indicators that could effectively capture ecosystem changes and draw on those insights to encourage shared learning. However, despite the emphasis on developing a process for indicator development, there remain few examples in the literature reviewed here that mention how indicator processes can be a catalyst for relational processes that support learning and adaptation.

The potential for indicators to be a context for co-development, and subsequently, the social learning necessary for adaptive management in the context of complexity (see Raakjær et al., 2007) is an area in need of further reflection. In particular, the systems of power and knowledge that prevent such processes will be a site of contestation. For example, learning more about system change will link to management interventions (e.g., changes in harvest allocation, decisions on zoning or enclosures) that are adaptive to future conditions (see Johnson, 1999; Garaway and Arthur, 2004). In this regard, two issues emerge as particularly important. The first is a willingness and capacity to critically reflect on indicators and indicator processes as systems change and context evolves also enables adaptation and learning - indicators must remain sensitive to shifting management priorities. Second, additional opportunities to revise and/or revisit indicators that more effectively track issues of concern for Indigenous peoples will be an emerging feature of those processes that support meaningful adaptation and learning. Indicators are a representation of social norms linked to particular epistemologies and onotologies, and often developed in a colonial context (Forsyth, 2004). However, there is clear evidence that incorporating and learning from Indigenous and hereditary forms of knowledge leads to improved social and ecological understanding (Stevenson, 2006; Berkes, 2009; Tengö et al., 2014; Mistry and Berardi, 2016; Ban et al., 2018), and these forms of understanding can help to reframe indicators in ways that better support adaptive decision-making efforts.

2.6 Conclusion

Reflecting on the relational dimensions of knowledge and power draws attention to contested political, social and cultural issues that influence the development of indicators and their implementation. We have highlighted four critical dimensions that drew attention to the value of a relational perspective, and that if reflected upon, may lead to better indicator process outcomes: 1) centering identity and positionality as a way of levelling differentials of power; 2) indicator 'fit' and the politics of scale; 3) engaging rather than erasing social-ecological complexity; and 4) critically reflecting on social norms and relationships to foster adaptation and learning.

Indicator processes must start with an understanding that science, decision-making efforts and society shape one another – they co-produce the conditions in which indicators emerge and there is a continuous feedback loop across these social spaces. Knowledge is a product of society, which is simultaneously shaped and informed through social processes (Jasanoff, 2004), and is a representation of societal and cultural contexts (Forsyth, 2004). Therefore, whose knowledge is chosen and who decides what knowledge is used and for what purpose in the context of indicator processes is crucial. Clearly, processes in which knowledge/power relations are considered (e.g., the arena of KCP) can form the basis for the effective development of indicators. However, there are relatively few instances in which indicators have actually been 'co-produced' in ways that consciously engage knowledge/power dynamics as a starting point. This suggests there are important opportunities to enhance processes of indicator development in ways that are inclusive of a plurality of knowledge sources and to share the lessons of that process more widely.

Indicator processes need to allow for flexibility, diverse interests and understanding that broadens instead of narrows problem definitions. The careful inclusion of individuals and organizations that engage directly with indicators can allow for a realistic conversation about the grounded social, economic, political and ecological realities influencing choices about what to assess with indicators, where, by whom and how (Wyborn et al., 2019). Ultimately, this paper outlines an agenda for indicator practice and points to research that is informed by diverse experiences and critical perspectives on knowledge/power that highlight is a multi-dimensional, multi-scalar process. Such processes are inevitably engaged in and with the institutionalized (often colonial) forms of decision-making common in most resource management settings (Todd 2018; M's-it No'kmaq et al. 2021). In many contexts such forms of decision-making are being challenged and the relations of power re-evaluated. As such, indicators are a window into such forms and practices of environment and resource management, and their development and application must be collaborative and prioritize diverse knowledges and perspectives.

Chapter 3

Transitioning towards ‘deep’ knowledge co-production in coastal and marine systems: Examining the interplay among governance, power and knowledge

3.1 Chapter Summary

Knowledge co-production (KCP) is presented as an effective strategy to generate the understanding needed to inform responses to complex coastal and marine social-ecological challenges. Co-production processes are further posited to improve research and decision outcomes in a wide range of problem contexts (e.g., biodiversity conservation, climate change adaptation), for example, by facilitating social learning among diverse actors. As such, KCP processes are increasingly centred in global environment initiatives such as the UN Decade for Ocean Science and Sustainability. However, KCP is not a panacea, and much uncertainty remains about its emergence and implementation, and in particular, the manner in which broader governance contexts determine the interplay of knowledge, power and decision-making. Three objectives guide this paper: 1) to interrogate more fully the interplay among social relations of power, knowledge production practices and the (colonial) governance contexts in which they are embedded; (2) to consider the challenges and limitations of KCP in particular places, by drawing attention to key governance themes and their implications for achieving better outcomes; and 3) to work towards a fuller understanding of a 'deep knowledge co-production' that cautions against a tendency to view knowledge, processes in coastal and marine governance settings as an instrumental or techno-managerial problem. A qualitative and reflective approach was used to examine multiple dimensions of the interplay of KCP and governance in several marine and coastal contexts, including Canada, New Zealand and Papua New Guinea. In particular, our analysis highlights the importance of: (1) recognizing diverse motivations which frame co-production processes; (2) the manner in which identities, positionality and values influence and are influenced by governance contexts; (3) highlighting governance capacity with respect to spatial and temporal constraints; (4) the importance of institutional reform and links to governance; and (5) the relationship between knowledge sharing, data sovereignty and governance. This paper seeks to encourage those involved in KCP to engage carefully and critically in these processes and make co-production more than a box to tick.

3.2 Introduction

How can we support just, equitable and ecologically sustainable governance of coastal-marine spaces and ecosystems? KCP is one way in which we seek to do this. Indeed, the UN Decade of Ocean Science for Sustainable Development (2021-2030) has made an explicit call to co-create or co-develop science for future oceans and coastal systems, while the sustainable development agenda (UN SDGs) and recent Kunming-Montreal Global Biodiversity Framework (2022) emphasize a need for processes of knowledge generation to improve social-ecological system understanding and to identify transformative solutions to coastal and marine challenges (see Mills et al. 2022; Mahajan et al. 2022).

We define KCP as the collaborative process of bringing a plurality of knowledge sources and types together to formulate and address a defined problem and build an aligned and systems-oriented understanding of that problem for an actionable outcome (Armitage et al., 2011; Norström et al. 2020). KCP offers one approach or pathway to catalyse effective governance and foster the sustainability of linked systems of people and nature. As such, KCP is increasingly implemented across the marine sciences (Karcher et al. 2022a; Mills et al. 2022). Accordingly, the literature on KCP is also rapidly expanding (Bremer and Meisch, 2017; Chambers, 2021; Schneider et al., 2021). This is not surprising, as Miller and Wyborn (2020:94) plainly put it, “Co-production is an inevitable and ubiquitous feature of modern societies. It cannot not happen”. Scientists and practitioners are thus gravitating towards KCP as a pathway forwards that incorporates participatory and transdisciplinary approaches (Cash et al., 2006a; Lemos et al., 2018; Cvitanovic et al., 2019; Norström et al., 2020). In this regard, inclusion of Indigenous knowledges is central, although in ways that are respectful and that acknowledge the past privileging of dominant systems of knowledge (see Liboiron, 2021). KCP is further hypothesized to facilitate social learning, thus making research more democratic through stakeholder and rightsholder (i.e., Indigenous) involvement, and more actionable by tying it to governance (Djenontin and Meadows, 2018; Steger et al., 2020).

However, the rapid expansion or ‘mainstreaming’ of KCP (and allied concepts like co-generation or co-creation of knowledge) is prone to processes that can perpetuate and co-opt (intentionally or not) past decision-making practices that marginalize particular communities and be naïve to relationships of power/knowledge that influence management and governance initiatives (see Turnhout et al., 2020; Muhl et al. 2022). Fundamentally, there remains a significant gap in examinations of the interplay of governance, power and KCP in several crucial ways. For example, there is the manner in which KCP is hypothesized to lead

to better governance outcomes. This is the common orientation of much scholarship and instrumental practice. Less examined, is the manner in which certain forms of governance, and especially those rooted in systems of colonization, may marginalize Indigenous and other place-based ways of knowing. In doing so, such systems of governance continue to uphold and reinforce dominant knowledges and inequitable patterns of social and institutional relations associated with co-production (Root-Berenstein et al., 2022; Silver et al. 2022). We acknowledge that colonialism intersects with other hierarchical systems of power (e.g., capitalism, patriarchy, race). Yet, much of the focus on KCP has centered on its apparent positive and normative benefits and side-stepped some of these broader political and economic structures.

Those engaged in co-production processes may benefit from further reflection of the knowledge processes we are engaged with, whose and what knowledge is being used to improve governance outcomes, and the politics that frame appropriate knowledge for resource management primarily through discourses of science-based or evidence-driven decision-making in ways that side-line other systems of knowledge (Daniel, 2019: Littlechild et al., 2021). How researchers and research partners co-construct or co-produce knowledge is an important entry point into this discussion as KCP can still underpin colonial forms of management and decision-making (Todd, 2016, 2018; Liboiran, 2021). Here, these colonial practices of governance and decision making are linked to Eurocentric systems of knowledge (see Chapter 1) that can perpetuate marginalization of less powerful groups and contribute to the appropriation of natural resources in favour of a dominant group (see Silver et al., 2022). A singular designation or definition of colonialism does not exist and histories and experiences of colonialism are complex and unique to geographical settings, varied human situations and agendas (Harris 2004; Coulthard, 2010). However, Western European colonialism has emerged as a globally impactful system of strcutural and discursive power that has shaped the governance of resources and places. Processes of KCP can thus contribute to or further exacerbate forms of 'dispossession' through 'collaborative' discourse that perpetrates and decontextualizes colonial power structures if the underlying knowledges informing decisions are not critiqued or reflected upon (see Harris 2004; Silver, 2013) (i.e., undermining Indigenous governance or land rights through assimilation). Without critical reflection, KCP may reproduce and reinforce power structures and relationships, but just under a label that is more appealing.

Accordingly, several objectives guide this paper, with particular reference to coastal and marine contexts: 1) to interrogate more fully the interplay among social relations of power,

knowledge production practices and the governance contexts in which they are embedded; 2) to consider the challenges and limitations of KCP in particular places, by drawing attention to key governance themes and areas for change and their implications for achieving better conservation and social-ecological outcomes; and 3) to work towards a fuller understanding of a 'deep KCP' that cautions against a tendency to view knowledge/power processes in coastal and marine governance settings as an instrumental and technocratic problem. KCP is not a panacea, and we aim to reflect further on its intent and principles, yet still appreciate its action-orientation and as a crucial ‘practice for sustainability’.

Our paper is organized as follows. In the next section we briefly synthesise the literature on KCP and identify and discuss gaps. We then outline the reflective methodology followed here to examine a series of cases of KCP in which we have been engaged. Drawing on our reflections, we then identify a series of focal points at the intersection of KCP, power, and governance, and reflect upon these focal points as potential pathways of change to support future stewardship of coastal and marine systems. We do so by considering in particular the political and historical institutional structures in which KCP processes are enmeshed. We conclude with some observations for ongoing research and synthesise some key lessons for practice.

3.3 Knowledge, power, and governance

KCP has a diverse intellectual history and set of assumptions. For instance, co-production offers a theoretical lens for understanding and critiquing knowledge and power (Forsyth, 2004; Jasanoff, 2004). Alternatively, co-production serves as an applied framework to achieve better outcomes in a wide range of sustainability contexts (Miller and Wyborn, 2020; Chambers, 2021; Muhl et al. 2022). As well, there are several related terms and concepts used in the literature, and a range of mechanisms identified to achieve the intent behind these concepts (see Box 3-1).

Box 3-1 Knowledge co-production and related ideas

The process of creating and disseminating knowledge collaboratively can be defined in multiple ways. Some related concepts and approaches are boundary spanning (Bednerek et al., 2018), knowledge brokering (Canadian Health Services Research Foundation, 2003; Meyer, 2011), exchange (Levesque et al., 2007), knowledge mobilisation (Levin, 2008), knowledge management (Lin et al., 2006), transfer (Agrawal, 2001; Buckley and Giannakopoulos, 2011), translation (Straus et al., 2009), utilization (Greenhalgh et al., 2004), and finally, knowledge-to action (Graham et al., 2006). This multiplicity of terms all emerge from slightly different strands of literature, yet have a number of similarities. For example, knowledge mobilization involves dissemination, transfer and translation, with an emphasis on influencing decision-making (Levin, 2008). However, for our purposes we have chosen KCP and its interplay with the processes and arrangements associated with governance.

KCP as articulated in Science and Technology Studies (STS) encourages a critical perspective on the role of science, society, and knowledge (Forsyth, 2004; Jasanoff, 1996; 2004; Goldman et al., 2018). In particular, a core insight from STS is how difficult it is to separate science from its social context, pointing out that the questions we ask (and how to study them) is driven by politics, values and power relationships (Todd, 2018). As a scientific community, and more broadly as members of society, STS scholars illustrate the importance of engaging with questions of how we understand the world and how science (e.g., disciplines) establish and reinforce institutions that dictate resource governance (see Silver at al., 2022). The 'sustainability sciences' literature has generally taken a more normative and action-oriented framing of KCP (see Chambers et al., 2021). Here the focus is less on reflection about the role of science, and instead on the interactive process among researchers and various stakeholders to define questions, consider the evidence, and generate solutions (Lemos and Morehouse, 2005; Miller and Wyborn, 2020; Chambers et al., 2022). This latter characterization of KCP tends to be dominant in the context of coastal, marine and ocean science initiatives. Yet critical reflection on the underlying assumptions, and broader influences of institutions of governance and relations of power is imperative.

There remain a number of important gaps in the literature on co-production as applied in coastal and marine problem contexts, including several aspects of its interplay with systems of governance. For instance, scientific and western knowledge is assumed as the logical starting point for understanding the socio-ecological complexity of oceans and coasts. Notably, however, there is well-established recognition of the importance of local and place-

based Indigenous and non-Indigenous knowledges about ecosystems and people, how they are connected, and how those insights are crucial for good governance (Jessen et al., 2021). Simplified notions of 'integrating' knowledge systems or more problematically, 'validating' local or Indigenous knowledges in governance contexts are still prevalent. If the aim is to 'co-produce' a systems-oriented and shared, values-informed understanding of complex governance challenges, more awareness of these dynamics of knowledge and power is needed. As well, much of the literature on KCP emphasizes methodological process, yet the politics of choice about who is involved in the research process will affect what knowledge is co-produced. Here the colonial and imperialist roots of science and its relationship to governance (Reid et al., 2021; Hill et al., 2020; Salomon et al., 2023) can neglect the spoken word or the power of stories as sources of governance change.

Moreover, what is often missing in much of the current KCP scholarship (e.g., in the United States, Canada, Australia, and New Zealand) is acknowledgement of the historical and colonial governance context within which co-production takes place. In Canada, for example, the assertion of rights and reconciliation and dialogues about Nation-to-Nation governance will (or should) generate new challenges to the existing knowledge practices that underpin current governance and decision-making processes with a potentially profound influence on how KCP processes are embraced. While many of the prevailing assessments of KCP emphasize power and how KCP can be enhanced to include and accommodate Indigenous knowledges, there is limited consideration or critical examination of the structures of dispossession that currently remain (see Harris, 2009; Harris et al., 2010; Wolfe 2006; Artelle et al. 2021) and continue to shape what knowledge is privileged and ultimately used to inform decisions in government.

Co-production is hypothesized to catalyze better governance outcomes, but there is need to reflect on how governance systems rooted in enclosure, appropriation, and dispossession entrench forms of power that undermine current coproduction efforts. Dorries (2022), for example, has highlighted the link between colonization of land and privileging of private property regimes that perpetuate particular knowledge claims about resources and ownership. Similarly, Bhandar (2018) documents how mainstream management and planning reinforce racialized property regimes founded on settler colonialism and capitalism that create a backdrop for any governance process (see Harris 2004; Alfred and Corntassel, 2005; Wolfe, 2006), including those involving coastal and marine spaces (see Silver, 2013). Despite important claims of equity and participation (see Chambers et al. 2021), many co-production processes and their governance regimes are still dominated by conventional forms of science

and scientific tools (i.e., modelling) that seek to reduce and simplify contextual complexity, placing Indigenous and local values and knowledges as important but ultimately external to the systems of governing power (Scott, 1999).

Many of the practices used to govern natural resources are rooted in colonial and capitalist forms of decision-making, and they continue to perpetuate inequity and injustice under private property regimes (Harris, 2004; Whyte, 2018; Silver et al., 2022). Acknowledging these circumstances opens up possibilities for a consideration of deeper forms of KCP and efforts to support transformations towards better governance systems (Daniel, 2019; Parsons et al., 2021).

3.4 Context and methods

The insights in this paper emerge from detailed examination of marine conservation and resource management cases in which the co-authors of this paper are involved. We are an interdisciplinary team comprised of Indigenous and non-Indigenous researchers and practitioners, and we each bring a variety of perspectives to this analysis from our lived experiences, shared knowledge, and/or professional and disciplinary training. Our group has several decades worth of experience interacting with coastal communities (in low- and high-income countries, and researching and supporting marine conservation and resources management initiatives. Further, we are engaged in research and partnerships where both Indigenous knowledges and scientific knowledge are used to understand coastal and marine issues. Collectively, we acknowledge that our individual experiences influence our framing of the issues discussed here. We are each differentially positioned and bring different experiences, privileges, and biases to this effort.

The analysis on KCP and governance reflected in this paper draws on a qualitative assessment (Yin, 2009; Creswell and Creswell, 2017) of a series of problem contexts in which the authors have been engaged. In doing so, we follow an inductive strategy to explore the relational complexity of KCP processes, including the interplay of knowledge, power and governance. We adopted a reflective and qualitative assessment (see Starman, 2013) of co-production opportunities in which we are or have been involved as a way to catalyze in-depth discussions and collaboratively identify specific lessons for successful KCP. We recognize the limitations associated with this approach, as the lessons we document are shaped by the places we have examined. However, the situations themselves are diverse in both region and scope, and yield specific examples while also highlighting broader implications for KCP. The

four contexts in which we engage with KCP and governance include: (1) coastal ecosystem-based management initiatives in Haida Gwaii, Canada; (2) experiences with coastal governance and ecosystem management in New Zealand; (3) a knowledge brokering support program in Papua New Guinea aimed at fostering coastal livelihoods, and; (4) the historic and present day management experiences with the in-shore (coastal) cod fishery in Newfoundland and Labrador, Canada (see Appendix A for descriptions and further context on each example including information on objectives, geographic scope, social-political and institutional context, and ecosystem conditions).

A number of criteria were used to select the contexts we have examined: (1) KCP experiences are or were taking place in reference to coastal and marine resources; (2) the presence of diverse knowledge sources and actors (e.g., Indigenous and non-Indigenous knowledges and partners); (3) initiatives spanned local to regional scales; (4) the examples reflect various stages of research and action (i.e., some completed, some ongoing); (5) engagement and participation in the process of KCP had occurred for over 10 years; (6) leadership and/or participants (i.e., co-authors) in the examples felt that they had lessons for success and were willing to participate, (7) leadership actively centred Indigenous peoples and/or recognized the importance over time of diverse knowledges and perspectives; (8) reports and other technical documents existed that supported and endorsed KCP on the ground; and (9) were geographically diverse and contextually varied. Notably, one of our cases also serves as a 'counter-factual' example and was included to also reflect the absence of explicit knowledge processes.

The authors of this paper are (or have been) embedded in the case study contexts we examine here. As such, our analysis is based on an extended period (over 18 months) of individual and collective reflection by authors through a series of structured virtual workshops and follow-up individual or small group conversations. We consider our research a reflective practice (see Fazey et al. 2018) in which our main concern is to foster changes within the systems we are engaged, and not consider them as an 'external' problem subject to analysis. This form of reflexive research to address situations of embedded complexity further aligns with the notions of more detailed ethnographic work in the context of the organizations and decision-making situations created to foster KCP (i.e., organizational ethnographies as framed by Yanow et al., 2012). Specifically, our research process centers on understanding a concept (e.g., KCP) by examining its social relations and structure within the organizational contexts in which we are embedded (see Ybema et al., 2009; Ciuk et al., 2018).

We adopted an inductive and transdisciplinary approach to allow for flexibility in identifying and understanding issues of relevance within the examples examined in this paper. An inductive approach is appropriate for this research as it allows for an analysis of the themes that arise through engagement with rightsholders and key stakeholders. We examined the social relations and structures through a dialectic and shared reflection through workshops and meetings with 13 core collaborators. It was important that practitioners and Indigenous co-authors were included, and part of the processes in which we were examining. For example, many members of the author team are situated within the organizational practices (e.g., co-management bodies, government departments, development agencies) engaged in KCP processes. Members of our author team are thus co-interpreters and co-constructors in the analysis while simultaneously reflecting on the strengths and limitations of the organizations they are a part of, and their own role in shaping those organizational practices. This has required authors to simultaneously reflect on their own positionality during the process of case study analysis and in self-reflection of our underlying assumptions and the questions posed (see also Fazey et al., 2018). To engage in this reflexive practice, we followed a series of steps (see Figure 3-1) to co-construct a series of questions engage in the analysis (these steps are further summarized in Appendix B).

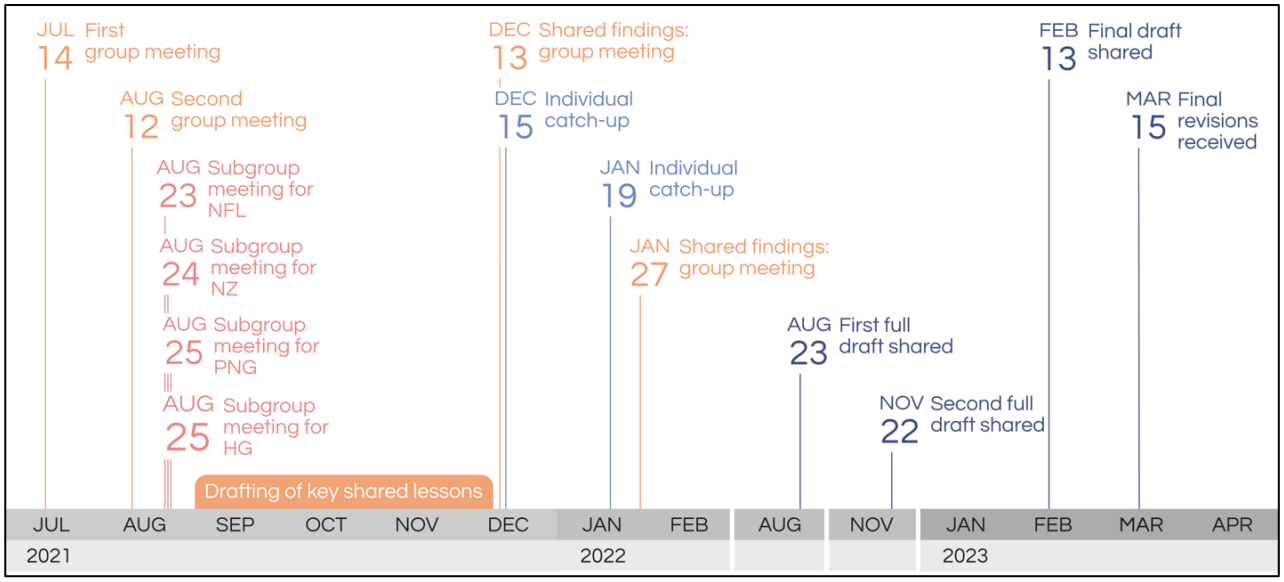


Figure 3-1: Timeline of the co-creation of the paper

3.5.1 Results and discussion

Consistent with the objectives of this paper (and as outlined above) we co-developed a framework to facilitate critical reflection of KCP processes with reference to the structural constraints and embedded colonial practices of governance within which knowledge

practices are still often situated (see Figure 3-2). As interest in KCP grows (Chambers et al. 2021), there remains limited examination (or practical guidance) on how to navigate historical influences and challenges of governance. For example, information is scarce on how the governance context for KCP ultimately determines scope for knowledge sharing among different groups, creates conditions (or not) to navigate and balance power dimensions, privileges what knowledges are used to frame questions, and normalizes particular biases about knowledge. Ultimately, themes have been articulated during our process in ways that help us reflect more carefully on the intersection of KCP and governance practices, and which offer in part a working 'theory of change' for how better or more realistic outcomes can be achieved for coastal and marine conservation outcomes (see Figure 3-2). The five core themes include: 1) engaging more explicitly with the core motivations of individuals situated within broader or collective governance contexts; 2) surfacing and meaningfully engaging with the identities, positionality or participants in KCP and their implications for values and relationships that are at the core of governance processes; 3) highlighting governance capacity with respect to spatial and temporal constraints; 4) drawing attention to the institutional reforms needed to support co-production and overcome colonial and capitalist practices of governance; and 5) emphasizing the importance of data sovereignty as expectations about knowledge sharing shift, and particularly in contexts where customary practices and place-based relationships with resources are paramount. By drawing attention to these dimensions and using examples to demonstrate how they function we hope to further problematize and challenge common tendencies to instrumentalize KCP, and to ensure KCP in marine and coastal research, and more broadly in conservation and resource governance practice, is understood as more than a 'box to tick'.

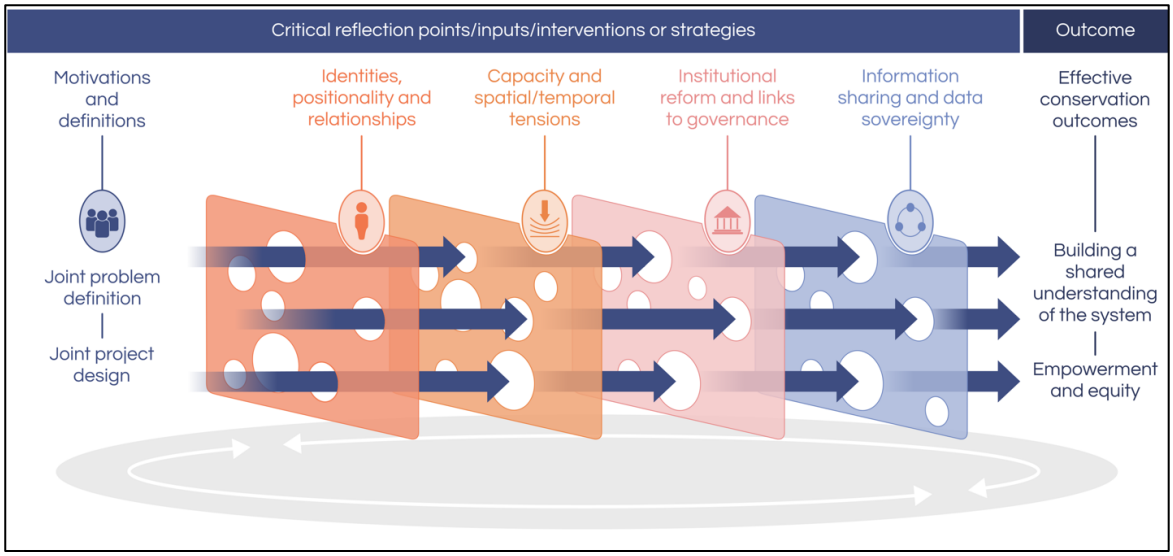


Figure 3-2: Moving from Promise to Practice in KCP: A working theory of change

3.5.2 Centering motivation as a catalyst for KCP

The importance of engaging directly with the core motivations of individuals participating in KCP processes emerged early on as an area of interest, and particularly in relation to the broader or collective governance contexts in which we participate. Many of our conversations revolved around questions such as, 'why do we engage in KCP?' and 'why would our research partners be motivated to participate in what can be challenging collaborative efforts?' For many members of our team, addressing these questions is a crucial component of setting the groundwork for how marine conservation and resource governance initiatives will unfold. Two central issues emerged with regard to motivation. First, our team documented the importance of understanding how motivations are catalysts for working towards positive relationships and shared values, which are often noted as important in co-production but are not often unpacked. Second, we reflected on the manner in which motivation may often emerge from a perceived 'duty' to ensure good relations with each other as individuals, but also in terms of our duty to have responsible relations with the land and seas.

To build governance relationships, some common motivations (and shared goals) among different groups are necessary. This was the case in both Haida Gwaii in Canada and the Sustainable Seas National Challenge (SSNSC) in New Zealand, where clarifying motivations helped center the relationships needed to catalyze co-production processes. For example, across the duration of the SSNSC, more than half of the Māori researchers have stayed with the programme. As one of our participants noted, one of the motivations is that there is a

sense that the Challenge will care for their experiences as Māori, in part because there are Māori leaders within the overall Challenge leadership team. In SSNSC there are structural supports to create and hold space for Māori knowledge and approaches, sustaining and encouraging motivations to partner to develop shared values. Motivation to build necessary relationships has also been linked to how knowledge is valued and positioned. Specifically, the challenge has proactively sought Māori engagement and contributions in ways that shape new understandings and practices for ecosystem-based management.

The importance of motivations was also highlighted in the Knowledge Brokering Support Program in the Papua New Guinea example. In this context, building the capacity of practitioners and officials to support the design, development and implementation of coastal resilience programs was based on relationships formed through years of research collaborations with communities and local NGOs. Notably, these relationships go beyond the conventional terms of reference for the work and were rooted in some internal motivations of those involved to build shared values and common goals despite some challenging institutional and governance circumstances. For example, one of our co-authors highlighted working on community development grants and efforts to help local communities, not because of the economic or social capital incentives, but because of individual motivations to extend opportunities for those communities. In contrast, in the case of the cod fishery in Newfoundland and Labrador, there was a strong vested interest or motivation to 'keep things the way they were' in the management system in the 1980s (i.e., in terms of quota allocation, how science was used to frame decisions about cod stocks, etc.). In this case, the knowledge practices at the time were often characterized by a lack of unity, limited capacity to engage with diverse perspectives, and ultimately the undermining of the legitimacy of fisheries management with negative implications for relationships that exist to this day. In Newfoundland and Labrador, poorly regulated fishing and institutional challenges associated with knowledge sharing meant that it was impossible to co-produce an understanding of what was happening in the cod fishery. This ultimately contributed to its collapse (Hutchings and Myers 1994).

This second key motivation to participate in and/or catalyze KCP processes centres around the notion of 'duty'. Here we are referring to duty as ensuring good relations with each other, but also the notions of reciprocity and respect with the 'land' and seas. For example, for the Haida Nation, a key motivation is their collective worldview of being land custodians. The Haida Nation is responsible for the lands and waters of Haida Gwaii and has taken a leadership role in decision-making. This duty to land and sea and better relations in the Haida

Gwaii example is similar to the idea of 'Kaitiaki' as highlighted in the New Zealand context, which reflects both a cultural obligation and a call to action. *Kaitiaki* is the recognition of an intergenerational connection and responsibility (i.e., duty) that arises from a kin-based relationship to people and place (see Box 3-2).

Box 3-2 Kaitiaki and the notion of 'duty'

A Kaitiaki is a guardian, keeper, preserver, conservator and protector. When you add the suffix 'tanga' it transforms to mean guardianship, preservation, conservation and protection. Kaitiakitanga emerges from a distinctly Māori worldview and is connected to a range of other key Māori principles or concepts. Of great importance is its connection to whanaungatanga – that is, it is an intergenerational obligation that arises by virtue of the kin relationship (or whakapapa) between people, and between people and place, and the wider environment. Within a Māori worldview people are descendants of the natural world, and as within families, that familial connection comes with obligations to make wise decisions that sustain wellbeing. Kaitiakitanga has a spiritual aspect, encompassing not only an obligation to care for and nurture physical well-being, but also mauri – or the spiritual essence of existence. A notion often captured in Māori proverb reinforces the responsibility of kaitiakitanga by noting that we are effectively borrowing resources from our mokopuna (grandchildren), so are obligated to be good ancestors in our decision-making and practice.

However, this sense of duty as a core motivator to secure good relations in a co-production process is not always shared by all participants, or at least expressed in all circumstances. For example, Haida Nation representatives on the Archipelago Management Board (a co-management entity with Haida and non-Indigenous government representatives and the explicit task of bringing different knowledges and perspective together) have voiced frustration because representatives of the federal government raise the issue that a process "can't fetter the Minister". In other words, motivations to participate are situated in a governance context that grants decision-making authority to an external (i.e., colonial) actor even though decisions are meant to be made together. In response to this, Haida representatives often make the point that the Haida Nation also can't fetter their decision-makers. This response draws attention to notions of duty of both the Haida and federal governments, and responsibilities to develop a co-management process and related knowledge practices that are built on respect and reciprocity. Ultimately, however, the duty to nurture good relations and reciprocity can bring different constituents into struggles about motivation that are at the centre of competing governance principles.

3.5.3 Identities, Positionality, Values and Relationships

The literature on KCP regularly points to the importance of relationships and relationship building as a core feature of successful outcomes (Lemos and Morehouse, 2005; Armitage et al., 2011; Robards et al., 2018). For example, Chambers et al. (2022) note that across 32 initiatives spanning six continents, four relational archetypes emerge to balance power and connect process to action. Norström et al. (2020) similarly note in their four principles for co-management that participant interaction is necessary to foster trust and learning through sharing experiences, values and goals for collective action. However, what is often masked in these discussions is a deeper reflection on the identities, positionalities and values that sustain these relationships, or make them challenging to foster. Indeed, few scholars in KCP are specifically examining how relationships and trust (as common determinates of co-production) are linked to the identities and dimensions of positionality that influence relational processes in coastal and marine governance settings (see Muhl et al. 2022). Further, our reflections reveal that even when motivations to engage in co-production are surfaced, the way in which identities and positionality support learning, growth and connection is critical for success and failures in the examples in which we are engaged. In this regard, we consider positionality as the way in which people situate their identity and their values in relation to societal context and their interactions with other people, and refer to identity as the manner in which people perceive themselves "…and the behaviors, norms and subsequent actions people take in a given decision-making context in ways that align with their values" (Muhl et al. 2022: 454).

Two key messages emerged in regard to meaningfully engaging with the identities and positionality and their implications for the governance processes in which KCP are situated. First, identities and positionality invariably influence the relationships and the development of equitable governance partnerships critical to successful KCP. For example, in the New Zealand case, program leaders recognised early that achieving outcomes within the limited timeframe of the initiative meant having to design projects around existing relationships and aligning momentum, and doing so by building on situations where common identities could be supported. Often this required that projects were led or co-led either by the whānau, hapū, iwi (family, sub-tribes and tribes) or by researchers with connections (whakapapa) to either of those groups, or alternatively to specific locations or places (e.g., specific bays) where there were some common identities. These experiences illustrate how identities inside and outside of the co-production process become important and the importance of situating initiatives around shared values that are sensitive to how Māori worldviews are positioned in the

Challenge and woven throughout practices, initiatives and governance principles (including prioritizing projects on ecosystem-based management that centre Māori knowledge).

As reflections of our examples revealed, governance contexts and knowledge practices often assume that people hold one primary and generally 'fixed' identity. Yet, in co-production processes individual identities and roles can shift based on experiences and obligations both within and outside of those governance processes (i.e., as individuals in a broader community). For example, as noted above, within the New Zealand case there is potential for people to wear multiple hats with implications for KCP (i.e., as researcher and member of local iwi). The key identity may be 'researcher', but the individual may have a range of other identities relevant to the research such as iwi (tribal) member and governor of affected iwi owned assets (such as fisheries quota). Identities (and positionality) of participants in co-production processes also extend into relationships connected to specific environmental contexts, given in particular the relationship among place and Indigenous knowledges. As an Indigenous team member explained, Indigenous knowledges are situated in a community's connection to place-based systems and specific features of that place around which knowledge practices and the cultural transmission of knowledge is linked. For those engaged in the co-production process, they are linked to place-based identities, or the idea of tūrangawaewae or 'place to stand', which is the place where the ancestors stood and where your descendants will stand (and thus take on the responsibility of caring for that space) (see links to the discussion on 'Kaitiaki' - Box 3-2). How one 'walks on the land', the way that you interact not only with people, but the environment is important. This suggests that individual identities and positionalities must connect across multiple platforms (with other individuals, with nature and with one another's culture), and that most participants are not easily 'pigeon-holed' into a single identity.

In the Haida Gwaii example, our analysis similarly revealed that relationships relevant to co-production exist across multiple spaces and governance contexts. For example, different resource users or actors may experience conflict in certain governance settings (e.g., a fishery advisory committee), but their children may be in the same class together, or one may coach the other's child's soccer team. Relationships bridge different boundaries when people live in a small place together, and there is a need to embrace the multiplicity of identities and positionalities that shape those relationships. As a co-author shared, "…you have to stand behind what you say because you are accountable to your own community when you make a decision." Conservation and resource management initiatives affect livelihoods (and the identities that go with those livelihoods) in multiple ways and are enmeshed within day-to-day

life and encounters. As another co-author noted with reference to these co-production efforts, “You have to be prepared to meet the person you have impacted in the grocery store and look them in the eye”.

In the Papua New Guinea (PNG) case, the co-production process was (and continues to be) built on relationships that were already established through prior long-standing development initiatives, but also relationships closely connected to identities of participants with particular places. During the height of the Covid pandemic, the knowledge brokering process (see Appendix A) was disrupted, and the positionality of the knowledge brokers changed. A co-author noted that in the PNG case study, the knowledge brokering project would most likely would not have been attempted had prior knowledge of the Covid pandemic been available, because relationships are best built through face-to-face interaction. Relationships that mature when working on the ground and the shared experiences from that work are what has helped to build the trust among Australian researchers, PNG practitioners and local communities. However, the inability (because of the pandemic) of Australian researchers to engage on the ground with the PNG counterparts and local communities has highlighted the subtle hierarchical prominence that western knowledge tends to still have even when programs are based on shared values and common goals. In the PNG case study, the pandemic ultimately provided the unforeseen advantage for practitioners and communities to move away from an initially more hierarchical orientation to knowledge generation and sharing towards a co-production model. In this context, knowledge brokers in the community (i.e., the women) have been able to take greater ownerships of projects by adapting tools, processes and approaches in line with their capacity, resources and their communities’ needs and visions (see Box 3-3).

Box 3-3 Positionality and agency in the Papua New Guinea (PNG) Knowledge Brokering Support Programme KBSP case study

A change in the positionality of various groups within the program has created more space for the Papua New Guinea (PNG) knowledge brokers to adapt the participatory tools, processes and approaches to their capacity and resources, to better emphasize local needs and visions, and consequently to foster greater ownership. In this way, the PNG knowledge brokers, all of whom are women, and who have been involved in the Knowledge Brokering Support Program (KBSP), have gained more agency and power by stepping up and having to direct the communities. The KBSP program has thus provided a space of power and agency for PNG knowledge brokers to do the work necessary with the communities, in which new knowledge is once more co-produced between PNG practitioners and local communities. This example highlights the role of positionality and how relationships that develop on the ground are beneficial, but when it comes to agency, there is a delicate balance with positionality, remnants of intrinsically inherited hierarchical biases and empowerment.

A second key message to emerge from reflections of our diverse organizational and governance contexts centres on the importance of shared identity, and the importance of finding those points of shared identity to foster relationships. Where those links are not made, they will lead to disconnected and increasingly marginalised communities who cannot or will not engage in co-production efforts. As our reflections revealed, in cases where an individual perceives themselves to be marginalised (i.e., 'everyone for themselves') from a co-production process, or the presumed benefits of a governance process, the prospects for building the relationships and trust that are fundamental to KCP will be significantly curtailed. Simply, communities that are disconnected and marginalised (e.g., economically dependent on resources with little to no long-term financial support) in broader governance processes may actively or passively undermine KCP (withholding or not sharing knowledge), and especially those processes that do not engage with the structures (political, economic, etc.) that create the conditions of marginalization in the first place. The case of cod fisheries in Newfoundland and Labrador served as a reminder that when resource users are marginalised in decision-making, they may engage in self-defeating behaviour. For example, many inshore cod fishers continued harvesting despite the knowledge that they were depleting the resource. Because there was very little co-ordination or shared knowledge between groups (e.g., inshore fishers, government scientists), each actor group (e.g., foreign vessels, local fishers) was largely operating on objectives framed within their particular positions and/or livelihood identities. There are many reasons for the collapse of the cod fishery, but the lack of

knowledge sharing and the manner in which individual and collective identities framed decision-making remains an important factor.

3.5.4 Governance Capacity and Spatial/Temporal Tensions

Our third critical reflection point centred on the governance capacity and spatial and temporal tensions woven through KCP. For example, processes of KCP take a significant amount of time and resources (Karcher et al. 2022b). Yet, less emphasis is placed on understanding how the tensions associated with project timelines for co-production are multi-faceted. On the surface many assessments of instrumental forms of co-production suggest they involve reconciling institutional priorities, or a mismatch with funding cycles linked to short-term political choices. However, tensions around timelines are often more nuanced and may be linked to misalignments or conflict regarding intergenerational worldviews and the outcome of historical governance practices and relationships. For instance, in the Haida Gwaii, New Zealand and Papua New Guinea contexts, the tensions around timelines for co-production have much to do with the emphasis on developing place-based interventions in relation to expectations about intergenerational benefits. In this regard, engagement in Indigenous communities must recognize the work that was started many generations before (e.g., in the Haida and Māori contexts) and the manner in which key foundations for co-production are situated in hard won historical agreements. Co-production practices or individuals that insert themselves in such processes without due consideration of these tensions risk undermining or marginalizing decades of struggle to reframe relationships of power and knowledge (Vincent et al., 2020; Zurba et al., 2022). Instrumentalized forms of co-production become merely another form of knowledge (and possibly territorial) dispossession in such circumstances.

The complexity of process timelines associated with co-production and governance have important capacity implications as well. As noted above, processes of KCP require time to build relationships, but often do not consider the individual (or even organizational) risk of 'burn-out'. As our reflective cases reveal, many of the people that are drawn to co-production processes (see the Motivations section) are embedded in many other personally demanding situations with limited time to recharge. Sometimes one person will have responsibilities for multiple processes across different projects, making deep engagement with co-production personally taxing. These challenges have been exacerbated by the impacts of the Covid-19 pandemic, and as reflected in the Papua New Guinea example, can be further compounded by the lack of remuneration or economic incentives for certain groups (e.g., volunteers,

resource harvesters that must take time away from their livelihood work) in co-production processes that also hinder their capacity to engage as equals with those in more 'formalized' roles (i.e., paid employment). This was noted as common issues in the case of iwi in New Zealand co-production efforts.

Still, as reflected in the Papua New Guinea context, the urgency for immediate actions to improve marine resource governance and livelihood sustainability does not disappear. Long-term co-production processes are in tension with the need for more immediate decisions because people rely so directly on coastal and marine resources for their livelihood needs. As reflected in the examples here, therefore, engaging more deeply with co-production requires further sensitivity to the manner in which different governance realities and processes are linked. Like a system of cogs, international organizations and/or NGOs, research organizations, granting and funding councils, and community organisations each operate with different temporal expectations and cycles of activity. Yet, these processes are connected and affect one another in ways that are not always recognized as fundamental to co-production. For example, funding cycles and timelines rarely coincide with community realities where livelihood challenges can emerge quickly or be exposed to unexpected seasonal changes or threats. In co-production then, time represents different meanings and work in different governance contexts with implications for outcomes.

Two additional capacity issues emerged from our case reflections. First, our cases highlighted how time is strategic as a leverage point in governance efforts with implications for co-production. Specifically, time can be used strategically to either: (1) increase pressure on external actors to engage more meaningfully in KCP; or (2) to wait out a person in a position of authority that may impede meaningful momentum. In Haida Gwaii, for instance, efforts to meet specific timelines outlined in agreements (including those associated with resource rights and the transfer of decision-making power) have not always been successful. This does pose a systemic barrier to action. However, there are also individual manifestations of this pattern in which individuals representing federal organizations could be more entrepreneurial and/or seek to lead more proactively yet choose instead to slowdown processes of change. However, as our experiences show, individuals in government roles tend to cycle through fairly regularly and these changes can be leveraged when new individuals take on these positions. In some instances, this is problematic because helpful knowledge or experience may be lost every time there is a change in a government position, and as one co-author noted, "...it is like continuously having to re-start the process of KCP at least with a part of the cog mechanism". In contrast, as was noted in the Haida Gwaii example, if an individual is

creating a barrier (whether intentional or not), or a government representative is privileging one form of knowledge over another, the Haida Nation can "wait them out" and try again when a new representative is appointed. As a practice embedded in a governance context, co-production requires patience, and several of the cases here highlight again how a 'long game' is best for certain participants within those co-production processes. Inaction or resistance is itself a form of co-production action.

Finally, an intriguing spatial and temporal challenge that emerged in the context of our reflections was the role that the ecology of place has in constraining or facilitating KCP. This is a driver or variable in most KCP processes that has received limited attention, even though decades of scholarship draw attention to the manner in which our environments are 'co-produced' through human interaction (Hill et al., 2020), and the role of governance in privileging certain social-ecological system configurations over others (Berkes et al. 2003). For example, the governance of a resource (e.g., fish) that cross boundaries due to migration, or that have diverse, fluctuating ranges according to water temperature or prey dynamics can quickly highlight the limitations of dominant (i.e., science) knowledge systems. Newfoundland and Labrador, provides one example of how ecological dynamics (i.e., of cod) generate temporal and spatial challenges to successful KCP (see Box 3-4). These challenges are further exacerbated by climate change or global market demands.

Box 3-4 Ecology and spatial tensions in co-production

The Northern cod stock is dispersed over a vast area that includes most of the Labrador Sea and the northern and eastern areas of the island of Newfoundland. Historically the fishery included both inshore and offshore domestic harvesters as well as a significant international fishery that occurred outside of Canadian jurisdiction. The ocean environment around the Newfoundland and Labrador is subject to both seasonal and longer-term change. It is subject to temperature and other oceanographic changes that can have a significant impact on the productivity of cod and other species. The diverse interest groups as well as ever changing and unpredictable environmental conditions limits the adaption of KCP from the management process.

Any KCP process is going to grapple with difficult questions of appropriate spatial and temporal scales of analysis and action. These are not simply technocratic or questions about analytical tools, but rather reflect the governance context and complexity. Ecological scale and resource dynamics create materially significant conditions for co-production efforts (e.g., challenge of managing a species or multiple species given their life cycle) and broader

environmental conditions (which are increasingly uncertain), including how different types and sources of knowledge are meaningfully explored in what are often science-driven and institutionalized practices (see Armitage et al. 2019; Silver et al. 2022). In many situations, the relationship between the ecological system and its governance context reduce opportunities for deeper forms of co-production process. This implies co-production processes are only feasible at a certain geographic scale, minimises the number of factors upon which to focus (e.g., prioritizing certain objectives), and thus limiting how communities can be meaningfully engaged. Notably, as reflected in the New Zealand case, the formal regulatory framework to manage different marine resources is often very different from the scales at which Māori knowledges about those ecosystems are oriented. Similarly, in Papua New Guinea, co-production processes are nested within a complex legislative and regulatory framework characterized by multiple 'boundary areas' with adjacent jurisdictions (e.g., Australia and Indonesia). Here, there are several agreements and treaties to manage activities and shared resources that intersect with national laws and management plans, yet the coastal and marine ecosystems and their dynamics do not align well with this governance complexity, making co-production processes particularly challenging. Even within particular places, there are fundamental divides in language and cultural groups in Papua New Guinea with strong land and sea ownership customs tied to local ecologies.

3.5.5 Catalyzing Institutional Reform

KCP processes do not exist in a vacuum. As reflected in our cases KCP outcomes intersects with a willingness among participants to engage in processes of institutional reform and by challenging particular institutional practices and forms colonial governance. Three key messages emerged about the institutional and governance reforms needed to catalyze better co-production processes and outcomes, and especially in contexts where colonial and capitalist structures of resource management continue to privilege certain knowledge claims (Hill et al., 2020; M's-it No'kmaq, 2021)

First, formal 'legal' or policy frameworks for KCP can facilitate better outcomes, and especially in contexts where Indigenous sovereignty and knowledges are central to management efforts. For instance, the institutional and constitutional context in Aotearoa New Zealand has a significant influence on enabling KCP. That context helps to frame Māori rights in resource management, as well as inform research funding investment decisions. Within the Sustainable Seas initiative specifically, a policy commitment to structural change and equity requires careful reflection on the membership of the programmes Governance

Group, Leadership Team, and advisory panels. As a result, in the Sustainable Seas initiative there is dedicated space for Māori leadership, partnership (i.e., Māori are partners in the research as leaders driving the research) and participation (i.e., with Māori as operators or because they are interested in being part of the research). These leadership, partnership and participation roles are a feature of the initiative, and not just for research that aims to directly address Māori priorities, but across the breadth of the entire research programme. Across the program, outcomes are premised on the inclusion and alignment of both mātauranga Māori and historically dominant forms of ecosystem science. The policy context thus enables (and is further enabled by) necessary changes in the attitudes of researchers, stakeholders and the governance group.

The situation in the Haida Gwaii context is somewhat similar. Here, a foundational set of policies, agreements or 'living documents' (e.g., the *Gwaii Haanas Agreement*) provides a crucial foundation and expectation for KCP. The Gwaii Haanas Gina 'Waadlu<u>x</u>an Kil<u>G</u>uhl<u>G</u>a Land-Sea-People Management Plan itself was co-developed by the Haida Nation and the Government of Canada in collaboration with local communities, rightsholders and stakeholders, and establishes a foundation for a range of management and implementation initiatives based on co-management and power sharing through the Archipelago Management Board (AMB), a co-management body comprised of three representatives of the Haida Nation and three representatives of the Government of Canada, including two from Parks Canada and one from Fisheries and Oceans Canada. This policy context for co-production is a unique outcome catalyzed by a governance shift in which the Haida are asserting inherent title over their territory and requiring co-management of all resources while the land title issue is being resolved.

Reflections on our case studies and organizational contexts highlighted a second key insight: knowing the political leverage points that engender meaningful co-production processes. In the Haida Gwaii context, one of the strategies employed by the Haida Nation has been to observe the political climate in which they operate and to look for 'openings' where bridges of knowledge sharing, and collaboration could be built. Part of the successful partnerships that have been formed in this case involve understanding which partners can push at what doors, and in ways that are actionable in relation to their priorities. For example, Haida Nation representatives are able to take actions that federal government representatives cannot, such as calling federal Ministers when they are dissatisfied with progress on key files. As our reflections showed, for those involved in KCP processes, knowing such political leverage points is part of understanding how to manoeuvre and negotiate within a governance system.

Finally, elections can be windows of opportunity to advance knowledge processes and gain traction on the outcomes of co-production processes (see Box 3-5).

Box 3-5 Political leverage points

In Haida Gwaii, we say that we are playing the long game. Sometimes one just has to exhale and wait for a door to be opened. Elections are often the best time to push doors that are a little bit open. If a door is fully shut, you can't direct your energy there. Knowing that is part of being aware of limits, as many people are spread thin across multiple projects. But if a door is partially open, it is worth pushing. Just before elections governments want to make announcements and so processes can move forwards quickly. This is part of effective co-management. You need to have the right people at the table, you need to be able to work with external partners but still be aware of internal considerations and successfully balance everyone's objectives in a way that moves things forwards.

The third key insight to emerge from our analysis is the importance of internalizing (from the personal to the institutional) the experience of how KCP comes about. For example, in the Haida Gwaii example, participants noted that sharing the Haida way of life creates interpersonal connections that extend beyond work and institutionalized identities. As one of our co-authors expressed, "Once you're out on the water, it is a natural way to break down barriers. You watch people change out there. All the titles and all that, they let it go for a while and the experience gets inside of them and they never forget it." These in-person experiences in a place where knowledge, culture and an environmental experience are shared, help to build connections that bridge the institutional and governance barriers that often exist. Experiences in the Haida Gwaii context also point to the importance of finding strategies to break inevitable tensions by being able to laugh together, find commonalities and know that decisions are shared and co-owned. Further, opportunities to collectively 'de-brief' within institutional processes were noted as important. Debriefing a solution or decision can help reduce the tension associated with a process of knowledge sharing and deliberation, and further support the sense that any decision made is one for which everyone takes responsibility. Finally, internalising the experience of co-production requires that decision-makers have a connection to the issues at hand and have a stake in finding durable and equitable outcomes. Experiences from the Newfoundland and Labrador cod fisheries example highlighted this institutional paradox. Many of those involved with the mandate to make decisions about managing the cod stocks were disconnected from the places of concern and from each other (see Box 3-6).

Box 3-6 Disconnection from place leads to un-knowledge co-production

Disconnection from place and lack of knowledge sharing for governance very much describes the Newfoundland & Labrador northern cod fishery when it collapsed in 1992. Centralized decision-making for the management of the cod fishery resulted in a disconnect between the fishing communities and the fisheries managers. The cod fishery, especially the inshore fishery, was very much seen as an industry of last resort and lacked any long-term economic vision. This was further compounded by the lack of political persuasion within the Canadian confederation given that Newfoundland and Labrador held only seven federal seats in Parliament. The highly decentralized inshore fishery long suffered from a lack of focus and strategy. Historically, many policy-makers and political leaders considered the cod fishery as a low skilled industry that limited further economic development and diversification. It is interesting to note that with the decline in the cod fishery, far more lucrative shellfish fisheries emerged for shrimp and crab. The current fishery management regime is far more inclusive of the harvester community perspective. The fishing enterprises associated with the shrimp and crab fisheries are reliant on larger vessels, sophisticated technology and higher levels of training. While many conflicts remain, knowledge co- production is far more present in the post-cod fisheries.

3.5.6 Information Sharing and Data Sovereignty

KCP is about producing new insights together and sharing information, while also navigating some of the critical reflection points discussed above and engaging critically with the systems of governance that shape those processes. However, careful consideration of the sovereignty implications and ethics underpinning knowledge and information sharing has too often taken a secondary role in these critical reflections. Reflections from our examples draw attention to two aspects of information sharing and data sovereignty. First, sharing data and knowledge is important if learning outcomes and empowerment are to be achieved. Second, doing so without also respecting data sovereignty ultimately undermines a foundational premise of KCP. For instance, engaging with diverse knowledges will generate important insights, yet doing so without challenging linear flows of colonial knowledge and related governance practices (e.g., some modelling exercises, expert advisory groups) that are prioritized in most settings will exacerbate knowledge inequities further (see Muhl et al. 2022).

First, sharing data and knowledge is linked to learning. In the Newfoundland and Labrador case, for example, a lack of data-sharing was the foundation of a long-term fisheries

management problem that contributed to a stock collapse (see Box 3-6). Yet, unpacking how the process of knowledge sharing fails to take place requires further reflection, and a recognition of the myriad and context-specific ways it may occur in many KCP processes. Conventional strategies of sharing findings through written reports is a recognized challenge, and certainly emerged as an issue in our own reflections. As one example, the language used in written reports can be 'overprotective' (e.g., de-identifying data) or exclusionary (e.g., using jargon or using language that may cause harm), and therefore, undermine opportunities for broader use of the information and ideas in that reporting. In the Papua New Guinea example, for instance, data is de-identified (i.e., names are removed) because of internal ethics processes and data sensitivity. On the surface this has seemed to make sense. Yet, as a result, key information has gone unshared in report-back processes, and this has included withholding data that could be useful to a community. Without the connection to place and the individuals that raised the issues, the value of that information is lost, as is its practical use by the community. As our deliberations revealed, the loss of certain information in the Papua New Guinea case has undermined opportunities to reflect and learn, and has created a tension with the co-production process.

This example from Papua New Guinea did raise the question of how best to balance sensitive information sharing with the importance of maintain sovereignty of that information and adherence to principles of confidentiality. Experiences in the New Zealand context offer one example. In this instance, learning and empowerment is fostered by bringing Māori researchers together to share knowledge for the next generation. Such knowledge sharing processes provide space to discuss challenges and provide feedback to or between communities, researchers and decision-makers on a range of coastal ecosystem-based management issues. Those settings also provide space for consideration of 'language', especially when there are different language systems. In particular, there is significant effort to ensure different systems of knowledge are presented in ways that are more accessible and understandable to a broad range of participants in the process, while addressing concerns about sovereignty of data (see Box 3-7).

Box 3-7 Postcards and maps for information sharing and data sovereignty in New Zealand

Data sovereignty is preserved through shared images that provide knowledge, while still protecting sensitive knowledge. Project milestones were co-designed to enable knowledge and data to be managed in accordance with whānau, hapū and iwi aspirations. An example of this involves sharing maps but not giving the 'key' or legend (see Paul-Burke et al., 2020), and using postcards to share key concepts and knowledge in a way that is easily understood (see example postcard below). Further, there are multiple examples of full reports, models, and tools for ecosystem-based management that have been co-developed but held only by the whānau, hapū or iwi, while the summaries and high-level graphics are shared more broadly. Other examples of strategies that foster sharing while emphasizing data sovereignty include the development of digital repositories with security measures designed from within cultural narratives enabling appropriate protection. Such repositories help share knowledge in ways that are non-technical and culturally appropriate.

Sharing knowledge and data can be a barrier to meaningful co-production processes. This is a challenge that is not articulated adequately in most instrumentally focused co-production literature, although some recent work is drawing attention to its implications for collaboration. For example, the products of KCP practices (e.g., academic publications, data sets, etc.) enable certain cultural discourses and languages and undermine others. The subsequent institutional, social, and political economic relations that are aligned with those discourses

require careful consideration to ensure that positionality and power are not implicitly or explicitly reproduced or reworked (see Derickson, 2022). Indeed, in many conservation settings, Western agencies use their knowledge and data forms to claim discursive legitimacy and thus re-exert political and economic control. As a result, in many co-production processes (even those that have been ongoing for several years), there can still be some mistrust within groups because of unmet expectations from previous projects or programs. Of more fundamental concern, however, are the harms from colonisation, and the dispossession of territories and knowledges linked to those territories through a range of governance practices and state-sponsored conservation or resource management schemes. Indeed, some projects involve aspects of hereditary or customary knowledge that is linked to the protection of species of ceremonial, commercial or ecological importance (see Moola and Roth, 2019; Paul-Burke et al., 2020; Salomon et al., 2023). Data sovereignty in a co-production process in such circumstances is crucial.

As reflected in our examples, there is rarely an ideal process to address the tension between knowledge sharing and data sovereignty. However, acknowledging that KCP processes are more sensitive to these tensions is crucial to trust-building and a future willingness to share information (Cvitanovic et al. 2021). In the New Zealand case, Māori researchers and communities have decided what information is public, and what is held by communities, and thus how it should be stored, organized, analyzed and cared for over the long term. These efforts have included digital repositories or 'pataka kōrero' (narrative / knowledge storehouses) designed, developed and applied by those Māori groups and communities from whom the data and information has been sourced. Such repositories also include science data and information that has been tailored and made more accessible to the Māori communities involved. Notably, co-production efforts for ecosystem-based management in the New Zealand case has included the production of maps that show generally where the work exists. However, the maps do not explain what particular codes or legends mean in sensitive areas, or areas of customary practice. In some projects, all data is shared when not classified or deemed culturally sensitive (i.e., key information for the next generation). Such processes do 'show' for those engaged or thinking of engaging in governance processes that it is important to create space and a place (e.g., a cultural database) for communities to store knowledge, even if not specifically relevant to the project. Thus, in New Zealand, examples of these repositories have proven extremely important to inform whānau, hapū and iwi environmental planning and management, while also serving local and regional councils engaged in ecosystem-based management and where those Māori communities have agreed to share access.

3.6 Conclusion

The intersection of knowledge and power is a well-established focus in co-production processes, and highlighted in particular by Indigenous scholars (Liborian, 2021) and others offering critiques from the perspective of science and technology studies (Jasanoff, 2004). However, there has been a rapid growth in the promotion of KCP as an instrumental strategy to foster sustainable outcomes in conservation and resource management settings (Armitage, et al., 2019; Miller and Wyborn, 2020; Norström et al., 2020; Chambers, 2021). Increasingly, this includes the promotion of KCP as a 'catch-all' for engagement in coastal and marine governance processes as reflected in the recent calls for co-production as part of the UN Decade of Ocean Science. KCP practices do hold much promise for generating meaningful marine conservation and resource management outcomes, yet without a careful examination of the interplay of governance context and co-production process, those aspirations are unlikely to be met, and may in fact exacerbate inequities of power and how knowledges are prioritized. The reflective analysis of the examples and organizational contexts here have sought to highlight in particular the interplay among KCP and governance, and draw attention to a series of tensions, issues and opportunities that emerge from the broader governance contexts in which knowledge practices are situated (see Table 3-1).

Table 3-1: Summary of Key Messages

Theme	Synthesis of key messages
Motivation	• Relationships and shared values are core to starting a process and need to be unpacked and discussed when framing the problem contexts and goals • 'Cultural' obligation or responsibility (sense of duty) can underpin the motivation if there is a spiritual connection to the land that requires a person to 'be a good ancestor'
Identities and positionality	• KCP processes build friendships, relationships and partnerships. However, people cannot be pigeon-holed into a single identity and often decisions made will impact the surrounding community in which a decision-maker is situated, making them accountable

	• Positionality of marginalized groups can undermine KCP if knowledge is not shared and there is no coordination, that can create sense of individualism undermining the process • The pandemic provided the unforeseen advantage for practitioners and communities to move away from an initially more hierarchical orientation to knowledge generation and sharing towards a co-production model with greater ownerships of projects
Governance capacity and spatial/temporal tensions	• Ecological dynamics (e.g., of cod) generate temporal and spatial challenges to successful KCP • Time is strategic as a leverage point in governance efforts with implications for co-production. Leverages include: (1) increase pressure on external actors to engage more meaningfully; or (2) to wait out a person in a position of authority that may impede meaningful work
Institutional reform and links to governance	• In-person experiences in a place where knowledge, culture and an environmental experience are shared helps to build connections that bridge the institutional and governance barriers to collaboration • 'Legal' framework (esp. for Indigenous sovereignty and knowledge) has to be in place to hold all members accountable to a shared document • Knowing the political leverage points can engender meaningful co-production processes
Information sharing and data sovereignty	• Products of KCP practices (e.g., academic publications, data sets, etc.) enable certain cultural discourses and languages and undermine others. Therefore, data sharing is important for learning and empowerment but needs to be shared appropriately • Customary knowledge that is cultural and place-based must be respected for data sovereignty • There is tension between knowledge sharing and data sovereignty. However, sensitivity to these tensions is crucial to trust-building and a future willingness to share information

KCP clearly emphasizes the importance of conscious partnerships among different groups of people to address sometimes contested objectives (Clark and Dickson, 2003). Conscious partnerships involve participants choosing to work together on an issue in which different

forms of knowledge are woven into decision-making to produce new insights and varied outcomes (Miller and Wyborn, 2020). Yet, engaging in a KCP process without consideration, for example, of historical and colonial governance contexts in coastal and marine settings (see Silver et al. 2022), can result in processes of dispossession from resources, places, knowledges and their cultural contexts. In most settings, including those examples which we have highlighted here, KCP is not simply an instrumental strategy to bring people together, but a catalyst to shift the institutional relationships that govern power and knowledge in the first place. Such a shift helps to reframe relationships among society and science, state and citizen (Ostrom, 1996; Lemos and Morehouse, 2005; Cash et al; 2006b; Wyborn et al., 2019), and navigate spaces of reconciliation and Nation-to-Nation relationships with Indigenous peoples in the lands and seas that are sites of so many conservation and resource management initiatives. As we have illustrated with several examples from our reflections here, much of the literature and examples of practice about KCP in the sustainability literature have struggled to fully account for its potential to exacerbate historic patterns of racial oppression, or to articulate how knowledge processes can serve to foster more anti-colonial and emancipatory, equitable and just governance approaches. We have drawn some initial links to these issues through our reflections and cases here, yet note that the future of KCP will require much more comprehensive and systematic engagement with such challenges.

Chapter 4

Navigating K̲u/K̲uu (sea otter) return in Canada's Pacific Northwest: Co-producing scenarios of the future to reflect on the potential implications for place-based governance

4.1 Chapter Summary

Sea otters (*Enhydra lutris*) are returning to Haida Gwaii, B.C. following their extirpation from the 19th century fur trade. However, as a keystone species, they have a profound effect on ecosystem structure and function. Potential effects from sea otter return on local species of value to coastal First Nations present a governance opportunities and uncertainties. Understanding how sea otter return may affect linked social-ecological systems and how best to govern sea otter return in ways that are place-based and locally relevant requires engaging with local communities. Our objectives in this paper are: 1) to co-produce place-based scenarios of alternative futures associated with sea otter return in Haida Gwaii; and 2) to use the scenarios to help examine some of the potential management and governance implications associated with sea otter return. Three key insights emerged from this analysis. First, the value of co-developing future scenarios of sea otter return created buy-in and a creative and accessible strategy to understand otter-human relations and to engage participants in reflections about sea otter management and governance. Second, the scenarios and subsequent discussions affirmed a strong consensus that management actions in response to the return of sea otter should reflect established Haida principles and values. Third, several more specific management approaches may help to navigate sea otter return, including the importance of spatially-sensitive (i.e., place-based) management, engaging in shared learning processes, linking management to food security, and situating management choices within a broader commitment to Haida-led research. We conclude with suggestions for how the insights from this process about the management and governance of sea otter return can be incorporated into more formal decision-making tools and models. The incorporation of these insights into models can help center Indigenous governance systems in deciding the future of otter-human relations.

4.2 Introduction

In the place now called 'British Columbia' (B.C.), people and sea otters (*Enhydra lutris*) interacted for millennia prior to European arrival (Salomon et al., 2015; Lee et al., 2021; see Appendix C). Oral histories and archaeological records show that Indigenous peoples valued

and managed their interactions with sea otters, and that sustainable hunt and trade persisted for at least 12,000 years (Salomon et al., 2015). However, by the 1850s, the European-driven Pacific maritime fur trade led to the extirpation of sea otters from B.C. waters as well as a number of other regions of the northwest coast (ibid). In response, between 1969 and 1972, the Canadian and US governments collaborated to reintroduce 89 otters from Alaska to Checleset Bay on the West Coast of Vancouver Island (Watson and Estes, 2011).

The subsequent rapid growth (19% per year between 1977-1995) of the population of sea otters after reintroduction has been augmented by several decades of legislated protection (Nichol et al., 2015; Pinkerton et al., 2019). Sea otter status under the 2002 Canadian Species at Risk Act (SARA) and the 1973 US Endangered Species Act has enabled conservation 'success' – they have transitioned from threatened status to a species of 'special concern' in 2007 (DFO, 2014). However, the return of this keystone species profoundly influences local ecosystem structure and function (Estes et al., 2011; Ripple et al., 2014; Pinkerton et al., 2019), and generates unexpected effects in an ecosystem context that has adapted more recently to the absence of a top predator (Kemp et al., 2012; Ripple and Beschta, 2012). Specifically, the return of sea otter alters interactions among prey species and may cause cascading trophic effects (see Box 4-1; Schmitz et al., 2023) that can also influence access to the foods (e.g., shellfish) upon which Indigenous and other coastal communities rely (Markel and Shurin, 2015; Burt et al., 2020; Schmitz et al., 2023).

The federally protected status of sea otter in Canada has catalyzed other challenges. For example, the Nuu-chah-nulth, into whose traditional territory the sea otters were reintroduced between 1969-1972, experienced a loss of access to shellfish as a result (Watson and Estes, 2011; Thomas, 2018; Popken et al., 2023). Further, the reintroduction of sea otter as a protected species meant that the Nuu-chah-nulth could not hunt them, even though the species has impacted their constitutionally protected rights to Food, Social, and Ceremonial (FSC) fisheries (Blood and Associates 1992; Nichol et al., 2009). Constraints on the ability of the Nuu-chah-nulth to exercise their inherent rights highlights emerging challenges associated with the reestablishment of this iconic species. The natural return of sea otter to Haida Gwaii thus generates new questions about interactions with people and ecosystems, and the broader implications for food security, commercial harvest and Haida authority over marine resources.

Our objectives in this research were: 1) to co-produce place-based scenarios of alternative futures associated with sea otter return on Haida Gwaii; and 2) to use the scenarios to help

examine some of the potential management and governance implications, opportunities and challenges associated with sea otter return. In doing so, our effort to understand the return and subsequent recovery of an iconic species (i.e., sea otter) provides an opportunity to engage with new decision-making tools and processes (i.e., qualitative/visual scenarios) in ways that help to reflect on place-based ecologies, economies, and marine-based food security.

This chapter outlines one initiative that was nested within a larger project: 'X̲aayda Gwaay.yaay K̲uugaay Gwii Sdiihltl'lx̲a – The Sea Otters Return to Haida Gwaii' (or K̲u/K̲uu project). The K̲u/K̲uu project is led by the Council of Haida Nation and Parks Canada, and the goal of this project is to understand what co-existing with sea otters on Haida Gwaii can look like now and into the future. This K̲u/K̲uu project is developing interactive sea otter ecosystem model(s) for Haida Gwaii, to explore the impacts of otter return.

The K̲u/K̲uu project provides an opportunity to engage with a wide range of individuals and organizations that are preparing for sea otter return, and thus it has provided the overall framework within which the future scenarios (as a decision-support tool – see Chapter 1) outlined here have been developed. As such, the collaborative 'X̲aayda Gwaay.yaay K̲uugaay Gwii Sdiihltl'lx̲a – The Sea Otters Return to Haida Gwaii' project and the research presented here are intended to contribute to the ongoing development of a sea otter management plan in support of marine management efforts of the Council of Haida Nation (note that the specific outcomes and insights of the research presented below do not necessarily reflect the views of either the Council of the Haida Nation or Parks Canada). Finally, this research contributes more broadly to ongoing scholarship and application of knowledge co-production (KCP) approaches (Cooke et al., 2021; Muhl et al., in review), as well as emerging scholarship at the intersection of marine resource management, Indigenous governance and reconciliation (see Jones et al., 2010; Pinkerton et al., 2019; Lee et al., 2019; Burt et al., 2020; Silver et al., 2022; Salomon et al., 2023)

Box 4-1 Ecological context of sea otter return

Historically, sea otter presence improves kelp and eelgrass habitats through shellfish and invertebrate (e.g., urchin) predation. In turn, this creates positive indirect effects on rockfish and finfish that use eelgrass and kelp beds (Tinker et al., 2008a; Markel and Shurin 2015, Raimondi et al., 2015, Lee et al., 2016; Gregr et al., 2020). The indirect effect of a predator on plant biomass is known as a trophic cascade. Therefore, sea otter return can potentially increase carbon uptake and storage, as they cause trophic coastal cascades in kelp forest ecosystems (Wilmer et al., 2012; Schmitz et al., 2023). However, the extirpation of sea otter has had social, cultural and ecological consequences on Haida Gwaii and has created a series of environmental changes that have profoundly shifted social-ecological relationships (see Appendix C; Lee et al., 2019; Burt et al., 2020). With the natural return of sea otter, another 'regime shift' (Burt et al., 2018) may be underway, and species of economic, social and cultural importance to the Haida (e.g., abalone, urchins, kelp, rockfish etc.) will be affected. The return of sea otter has implications for food security for coastal First Nations, and particularly for certain cultural foods (e.g., shellfish) which are already under pressure from anthropogenic effects (e.g., climate change). Kelp and eelgrass density will be slow to increase, and other positive effects associated with kelp and eelgrass recovery will also take time (see Figures below for detailed description of potential changes). However, while sea otters predominately predate on invertebrates and other shellfish, they can also increase invertebrate and shellfish ranges and coverage as the density and depth of kelp forests increases over time (Lee et al., 2019).

4.2 Setting the Governance and Management Context of Sea Otter (Ku/Kuu) Return

We define governance as an integrated social and institutional process that considers values, beliefs and principles, while also reflecting diverse stakeholders and a context for legitimate decision-making (Kooiman and Bavinck, 2005; Van Tatenhove, 2011). Governance can also refer to a way of steering or governing that is manifested in different types of management choices (Armitage et al., 2012) (e.g., harvest rules). In Canada, a settler-colonial state, resource governance and management agencies charged with meeting constitutional and legal obligations are generally structured by Western scientific approaches and practices designed to inform marine mammal conservation and fisheries management (Silver et al., 2022; Salomon et al., 2023). With reference to sea otter return specifically, governance uncertainties are best understood in terms of the federal government's claimed authority to manage species at risk (Singer et al., 2023), and the inherent rights of Indigenous nations to govern their traditional territories and waters (Harris & Millerd 2010; Salomon et al., 2015). Navigating governance trade-offs in this context will require efforts to bridge both

conventional scientific knowledge and methods, as well as Indigenous perspectives and experiences (Lee et al., 2019; Pinkerton et al., 2019; Burt et al., 2020).

Decisions about sea otter return in the Pacific northwest (e.g., use and conservation, resolving conflicts with other uses) leads us into the realm of Indigenous governance, and the growing recognition that the perspectives and lived realities of Indigenous people are fundamental for effective place-based decision-making of marine resources (von der Porten and de Loë, 2014; Artelle et al., 2018). We use 'place-based' here to refer to governance approaches that center decision-making with reference to the values of Indigenous nations that are historically linked to their traditional territories, and their relations to each other and the land. Indigenous governance is defined as the customary systems of decision-making that have been utilised across generations, such as resource sharing processes (Sium et al., 2012; Artelle et al., 2019; Dick et al., 2021; Zurba et al., 2022). Scholars of Indigenous governance have challenged the status quo in marine resource management and advocate for new forms and arrangements of collaboration with the 'state' (von der Porten et al., 2019)

For instance, M's-it No'kmaq et al., (2021) outline seven principles to guide biodiversity conservation and resource management: (1) supporting Indigenous worldviews of environmental systems, (2) learning to use Indigenous language to understand ecosystems better, (3) respectfully observing the relationships the land, waters and animals have to one another, (4) honour and strengthen these observed relationships in ways that foster reciprocity, (5) reflect on the past to acknowledge the wrongs and look to the present and future with those lessons learned in mind, (6) respect Indigenous knowledge and ways of knowing, and (7) use storytelling as that is the platform that is most appropriate for learning and sharing. Similarly, Reid et al., (2021) in their overview of Indigenous-led spatial planning highlight that Indigenous knowledges and mainstream or scientific knowledge when used together can create better governance outcomes. In this context, knowledge systems are not assimilated but rather used to generate a plurality of perspectives to address governance challenges. With reference to fisheries more specifically, Silver et al., (2022) recently examined the manner in which fisheries science and management in Canada, despite efforts to reflect a wider range of First Nation objectives, remain embedded in colonial structures of decision-making that tend to reinforce historical power dynamics.

Despite advances in understandings of plural governance systems (Lee et al., 2021; Mbatha, 2022), a common or unified perspective on Indigenous governance is difficult to summarize (i.e., there are some 600 First Nations in Canada, as well as diverse Inuit and Metis

communities). However, there are some collective features or attributes that help to shape what Indigenous governance scholars and practitioners view as pathways forward (Tully, 1995). These attributes are summarized by von der Porten (2012) and reflect the insights of other Indigenous governance scholars: (1) involving Indigenous voices in political discussions (Henrickson, 2001; Preston, 2009); (2) strengthening Indigenous-Indigenous partnerships (Simpson, 2008); (3) strengthening Indigenous-non-Indigenous partnerships (Turner, 2006; Price, 2008); (4) addressing colonialism (Alfred, 2005 and 2009; Bryan, 2009); (5) supporting and applying reconciliation processes between the state and Indigenous nations; and (6) asserting and championing Indigenous nationhood (Simpson, 2008).

In British Columbia, specifically, Salomon et al., (2023) have summarized a nested set of principles that can be used to inform the governance choices associated with sea otter return. These governance principles are summarized from 17 Indigenous Nations in the Pacific northwest and provide a framework to understand and steward the relationships among humans and nature (in this case, sea otter). The nine governance principles and laws, include respect, responsibility, reciprocity, accountability, interconnectedness, balance, stewardship, seeking counsel and sharing knowledge, and "land, ocean and people for which a hereditary chief has responsibility and authority to caretake". These governance principles (and the societal values they reflect) are generally consistent across diverse coastal First Nation, yet each Nation has a unique language and way of expressing these principles in practice. How customary (hereditary) forms of governance may be aligned with or even possibly given primacy over state forms of management are a point of uncertainty, and implementing these principles requires shifting systems of governance in ways that reflect a broader suite of values and consideration of diverse systems of knowledge (Nadasdy, 2003; Turner, 2006; Bryan, 2009).

As reflected above, these governance principles are increasingly being centred in resource management and conservation planning. First, there is significant ecological and social uncertainty, trade-offs and potential for conflict because sea otters have and/or will start to influence environments from which they have been absent (Salomon et al., 2015; Ibarra, 2021; Slade et al., 2021). Conflict and trade-offs are linked to customary harvesting being endangered with a reintroduced species competing for similar marine resources (e.g., shellfish), including those that First Nations have a constitutional right to access for food, social and ceremonial purposes (Pinkerton et al., 2019; Popken et al., 2023). Uncertainties associated with climate change further compound governance challenges.

Second, there are inevitable dynamics between the conservation and management objectives of the federal government and First Nations directly affected by sea otter predation on food resources. Sea otters are listed under Canada's Species at Risk Act (SARA, 2002), which offers direction to federal and provincial/territorial authorities with regard to assessment, protection, recovery planning, implementation, and monitoring and evaluation of species of concern (Kraus et al., 2021). Further, both the British Columbia Fish and Wildlife Branch and Fisheries and Oceans Canada (DFO) have specific management regulations associated with sea otter that include prohibitions on harvesting (Pinkerton et al., 2019). However, these regulations do not consider the long history of coastal First Nations stewarding and living with sea otters prior to the 19th century fur trade, nor the connections to food security concerns or interests in cultural revitalization of customary practices associated with sea otter. Indigenous rights to self-determination and Canada's commitment to the United Nations Declaration on the Rights of Indigenous Peoples (2007) suggests the importance of a co-developed approach to sea otter return. However, there remains a relatively rigid (see Kraus et al., 2021) and historically colonial framework for species-at-risk and a tendency to compartmentalise decisions about certain species in ways that do not account for broader ecosystems or relational values of species held by Indigenous peoples (Simberloff, 1998; Pikitch et al., 2004; Lee et al., 2019; Salomon et al., 2023).

Third, the Haida have recently signed the GayGahlda "Changing Tides" Framework for Reconciliation (Council of the Haida Nation, 2021) which outlines expectations for Haida-led marine management. The GayGahlda "Changing Tide" Framework was signed by the governments of British Columbia, Canada and the Haida Nation, and recognises the Haida's inherent rights and title to the archipelago of Haida Gwaii, including the right to self-governance. The protected status of sea otter adds further complexity because of the subsequent constraints on management action (e.g., hunting, harvesting) (Marshall et al., 2016; Guerra, 2018). A key challenge is how best to explore these governance challenges associated with uncertain sea otter futures, and to draw further attention to some of the core governance principles and more specific potential management issues that may help to inform future management plans for sea otter return.

4.3 Methodology

This research adopts a transdisciplinary knowledge co-production process (see Vinke-de Kruijf et al., 2022) to better understand the management and governance dimensions of sea otter return. We define KCP more specifically as the collaborative process of bringing a

plurality of knowledge sources and types together to formulate and address a defined problem and build an aligned and systems-oriented understanding of that problem for an actionable outcome (Armitage et al., 2011; Norström et al., 2020). As such, KCP reflects a process in which researchers, other knowledge holders and knowledge users collaborate to co-create knowledge that is "actionable in decision-making" (Mach et al., 2020:30; see also Karcher et al., 2022).

Western forms of knowledge (i.e., conventional science) and quantitative models typically drive fisheries and marine governance processes both in Canada and globally (Finely and Oreskas, 2013; Silver et al., 2022). These governance processes and the knowledge that inform them frequently emphasize ecological and/or narrow economic efficiency objectives, and often at aggregate scales (Hilborn et al., 2015; Armitage et al., 2019; Elsawah et al., 2020). However, place-based and Indigenous knowledges and community values are needed to make context-sensitive decisions, and especially where efforts to address trade-offs among diverse objectives (cultural, economic and ecological) require more understanding of spatial social–ecological sensitivities (e.g., sea otter return and predator-prey linkages to sea urchin fisheries) (Woodward et al., 2012; Punt et al., 2018; Salomon et al., 2018; Alexander et al., 2019; Norström et al., 2020; Okamoto et al., 2020). This is particularly pertinent when there is uncertainty about ecological implications of sea otter return, and sea otter-human interactions (see Burt et al., 2020).

To engage diverse perspectives and values, we co-developed place-specific visual and narrative scenarios of sea otter return futures and then used these co-created scenarios to collaboratively assess the management and governance implications of sea otter return. We define scenarios here as "…plausible example(s) of what could happen under particular assumptions and conditions" (Peterson et al., 2003:2). There are diverse scenario approaches, but our aim here was to develop exploratory scenarios (i.e., what could happen) in ways that reflect current understandings but also allow for discussions about normative concerns (i.e., what should happen).

The scenario-based co-production approach involved two primary steps, each of which are outlined below: 1) a collaborative process to establish a working group to co-develop the visual scenarios and associated narratives of alternative futures of sea otter return, as well as a series of questions to explore some potential management and governance implications; and 2) using the co-developed scenarios and governance questions to engage a subset of

members of the Haida community (e.g., selected Elders, youth, resource managers) with regard to place-based sea otter futures (see reference to some limitations below).

As discussed above, this research process is situated in a larger collaborative project lead by the Council of Haida Nation (CHN) and Parks Canada (PC): "Xaayda Gwaay.yaay Kuugaay Gwii Sdiihltl'lxa: The Sea Otters Return to Haida Gwaii" (the Ku/Kuu project). The aim of the sea otter (Ku/Kuu) project is to bring together knowledge and data from multiple knowledge systems including Haida, local, and western scientific knowledge, and to support the ecosystem-based management of sea otter. Working in the context of the (Ku/Kuu) project, a first step in the future scenarios initiative was to form a working group of individuals with specific interests in and/or expertise associated with sea otter return in Haida Gwaii. Specifically, an initial meeting took place in May 2022 where project members from the CHN and a Haida member from PC identified relevant Haida experts suitable for the scenario initiative. An invitation email to participate more formally in the scenario co-development working group was co-drafted by the team and emailed by a representative of the Council of the Haida Nation to the selected group of Haida Elders, youth, archaeologists, and other experts on sea otters and marine management. The validity of this process was enhanced, as the invitation email was prepared in partnership with CHN representatives and thus affirmed that the work was being done collaboratively.

Additionally, one non-Haida expert in sea otter ecology and modelling was also invited to provide additional ecological information. With the support of the Ku/Kuu project, a local graphic artist was also commissioned and included in the discussions to provide preliminary sketches, help capture initial ideas of the working group, and subsequently produce the scenario visuals. Ultimately, through a series of Ku/Kuu project efforts, a working group was formed with seven members who together hold decades of place-based knowledge and experience about the land and sea in Haida Gwaii. Membership of the scenario working group is in part a reflection of some of the important and pre-existing relationships several Ku/Kuu project staff had with community members. In this way, the working group does reflect a certain 'informed' perspective on sea otter return.

In addition to the expertise of working group members in providing the knowledge to develop scenarios, we also drew on informal conversations with other knowledge holders about what species and places to incorporate and we engaged with relevant literature on sea otter recovery and return to provide critical detail on ecological relationships and the connections to Haida values about species of concern (see Reidy and Cox, 2013; Szpak et al., 2013;

Pinkerton et al., 2019; Estes and Carswell, 2020; Gregr et al., 2020; Grimes et al., 2020; Moss, 2020; Nichol et al., 2020; Gorra 2021; Ibarra, 2021; Tinker et al., 2021 Slade et al., 2022; references to Haida Oral texts from the museum, and references to the information in the 2011 Haida Marine Traditional Knowledge Study; Haida Marine Traditional Knowledge Participants). Engaging the literature and cross-checking information ensured the scenarios reflected a full range of multi-species interactions and social-ecological relationships.

We held three meetings of two hours each over a period of three months in Fall 2022 to co-construct the scenarios. These meetings required a process that made people feel comfortable and focused on a shared commitment to better understanding sea otter return. Meeting rooms at the Skidegate Council of the Haida Nation provided the main venue for the meetings, and when participants were unable to attend (for example, a conflicting workshop), a follow-up call or in-person meeting would be arranged to ensure all working group members were kept up to date and given an opportunity to provide their inputs. Co-creating these visual scenarios provided the context to generate legitimate and relevant insights into how sea otters could potentially impact spaces of importance to Haida and highlight the relationships among otter and other significant species (e.g., shellfish, urchins, kelp) in a variety of habitats.

In this regard, one of the earlier decisions of the working group was to show a range of areas across the north and south of Haida Gwaii so that the scenarios would be familiar to the people living in different parts of Haida Gwaii. Indeed, choices about the sea otter scenarios were framed by three core criteria (see Figure 4-1): 1) the scenarios needed to emphasize locations that are relevant and/or familiar and seen as important for harvesting and/or cultural purposes; 2) the scenarios should show a diversity of habitats (e.g., rocky reefs, beach, muddy estuary) to provide contrast; and 3) different relevant species and their relationship to sea otters should be highlighted to show potential futures in different habitats.

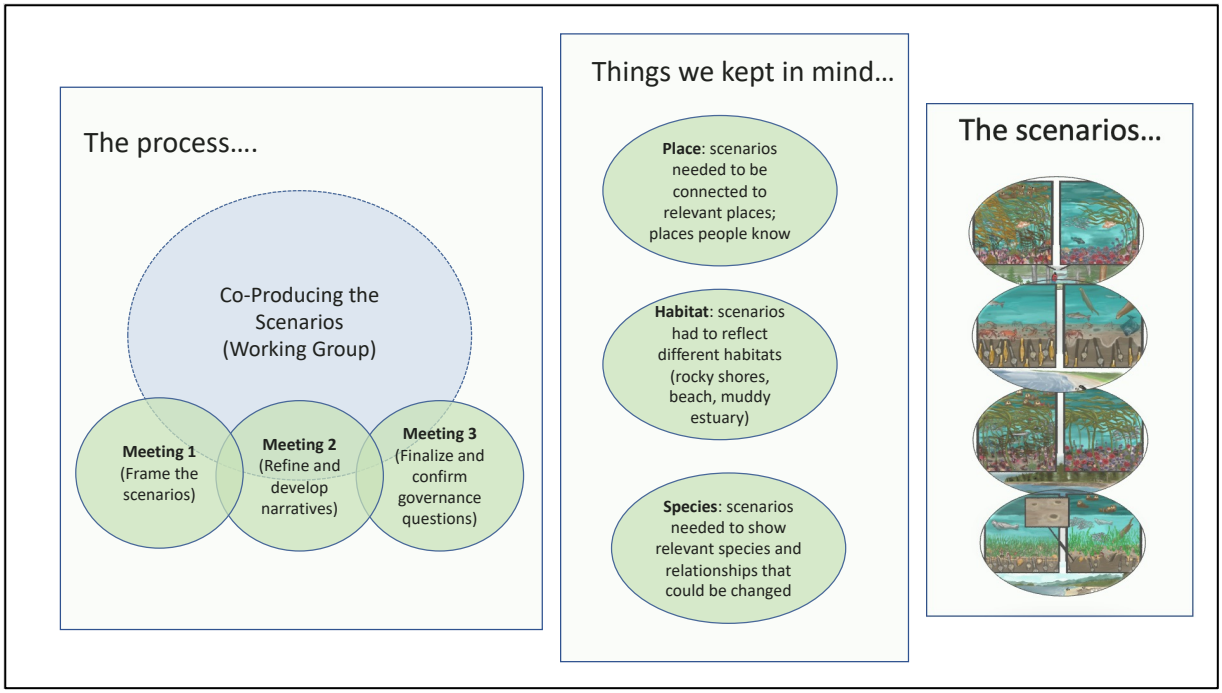
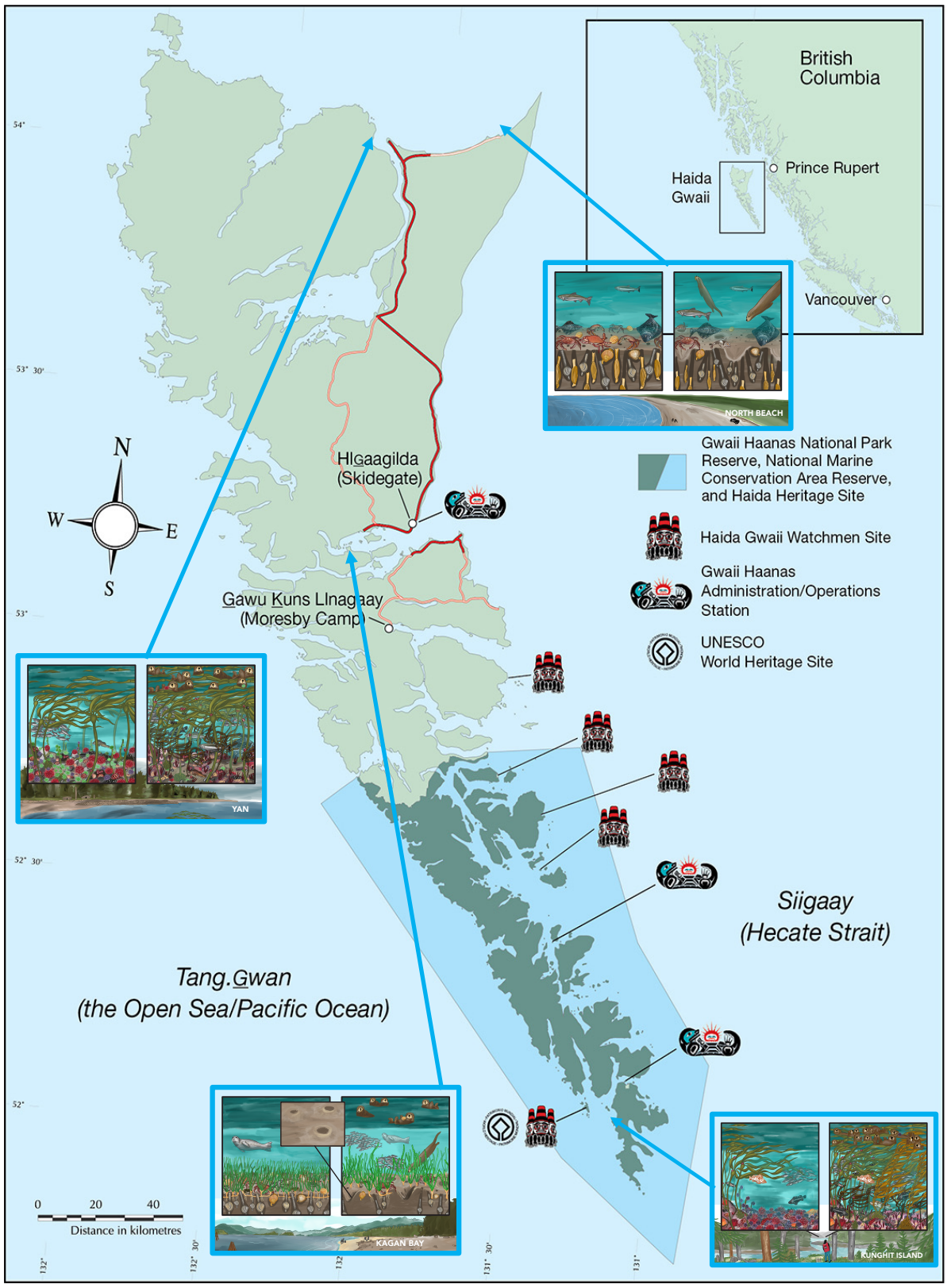


Figure 4-1 The process of co-creating the scenarios with the working group

Ultimately, and after some discussion and reflection over two sessions, the working group identified four key places across Haida Gwaii (Kungit Island, North Beach, Yan and Kagan Bay – see Figure 4-2 for locations). Each of these co-developed scenarios provides a novel tool in which relationships and trade-offs among alternative futures can be explored in the context of sea otter return. Further, accompanying each scenario was a brief narrative description (see below). The narratives were designed to complement the images, and X̲aad Kíl (Haida language) was incorporated into the narratives to strengthen their impact. In this regard, a member of the Council of the Haida Nation marine planning team (and collaborating researcher on this project) helped rewrite the narratives so that they flowed more naturally when spoken, and to ensure they incorporated X̲aad Kíl pronunciation in ways that represented both northern (Masset) and southern (Skidegate) dialects.



Map Source: **Gwaii Haanas Gina 'Waadlux̲an KilG̲uhlG̲a Land-Sea-People Management Plan 2018**

Figure 4-2 Location of scenarios on Haida Gwaii

Once the scenarios were created, a series of workshops and a supplementary interview were undertaken to engage further on issues of management and governance. These workshops were co-facilitated with a CHN marine planner, who grounded the process in the context of the project and framed how potential insights from this work might be used. We found that by describing the process of how the scenarios were co-created, helped to better situate and contextualise the research, and how it came about.

To guide these processes, we used a series of governance questions that had emerged in the working group meetings. Once developed, these questions were shared for feedback with a CHN representative, the working group and during an online project meeting with the 'Ku/Kuu' project, and adjusted based on recommendations. As co-facilitators we asked the questions in the workshops to participants after presenting the scenarios and accompanying narratives. The engagement process took place from November 2022 to February 2023 and included four workshops and one supplementary interview across a total of 30 participants. Specifically, the workshops included Haida language workers from Xaad Kíl Née, Elders from the Skidegate Haida Immersion Program (SHIP), the Archipelago Management Board and a workshop/meeting with the Council of the Haida Nation executive committee. The supplementary interview with a local Haida archaeologist and heritage coordinator was undertaken to augment historical understandings of the interactions among otters and Haida. All workshops and the interview were recorded, and the main text transcribed for further analysis. Notes were taken during and after the workshops.

Finally, the scenarios were shared at the Ku/Kuu sea otter community forum in March 2023. This forum was designed to share knowledge and information that resulted from the "Xaayda Gwaay.yaay Kuugaay Gwii Sdiihltl'lxa: The Sea Otters Return to Haida Gwaii" project. The forum had multiple engagement stations, including one that highlighted the sea otter scenarios. As noted above, throughout the engagement process, we emphasized that the scenarios are not intended to be an 'exact representation' of specific places and/or ecological or human-otter interactions. Instead, they exist as a 'plausible' version of the future to identify place-based relationships associated with sea otter return.

The second objective of the research was to use the scenarios as an opportunity to engage community members and to reflect on the potential management and governance issues that may emerge in specific places in Haida Gwaii (as noted above). This objective served as the starting point for an inductive analysis of the results from the discussions and workshops. As is typical with workshop transcripts that involve different voices and participants, a formal

coding process is not feasible. However, notes from discussions and transcripts from the workshops were initially reviewed for clarity and to begin the process of identifying emergent themes. Subsequent analysis of the transcripts with reference to the governance and management questions asked of workshop participants revealed particular patterns and categories about key issues, concerns, opportunities and the values and beliefs that frame governance of sea otter return (e.g., maintaining ecological balance with sea otter return and ensuring shellfish access remained). The insights associated with the review of the workshop transcripts and notes were also augmented with the conversations and insights from working group members about what the scenarios revealed.

There were a few limitations associated with this process. First, the individuals engaged as part of the working group as well as during the four workshops and community engagement session, are not a comprehensive representation of Haida and/or non-Haida views on sea otter return. The process of engaging people was compressed because of project timelines and delays associated in part with Covid concerns. As a result, we present some of the insights below with an understanding that more effort is needed to comprehensively examine the wide range of community values and perspectives on sea otter return.

Further, results from discussions and workshops highlighted the importance of understanding the background and/or disciplinary knowledge of individuals that provided insights during the process. For example, those participants who were older tended to reflect on different species that they had consumed previously and had memories of, with a greater emphasis on shellfish concerns. In contrast, individuals engaged in formal organizations focussed more on the governance implications for stewardship and determining best practices for management to foster a return to historical norms. Finally, the categories or themes that emerged were cross-checked with members of the working group and reviewed with reference to related literature. However, these themes and insights ultimately reflect the choices by the researcher(s) to highlight what appear to be the most salient points, and are not necessarily indicative of a wide range of Haida perspectives, nor official perspectives of the organizations within which the scenario process was embedded. Selected quotations are offered below to help clarify and/or illustrate some of the key messages shared through the scenario engagement process, and to provide additional perspectives on potential issues associated with management and governance of sea otter. However, given the nature of participation in the working group and four workshops, the quotes are not meant to be a representative sample of perspectives and viewpoints. Ethics approval for this research was provided by the

Council of Haida Nation (August 27, 2021) and the University of Waterloo Office of Research Ethics (ORE #31165).

4.4 Insights and Reflections from the Co-Production Process

Three main insights or reflections emerged from the research process, and each are discussed below. First, we reflect on the scenario co-production process itself. The scenarios yielded helpful insights on how to engage community members in discussions about future conditions which are hard to envision, and the possible management and governance implications that might be associated with alternative sea otter futures. Second, we draw attention to and affirm how many participants emphasized the importance of Haida governance principles and values as foundational in efforts to manage choices about sea otter return. This emphasis is consistent with other initiatives that document these (and related) principles and their ongoing importance for effective outcomes (see Lee et al., 2019; Reid et al., 2021; Reid et al., 2022; Salomon et al., 2023). Third, we outline some of the potentially more specific management actions associated with sea otter return that workshop participants (and working group members) identified as part of the discussions catalyzed by the scenario co-creation and community (e.g., workshops) process. Several of these management actions have been identified in other contexts and broadly support a number of ongoing strategies associated with marine and fisheries management more generally (for example, see Okamoto et al., 2020).

4.4.1 Co-production of place-based alternative future scenarios of sea otter return

As outlined above, four visual and narrative scenarios were co-produced, and each one was connected to a particular location on Haida Gwaii. Each scenario highlights what working group members felt were important variables and relationships associated with sea otter return, and in ways that depict a realistic present and a plausible future. The four figures show each of the place-based visual scenarios. The narratives that accompany each scenario are available in Appendix D (note: these narratives do not reflecting specific perspectives or knowledges of community members but we were generated to complement the visual image and catalyze discussion).

The first scenario (Figure 4-3) is based in Kungit Island and shows a rocky reef area with a focus on shellfish and invertebrates. The scenario also reflects how in 25 years the area may change with sea otter return. Specifically, the scenario highlights how there would be a likely

decline in shellfish and invertebrates (e.g., abalone, urchins) but explains (in the narrative) that because of the decline in grazing marine invertebrates, there would likely be an increase in kelp species and density that would be more robust and subsequently provide shelter and nurseries for fish species (e.g., rockfish). The scenario also depicts sea otter behaviour: there would be rafts of sea otters, including mums and pups, that would mostly stay within 10km of the area. The subsequent narrative also provides some otter species information, such as how much food they eat in a day.

Figure 4-3 Kungit island visual scenario

The second scenario (Figure 4-4) is of Kagan Bay, an estuary in the north end of Haida Gwaii, and highlights different key species within this habitat and the likely associated otter behaviour. Here the scenario focuses on how sea otters would likely reduce clam and cockle size and numbers, and that the marks from their digging would make the area have craters like a moonscape. The scenario also emphasizes that the digging would cause the eelgrass to germinate, flower and grow, becoming more robust and healthy. The scenario emphasizes that sea otter control green crab numbers through predation. However, sea otters would likely not remain in the area and would shift and move around. The scenario (and narrative) illustrate that sea otters remove some species that are important for food harvesting, but that they also benefit other species.

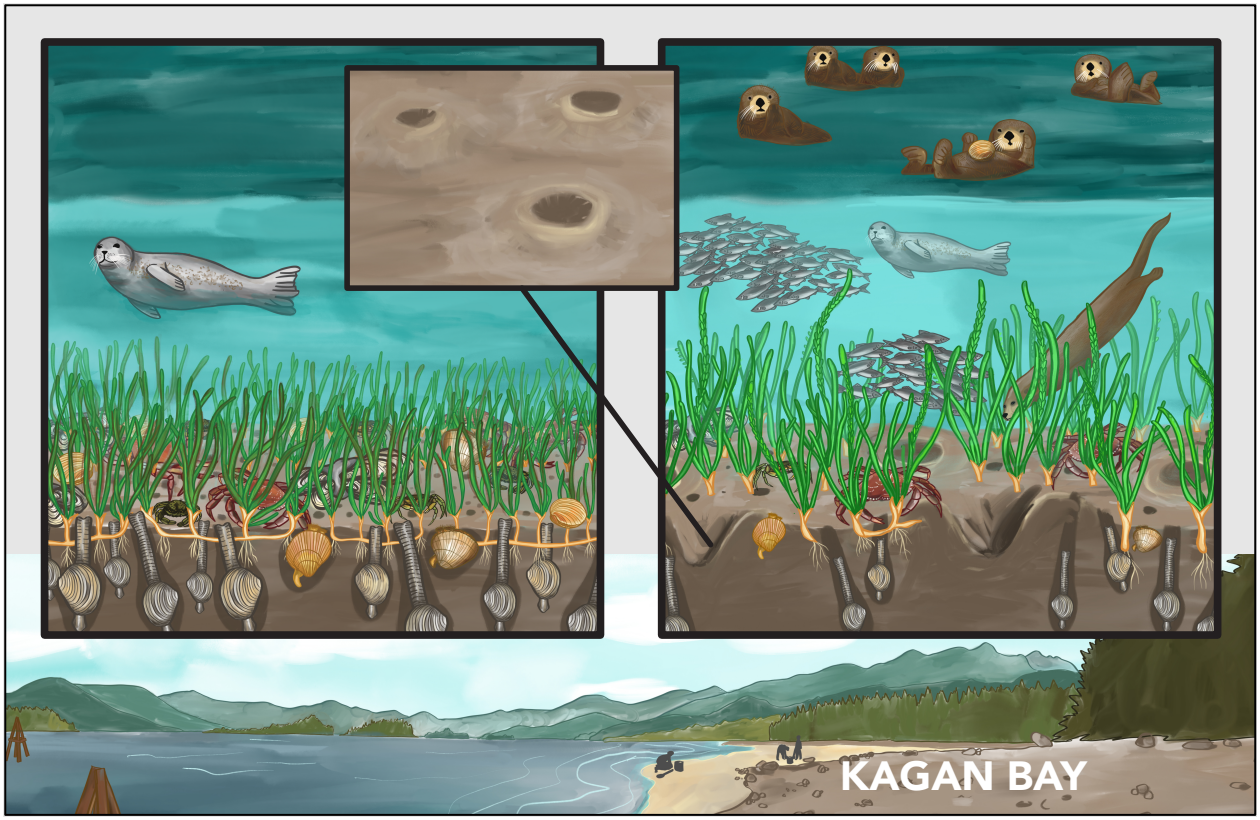


Figure 4-4 Kagan bay visual scenario

The third scenario (Figure 4-5) shows a sandy beach area (North Beach) that is often used for harvesting of razor clams and commercial harvests of Dungeness crabs. The otters in this scenario would be non-territorial males that would visit the area seasonally in summer. Due to the wave action, they would be unable to access North Beach in the winter. The scenario and narrative provide some information on the depths to which otters can dive. The scenario highlights the reduction in size and number of clam species and Dungeness crabs due to otter return. By sharing this situation, we show that sea otters will affect environments that people rely on in negative ways too and require management.

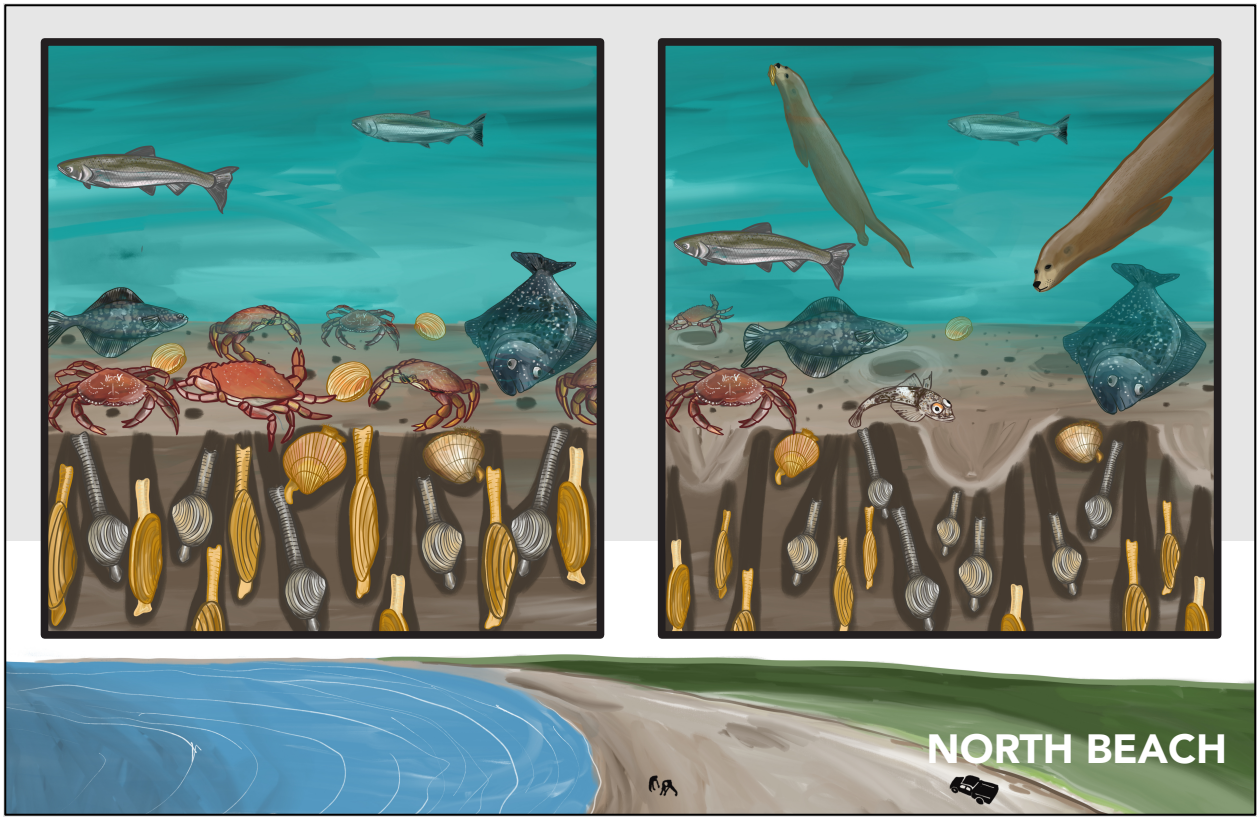


Figure 4-5 North beach visual scenario

The last scenario (Figure 4-6) illustrates a rocky reef in the north of the island (Yan). Yan is an area where Kelp is harvested. Here the scenario illustrates the decline in shellfish and invertebrate species like abalone, sea cucumbers, urchins and chitons, to name a few. The otter behaviour in Figure 4-3 and 4-5 is similar so in this scenario the focus is on how in time various species will adapt to sea otter presence and change their behaviour. For example, abalone learn to hide in cracks and crevices, and due to the greater abundance of kelp, they are able to feed on pieces of kelp that are drifting and have naturally broken off (rather than openly searching for food). The scenario also illustrates that relationships among species and habitats are complex and that we may co-exist best with sea otters when Haida principles are centred.

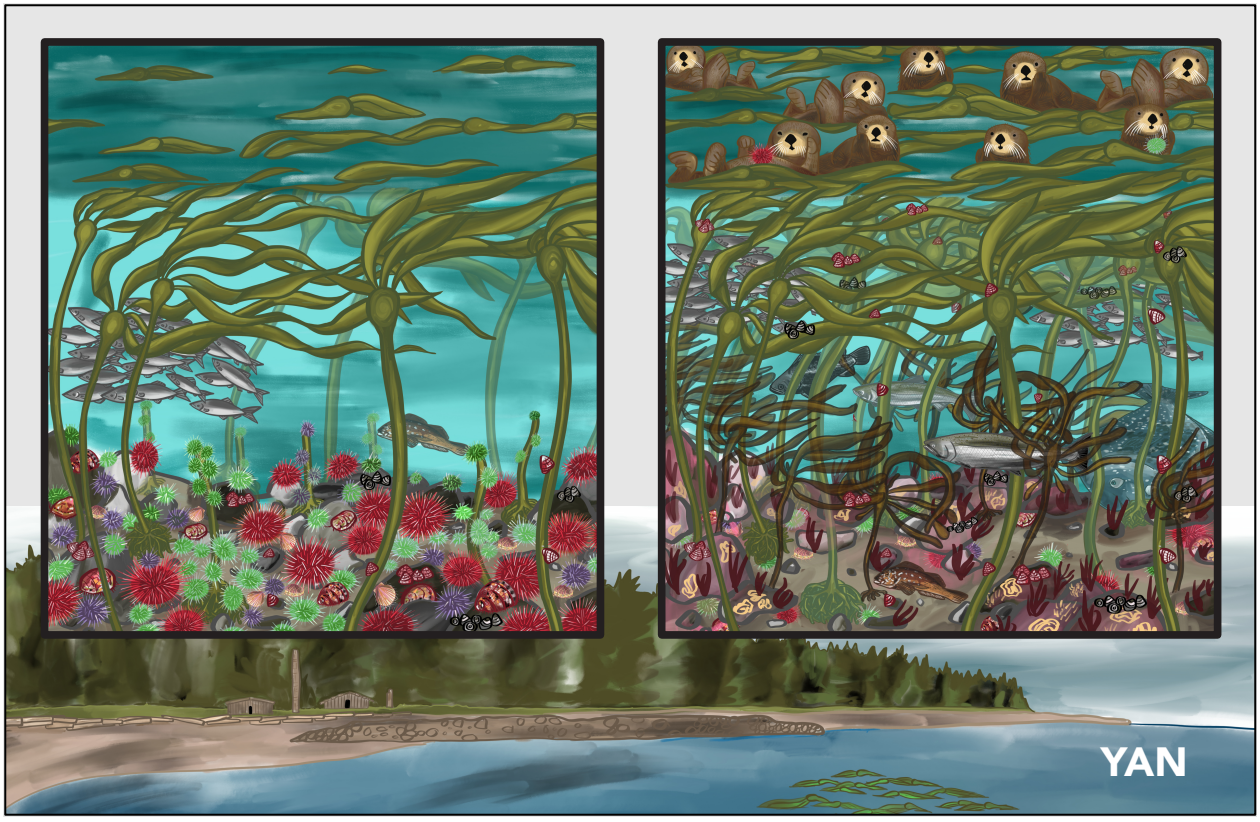


Figure 4-6 Yan visual scenario

Two key lessons emerged from the scenario co-production design and use effort. First, the initial process of co-creating scenarios with the working group helped to provide perspectives that were used to develop the complementary narratives and to outline some of the key relationships of potential interest (see Appendix D). The co-creation process also helped to shape the governance questions we subsequently asked. For instance, how the scenarios were developed and applied draws attention to the importance of different systems of knowledge about sea otters. Accordingly, the scenarios proved helpful as a tool in which relationships and trade-offs among alternative futures could be explored. In that sense, each of the scenarios reflect Haida governance principles in some different ways and that was likely an important reason why the scenarios resonated with workshop participants.

Second, the scenarios evoked conversations on deeper topics that would not likely have been explored in the same way without the visuals and subsequent narratives. For example, in one of the workshops with the SHIP Elders, participants highlighted how they could better visualise the changing relationships among people, otters and ecosystems. Moreover, individuals with more recent and direct experience (i.e., individuals involved in underwater

dive surveys) could also attest to the accuracy of the visual scenarios and thus create buy-in with the larger group. As one participant noted: “I appreciate the ongoing and continued communication. It's a good way to go about it, it [the scenarios] are accessible and you get a good idea of the impacts. You don't have to know anything or feel like an expert or anything (Workshop participant, November 22nd).” In this context, there was also a process of learning as participants asked questions about the scenarios, allowing for clarifications about what data informed the images and accompanying narratives. One participant shared that they left the workshop feeling a lot more knowledgeable and ‘more calm’ about the return of sea otters, especially now that they saw them as animals that had existed for a long time on Haida Gwaii (before the fur trade), and that their ancestors had lived with sea otters. Reflections around relationships (people-people, people-otter) subsequently led to other discussions (see below) about navigating sea otter return in ways that honoured the relational values emphasized in the visual scenarios and narratives.

In the subsequent sections we draw attention to two further management and governance insights that emerged from the scenario co-production process: (1) affirming the importance of recognizing and applying Haida governance principles to guide sea otter return and management choices; and (2) the identification of several potential and more specific management actions and strategies associated with sea otter return.

4.4.2 Affirming Haida governance principles as a guide for sea otter return and management

Engagement with the scenarios, both during their co-development and subsequent use in the community, affirmed a central concern among participants for a commitment to Haida governance principles (see also Salomon et al., 2015; Lee et al., 2019). For those engaged in ongoing marine management work (e.g., representatives of Haida organizations) the centrality of these principles is clearly well-established. Ultimately, such principles can guide sea otter return and support important decisions about trade-offs with commercial shellfish harvesting and food security (see also Burt et al., 2020; Popken et al., 2023). In this regard, Salomon et al., (2023) summarize the richness of governance principles and values that shape how coastal First Nations, including the Haida, interact with marine resources. Insights from our scenario workshops were consistent, and notably, affirm for those less connected to this context, how central these governance principles are.

For example, during the engagement with the working group and subsequent workshops and interview, the principle of Yahguudang/Yakguudang (Respect) was consistently highlighted

as necessary to support future decisions on sea otter return. As the Council of the Haida Nation (CHN, 2023) defines it, “Respect for each other and all living things is rooted in our culture. We take only what we need, we give thanks, and we acknowledge those who behave accordingly”. This principle was repeatedly expressed in the context of scenario development and in how the scenarios were interpreted by workshop participants. For instance, once participant highlighted that there is a relationship between people and otters that requires mutual respect, implying we need to be careful in our decision-making to not privilege one over another. Both otters and people have rights. As one Haida Elder stated during a workshop: “So the teachings my mom gave me is that I can't ever think that I have any more rights to live here than the smallest insect to the largest animal., It is our legacy to take care of it, why every Haida person's legacy is to take care of the beings and the everything that is on Haida Gwaii and to keep it safe.” (Workshop participant, December 2nd). In this context, the Elder (and others) was referring to the importance of acknowledging and being conscious of the animal and staying respectful and connected.

Similarly, respondents also highlighted how it is important to see the otter as more than a ‘resource’, and also to take ‘Laa guu ga kanhllns (Responsibility) for its wellbeing. Here, ‘Laa guu ga kanhllns refers to the responsibility to manage the land and sea together for future generations (see Saloman et al., 2023). As one participant (3 February 2023) noted, “…our ancestors, you know, and others just were very conscious. And that goes back to that relationship of being respectful and having that relationship, … It's not a resource. It's not just an animal that you kill and eat. It's a supernatural being sometimes. It's a living being. They have names.” Often, when participants were discussing ideas of responsibility, they were doing so with reference to broader ideas about ‘relationships’ with sea otters and values about Gina ‘waadluxan gud ad kwaagid (interconnectedness). As expressed by a participant (12 January):

“Our relationship is important. And I always think too like, everything is connected to everything else… every little living thing is valuable, and it's not something to be disrespected… we need to adapt to them [sea otters] coming back, and how that impacts the rest of the ecosystem.”

For many participants, in addition to the principles emphasized above, the return of sea otters is seen in part as a restoring of the natural giid tlljuus (balance) of how things were pre-contact. For example, with reference to the North Beach scenario, one participant noted, “there's this balance that was once there and we haven't witnessed it, so we've become

accustomed to all these larger sea foods [shellfish]". Many participants emphasized, with regard to this idea of balance, how they were quite uncertain about the future of the shellfish fishery which has already experienced changes in quantity and size, patterns which some connect to climate change (Ainsworth et al., 2007; Turner and Clifton, 2009; Talloni-Alvarez, 2019). Ultimately, there is concern about how to balance sea otter impacts with the resources that people are accustomed to using, and the manner in which sea otters will continuously cycle through different spaces and resources (i.e., patterns of intense consumption and ecosystem renewal as otters seek other resources and 'eat down the food chain' (see Watt et al., 2000; Tinker et al., 2008 Hoyt, 2015; Newsome et al., 2015)

However, participants also acknowledge that as shellfish decline in certain areas, kelp would subsequently increase and have an effect on other desired species of cultural and economic importance (i.e., rockfish). Participants thus expressed that in some areas sea otters could harvest shellfish and it would not affect the community because these are places where people do not go. As one individual noted, "...there is a balance to be found... if you look at the beach as a whole. There's a lot of rocky reefs just outside of that area [North Beach]. And then there's stretches of beach where no one really harvests". It is important to keep in mind (as highlighted by participants) that there is an age dimension associated with how people think about balance, and other governance principles associated with sea otters. One participant (22nd November) noted that, "….I'm not involved in any of the fishery, and I don't have a lot of interest in those fisheries that would be impacted at this time. So, it doesn't really seem like there are many negative parts to me because I don't feel like I have a direct connection and won't be impacted by them returning." While the participant could acknowledge that others would be impacted, their perspective was to look at the positive attributes of sea otter return (e.g., increase in kelp, potential tourism, etc.).

Ultimately, many of the conversations about Haida governance principles the emerged as part of the discussion about the four scenarios provide essential context for some of the more specific discussion about possible alternative management choices (e.g., harvesting and management control programs). Moreover, the changes narrated in the four scenarios about the implications for shellfish and food security provided multiple entry points for more detailed insights on day-to-day management actions that might be helpful messaging in a sea otter management plan. These insights included ideas about spatially sensitive and placed-based zoning; the importance of shared learning processes about management with other coastal First Nations; and the importance of specific management actions being linked to Haida-led research.

4.4.3 Possible management actions to help navigate sea otter return

Across the four workshops, selected sea otter management strategies or choices were highlighted by participants as potentially important. As noted above, and because of the limited representation of participants, these management actions do not likely reflect the full range of perspectives. Moreover, how the management actions have been categorized here reflects how the researcher(s) interpreted and understood the contributions from participants. Nevertheless, the selected management strategies that did emerge reflect three themes: 1) there was a strong message about the importance of partnerships as a foundation upon which to support management (e.g., to foster capacity, resource sharing, etc.); 2) management efforts must be linked to Haida-led research and monitoring. In this regard, there was a clear view in the workshops (and during the scenario co-production process) that such research activities ultimately should be Haida-led to ensure data sovereignty and year-round monitoring; and 3) data sovereignty (i.e., who controls data and information) for management action is linked to Haida leadership, supporting active co-management, and ensuring research is relevant, appropriate, and useful.

Nested within this conversation on management actions were three additional sub-themes, each of which are addressed below: 1) management actions (e.g., harvesting, exclusion zones, etc.) should be spatially sensitive and placed-based; 2) learning about management actions (what works, what does not) will benefit from shared processes with other coastal First Nations; and 3) management actions should serve to reconnect people and culture to provide entry points for place-based economies and food security.

4.4.3.1 Spatially sensitive and place-based management actions

With reference to the North beach and Yan scenarios in particular, discussions about future sea otter management highlighted the importance of a place-based, and spatially sensitive approach (see also Okamoto et al., 2020). There are several reasons identified for this, including a recognition of how sea otter return may shape place-based relationships linked to the ability of Haida to harvest species of social and ceremonial importance, the connections to localized (and spatially diverse) implications for commercial harvest (e.g., shellfish), and the manner in which sea otter return may influence Haida social relationships. The focus on spatial priorities was also mentioned in the subsequent community forum, where participants

noted that there may be areas where sea otters might be encouraged, due to their predation on urchins (thus facilitating the recovery of kelp) and targeting of undesirable invasive European green crab species.

As one individual noted, the Yan and Kungit scenarios appealed to them because they could envision a physical change in the marine environment with less sea urchins, and the importance of documenting these changes in a spatially specific manner:

> "Being a watchman, living down south in areas like in front of Tanu, SGang Gwaay, Kuna, Windy Bay and Hot springs, we actually get to snorkel and food gather. I've been down there for over 15 years and areas that, like Kungit Island, and even Yan are quite similar to places like Tanu and [there is an] immense sea urchin population that just runs around like a bunch of hoover vacuum cleaners. It would be really interesting in my lifetime, let's say when sea otters do get up there, …because I get to physically see change over time." (Participant, 3 February 2023)

A number of additional management implications associated with this spatial perspective also emerged from the workshops, as well as during the scenario co-production stage. For instance, several participants highlighted the opportunities for and challenges of creating 'exclusion' areas or spatial closures (e.g., North Beach). As one participant explained (participant, 12 January), this could occur naturally through human presence and described it as a 'natural cycle' that was also related to migration.

> "There's this natural cycle…humans are around Tow Hill in the summertime and in the winter months, you're not really around. In the winter months, sea otters will naturally go off to more rocky places. Speaking with my mentor, she talks about going to North Beach starting in March, and then they would be there until fish camp started… we would be in a certain place for a few months and then move on to the next place to get the next resource. And I imagined during our time, in these places, there would be that active exclusion [of sea otter] in these seasonal periods."

How to manage sea otters also depends in part on the place-specific human priorities. There might need to be a more concerted effort in certain places when people feel certain species (e.g., clams and crabs) are threatened. Many participants across all four workshops felt that there was a compromise and a balance that requires careful management and observation over time. This perspective is exemplified by a participant who stated:

> “North Beach is a very important place for us to food harvest because it's accessible. And so like, in terms of management strategies, I would see that being a priority area and then Yan nowadays is mostly used for seaweed harvesting, and some food harvest… So harvesting invertebrates - it's not as much of a priority because people don't live there or people don't take their boats across that way.” (participant, 12 January 2023)

With reference to herring, for instance, Okamoto et al., (2020) noted how spatial closures can generate significant trade-offs across social and ecological objectives. Similar issues may emerge in relation to sea otter return. Indeed, the choices of the scenario working group itself to generate very localized and place-specific scenarios (e.g., Kagan Bay), draws attention to how those trade-offs are not easily generalized in management planning. As a participant (17th November 2022) noted, decisions about limits or spatial inclusions must be linked to ongoing research needs (see above) and the importance of obtaining “…some Haida knowledge of how to manage them [sea otter interactions] …where they are hunted, …. And how are they managed around the clam beds, and all of that, right. I feel like if I get into that, I think I think we get some sort of answers.”

Similarly, participants across all four workshops discussed potential management interventions and the different ways otter behaviour could be changed, such as ideas around using boats and tagging to create a ‘landscape of fear’ (Laundré et al., 2010). Such actions would scare otters away from certain areas while also generating opportunities for contracts and economic incentives that provide an alternative to hunting while the sea otter population stabilizes. A number of participants, particularly Elders, raised concerns about the use of sea otters and felt that ‘hazing’ (the use of a dead sea otter to scare away others) was not in alignment with Haida values. There was emphasis on the fact that if otters were hunted, the whole otter must be used. Use of otters solely for their pelts was not appropriate, and that the meat and bones should be used too as that showed respect for the animal and its life. Similarly, participants felt that hunting should target male otters, not females or pups. That was declared as “obvious” when discussing sea otter harvest methods with Elders in SHIP.

4.4.3.2 Shared learning processes key to management of sea otter return

The discussions associated with the four scenarios supported an important process insight related to management that has been articulated in other contexts: there is much to be

gained by engaging in shared learning with other coastal First Nations that have already experienced sea otter return, including those Nations that have also focused on understanding or relearning about pre-colonial management strategies (see Burt et al., 2020; Slade et al., 2022). Learning, observing and living with change is a key component of adaptive management, and in reflecting on relationships with sea otters that had existed pre-contact with other groups may be particularly important as a management strategy.

For instance, participants across all four workshops noted that research needs to be done with reference to how sea otters may have been stewarded in the past. This requires sharing experiences across the Pacific Northwest. For example, as one participant stated (17th November), “I keep going back and trying to figure out you know, what, what would it look like pre pre-contact and what was the interaction between people and otters? I keep feeling we need to work with some of the cultural folks to try to figure out how much were they [sea otters] being used and what we're being used for. And I think that will help with the management tools as well.”

Several participants also suggested that sharing research and data would also help foster a Nation-to-Nation relationship in coastal British Columbia, as many nations are grappling with the same problem. Shared learning and working together was suggested as one way of building better management opportunities in the longer term. As one participant stated, “It would be very beneficial, not just for Haida Gwaii but probably the rest of coastal BC or anywhere else where they're dealing with this type of reality of having natural species come back.”

Another participant highlighted how the Coastal Guardian Watchmen Network, which has been run by eight First Nations since 2005 on Haida Gwaii and that is connected to coastal BC and Alaska, was a good model for research and sharing experiences (Coastal First Nations, 2022). This model is relevant in terms of sharing information and the learning that takes place with other First Nations.

“We literally have relatives 40 miles north of us that do hunt sea otters. That's true, and so we need to consult them. They actively have this relationship with sea otters and it's an oversight to have these concerns and not consult them on what they're doing.” (Participant, 12 January 2023).

Another participant highlighted the importance of learning from other Nations and adapting that knowledge for the context. They called it “Haidaising the process” and said:

“If other nations have already done research, you don't need to reinvent the wheel. You could see what they've done. Pros and cons of their research approach or what they've run into and take their model and have that information so you're not starting from square one. Then just take that knowledge and tailor it to Haida Gwaii, … and we just 'Haidise it', that's kind of terms that we use a lot when we do stuff our way”

4.4.3.3 Management actions must support place-based economies and food security

For many participants, management actions were not something ‘outside’ of other concerns related to sea otter return. Instead, management of sea otter return appears to be recognized as an important pathway to support more place-based economies and food security in Haida Gwaii. For instance, certain participants in the community workshops emphasized that sea otter return should be centred around trading, revitalising trade networks, and fostering community. Others noted that sea otters are a potential economic driver and that could be linked to contracts (e.g., for research, harvesting, monitoring) and wealth creation in Haida Gwaii. One participant (12 January 2023) illustrated this tension with a story about economic motivations and questioning what values frame decisions:

“When one thing that came to mind when it mentioned, using them to boost the economy, there's just the one story that I heard when the Indian agents were coming. Coming into our villages our territories. The Indian agents came and collected regalia. They were confiscating all our regalia, everything that made us who we are, and Indian agents offered each chief, each household, each individual twenty dollars, and twenty dollars was a lot of money in those days and there was one chief who gave up all his belongings, all his regalia, and he refused the payment. And up until that point in time, the Indian agents didn't know how to void a check. He didn't want to take the money because if they want something or if they need something, he's just going to give it to them because that's our way of life. That's what we do. So, when I heard the boosting the economy with sea otters, I think is that something that we want to keep adding to the construct of, you know, the loss of identity of who we are like, is that really a selling point that we want to use? Maybe we can boost the economy because of the world that we live in today. But do we want to? What kind of contribution that we want to make to it? Do we want to use it to our advantage with our cultural identity, or do we want to be known as just like everybody else and say, yeah, we help the economy job wise.”

There was concern that sea otter return might motivate behaviours that are not consistent with Haida values (as discussed above). As noted by another individual (Participant; 3 February 2023):

“The sea otter fur trade really changed our relationship with the sea otters and the marine environment. Unfortunately, we just got in with the economics and capitalism pretty quickly. It didn't take us long to adapt to that Western need for sea otter. And unfortunately, as you know, from the late 1700s to around the 1830s, sea otters were pretty much extinct on Haida Gwaii…. Now we're trying to find a balance of how can you use that word 'decolonizing' say economics or capitalism that you could have a management strategy where you could weave in traditional values to be paramount and have a Western capitalist need at the bottom?”

While there was concern that people would be interested in trading otter pelts, participants perceived sea otters as important for ceremonial use, to revitalise cultural practices and create educational programmes connected to sea otter pelt processing and use.

“If we start seeing an increase over a longer period of time, it should be used for ceremonial use, where weavers and artists could start making traditional clothing with the sea otters and the cedar, it should never jump into a big money market where people will pay ten grand per pelt. It should be for ceremonial and traditional use first … and that could be a part of learning how to prepare hides. Get people to learn how to stretch it, how to cure it and how to incorporate it into the clothing like the cedar tunics and dresses.” (Participant, 3 February 2023)

Indigenous management systems consider humans as part of ecosystems, and therefore, there is need to also address issues of social justice such as food security, poverty and human rights (Alison et al., 2012). In particular, increasing individualism connected to a perceived lack of community did frame some of the discussions about sea otter. As a result, the way sea otter are ‘managed’ may help to re-establish relationships both with sea otters and with one another. As a participant stated in regard to poaching:

“…when we have these issues, like poaching, … we know that they have financial instability most of the time, which is why they're doing what they're doing. And so that is like a social issue. And that's clearly like we need to build up our people and provide the basic necessities for people.” (Participant, 12 January 2023)

Poaching is neither widespread nor specific to Haida Gwaii. Rather, it is a global issue, and the reflections of this individual highlight the importance of addressing broader concerns about social justice and the need for people to reconnect with the land. Reconnecting people to the natural world was highlighted by participants as a possible positive outcome of Haida-led research and job creation through research positions involving sea otter return. A focus on employment was identified as especially important in the winter season when there are fewer jobs available (i.e., tourism low season). Generating employment opportunities and having more people doing research also provides data and shared learning outcomes that would help with some of the uncertainty about sea otter return grounded in place-based management. As one interview participant stated (3 February 2023), “data would help people who are really fearful of the change. So, there is definitely a lot of bonus having your own people with the Guardian program doing stuff like that … You will have information and you'll have your guardians to work with people and check how much and what they are harvesting. Get more people living in our natural environment, bringing family, fishing, food gathering and actually get to see how it could be by having people as we always used to live everywhere on Haida Gwaii.”

4.6 Conclusion

The return of sea otter is a linked social-ecological and governance challenge. We have used a transdisciplinary KCP process to develop place-based scenarios and accompanying narratives of sea-otter return, and to subsequently use these scenarios to collaboratively explore some potential management and governance implications of sea otter return in Haida Gwaii. In doing so, we draw attention to local and Indigenous perspectives, experiences and values for spatially-oriented or context-sensitive decisions that can aid in the co-development of a sea otter management plan. KCP processes are especially pertinent in areas where efforts to address governance trade-offs among diverse objectives (ecological, cultural, economic) require more understanding of spatial social–ecological sensitivities (e.g., sea otter return and predator-prey linkages), and the implications for a wide range of culturally and commercially important fisheries. Using place-based scenarios further centers the importance of Haida governance principles as fundamental to relevant and legitimate decisions about future otter-human relations. We highlight three main conclusions from this research.

First, the co-produced scenario method was particularly effective in securing meaningful engagement with rightsholders and visualizing future consequences of potential management actions associated with sea otter. The approach we have outlined here may provide a helpful foundation for further sea otter management planning. Scenarios like the ones co-developed here can incorporate diverse knowledges, perspectives and values in a broader context of marine resource co-management, and in doing so, contribute to ongoing efforts to potentially disrupt conventional ways of making decisions (see Reid et al., 2022; Silver et al., 2022; Salomon et al., 2023).

Second, the feedback from the workshops illustrates the ability of the scenarios to offer further insights into broader social and ecological relationships and dynamics. Outcomes of this research show that if efforts to study and monitor otters are scaled up, and particularly if those efforts are driven primarily by Haida, there is a significant opportunity to further gain the place-based insights required to inform ecosystem-based management (Berkes et al., 2012; Smith et al., 2017). Indeed, the visual scenarios and the relationships that participants highlighted as important can potentially serve as a foundation to identify socially relevant indicators of change.

Finally, this research illuminates the ramifications of the return of a keystone species following extirpation. The outcomes of this research (i.e., some of the ways participants in the workshops asked questions about or discussed the return of sea otter) demonstrate that there are several potential desirable futures (e.g., those that are more conservation focused, those more focused on maintaining economic opportunities, etc.). This research does not provide enough coverage of different views to point to a consensus or clear direction. However, the discussions catalyzed when presenting the visual scenarios does seem to point to the importance of a governance and management process that centers local values and principles, includes greater awareness of the complexity of decision-making responsibilities and rights, and that recognizes how the effects of sea otter return are deeply connected with Haida livelihoods, culture and food security issues. Sea otters would appear to represent, for many, the hope of cultural and ecological revitalization.

Chapter 5

Conclusions

5.1 Chapter Outline

The aim of this final chapter is to synthesize the major findings and novel contributions from this research. First, the chapter begins by revisiting the goals and objectives I addressed. Second, I summarize the key findings across the three manuscripts (Chapters Two to Four). Third, the novel contributions to theory and practice (i.e., empirical and applied) are synthesized. Finally, this chapter concludes with a consideration of the limitations of the research, explores future research directions and offers some personal reflections.

5.2 Goals and objectives

The goal of my research was to examine the interplay of knowledge processes, power and ecosystem-based management in the context of coastal-marine resources. Three specific objectives guided my research:

1) to critically examine the opportunities, limitations and impact of KCP in the application of indicator approaches for coastal-marine resource management and governance initiatives globally (manuscript 1);
2) to examine more specifically, the interplay of governance and KCP by drawing upon a detailed reflection of selected international cases of coastal-marine ecosystem-based management (e.g., Canada, New Zealand and Papua New Guinea) (manuscript 2); and
3) to co-produce place-based, visual scenarios of alternative sea otter (*Enhydra lutris*) futures in Haida Gwaii, British Columbia (Canada) as a means to engage diverse knowledges and co-examine opportunities for the ongoing restoration of coastal-marine systems (manuscript 3).

The dissertation achieved these objectives through a systematic scoping review (objective 1); a reflexive analysis of selected coastal-marine EBM processes (objective 2); and scenario co-development and participatory research involving a series of workshops (objective 3). All of these initiatives collectively advanced the knowledge gaps highlighted in the introductory chapter. The objectives guided and informed one another as the manuscripts were developed

as part of an interactive process. KCP was the connecting thread that informed how I examined the interplay of knowledge and power with respect to governance and ecosystem-based management. In particular, a number of aspects of my research challenged the role of Western knowledge systems and the manner in which governance arrangements and decision-making tools (i.e., indicators) continue to be informed by methods that reduce complex ecosystems and associated human social systems into single species models (Eckert et al., 2020; Silver et al., 2022).

The research objectives in this dissertation led me to reflect on how scientific knowledge and power are connected in a feedback loop that reinforces a command-and-control narrative, and that perceives coastal and marine spaces and associated 'resources' as sites of access and/or open to exploitation (see Todd, 2018; Silver et al., 2022). I used KCP as a lens through which to analyse and challenge how knowledge was created and applied in relation to selected decision-making tools (i.e., indicators and place-based scenarios), As a result, each of my three research objectives is an attempt to critique and disrupt this conventional and sometimes overtly colonial institutional context in which feedbacks among knowledge, power and governance emerge. These critiques are reflected in an examination of how coastal-marine indicators are developed (objective 1), by providing practical examples of KCP in changing governance contexts (objective 2), and through empirical research where visual and narrative scenarios were used to generate place-based, locally relevant governance insights (about sea otter return) in a way that centres local values and captures systems complexity (objective 3).

5.3 Major findings

The findings from this research are presented across Chapters Two to Four in the dissertation. The chapters were developed as three independent manuscripts. Chapter Two involved a systematic scoping review of indicator approaches to critically examine the opportunities, limitations and impact of KCP in indicator development. I also reflected on how indicator approaches examined in the first manuscript were used for decision-making. I supplemented the systematic review (n=67) with a targeted review of grey literature, and also drew upon grounded reflections with co-authors who are engaged in this space. Key issues associated with knowledge/power interactions and indicator development were synthesized to identify pathways forward that also helped to frame and understand subsequent phases of my research. Specifically, four key findings were identified that may lead to better indicator process outcomes: 1) centering identity and positionality to reflect power differentials; 2)

emphasizing the importance of indicator 'fit' and the politics of scale; 3) engaging rather than erasing social-ecological complexity; and 4) reflecting on social norms and relationships to foster adaptation and learning. Ultimately, it's very difficult to show that these indicator processes lead to more effective decision-making in the temporal scales that are the focus of this analysis. We do know, however, that status quo approaches have not always been successful as they exclude groups and can risk causing tension and conflicts between stake and rightsholders with decision-makers. Therefore, by reflecting on these relational dimensions of indicator development, the findings from this research emphasize how engaging with diverse knowledges, realities and perspectives during indicator development can lead to more effective decision-making in coastal and marine governance. The four dimensions highlighted above are relevant to a wide range of resource and environmental management contexts and provide a pathway to catalyze more effective indicator processes for decision-making and governance more generally.

Chapter Three advanced a novel, critical and reflective process which engaged with four selected international processes of KCP. This reflective process involved thirteen collaborators who were also co-authors of the paper, most of whom are embedded in an organizational context which allowed for a modified 'organisational ethnography' of co-production. The four examples we drew on to reflect on KCP for coastal-marine governance and ecosystem-based management include: (1) coastal ecosystem-based management initiatives in Haida Gwaii, Canada; (2) experiences with coastal governance and ecosystem management in New Zealand; (3) a knowledge brokering support program in Papua New Guinea aimed at fostering coastal livelihoods, and; (4) the historic and present day management experiences with the in-shore (coastal) cod fishery in Newfoundland and Labrador, Canada. The reflective and 'organizational ethnographic' approach mean that co-authors were a part of the situations that we were co-analysing. This process involved in-depth discussions and efforts to collaboratively identify specific lessons for successful KCP with reference to the broader governance contexts in which those co-production efforts were situated.

The conversation and analytical outcomes helped to reveal the deep tensions that exist within organizations and revealed unseen but important dimensions for successful KCP. The key findings that emerged from this process were the importance of: (1) recognizing diverse motivations which frame co-production processes; (2) the manner in which identities, positionality and values influence and are influenced by governance contexts; (3) highlighting governance capacity with respect to spatial and temporal constraints; (4) the importance of

institutional reform and links to governance; and (5) the relationship between knowledge sharing, data sovereignty and governance. The key findings highlight the importance of engaging carefully and critically in KCP processes and challenge common tendencies to make co-production a technical or managerial challenge.

Chapter Four builds further on the findings and insights of the previous two chapters, the need to challenge how instrumental forms of KCP processes take place, and to ensure they are more than just a 'box to tick'. This chapter documents how a KCP process was used to drive a place-based and Haida-centered process to co-produce visual and narrative scenarios of sea otter return, and to understand how governance efforts can be used to collaboratively restore and sustain coastal ecologies and foster cultural practices. The working group formed to co-create the scenarios were mainly Haida knowledge holders, and they were selected due to their deep knowledge on marine species interactions and cultural understanding. The place-based scenarios provided a novel tool in which relationships and tensions among alternative futures of sea otter return were explored. The scenarios were an effective medium as they helped those engaged through workshops to better understand complex marine system and species interactions, and the manner in which subsequent changes in ecosystems because of sea otter return have implications for local food access and security. Engagement with the scenarios were important in also reducing some apprehension about the return of sea otter.

Three core findings emerged from this research. First, the process of co-developing the visual, place-based and narrative scenarios yielded important insights on how to engage Haida rightsholders in discussions about potential management and governance of alternative sea otter futures. Significant amounts of information went into that process (e.g., individual conversations and group discussions, links to sea otter ecology data, etc.) and that information was used by the working group and others to reflect carefully on the issues of sea otter return. In addition, the nature of the scenarios (visual, narratives) and how they were place-based and co-produced with respected community members fostered trust in the process. Second, the importance of Haida governance principles and values were affirmed in the scenario co-development and subsequent community engagement as central to shaping how sea otter return and management choices should take place. For example, an important Haida principle is related to 'respect' (Yahguudang/Yakguudang). Ensuring that the sea otter also have food and a right to place was seen by many people as important. Of equal concern, if hunted, those engaged in the discussion of the scenarios highlighted how all parts of the animal should be used to show respect for the taking of its life. Third, a key finding related to

the specific management actions associated with sea otter return which emerged as part of the scenario co-creation and community engagement (e.g., workshops) process. Key findings related to: (1) identifying spatially sensitive and placed-based management actions (e.g., harvesting, exclusion zones, etc.); 2) learning about management actions (what works, what does not) by engaging with shared processes with other coastal First Nations; and, 3) the need for management actions to reconnect people and culture in ways that provide entry points for place-based economies and food security.

The findings across the three results chapters (Chapters Two to Four) reveal the interplay of knowledge/power processes, decision tools and ecosystem-based management in the context of coastal-marine resources, along with the implications these interactions have on local communities and Indigenous peoples. Specifically, Chapter Two helped provide the theoretical and empirical basis for examining the relational dimensions of indicator development, and to highlight the opportunities, limitations and impacts of KCP. Chapter Three reflected on four international examples of KCP in practice by applying a deep reflective approach with co-authors, and thereby collaboratively identifying specific lessons for successful KCP. This helped to reveal the deep dimensions that exists within organizations and revealed the unseen but tacitly known dimensions for successful KCP that helped highlight and affirm the importance of centring Indigenous knowledge to understand how best to manage sea otter return in the context of Haida Gwaii (Chapter Four). The forthcoming section highlights how these findings from Chapters Two to Four revealed and contributed to the advancement of knowledge and provided novel and significant contributions.

5.4 Novel contributions

This research contributed to theory and practice (i.e., empirical and applied) to address gaps identified in the literature (see Chapter 1; Figure 1-3 - the conceptual framework). Broadly, my research contributes to theory and practice in two primary ways. First, my research has led to the ongoing development of novel frameworks to co-produce knowledge for marine and fisheries governance, with a particular emphasis on the return of sea otter. Using the framework to co-produce scenarios outlined in this thesis helps to consider and reveal the long-term consequences and extended human-otter history that should inform past and future governance (e.g., sea otters were ecologically extirpated over 200 years ago, and therefore, will take time to affect local ecosystems). Scenarios and their co-development thus require historical knowledges that predate colonial contact and that can help to provide

insights into current management choices. Therefore, the return of sea otter requires an historically sensitive management plan and there is potential to restore cultural practices, social-ecological relationships and sustain local food security through the creation of such a management plan.

There are varied and extensive tools to support decision-making practices in conservation and marine governance contexts, including the one presented by the natural return of sea otter in Haida Gwaii (Cook et al., 2014). In this dissertation, I have chosen to focus on indicators and scenarios specifically as decision-making tools to support better governance outcomes (Schwartz et al., 2017). As such, there is significant scope to highlight how KCP processes can inform the collaborative development and application of these evaluation tools and processes for better decision making.

Second, the outcomes of my research challenge conventional approaches to ecosystem-based management of coastal-marine resources. Specifically, my research has advanced a more 'relational perspective' (Kourantidou et al., 2020; Muhl et al., 2022) and connected, for example, indicators to understandings of knowledge/power interactions, and to reflect on how the choice of indicators shapes what is documented and measured in ecosystem-based management (Chapter Two). In addition, this research advocates for a more relational, intentional and 'deep KCP' which recognises how certain forms of governance, and especially those rooted in systems of colonization, may marginalize Indigenous and other place-based ways of knowing. In questioning and challenging such systems of governance, my research illustrates how KCP can potentially disrupt inequitable patterns of social and institutional practices (Chapter Three). Finally, by drawing on co-production as a relational process and in the context of Haida Gwaii, this research offers a series of place-based insights on sea otter return and the implications for Indigenous governance (Chapter Four). The outcomes of this research support ongoing shifts in governance in ways that are inclusive, collaborative, and centre Haida values. I further discuss below the novel and significant contributions with regard to each of my chapters and their related objectives.

As noted above, a novel contribution of Chapter 2 is to identify the benefit of a relational perspective on knowledge/power and the co-production of indicators for coastal-marine governance. There is a clear gap in the literature in regard to the implementation and application of indicators in ways that draw on this more relational view. Specifically, there are very few examples of the development, long-term implementation and application of coastal-marine indicators in ways that clearly address defined problems and decision-making

contexts that reflect aspects such as identity/positionality, complexity and social relationships. Indeed, once indicators are created, there often is little information on how they are made actionable (i.e., how they are applied and implemented to track changes or outcomes over time). However, identifying and reflecting on the relational dimensions of knowledge and power draws attention to contested political, social and cultural issues that shape the development and implementation of indicators. Indeed, indicators reflect an iterative knowledge process in which there are feedbacks among the underlying decision-making arrangements in which indicators are used and the societal context in which people's perception of one another and their social-ecological context produces that knowledge (Forsyth, 2004; Jasanoff, 2004). Knowledge is a product of society, and therefore, what knowledges are used and how, will shape the development and application of indicators and indicator choices. As my research shows, indicator processes that are inclusive of a plurality of knowledge sources are more likely to identify and addresses issues of relevance and be grounded in social, economic, cultural, political and ecological realities (Wyborn et al., 2019).

Ultimately, this chapter highlights a multi-dimensional, multi-scalar process that engages with the roles of knowledge/power and the challenges created by institutionalized (often colonial) forms of governance common in many coastal-marine resource management settings (Todd 2018; M's-it No'kmaq et al. 2021). In many contexts, these institutionalized forms of decision-making are being challenged and the relations of power re-evaluated. In the context of my own work, I used this research and its insights to help co-develop indicators that were applied and tested as part of a separate (although linked) initiative that is required as part of implementation of the Gwaii Haanas Land-Sea-People Plan. Specifically, my formal role in the Gwaii Haanas EBM Implementation Working Group served as a unique and valuable pathway through which I mobilized this research and allowed me to influence and understand the indicator development process both as an observer and participant. The published manuscript associated with Chapter 2 (Muhl et al. 2022), reflects some of the experiences with this applied marine ecosystem management and conservation context in Haida Gwaii.

The outcomes of this Chapter were also used in the context of a contract to advance thinking on human dimensions monitoring for Canada's *Oceans Act* Marine Protected Areas (MPAs) in which I served as a consultant. This project was initiated in June 2022 and included a literature review, identification of relevant principles to help guide human dimensions monitoring and evaluation for MPAs, and an overview of common frameworks used for human dimensions of conservation monitoring. The second phase of this project in August 2022 involved consultation with Fisheries and Ocean Canada staff (headquarters and

regional). Following this, in January 2023 two workshops were held to bring MPA managers together with Indigenous partners, rightsholders, stakeholders, and other MPA interests with the aim of collaboratively identifying why human dimensions monitoring is important for *Oceans Act* MPAs. Following the workshops, all insights from this project were synthesized into a discussion of potential next steps for developing an evaluation framework that is relevant at the national level and local level. My role in the consulting team helped shape the conceptual framing of the project and processes of engagement to ensure different voices (e.g., NGOS, rightsholders and other stakeholders) were amplified. Finally, I participated in and spoke on the importance of co-producing indicators at the first ever workshop run by Fisheries and Oceans Canada on 'Social Sciences and Humanities for MPAs in March 2023, as part of a "practical insights" panel. To this end the scoping review had multiple spin-offs, from contributing to scholarly theory to providing practical insights for MPA evaluation in Canada.

With regard to Chapter Three, KCP practices are emphasized in global initiatives like the UN Decade of Ocean Science, and in this context co-production has significant potential to generate meaningful marine conservation and resource management outcomes. However, without a careful examination of the interplay of the governance context and co-production process, those aspirations are unlikely to be met, and may exacerbate inequities of power associated with what and whose knowledges are prioritized. Ultimately, a major contribution of Chapter Three is to highlight the importance of considering how knowledge informs governance and the role of power in the context of coastal governance and EBM management processes in framing whose knowledge is used and how (Ban et al., 2018).

The second novel contribution from Chapter Three is related to the co-authorship team and the positionality they provided. By blending Indigenous and non-Indigenous perspectives of researchers and practitioners, the core findings presented in Chapter Three emerged from research partnerships in which both Indigenous knowledges and scientific knowledge have been used to understand coastal-marine issues. Inclusive engagement with co-authors combined with a reflexive approach and analysis of contexts within which co-authors were embedded lead to some novel contributions to theory (e.g., what themes arose and how the context of the organizations and decision-making situations created to foster KCP were influenced by the governance context).

Examining KCP in the context of its broader governance (often colonial) context offers novel insights because the influence of the historical institutional relationships that govern

knowledge and power are surfaced, and in turn help us to further understand the relationships between science and society (Shapin and Schaffer, 1985; Jasanoff, 2004; Bremer and Meisch, 2017) Greater attention to governance contexts can also act as catalyst to recognize what knowledge is produced and by whom, and thus navigate spaces of reconciliation and relationships with Indigenous peoples in the lands and seas that they steward (Fairhead and Leach 1995; Dryzek 2005; Kimmerer, 2013; Abu et al., 2019; Reid et al., 2021, M'sit No'kmaq et al., 2021).

As previously noted, a gap in much of the current KCP scholarship (and especially in places like Canada, Australia and New Zealand) is the lack of critical reflection of the fundamental shifts in governance power that are currently being navigated between Indigenous peoples and formal nation states. In Canada, for example, the restitution of rights and reconciliation and start of a conversation involving nation-to-nation governance and management of fisheries (e.g., the Changing Tides agreement in Haida Gwaii) will (or should) have a profound influence on how we think about KCP processes.

Chapter Four focused on putting my experience with KCP into practice by building on the insights gained from the previous two chapters and the associated initiatives in which I have been involved. Knowledge and power shapes how decision-making tools (i.e., scenarios and indicators) are developed and used (Armitage et al., 2019; Burt et al., 2020; M'sit No'kmaq et al., 2021; Silver et al., 2022) In Chapter Four I focus in particular on scenarios and the manner in which their co-development creates a space in which local and Indigenous community members can visualize, understand and make sense of interconnected relationships in a place-based context. Such scenario processes create capacity to engage with challenging research situations in ways that are of interest to them. The co-development of narratives and visual scenarios this research provides a novel contribution in making scenarios accessible to community members and helps to further generate crucial insights into governance and management recommendations associated with sea otter return. The incorporation of X̲aad Kil (Haida language) into the narratives with both Haida from the North and South of the island was also important as it also helped ground the scenarios in place by using local language in a way that was appropriate and relevant.

Furthermore, the scenarios co-developed here can inform the more formal models being developed to inform sea otter management and insights from this process about the management and governance of sea otter recovery can be incorporated into more formal decision-making tools and models can be considered. Many ecological models (although not

necessarily the ones developed in the Ku/Kuu project) used as decision-making tools are rooted in Western science. However, the co-developed scenarios can visually and accessibly depict multiple species interactions in a place-based manner. Moreover, the scenarios presented in Chapter Four are also able to better reflect the relationships among ecological and socio-cultural values. Including relevant rightsholders and stakeholders in the co-production of narratives and visual scenarios allowed for greater attention to the values associated with place-based relationships along with commonly held Haida principles. Feedback from the workshops reflected harvest-control decisions relative to food access and security in providing specific feedback. For example, outlining that certain areas were important for local harvest, while other areas were less important for local food security and could be areas where otters could 'harvest'. This links to the concept of otters and people having their own harvest 'rights' which is in line with Haida principles of respect and reciprocity. Ideally, outcomes of co-produced scenarios can further be parameterized and then included in more formalized EBM models, including the 'Ku/Kuu' sea otter recovery EBM model in which alternative strategies can be evaluated.

Using place-based co-created visual scenarios is one way to open up conversation about sea otter return such that Haida people can discuss protecting and fostering local food security alongside ecological restoration. Importantly, my earlier role in the Gwaii Haanas EBM Implementation Working Group and subsequently the Haida Gwaii 'Ku/Kuu' (Sea Otter) Ecosystem Model Project Team are pathways through which I have attempted to mobilize knowledge from my research. The insights from this work will help inform the management plan for sea otter return, and all the materials generated (e.g., the scenarios, narratives, manuscripts) can be used by the Council of the Haida Nation to conduct further research, and to communicate novel ideas and insights with community members.

An additional key contribution that emerged from this research, centers on the expectation of Haida taking on the lead role in deciding the future of otter-human relations in Haida Gwaii. This research provides a practical novel contribution as the Haida have recently signed the GayGahlda "Changing Tides" Framework, along with the province of British Columbia and the government of Canada. The Changing Tides agreement recognises the Haida's inherent rights and title to the archipelago of Haida Gwaii, including the right to self-government. Sea otter return, with its complex trade-offs as a keystone predator and subsequent effect on local economies and food security, is precisely the type of challenge that requires Haida-led management and to which this works helps inform.

Finally, a number of potential management implications emerge in relation to the three core objectives that guide my dissertation (see section 5.2). Table 5-1 summarises these management implications below. The management implications have been divided by manuscript but fit together to provide a picture of how KCP can ultimately provide cross-cutting insights for management practice.

Table 5-1: Potential Management Implications

Manuscript	Management Implications
Indicators	1. Provide support for capacity building and training with key resource management staff in how to develop indicators that are sensitive to social and relational complexity (noting most indicator efforts centre on ecological and non-human dimensions) 2. Ensure adequate funding (e.g., honoraria) to identified stakeholders and rightsholders so that they have capacity to meaningfully engage in monitoring and evaluation projects (e.g., for MPAs) and/or ensure dedicated staff (with budget line) to take responsibility for implementation 3. Commit to a timeline for development and implementation of indicators, with key dates to provide deliverables such as draft indicators and measures, consultation or engagement strategies, and feedback on initial indicators
Knowledge co-production	1. Anchor KCP initiatives within organisational operational procedures and practices to effect governance from the inside 2. Sensitize senior bureaucrats to the KCP process to provide support and encourage buy-in 3. Situate identities of KCP initiative participants to foster connections and share experiences, in order to help participants understand each other and create basis for trust 4. Create relevant databases for storing and sharing knowledge, along with protocols at the start of the project, along with communications guidelines around data sovereignty and plans for engagement to share data
Otter scenarios	1. Centre and affirm local and culturally-based resource management principles to underpin the rules surrounding how a species is stewarded to aid compliance. 2. Employ and foster local stewardship of keystone species by providing capacity building initiatives, but also funding locally-led research that fosters knowledge sharing

	3. Communicate research outputs and the process used to design management rules can yield key insights that can be helpful to shaping how, when and where to potentially manage species in relation to local concerns.

5.5 Limitations and future research

This section explores the limitations in this study and select opportunities for future research that may emerge from these limitations. There are several limitations associated with my dissertation research, and many of these are connected to my positionality and experience with research during a global pandemic (see sections on positionality, Chapter 1, and reflections, below). However, there are some more specific limitations associated with each manuscript. With regard to manuscript 1 (Chapter 2) efforts to balance sensitivity with comprehensiveness when it came to search terms for the scoping review are an inevitable limitation because there is a degree of subjectivity involved in choices being made. For example, search terms like "participation" are contingent on how they are defined by authors and not necessarily reflective of how issues of inclusion and representation are actually experienced. However, "participation" ultimately became a key search term because other terms like "knowledge/power" or "coproduction" yielded few viable results. As the literature on this topic continues to expand and with greater reference to knowledge and co-production, and since the review only covered work published until 2020, a recommendation for future research includes doing a more updated analysis. Increasingly, KCP is being referenced in policy spaces, and is a called for in the design and implementation of UN Decade of Ocean Science endorsed projects.

In regard to manuscript 2 (Chapter 3), the limitations associated with our approach are connected to the places we examined. While the situations themselves are diverse in both region and scope, they are connected to a few selected examples. Expanding this analysis to include other examples could further benefit the insights and outcomes of the research. Additionally, the reflection activities associated with manuscript 2 took place in the context of the COVID-19 pandemic, and as a result, we had to meet at specific times online. Because of this, not all co-authors could always be present at the same meetings, and on occasion smaller group meetings were necessary. Having workshops in person may have yielded more in-depth discussions and provided further space for reflection on key lessons learned about the interplay of KCP and the governance context.

The key limitation in regard to manuscript 3 (Chapter 4) is connected to the pandemic. The very nature of community research, and especially in an Indigenous context, requires time and trust-building. In addition, the context of my research activities in Haida Gwaii is very different from the large, South African city which I call home (see my positionality), and that required some time to adjust. In-person research was very important in seeking to understand human-otter relationships. However, due to the pandemic, timelines had to be compressed, and there was limited time once the scenarios had been co-created to engage with local community members and to get an even wider range of governance insights (e.g., from commercial shellfish harvesters). With more time, more knowledge surrounding the perception of sea otter return could have been gathered. A future research recommendation would be to host more workshops and individual interviews to get a wider range of perspectives, including local fishers and those involved in commercial fisheries.

Finally, in regard to the sea otter research in Chapter 4, Haida Gwaii is unique in its history, and results are difficult to generalize to other areas. I have sought to gain a rich understanding of how to co-produce scenarios for improved collaborative decision-making and apply these insights to support the challenge of sea otter return. Importantly, this research needs to be undertaken in ways that address the fundamental objectives or principles of Haida rightsholders and other stakeholders, with reference to marine food resource access and broader self-governance aspirations. As a result, I am not seeking generalizable insights from this context, but rather to affirm principles and and highlight potential management actions that may have some applicability to similar problem contexts in British Columbia and Canada more generally. For example, the insights from my research will be relevant to other marine conservation contexts where contestations over access to marine resources and concerns about food security and participation are experienced, and require place-based, locally relevant and meaningful solutions.

5.6 Final reflections

One of the aspects with which I have struggled in the writing of this dissertation was how to communicate the incredible stories that community members and others shared with me, and the deep, rich examples they highlighted. Distilling these stories (particularly in manuscripts 2 and 3) into key messages is one aspect of the challenge. But the process of turning those stories into words on a page does not always do justice to what people have said. When you are sitting in a space with someone, you are sharing their energy. It is a form of connection that only happens when you're in a room with someone and provides subtle nuances that

affect communication and build trust. That sense of connection can present in the way in which they express the story, the tone of their voice, the way that they move their hands or look into your eyes or gesture, even the atmosphere of the space that you're in helps convey information in a different way. Often for people to share these stories and talk about these things, it needs to be in a very safe space. To give an idea of what I am describing, think of the classic example of telling stories around a campfire, and the feeling that that creates and the meaning that that story holds in that space. If you take that story outside of that space, and I use the word 'story', very loosely because often people are not sharing a story, they're sharing an experience, or an idea based on their values and principles. That 'story', written and shared on a black and white page or on a computer screen for someone to read disconnects it.
As academics, we also have the challenge of choosing what to share about that 'story'. Often a narrative is defined down to a key principle, say interconnectivity, but does interconnectivity really capture the depth of what has been shared and expressed? Does the term capture the nuances, the details, or all those small aspects that person has in mind? I don't think it always does. And so, as a researcher and an 'outsider' in these communities and the contexts reflected in manuscripts 2 and 3, and in my case, from a completely different culture and country, some of the messaging will inevitably get lost and I had to trust my co-authors to help keep me on track as much as possible.

In many ways, I struggled with the feeling that I had taken something so authentic and real and placed it into a foreign, very westernised and privileged way of communicating (i.e., developing an academic paper) in which the words have been finalized and decided upon by an external researcher. Even if you share a common language, the way in which that language is structured is based on nuance and subtle biases, and I needed to be aware of this in my framing.

Finally, sharing knowledge through the written word is not how things are communicated and shared in many other cultures. For example, in Haida Gwaii, histories are oral, and potlatches are how documentation and recognition of concepts, values, governing principles and laws of an area are managed and resources are communicated. Similarly, in Haida Gwaii, totem poles can be used to document an event or someone's life using a physical carved structure. I learnt that even the act of carving a pole and the meaning contained within the care and detail of that carving, takes time. The process of carving itself is meaningful and reflected in the quality of the pole and what is chosen to be represented. As I reflect on my experience, I am not saying that writing doesn't take a long time (!). However, it is a very different way of sharing knowledge, values and principles. When it came to my identity and how I entered this

research space, it was very important that I be aware of my positionality, my biases and my experiences because those shaped the lens through which I looked at a problem. They also shaped even how I looked at the community because I was filtering what I experienced and witnessed through a lens of what I already knew and as I was trying to understand a new context and space. It took time for that lens to shift so I could understand more how things work within that context. For me, coming from a large South African city to a small island in Canada was a culture shock. It took me a while to understand how I could even mentally place myself in these spaces or even approach these spaces and explain who I was. I struggled with wanting to do things in a way that was right, but that can also be paralysing, because I did not understand the context fully. I felt like I almost did not want to do anything because I was so worried about doing something wrong and creating a bad first impression. In a small community, a bad first impression can quickly lead to feeling alienated, especially when you are already perceiving yourself an outsider.

It took months to feel like I could approach people, and it was only at the end of my time in Haida Gwaii, following a breakup, and when I was completely vulnerable, that I saw people step up and I felt held and cared for by members of the community. I finally felt like I was trusted and belonged and could be entirely authentic. As Cindy Boyko, a dear friend, and someone I came to regard as a mentor and who felt at many times, like my own Haida matriarch, who was so supportive and loving to me often says, “it’s not the truth unless everybody wins.”

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Appendix A
Supplementary Material: Case Study Descriptions

Knowledge Broker Support Program in Papua New Guinea

For decades, international and government donor and conservation agencies have been delivering programs to build the resilience of coastal communities in the Pacific, and this imperative is growing with the acceleration of climate change and future uncertainty (Meharg et al., 2022; Butler et al. in review). However, many of these initiatives have failed due to a lack of capacity and resources within the agencies to bring together and translate different groups' knowledge systems, languages, epistemologies, values and goals (i.e., scientists, agencies and communities). The Knowledge Broker Support Program started in 2019, funded by the Australian Department of Foreign Affairs and Trade to co-design and iteratively implement solutions and practices that would bring together and translate knowledge systems and languages amongst case study development programs in the Pacific region. The goal was to build a community of practice of knowledge brokers who could deliver more effective and long-lasting changes in the resilience of the communities and the resources that they rely upon in the Pacific (see Figure A1).

Figure A1. The Knowledge Broker Support Program aims to build the capacity of community-based brokers to bridge the gaps between different knowledge systems and languages in development programs in the Pacific region (Photo: Tom Greenwood)

In the first phase of the program, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia partnered with two conservation and aid agencies in Papua New Guinea (PNG), The Nature Conservancy and the Ok Tedi Development Foundation (Figure S2). These partnerships were based on previous working relationships that had developed trust amongst the case studies, and in some cases friendships. Both case studies focused on strengthening the resilience of communities in PNG by collaborations between CSIRO (research centre), the NGOs/development agencies and women in the communities to develop socially and ecologically sustainable practices around and use of coastal resources. The CSIRO scientists worked with the agencies' staff to co-produce tools, approaches and practices to provide unbiased and just platforms for the co-development and implementation of the projects.

Resources from marine and coastal ecosystems have had, and still have, a central role in the diet and the social and cultural life of coastal communities in PNG (Pernetta and Hill, 1981). These resources have also acquired an increasing economic value since the development of a cash-based economy (Kuk and Tioti, 2012). However, impacts from climate change coupled with increasing population, shift to a cash economy and the ever-increasing demand for marine and coastal resources from the Asian markets can jeopardise their sustainability (Government of Papua New Guinea, 2015; Busilacchi et al., 2018, 2021). Since gaining independence from Australia in 1975, PNG has been establishing the institutional framework to govern the exploitation and conservation of marine and coastal resources. This framework has been modelled on a Western-centric, top-down structure with the National Fisheries Authority managing fisheries of main economic importance. A lack of resources and capacity has prevented the development of a framework for coastal resources, however, which are nonetheless extremely important for coastal communities, but are under ever increasing pressure, and the efforts of international donor and conservation agencies aim to fill this gap.

Figure A2: KBSP case studies in PNG, working with the Ok Tedi development Foundation (OTDF) and The Nature Conservancy (TNC).

For more information on the KBSP:
https://research.csiro.au/pkb/knowledge-brokering-support-program/

Additional information on related projects: The Mangoro Market Meri implemented by The Nature Conservancy: https://www.nature.org/en-us/about-us/where-we-work/asia-pacific/asia-and-the-pacific-women-in-conservation/women-guardians-of-the-mangroves/ ; The OTDF Developing Sustainable Business models for women: https://otdfpng.org/exploring-small-scale-fisheries-opportunities-for-women/

Ecosystem-Based Management in Haida Gwaii (Canada):

Gwaii Haanas is a protected area in Haida Gwaii, Canada (see figure A3) that is known as one of the world's ecological and cultural treasures. The area has been cooperatively managed by the Council of the Haida Nation and the Government of Canada since 1993, when the *Gwaii Haanas Agreement* was signed. This agreement describes the parties'

divergent views on ownership of the area and describes how they will set aside this disagreement to focus on shared objectives and cooperatively manage the terrestrial area of Gwaii Haanas through the Archipelago Management Board (AMB). In 2010, the Gwaii Haanas National Marine Conservation Area Reserve was established, and the *Gwaii Haanas Marine Agreement* was signed, which expanded the AMB's role to include planning, operation and management of the Gwaii Haanas marine area.

The AMB is presently comprised of three representatives of the Council of the Haida Nation and three representatives of the Government of Canada (two Parks Canada, one Fisheries and Oceans Canada). Gwaii Haanas is a recognized leader in integrated and adaptive management, ensuring that protection, restoration and ecologically sustainable use opportunities are mutually achieved. The *Gina 'Waadluxan KilGuhlGa* ('Talking About Everything') Land-Sea-People Management Plan was ratified in 2018 and provides the planning context for the ecosystem-based management in Gwaii Haanas.

The Management Plan includes: (1) a vision for the future; (2) guiding principles grounded in Haida law; (3) a zoning plan driven by key ecological and cultural targets; and (4) goals, objectives and measurable targets for management of fisheries and marine resources. With reference to the plan's objectives and guidance from the AMB, a technical team has collaboratively developed a suite of governance, socio-economic, cultural and ecological indicators. A process of testing and evaluating fisheries of cultural and economic importance is underway in collaboration with Haida rightsholders, government and industry. Outcomes of this evaluative process will support AMB efforts to collaboratively and adaptively manage fisheries and other marine resources in Gwaii Haanas.

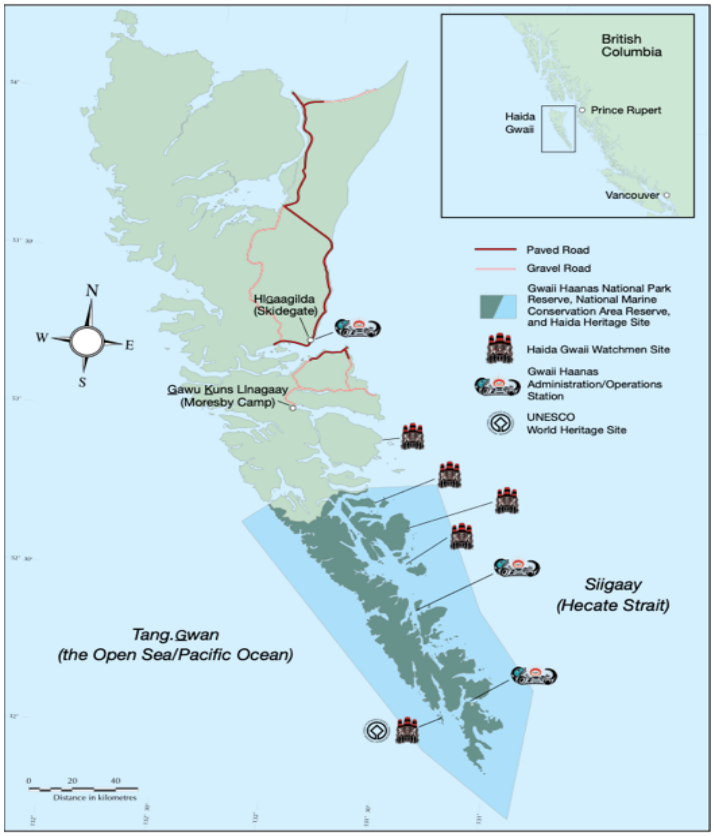


Figure A3. The location of the Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site outlined in blue

Ecosystem Management through the Sustainable Seas Initiative (New Zealand)

The Sustainable Seas initiatives is a mission-led 10-year research programme addressing the government set objective to '*enhance utilisation of our marine resources within environmental and biological constraints*'. Its research involves more than 220 researchers from over 60 organisations, across 75+ projects and activities whose key aims place the moana (ocean) at the very heart of their work. Those aims are to improve the health of our seas through the combination of ecosystem-based management decision-making, a thriving blue economy and Te Ao Māori approaches all distinctively tailored to our local and national contexts.

Achieving these aims requires transdisciplinary research led, partnered, co-developed and co-produced by researchers from kaupapa and mātauranga Māori, marine and social science, economic, and policy and legal backgrounds. Such leadership and expertise is gleaned from

Crown Research Institutes, Universities, private research organisations, iwi and hapū entities, businesses and industry bodies and government agencies (regional and national).
As a case study for this analysis, we look at two aspects. Firstly, the learnings and insights gained during the Sustainable Seas programme as a whole with regard to its evolving journey of co-development and co-production of knowledge, actions and outcomes. Secondly, we focus in on one of its many research projects bringing together mātauranga Māori (knowledge from within Te Ao Māori) and science. The project, titled *Awhi Mai Awhi Atu: Enacting a kaitiakitanga-based approach to EBM,* brings this knowledge to bare in better understanding the culturally and socially important species in Ōhiwa Harbour. It is co-developed and co-produced with hapū and iwi (sub-tribes and tribes) of the harbour and involves marine research that actively positions tikanga and mātauranga Māori as a fundamental approach alongside Western science. It takes this approach to investigate habitat connectivity of the degrading harbour and promote recovery of the once abundant mussel reefs and shellfish beds for present and future generations.

<u>In-shore fisheries management of cod stocks (Newfoundland and Labrador, Canada)</u>

Northern Cod has formed the core of commercial fishing activities and the establishment of human settlement patterns, cultural norms and traditions and local economies in the Newfoundland and Labrador, Canada since the early 1500's when European sailors first starting voyaging extensively to North America. While historic harvest levels are hard to determine with precision, it is clear that in the mid-1960's commercial harvest peaked at approximately 1.8M tonnes; by the early 1990's the commercial harvest was zero. The causes of this Cod Crash remain hotly debated in the literature and informal dialogue in the fisheries management community to this day. While consensus around the relative impact of causal factors such as over-fishing, political interference, government incompetence, foreign fishing fleets, and inadequate science remains elusive, it is clear that among the key factors at play, is the fact that data and information about the fishery were not produced collectively, were not widely disseminated or understood and did not effectively inform decision-making. The case in essence illustrates the opposite of Knowledge co-production and the pitfalls that are possible in its absence. It has been selected to contribute to an understanding of KCP by describing its antithesis and the management responses that were made as a result of it to offer insights into the nature of the changes needed to conventional approaches if KCP is to thrive.

Appendix B:
Summary of process of reflexive research and practice

The initial project emerged from a conversation between three of the co-authors at a conference on coastal marine systems. Subsequently, ideas were workshopped between the three co-authors for what 'ingredients' make knowledge co-production (KCP) more than 'a box to tick'. The best way to do this was decided on by drawing on diverse examples in which co-authors were engaged. Criteria to choose examples were decided upon, and a fourth co-author was brought in. Following this, prospective case study participants were contacted to be co-authors. Two to three representatives from each case study self-selected to be co-authors and an initial meeting was set up for July 2021. All meetings took place online due to COVID-19. In the first large group meeting all participants were introduced to one another, brief study overviews were presented of each case, following that potential cross-cutting themes that could be used to guide analysis were discussed and the overall objectives of the paper.

Following the first large group meeting, a visual representation of the different themes was created by the lead author as framework and circulated for discussion. The second group meeting took place August 2021. The visual framework of cross-cutting themes was used to construct questions that our group felt would best draw out critical and key responses. As part of an organizational ethnography approach, co-authors were able to tap into the sensitivity of hidden dimensions within organizations and co-create questions within the themes designed to draw out often overlooked but tacitly known dimensions for successful KCP. As co-authors and organizational members, the unpacking of processes surrounding successful KCP in governance can reveal concealed dimensions that have emotional, as well as political aspects entangled in both culture and power.

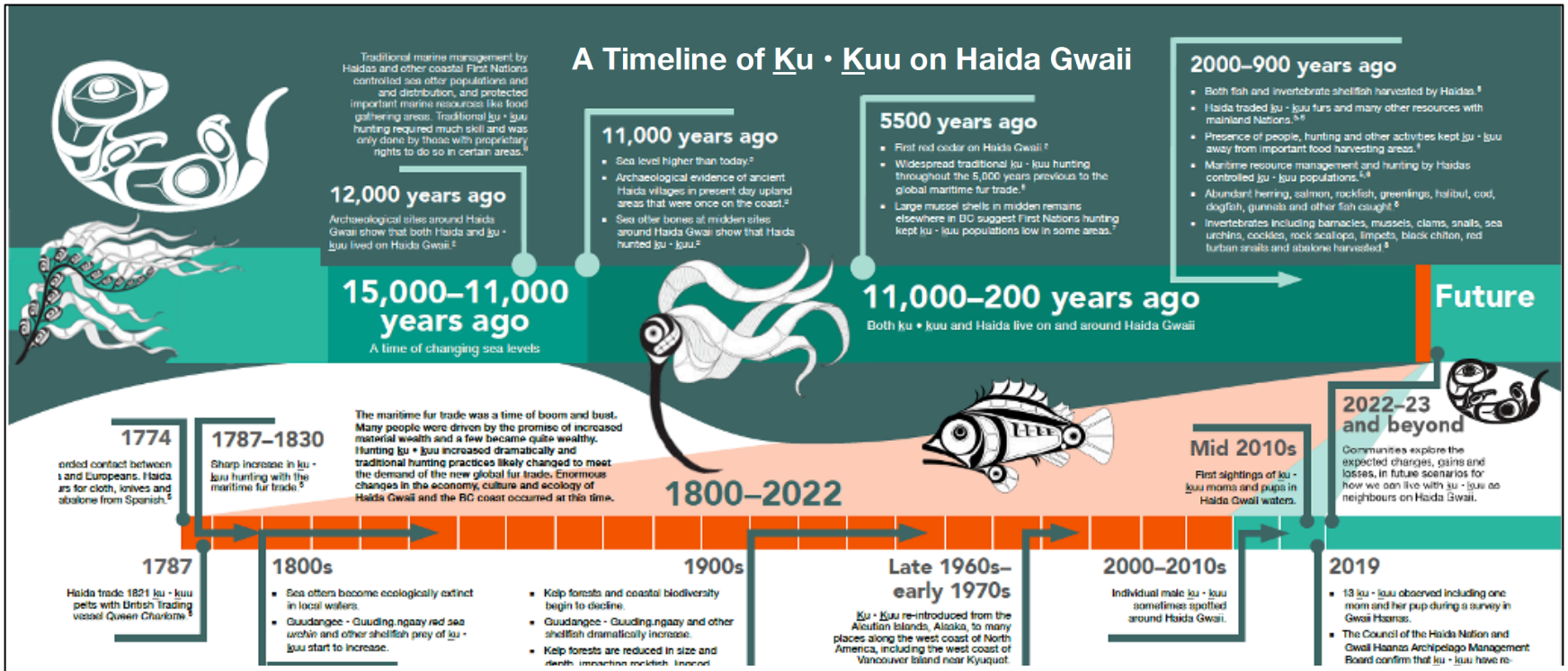
The questions that were co-created were then asked by the lead author to co-authors within subgroups based on case study (for example, all co-authors in the Haida Gwaii case study were asked questions as a group to reflect on their process of KCP). These meetings took place over subsequent months (see timeline for specific dates). All meetings were recorded and then later viewed and analysed by the lead author.

Following the sub-group meetings, a written summary of the conversations was reviewed with all team members for accuracy and completeness. Once all case study discussions were confirmed, an initial synthesis and comparison was completed using the co-created

framework. A third meeting was then held in December 2021 and January 2022 with two individual meetings to accommodate different schedules and time zones to share and finalise the key themes that had arose across the case studies. The key themes were organised into a general framework that we discussed. Unique features as well as commonalities were drawn on to reveal the key insights and lessons and consensus was achieved with any absent members contacted in January 2022 for their consensus and input. The manuscript was drafted by lead author EKM and sent out for feedback in August, with revisions and changes by co-authors returned to lead author by November 2022. The final manuscript was circulated in February 2023 and submitted to the journal end March 2023.

Appendix C

Timeline of Sea Otter Return



Source: Adapted and cropped from the Ku/Kuu Newsletter produced by the Council of Haida Nation and Parks Canada as part of the Xaayda Gwaay.yaay Kuugaay Gwii Sdiihltl'lxa: The Sea Otters Return to Haida Gwaii project.

Appendix D:
Scenario Narratives

Scenario 1: Kungit Island

Out beyond the memorial poles of SGang Gwaay lies an island…you can just glimpse it in the distance. It's called Kungit island. The island is surrounded with hlkaam (bull kelp), ngaal (flat kelp) kelp and sGyuu/sGiw (seaweeds) but the amount of kelp is nothing like it was in the past. The lack of predators like ku/kuu has led to the existence of many more animals, such as guiding.ngaay/guudangee (red sea urchins). These urchins graze on kelp, and this grazing pressure combined with other factors like climate change, has reduced the amount of kelp. But kelp is a habitat for many other animals and the lack of available kelp has affected those animals. For example, rockfish (sGan) are far less numerous.

But 25 years into the future, and with ku/kuu back in the water, we might see a completely different situation. Going out towards Kungit Island, a Watchman could see rafts of ku/kuu, and those rafts would mainly stay within 10km of the area, diving on the rocky reefs where plenty of food would be available. Ku/Kuu love to eat! They can eat up to a third of their bodyweight every day, diving down to take invertebrates like guuding.ngaay/guudangee and gahlyaan/GalGahlyan (abalone). Because they eat so much, there would be fewer and smaller shellfish. Animals like guuding.ngaay/guudangee would not disappear but rather they would start to learn how to hide in crevices and between rocks.

Although ku/kuu do have big appetites, they would not eat all the guuding.ngaay/guudangee or gahlyaan/GalGahlyan. Those animals would still continue to reproduce. And having less guuding.ngaay /guudangee is not a bad thing. With less hungry guuding.ngaay/guudangee eating the hlkaam and ngaal, there will be much more of it, and with more kelps there would be more fish, such as sGan. In this scenario, Ku/Kuu remind us that everything is connected (gina 'waadluxan gud ad kwaagiida).

Scenario 2: Kagan Bay

Just a short drive from Daajing Giids and Skidegate is a beautiful estuarine area where the tide rolls back to reveal extensive mud flats. This is Kagan Bay, a space where people currently harvest k'yuu (clams), sgyaal (cockles) and k'ust'aan/k'uust'an (dungenous crab), but where there are also invasive European green crabs and Japanese oysters.

In 25 years, Ku/Kuu would have a different effect in Kagan Bay. They would certainly eat the Japanese oysters and European green crabs, but they would also the eat k'yuu and sgyaal that people are harvesting now. Ku/Kuu would not remain in the same place, but rather they would shift and move around the area. In response, the shellfish would tunnel deeper and start to hide to avoid predation and would become a lot smaller.

In muddy estuaries, a sign of sea otters would be craters. Parts of Kagan Bay would look almost like the surface of the moon where they had been digging. But as the ku/kuu eat k'ust'aan/k'uust'an and dig for shellfish, healthier, genetically diverse beds of eelgrass (t'anuu/t'aanuu) would be established. The digging by ku/kuu in search of food gently disturbs the seabed which prompts flowering of t'anuu/t'aanuu and provides more space and sunlight for their seeds to sprout. Here Ku/Kuu illustrate 'balance' – Giid tiijuus.

Scenario 3: North Beach

North of Masset, just beyond Taaw Tldáaw (Tow Hill) as you drive through old growth forest, you will reach the long sandy stretch of Hl'yaalan Waagusd (North Beach). There is a razor clam (k'amahl/k'aamahl) fishery here. This is an important area for food, especially k'yuu, sgyaal, and k'amahl. Harvesting of clams is especially important before the winter months, from November to March, when there is less food available and opportunities to harvest are reduced for people.

25 years into the future and with the presence of ku/kuu, we can expect to see much smaller and fewer k'amahl/k'aamahl, and those that remain would be learning to burrow deeper. There would also be fewer k'ust'aan/k'uust'an. Ku/kuu can dive deep, with males sometimes diving to 100 meters, but most dives tend to be less than 18m and last for about 2 minutes. The k'ust'aan/k'uust'an learn this from this, and in time, move deeper to avoid getting eaten by the ku/kuu. Hl'yaalan Waagusd is also a place of strong winter currents, and this would influence the presence of ku/kuu. Here, we would likely only see non-territorial male otters (not rafts) that would visit seasonally in the summer. Still, their presence in Hl'yaalan Waagusd would likely reduce the size of clams.

Scenario 4: Yan

On the west shore of the mouth of Gaw Tlagée (Masset Inlet), long houses mark the old Haida village of Yan. A 30-minute boat ride from Gaw (Old Masset) will take you there. Yan has a rocky reef and a beach, with a fair amount of hlkaam (bull kelp), ngaal (flat kelp) and sGyuu/sGiw (seaweed). Many guiding.ngaay/guudangee (red sea urchins), styuu (green sea urchins), gahlyaan/GalGahlyan (abalone), and t'a/t'aa (chitons) can be found here. Red turban snails, sea cucumbers and shrimp also live in the kelp/seaweed patches. There are many types of shellfish that can be harvested by searching in the hlkaam, ngaal, and sGyuu/sGiw. For finfish, the kelps can also provide a safe nursey, source of food and provide safety from predators. Sometimes you can actually see skil (cod) move into the kelp when there is a predator nearby. Other fish species often found in these patches include ts'iin/chiina (young salmon), sGan (rockfish), xagu/xaaguu (halibut), and linang (herring).

25 years into the future with ku/kuu, there will be smaller and fewer shellfish. However, with less shellfish there will be more hlkaam, ngaal (kelp), and sGyuu/sGiw (seaweed)! And shellfish do learn to hide. Where there is more gahlyaan/GalGahlyan (abalone) there are likely to be more ku/kuu. There is a complex relationship between the two. Ku/kuu eat guiding.ngaay/guudangee, which means there is more sGyuu/sGiw for the gahlyaan/GalGahlyan's dinner, and over time gahlyaan/GalGahlyan learn to hide in crevices. Gahlyaan/GalGahlyan are likely to exist in greater abundance and will be much healthier in areas where ku/kuu have been for a long time (more than 50 years). The increase in hlkaam, ngaal, and sGyuu/sGiw will also result in more permanent kelp patches, and this in turn will affect rockfish (sGan). They might increase dramatically in numbers (maybe by 47 times!).

In Yan, ku/kuu will influence the surrounding ecosystems, but in time they can support a healthier biodiverse ecosystem. This scenario reminds us that the relationships among animals is complex and that we may co-exist best with ku/kuu when Haida principles are centred: Yahguudang/Yakguudang (Respect), Giid tll'juus (Balance), Gina 'waadluxan gud ad kwaagiida (Interconnectedness); Isda ad diigii isda (Giving and Receiving); Gina k'aadang.nga gii uu tl' k'anguudang (Seeking Wise Counsel), and 'Laa guu ga kanhllns (Responsibility).

Appendix E:
Ethics Protocol and Supporting Documents

VERBAL CONSENT FORM

Ethics script:

Just as a reminder to everyone and as we begin, permission for this process has been approved on behalf of the Council of the Haida Nation's Executive Committee. As this work may also form part of my doctoral research, I also have ethics approval from the University of Waterloo. As part of that ethics approval, I am required to outline a few key points. Specifically,

Participation in this study is voluntary.

You may decline to answer any of the focus group questions if you so wish. Further, you may decide to end your participation in the focus group at any time without any negative consequences by advising the researcher(s).

Your participation will be considered confidential by the research team and identifying information will be removed from the data that is collected and stored separately. However, your insights, experiences and ideas will be shared with other members of the focus group.

Your name will not appear in any paper or publication resulting from this study, however with your permission anonymous quotations may be used. Please be aware that even with the use of anonymous quotations, due to the focus of the study and those involved, it is still possible that others may be able to discern your involvement by recognizing comments made by you in study results.

By providing your consent, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

A copy of my UW ethics approval sits with the Kuu project, and I am happy to share it. Ultimately, all permissions for my contributions to this work are guided by the Haida Nation's Executive Committee.

Do you have any questions?

Are you aware that participation in the study is voluntary and that you can withdraw this consent by informing me of your decision?

Do you agree to participate in the study?

Collected data will be securely stored for a minimum of 7 years on password protected computers. You may withdraw your consent and request that your data be removed from the study by contacting the researchers within this time period. Please note that it will not be possible to remove your data once results have been submitted for publication. Only researchers associated with this project will have access to the data. Whenever information is transmitted over the internet privacy cannot be guaranteed. There is always a risk your responses may be intercepted by a third party (e.g., government agencies, hackers). University of Waterloo researchers will not collect or use internet protocol (IP) addresses or other information which could link your participation to your computer or electronic device without first informing you.

I hope that the results of my research will be of benefit to those organizations directly involved in the study, other organizations not directly involved in the study, as well as to the broader research community.
I very much look forward to speaking with you.

_____
This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#42629). If you have questions for the Committee, contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

For all other questions contact Ella-Kari Muhl by email at ella-kari.muhl@uwaterloo.ca.

Council of the Haida Nation research permit approval

HAIDA NATION

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August 27, 2021

Ms. Ella-Kari Muhl
PhD Candidate
School of Environment, Resources and Sustainability
University of Waterloo

Dear Ms. Muhl:

Re: Xaayda Gwaay.yaay Kuugaay Gwii Sdiihltl'lxa – *The Sea Otters Return to Haida Gwaii* Research Application

In reference to above, the application for research permission has been approved on behalf of the Council of the Haida Nation's Executive Committee. This project has met the Council of the Haida Nation's standards for research conducted in Haida territory.

This approval is in effect for the duration of the project from the above date. Any changes in the procedures affecting interaction with living subjects are to be reported to the Council of the Haida Nation Executive Committee. Significant changes will require the submission of a revised Research Permit Application.

Sincerely,

Signature concealed for privacy purposes

Gaagwiis *Jason Alsop*
President of the Haida Nation

C: D. Armitage, Supervisor

University of Waterloo Ethics Protocol

PROTOCOLS

UNIVERSITY OF WATERLOO

#42629 - Democratizing quantitative models for fisheries and marine ecosystem-based management

Protocol Information

Review Type	Status	Approval Date	Renewal Date
Expedited	**Approved**	**Sep 29, 2022**	**Nov 11, 2023**

Expiration Date	Initial Approval Date	Initial Review Type
Dec 04, 2023	**Dec 03, 2020**	**Expedited**

Approval Comment

Renewal approved. Study may continue for another 12 months- JE

Feedback

Protocol Renewal Form

Renewal form

What kind of application are you renewing?

Standard Application/Imported Record