

“We monitor by living here”:
Actualization of a social-ecological monitoring program grounded in Gitga’at
harvesters’ observations and knowledge

by

Kim-Ly Thompson
B.Sc., McGill University, 2015

A Thesis Submitted in Partial Fulfillment of the
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Abstract

The academic community and government agencies are increasingly recognizing how Indigenous knowledge can enrich environmental monitoring and inform adaptation in complex social-ecological systems. Indeed, Indigenous peoples have been monitoring, managing, and adapting to their environments for thousands of years. Despite the impacts of ongoing colonialism, many Indigenous peoples continue to monitor and exert their knowledge and governance systems through ongoing use and relationship with their traditional territories. This Master's research grew from the Gitga'at First Nation's Oceans and Lands Department desire to formally include the knowledge and observations of their land and sea users as part of contemporary stewardship initiatives.

The primary objective of this research was to provide a framework for an ongoing monitoring system based in the observations and knowledge of Gitga'at harvesters. In order to meet this objective, I asked three main research questions: 1. How has Indigenous knowledge interacted with environmental monitoring initiatives, and what are characteristics of effective and self-sustaining monitoring initiatives that engage Indigenous knowledge?; 2. What methods of Indigenous knowledge documentation and communication are best suited to the needs and objectives of the Gitga'at First Nation?; and 3. How does ongoing use and occupancy of Gitga'at territory inform community-based monitoring?

I first conducted a review of the literature on Indigenous knowledge and environmental monitoring to explore the ways in which Indigenous peoples and their knowledges have been engaged in other monitoring initiatives. I found that Indigenous knowledge has been engaged in a number of ways ranging from traditional land-based activities providing holistic social-ecological monitoring indicators, to the employment of Indigenous field technicians for externally-drive monitoring initiatives. Effective projects involved high degrees of community participation or direction; were built on partnerships based on trust and respect for various knowledge systems; used multiple methods to document and communicate Indigenous knowledge; and had institutional links between monitoring and management bodies.

To answer my second research question, I followed a participatory case study approach in partnership with Gitga'at co-researchers. We began with informal interviews with 36 knowledge holders to gauge interest in the project and to establish monitoring objectives. These were followed by two community meetings and 12 workshops to design methods for documenting their observations. We then iteratively designed and tested these methods over the course of two traditional harvest seasons. We interviewed 23 participants following the spring 2017 harvest season and 27 after the fall/winter 2017 harvest season. We also conducted 4 semi-structured interviews with department leaders to ensure that the information gathered was meeting the needs of the Gitga'at Oceans and Lands Department, Treaty Negotiators, the Hartley Bay School and the Gitga'at Health Department. Key outcomes are a harvest logbook, and an interview guide to be administered by community researchers following each harvest season.

To answer my third research question, I conducted a conceptual framework analysis on the notes and transcripts taken while designing and testing a monitoring program based in the observations and knowledge of Gitga'at land and sea users. An interconnected set of social-ecological concepts and indicators that are monitored by Gitga'at harvesters emerged. The framework I developed based on conversations about Gitga'at monitoring through harvesting activities highlights the importance of maintaining and revitalizing Indigenous knowledge and harvesting practices in order to continue social-ecological monitoring, as well as opportunities for scientific approaches to situate themselves within Indigenous frameworks and priorities.

This research provides the Gitga'at First Nation with foundations from which to pursue ongoing documentation of observations and knowledge produced through harvesting activities as a form of social-ecological monitoring. It also serves as a guide for other Indigenous nations that wish to embark on similar initiatives. Amidst discussions of marine and coastal resource co-management in British-Columbia and Indigenous resurgence, this research adds to the literature that re-enforces the importance of Indigenous governance and access to their lands and waters, and the continuation of Indigenous relationships to the land and sea in order to inform social-ecological monitoring for the benefit of all.

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Chapters 2, 3 and 4 of this thesis have been written as individual manuscripts to be published in academic journals. In addition to myself, Chapter 2 was co-authored by Natalie Ban and Trevor Lantz. Chapter 3 co-authors include Havana-Jae Fisher, Nicole Robinson, Nikkita Reece, Chris Picard, and Natalie Ban. Chapter 4's co-authors are myself, Cameron Hill and Natalie Ban. I would like to extend my thanks all these co-authors for their partnership, patience and dedication. Many thanks to Jana Kotaska for her close examination of this thesis and for pushing me to write with conviction about subjects I deeply care about.

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Dedication

To the next generation of Gitga'ata harvesters and caretakers

and

Friends who have become family in Hartley Bay

Chapter 1: Introduction

Introduction

Indigenous peoples have been monitoring, managing, and adapting to changes in their environments for thousands of years. In recent times, the academic community and government agencies have increasingly recognized how Indigenous knowledge can enrich environmental monitoring and inform adaptation in complex social-ecological systems. In collaboration with the Gitga'at First Nation, my thesis explores the interface between ongoing Indigenous relationships and responsibilities to their traditional territories, enacted through land and sea-based activities, and social-ecological monitoring. This research is centered on the co-creation of a process for the ongoing documentation of Gitga'at land and sea users' observations and knowledge of environmental change, and serves as a guide for other Indigenous Nations who wish to embark on similar initiatives. It also contributes to the literature that examines ways forward for leveraging both Indigenous and scientific knowledge in a time of rapid environmental change and Indigenous resurgence. This introductory chapter outlines the main themes that will be discussed throughout this thesis: environmental change, Indigenous knowledge systems, social-ecological systems and resilience thinking, and community-based monitoring. It also introduces the research setting and my position within it, and explains my research objectives and methodological approach.

Environmental change

This research takes place in a time of rapid global environmental change. These changes include loss of biodiversity (Hooper et al., 2012), species range shifts (Chen et al. 2011), increasing occurrences of extreme weather events (Stott, 2016), sea-level rise (Nicholls & Cazenave, 2003), and ocean acidification (Hoegh-Guldberg et al., 2008). These changes have been proven to be directly or indirectly caused by anthropogenic activities including land/sea use change and the combustion of fossil fuels (Kalnay & Ming, 2003; Vitousek et al., 1997). Though the many of these changes are linked to industrial activities, they are acutely felt by Indigenous and subsistence-based societies (Ford et al., 2016; Savo et al., 2016).

Community-based monitoring

Monitoring is the periodic collection and synthesis of information about the state of a system to enable the early detection of unexpected changes and inform appropriate management and/or mitigation. It is an essential component in the study of any social or ecological system undergoing change as it informs the adaptive management of those systems (Berkes et al., 2000; Parlee et al., 2005). A monitoring system is composed of the observation of natural and/or social phenomena, the collection, storage and analysis of information, and communication of results to inform decision making (Pulsifer et al., 2012).

Community-based monitoring (CBM) is often referred to in the conservation or climate change adaptation literature as the “monitoring of natural systems by local stakeholders, using their resources and in relation to aims and objectives that make sense to them” (Danielsen et al., 2014a). CBM can also help to fill data gaps in remote areas where professional monitoring is infrequent because it is less costly, can lead to quick management responses when linked to decision-makers, better uptake of management and conservation initiatives, and can elucidate global patterns of change when part of larger networks (Danielsen et al., 2005). CBM is also promoted in the literature for its potential to empower communities to make resource management decisions (Danielsen et al., 2009), to create job opportunities, and to develop skills and capacity for communities to engage in future research. However, CBM often involves external stakeholders such as government agencies and researchers for technical and financial support. Thus, there exists a spectrum of local participation in projects with a CBM label that span from externally driven with local data collectors to autonomous local monitoring, where local people lead all phases of the monitoring system (Danielsen et al., 2009). Often, when external agencies drive the design of a monitoring program, the monitoring slows down or stops entirely once they leave. Thus, it is necessary for decision making power, responsibilities and benefits of monitoring systems to be held by participating communities so that monitoring can be self-sustaining (Garcia & Lescuyer, 2008).

Social-ecological systems and resilience thinking

Social-ecological systems (SES) thinking emerged in academia in the late 1990s when it became increasingly clear that resource management and environmental issues involve not only ecological systems, but social systems as well (Berkes & Folke, 1998). Social and ecological systems are both complex systems; they do not behave in a linear way, are self-organizing, occur at multiple spatial scales, and changes within them can lead to unpredictable results. In as much, the interactions between and across social and ecological systems are also very complex and unpacking them requires interdisciplinary thinking.

Much of the SES literature focuses on resilience, the capacity for a system to withstand and adapt to change while maintaining its core functions and characteristics. Resilience hinges on the ability of an SES to adaptively manage change (Folke, 2006). SES literature has recognized Indigenous knowledge systems as adaptive resource management (Berkes et al., 2000).

Indigenous knowledge systems

Indigenous knowledge systems are based in experience, observation, and adaptive transmission across generations. They are fundamentally built on relationships between humans and the natural world, the spiritual world, and each other (Wilson, 2001; Kimmerer, 2000). Within this context, Indigenous knowledge systems often include ecological understandings, which can inform stewardship practices that are upheld by social institutions (Turner et al. 2010). There are many terms that have been used within the academic literature to refer to such place-based and worldview-informed ecological knowledge, traditional ecological knowledge, local Indigenous knowledge, and Indigenous ecological knowledge are just a few. In this thesis I use the term “Indigenous knowledge” to emphasize a way of knowing based on longstanding and adaptive relationship with place. The embeddedness of place-based experiences within Indigenous paradigms that span multiple generations is a key difference between the local ecological knowledge that is accrued within much shorter time spans (Berkes, 2012). Given that holders of Indigenous knowledge receive intergenerational teachings embedded in Indigenous worldview while also accumulating lessons through lived experiences, they are also holders of local

ecological knowledge. Given that Indigenous peoples have developed knowledge and ways of living specific to their ancestral homes, there are many unique Indigenous knowledges. When referring to the knowledge system held and used specifically by Gitga'at people in relation to their lands and waters, I use the term Gitga'at knowledge.

The explicit rooting of Indigenous knowledge systems in long-standing relationships with the natural world differs from the scientific method's aim for an "objective" study of natural systems. While Indigenous knowledge systems encompass the many relationships between humans and the natural world, the scientific method tends to be more reductionist and to quantitatively study of components of a whole. Despite some who claim that the disparate origins of Indigenous knowledge and the scientific method render them mutually unintelligible, others emphasize their common grounding in empirical observation (Agrawal, 1995; Snively & Corsiglia, 2001) and that each way of knowing is in fact a culturally informed approach (Lertzman, 2009).

Many have demonstrated that thanks to their differences, each knowledge system can provide different yet complementary indicators, which together can inform enriched understandings of the natural world (eg. Moller et al, 2004). This has encouraged the global scientific community and government resource management agencies to contemplate ways of "integrating" Indigenous knowledge with information generated through the scientific method (United Nations Conference on Environment and Development, 1992; Fisheries and Oceans Canada, 2016). However, due to ongoing colonial power structures, the validity of information produced by Indigenous knowledge systems is typically still evaluated and presented according to European scientific paradigms, which tends to decontextualize empirical information about the natural world (e.g. population abundance estimates and body condition) from Indigenous lifeways and spiritual traditions (Nadasdy, 1999; Simpson, 2000).

Indeed, there continues to be a need for non-Indigenous conservation and resource-management agencies to reckon with the colonial contexts of their efforts and the necessity for Indigenous knowledge to be communicated and used on Indigenous terms (Bohensky & Maru, 2011; Muir, et al., 2010; Ellis 2004). In places like Canada, where policies of forced assimilation and ongoing

industrial development continue to marginalize Indigenous lifeways and way of knowing, attempts to “integrate” Indigenous and scientific knowledge must first ensure that Indigenous and settler-colonial leaders have at least equal power in their shared responsibility to care for their lands, waters, and people. Thankfully, the resilience and resurgence of Indigenous peoples have enabled many Indigenous groups to leverage information generated through scientific and Indigenous ways of knowing according to their own objectives and cultural contexts (eg. Housty et al., 2014; Jones et al. 2010; Poepoe et al. 2007). In turn, this thesis outlines the efforts of the Gitga’at First Nation to document its harvesters’ observations and knowledge to inform its own objectives.

Gitga’at people and stewardship of Gitga’at territory

The Gitga’at people are a Tsimshian tribal group who have occupied and cared for their lands and waters on the North Coast of British Columbia for thousands of years. They are one of 14 Tsimshian tribal groups who share a common language (sm’algyax) and matrilineal society along four waaps (house groups), Gispwudwada (Killer whale), Laxgibuu (Wolf), Ganhada (Raven) and Laxsgiik (Eagle), within which all members are considered kin. Sm’oogyits (hereditary leaders and spokespeople) are responsible for the well-being of their waaps and health of their territory. Thanks to recent archeological and anthropological work, it is becoming clear that technologies such as the use of fish traps, holding ponds, and clam gardens, in combination with complex social institutions, have been important in sustainably managing Gitga’at territory for millennia (Greening & Chalmers, unpublished data). Each waaps has its own adaawx (true stories) that narrate and validates its ownership and stewardship responsibilities, and overarching ayaalx (laws) guide ways of living well together (Greening, 2017). In pre-colonial times, Gitga’at people occupied numerous village sites throughout their territory (Figure 1) and travelled among them on a seasonal basis. Today there are approximately 600 members of the Gitga’at First Nation, with approximately 120 people living in the home community of Hartley Bay (Txałgiu), a few hundred in Prince Rupert (Kxeen) and the rest dispersed throughout British Columbia and North America.

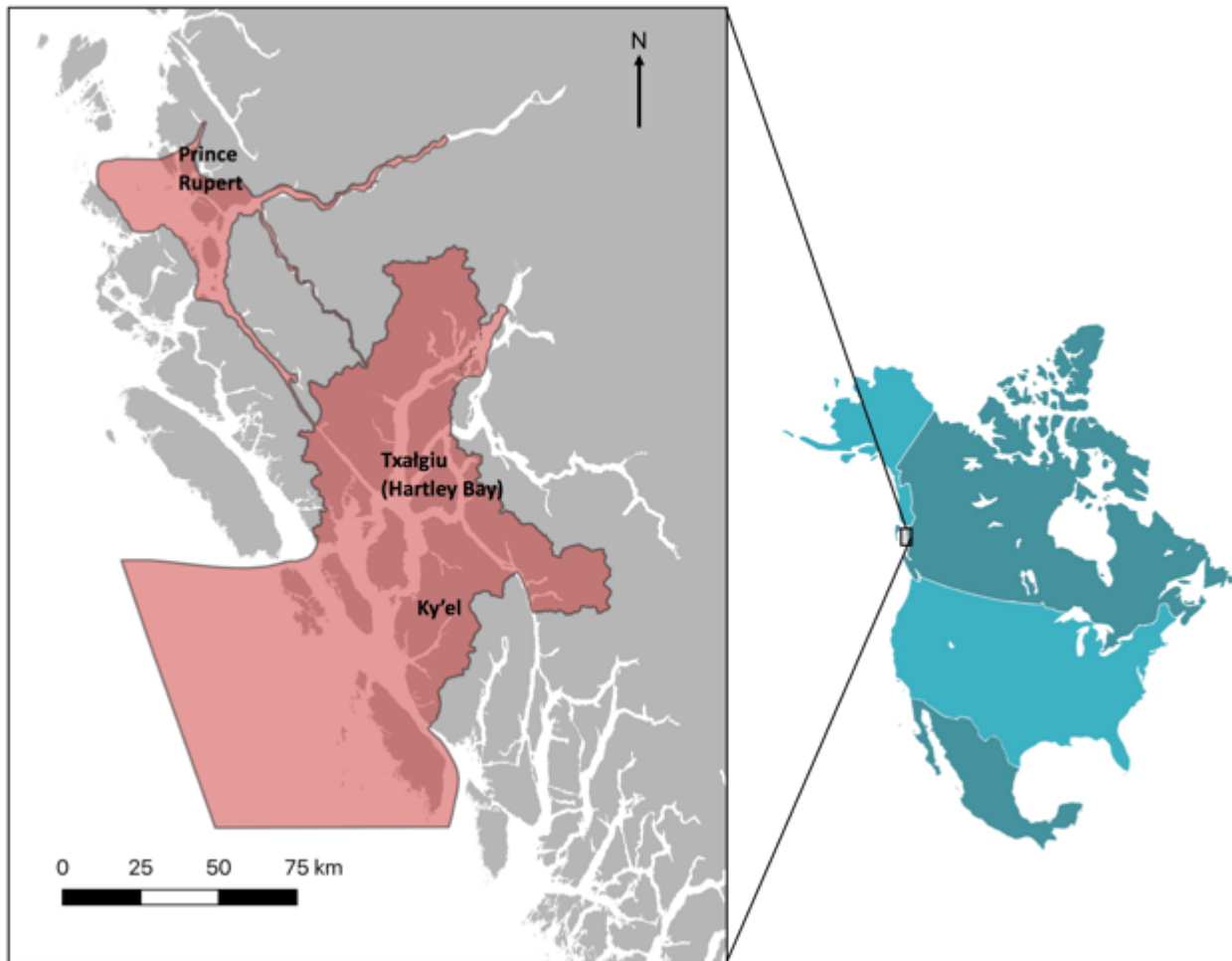


Figure 1. Gitga'at Traditional territory and harvesting areas. The villages of Hartley Bay and Ky'el and the city of Prince Rupert are also shown.

Gitga'at culture, economy and society remain intricately tied to their lands, and particularly their waters (Figure 1). The harvest of marine species follows seasonal rounds, whereby bivalves such as ts'a'ax (butter clam), gaboox (Nuttal's cockle), and gyels (blue mussels) are harvested after the first frost; 'wäh (oolichan), ła'ask (seaweed) and txaw (halibut) are harvested in the spring; and all 4 species of hoon (salmon) are harvested in the summer and fall months. This list is not comprehensive, as there are several other coastal and terrestrial species that are harvested by Gitga'at people (Gitga'at First Nation, 2011). Recent household surveys have indicated that a large portion of Gitga'at people living in Hartley Bay and Prince Rupert consume traditional sea foods on a daily basis, indicating a strong continued relationship between the people and their territory (Fediuk & Reid, 2014).

Sm'ooiyits continue to maintain authority about the stewardship of Gitga'at territory. In contemporary times, their interests are administered and implemented through the Gitga'at Oceans and Lands Department (GOLD). Gitga'at has its own set of ecosystem-based management principles which include respect for Gitga'at ancestral title and aboriginal rights, as well as for the rights and needs of others, ecological integrity and natural biodiversity. They emphasize the need to draw on the best available cultural, local and traditional, science and technical information to guide decision making, and the need to continue to recognize the balance and interconnections between people, other species and the environment, as well as need to manage the marine environment so that future generations can benefit from its abundance (Gitga'at First Nation, 2011). The Gitga'at Guardian program is the implementation arm of the GOLD, and actively asserts Gitga'at presence and stewardship authority on the water by engaging in inventory and research projects about priority resources in Gitga'at territory. This includes routine assessments of Dungeness crab stocks, analysis of contaminant levels in bivalves, abalone surveys, and salmon stream walks (Thompson & Picard, 2015)

The Governments of Canada and British Columbia have recently endeavoured to work collaboratively with Gitga'at stewardship initiatives. The Canadian Department of Fisheries and Oceans (DFO) has expressed its desire to incorporate Indigenous knowledge into its resource management and decision-making processes (eg. Fisheries and Oceans Canada, 2016). Gitga'at First Nation also figures among 17 First Nations who, in collaboration with the government of British Columbia, committed to the implementation a marine use plan developed through the Marine Planning Partnership process. The plan for the North Coast sub-region, which includes Gitga'at territory, was developed using an ecosystem-based approach and is informed by First Nations' strategic marine use plans and endeavours to include Indigenous knowledge (North Coast-Skeena First Nations Stewardship Society & Province of British-Columbia, 2015).

Research objective and questions, and thesis structure

The idea of a repository for Gitga'at land and sea users' observations of environmental change emerged during community climate change adaptation planning in 2012 (Reid et al., 2014; Turner et al., 2013). This proposition, alongside Gitga'at First Nation's continued interest in drawing on local observations and traditional knowledge to guide stewardship, led to the initiation of my current research project. The primary objective of this thesis is to design an ongoing community-owned monitoring system based the knowledge and observations of Gitga'at land and sea users. Given the importance of the marine environment to Gitga'at livelihoods, it focuses on marine resources.

Through this thesis I seek to answer the following questions:

1. How has Indigenous knowledge been involved in community-based monitoring programs, and what are the characteristics of self-sustaining programs?;
2. What methods of documenting Gitga'at observations of change are best suited to community objectives? and;
3. How does ongoing use and occupancy of Gitga'at territory inform community-based monitoring?

This thesis deals with many aspects of Indigenous knowledge and people in relation to monitoring. Thus, Chapters 2, 3 and 4 have been written as stand-alone manuscripts for publication within peer-reviewed journals.

Chapter 1 introduces the themes and topics related to this thesis. I then outline my research objectives, and position myself vis-à-vis the research and the methodology I've used.

Chapter 2 is a review of the literature that expands on the themes of Indigenous knowledge and community-based environmental monitoring. I analyze the various ways in which Indigenous peoples and knowledge have been engaged in environmental monitoring initiatives, highlight the challenges of such endeavours and characteristics of successful monitoring programs based in Indigenous knowledge.

Chapter 3 documents the process by which we initiated, designed and tested methods for documenting harvesters' knowledge and observations of environmental change over the course of two harvest seasons. It also reflects on the potential of the resulting methods - a harvesters' logbook and post-harvest season interview guide - to meet monitoring objectives set by the Gitga'at Nation.

Chapter 4 sketches a Gitga'at-specific social-ecological monitoring framework according to the elements and indicators that participants described during their post-harvest season interviews (spring, n= 23; fall/winter, n= 27) and summarizes their observations of social-ecological changes documented over the course of both harvest seasons.

Chapter 5 brings together the lessons learned in the preceding research chapters, reflects on the limitations of this study, presents its practical applications, and suggests future research avenues.

Methodological approach

As a non-Indigenous researcher doing research in an Indigenous setting, I took an anticolonial participatory case research approach (Reilly, 2010). Participatory case research combines the reflexive and collaborative nature of participatory research (Chilisa, 2012) with the context-specific methods of case study research (Gillham, 2000). Participatory methods, which make the voice of the community and knowledge holders explicit in all research phases by facilitating research *by* and *with* communities (rather than *for* or *about* them) are also necessary in research endeavors that center Indigenous sovereignty and decolonization (Carlson, 2017; Chilisa & Tsheko, 2014; Smith, 2008). Though the methods of each participatory project should be specific to the community's objectives, some common processes in the research design-phase include planning sessions, community-meetings, focus-groups, informal interviews and participation in day-to-day community life (Natcher & Hickey, 2002; Wulforth et al., 2008; Chilisa, 2012). Anticolonial participatory research also calls for "de-centering the University" and prioritizing the objectives and goals of the community (Adams et al., 2014; Coombes et al, 2014; Simpson, 2017). To ensure equitable benefits, representation, and delineation of responsibilities, this

research began with a formalized research protocol agreement between the University of Victoria and the Gitga'at First Nation. Such de-centering of academia can also make room for Indigenous participants and researchers to center their own research paradigm, whereby knowledge is created and shared within relationships between people and other beings (Wilson, 2001). It is crucial that relationships between research partners be given time to build and that the research process itself not only builds on, but builds up and deepens existing relationships. However, the time for creating mutual understandings and learning through shared experiences is rarely accounted for in the structure of Master's thesis project. Though my relationships with Gitga'at harvesters and leaders began prior to my Master's research, I recognized that learning together over the course of this Master's program meant that I should continue to be present and involved in ongoing life in Hartley Bay and Prince Rupert. Thus, once I completed mandatory coursework in residence at the University of Victoria, I moved back to Tsimshian territory for the remainder of my program.

Following the initiation of this research, I conducted a review of the literature pertaining to Indigenous knowledge in community-based monitoring projects to answer my first research question. Literature review methods are detailed within Chapter 2. To answer my second research question I facilitated participatory activities to collaboratively design, test, and iteratively revise methods for documenting Gitga'at harvesters' observations and knowledge of change in their territory over the course of two traditional harvest seasons. As a researcher who was not raised in Tsimshian society, my cross-cultural capacities are limited. Thus, a key facet of this research and building lasting capacity within the community has been the involvement of Gitga'at co-researchers in tool design, data collection, analysis and reporting. To answer my third research question, I used a conceptual framework approach (Jabareen, 2009) to analyze interviews conducted while testing data collection methods outlined in Chapter 3.

My relationship to this research

As a human endeavour, research carries the biases, motivations and personal history of the researcher. I want to be transparent about my personal relationship to this research project, especially given its explicit setting at the intersection of Indigenous and settler societies. My

mother's family gained Canadian citizenship after arriving as refugees of the Vietnam war in the late 1960s. My father's family arrived from Scotland and Ireland and settled in various parts of northeastern North America in the late 1800s. I was born and raised in Kitchener, Ontario, on the shores of the Grand-River, within the Haldimand Tract belonging to the Haudenosaunee of the Six-Nations of the Grand River. I then lived in Tiotia:ke (Montreal, Quebec) while pursuing a Bachelor of Science in Biology at McGill University. In these formative settings, I was an unwitting beneficiary and participant of settler-colonialism. My awareness of my position was sparked by two summers spent in Gitga'at territory participating in an ongoing research project about whale habitat use, and by the teachings and guidance of Dr. Allan Downey.

Since completing my B.Sc. I have lived primarily in Hartley Bay, while working for the Gitga'at Oceans and Lands Department to analyze and report on biological data collected by the Gitga'at Guardian Watchmen program. By working with the Guardians and spending time with friends and Elders, I learned about Gitga'at expertise and knowledge, and that the scientific method is but one way of understanding the natural world. This thesis has been a conduit for continued personal and academic decolonization. As a University-affiliated researcher and someone who has been a beneficiary of a colonial system, this has been an ongoing learning and un-learning process.

In the months during which I was drafting this thesis, I was adopted into the Ganhanda clan, in the house of Wii Hai Waas. The feast name I carry is K'ap Kuul Wiisagm Gyem Gyematk, which means "once occurring big moon." As an individual without Tsimshian ancestry and not raised in Tsimshian society, I am actively learning about my place and responsibilities as an adopted member. A fellow Ganhadada friend has advised me to approach my adoption as a dual-citizenship and to live according to Tsimshian laws and protocol especially when in Tsimshian territory, which is where I primarily reside. It is from within the processes of learning how to be a citizen of Tsimshian society that I have tried to write this thesis. Though I have sought advice throughout this project, I am aware that I still have much learning and unlearning to do.

Chapter 2: Indigenous knowledge and environmental monitoring

Introduction

Environmental monitoring – the routine collection and analysis of information to enable early detection of unexpected changes – is essential for adaptive management to ensure the long term sustainability of ecosystems and human communities (Alessa et al. 2016, Pecl et al. 2017).

Increasing recognition of the complex interdependence between ecosystems and human society has also highlighted the critical role of social change in building resilience in the face of ecological changes (Ostrom, 2009). Monitoring is essential for understanding these interactions, and how change affects them and the resilience of systems. In the social-ecological systems (SES) literature, resilience has been described as the capacity of a system to change in the face of perturbation in order to maintain its core identity (Folke et al. 2010). Monitoring systems can include aspects of ecological (e.g., Ostrom’s “resource unit”), social (e.g., “resource users”), and linked social-ecological (“interactions”) indicators.

Community-based monitoring (CBM) is recognized as a useful component of successful natural resource management and biodiversity conservation, because local communities – and particularly Indigenous peoples – have knowledge and lived experiences within the ecosystems in which they are embedded. CBM involves “monitoring of natural systems by local stakeholders, using their resources and in relation to aims and objectives that make sense to them” (Danielsen et al. 2014a), and often involves partnerships with external groups (e.g., government agencies and researchers). Local involvement in monitoring can help to enhance compliance and agreement with management measures (Danielsen et al. 2009).

The global scientific community and government natural resource agencies have shown increased interest in including Indigenous knowledge in conservation and resource management endeavors, including environmental monitoring (Fisheries and Oceans Canada, 2016; United Nations Conference on Environment and Development 1992). Indeed, some agencies mandate the use of Indigenous knowledge (e.g., Nunavut Wildlife Management Board, n.d., Priest and Usher 2004). However, the project of “integrating” Indigenous and scientific knowledges has

been critiqued due non-Indigenous agencies' tendency to dissociate empirical Indigenous knowledge from its political, social, and cultural settings (Bohensky & Maru, 2011; Nadasdy, 1999).

Indigenous knowledge has been described as adaptive place-based knowledge and experience that evolves through time, is transmitted orally across multiple generations, and is situated within overarching belief systems about the relationship between living beings, including humans (Berkes, 2012). There are as many Indigenous knowledge systems as there are Indigenous groups, each with their own cultural practices, spiritual beliefs and imbedded in ancestral territories. The embeddedness of place-based experiences within traditional belief systems that span multiple generations is a key difference between Indigenous knowledge and local ecological knowledge that has accrued in other local populations within much shorter time spans (Berkes, 2012). Given that Indigenous knowledge holders receive intergenerational teachings embedded in Indigenous worldviews, while also accumulating lessons through day-to-day lived experiences, they are also holders of both Indigenous and local ecological knowledge.

Given the growing interest – and mandates – in incorporating Indigenous knowledge in CBM initiatives, a review of the state of the scholarly literature on this topic is urgently needed to investigate how the field is growing in size and complexity, and to provide guidance for future monitoring efforts. The objectives of this review were to: 1. Outline the state of the scholarly literature about existing CBM projects that involve Indigenous knowledge; 2. Examine the range of approaches to documenting and using Indigenous knowledge in CBM projects; 3. Investigate common challenges encountered by these projects; 4. Characterize elements of effective initiatives.

Methods

Literature review

We searched Thomson-Reuter's Web of Knowledge using the terms *Indigenous environmental monitoring*, *Indigenous resource monitoring*, then [*“environmental monitoring”* OR *“ecological monitoring”* OR *“biological monitoring”* OR *“resource monitoring”*] AND [*“Indigenous*

Knowledge” OR “*Traditional Ecological Knowledge*” OR “*Aboriginal Knowledge*”]. Given that our search terms were in English, only English language publications were identified. Our search included all years up to the final search date of May 27th, 2018. We tested whether our search terms captured literature about specific Indigenous groups by adding the names of most commonly mentioned groups (i.e., “*Inuit*”, “*Maori*”, “*Aboriginal*”, “*Sami*”) to our search and checking whether and how many papers were missed with our general search terms. We found that only three papers were missed with our generic search terms. Given the many Indigenous groups that exist globally, it was not possible to include all groups individually.

We screened articles based on whether their abstracts referred to CBM involving Indigenous knowledge or Indigenous peoples. Although important in their own right, publications reporting on CBM programs that include local but not Indigenous knowledge or communities were not included in this study. In order to keep the review tractable, we sampled relevant grey literature when referred to within the academic literature (i.e. using citation tracing from literature cited in relevant articles).

Analysis

We analyzed the literature using a combination of a grounded theory approach (Pittman and Armitage 2016) and by following pre-determined questions that aligned with the objectives of the review (Table 1). We used grounded theory to identify and group the monitoring objectives and methods. We grouped indicators based on whether they monitored ecological units, social processes, or the interactions between ecological units and social processes (linked social-ecological indicators). In order to elucidate approaches to Indigenous involvement in environmental monitoring, we combined and adapted Danielsen et al.’s (2009) and Wilson et al.’s (2018) categories of CBM to create four types of ways Indigenous peoples and their knowledge can be involved within CBM projects: Type 1. Autonomous Indigenous processes, such as harvesting, travelling and spiritual practices, as monitoring; Type 2. Indigenous values guiding scientific monitoring; Type 3. Indigenous knowledge filling gaps of scientific monitoring; and Type 4. Indigenous people employed as external monitoring technicians by external groups used (Table 2). We then calculated the percentage of publications within each

category. Challenges and characteristics of successful initiatives were identified by a careful review of the literature and qualitatively synthesized to reflect main themes discussed.

Table 1. Objectives and associated research questions

Objective	Research question(s)
Provide an overview of state of the current literature on existing CBM projects that draw on Indigenous knowledge	<ul style="list-style-type: none"> - How has the number of relevant publications changed over time? - Where do relevant programs occur? - Which Indigenous peoples have been involved in these projects?
Examine how Indigenous Knowledge has been involved in CBM programs	<ul style="list-style-type: none"> - What are the objectives of CBM programs that use Indigenous knowledge? - What methods are to used document and communicate Indigenous knowledge (IK)? - What indicators are monitored? - To what extent are IK and scientific methods combined? - To what degree are Indigenous people involved in the design and implementation of these monitoring programs?
Investigate challenges encountered	<ul style="list-style-type: none"> - What are common challenges encountered by these programs?
Characterize elements of successful initiatives	<ul style="list-style-type: none"> - What are characteristics of monitoring programs that overcome challenges? - What lessons are provided by existing projects?

Table 2. Typology of involvement of Indigenous knowledge in community-based monitoring (adapted from Danielsen et al., 2009 and Wilson et al., 2018)

Categories of Indigenous knowledge in Monitoring	Initiation and Design by:	Data collection by:	Data interpretation by:	Authority over management decisions:	Number of publications reviewed:
Type 1: Autonomous Indigenous processes as monitoring	Indigenous group	Indigenous group	Indigenous group, or in collaboration with external group	Indigenous group, or monitoring activities seek to regain Indigenous authority	18
Type 2: Indigenous knowledge guides scientific monitoring	Indigenous group often in partnership with external group	Indigenous peoples often in partnership with external group	Indigenous group or in collaboration with external group	Indigenous group, or monitoring activities explicitly to regain Indigenous authority	24
Type 3: Indigenous knowledge fills in gaps in scientific data	External group, often with Indigenous consultation	Indigenous peoples, or in partnership with external group	Led by external group, often with Indigenous consultation	External group	19
Type 4: Externally driven initiative employs Indigenous technicians	External group, sometimes with Indigenous consultation	Indigenous group	External group, sometimes with Indigenous collaboration	External group	6

Results and Discussion

Overview of the literature

The literature search yielded 67 relevant publications (Supplementary Materials); 56 were peer-reviewed articles published in academic journals, 11 were grey literature published as reports (e.g. The Joint Secretariat 2003) or book chapters (e.g. Krupnik and Jolly 2002). Published works that discussed CBM including Indigenous knowledge have become more frequent since the late 1990s, with a peak in 2008 (Fig. 1).

Environmental monitoring projects that involve Indigenous knowledge occurred on all continents except Antarctica. Nearly half of relevant articles (n=29) described CBM projects in Arctic regions, including jurisdictions in Canada, Alaska, Scandinavian countries, and Russia. Another seventeen publications reported Indigenous knowledge in CBM activities in Oceania, fifteen in the South and Central America, six in African countries, and six in Asian countries. According to the literature reviewed, a total of at least 87 unique Indigenous groups have contributed their knowledge to CBM (Fig. 2, Supplementary Materials, Table 1). This is certainly an underestimate of the diversity of peoples who have been involved in CBM, as some publications use umbrella terms such as Aboriginal Australians, First Nations, and Maori that encompass several individual groups of peoples that self-identify with distinct names and cultural practices.

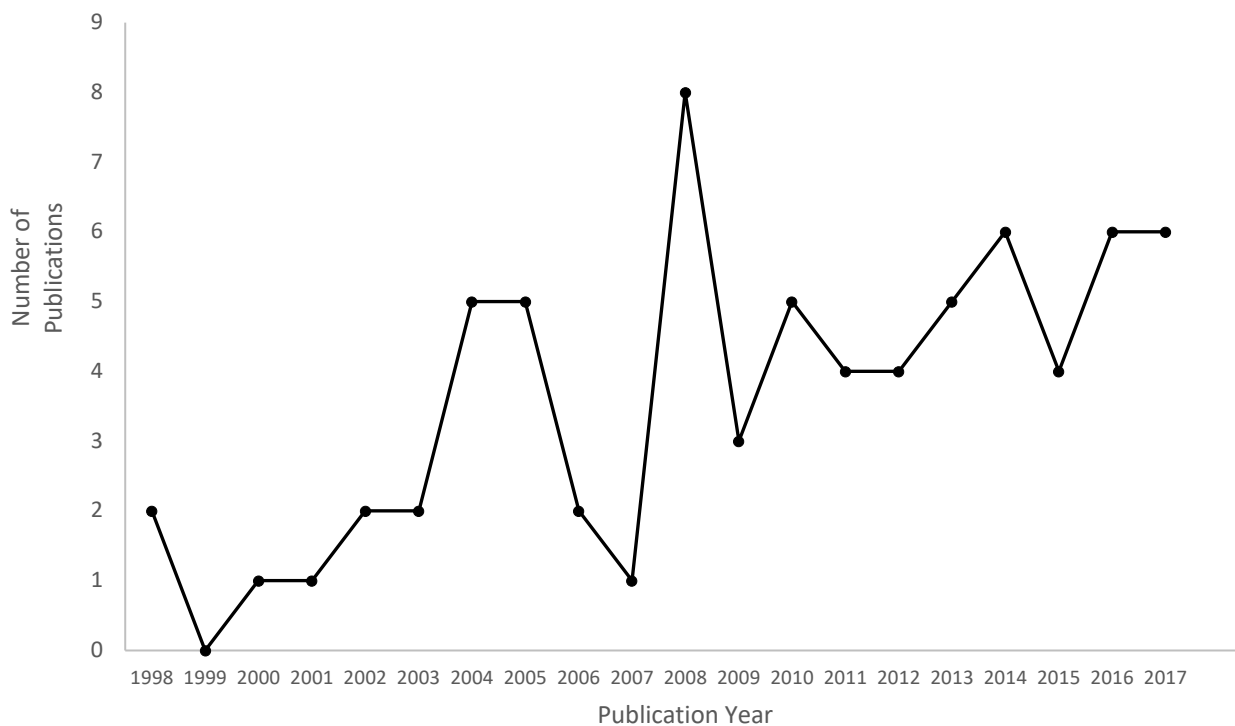


Figure 1. Number of publications related to CBM projects that involved Indigenous knowledge through time.



Figure 2. Map illustrating the geographic distribution of publications on community-based monitoring initiatives that involve Indigenous peoples and their knowledge

Approaches to involving Indigenous knowledge and peoples in CBM

All four categories of involvement of Indigenous peoples and their knowledge within CBM projects existed in the literature reviewed. 27% (n=18) of studies described autonomous Indigenous monitoring whereby land-based processes including, but not limited to, hunting, travelling, spiritual practices, and oral histories informed a holistic range of indicators. For example, through the gathering of traditional foods and time spent on the land, Kwakwa'kwakw and Maori knowledge holders gather holistic indicators from the surrounding environmental and social context to inform their own conservation and management strategies (Heaslip 2008, Lyver et al. 2008). In this type of monitoring, Indigenous peoples have been initiating, designing, collecting data and producing knowledge, and making adaptive management decision over the course of many generations. This type of monitoring originates from the cultural practices of Indigenous groups and is the foundation of how they have managed, governed, and adapted to changes ancestral lands for hundreds to thousands of years. Some publications noted the

potential of autonomous Indigenous monitoring to complement scientific monitoring methods (e.g. Moller et al. 2004).

The most common form of Indigenous involvement in monitoring described in the literature (36%, n=24) was Indigenous values guiding the use of scientific methods for monitoring purposes. For example, the Nyul Nyul people of northern Australia initiated the design of a monitoring program to inform management about the impacts of flooding, pollution, feral animals and groundwater development on culturally important wetlands. Monitoring schemes such as these were often the outcome of Indigenous community leadership in the conception and design phases of the monitoring project (e.g. Bell and Harwood 2012), and often involve cross-cultural partnerships with external researchers and scientists (e.g. Shaffer et al. 2014). Through this type of monitoring, Indigenous peoples are leveraging science and technology to maintain rights and responsibilities to care for their ancestral lands (e.g. Kennett et al. 2010).

The third category, reported in 22% of studies (n=19), involved leveraging Indigenous knowledge to fill gaps in scientific data. For example, Yanyuwa knowledge holders were interviewed about the spatial distribution and numbers of marine mammals in remote areas in Australia to inform a monitoring and conservation plan (Grech et al. 2014). In many cases, this type of monitoring was initiated by external groups, including governments and researchers, who formed partnerships with Indigenous communities (e.g. Constantino et al. 2012). Though data were often shared with partnering communities, this type of monitoring usually informed management decisions made by non-Indigenous governments (Fernandez-Gimenez et al. 2006).

Finally, some monitoring projects (9%, n=6) employed local Indigenous peoples to carry out standardized scientific measurements for externally-driven monitoring projects. For example, Makushi community technicians were trained and hired within the initiative to reduce emissions from deforestation and degradation (REDD+) in Guyana to conduct forest biomass assessments and land use mapping (Bellfield et al. 2015). This type of monitoring does not incorporate Indigenous knowledge directly and Indigenous peoples rarely had much power in determining monitoring objectives or methods.

Linking Indigenous involvement to monitoring objectives, indicators and methods

Monitoring objectives

We found 83 different objectives explicitly stated in the literature reviewed, with most projects having multiple objectives. We grouped objectives in the literature into 15 broad categories (Fig. 3). The most frequently named objectives of the monitoring projects were wildlife conservation (n=24, mentioned in 39% of publications), tracking environmental change (n=20, 33%), informing natural resource management (n=20, 33%), communicating Indigenous knowledge to non-Indigenous groups (n=13, 21%), and access to resources (n=13, 21%). Asserting Indigenous governance, climate change adaptation, community well-being, capacity building, sustainable development and capacity building were listed as objectives in 5-10% of publications. Revitalization of traditional knowledge, research, and carbon sequestration were named in less than 2% of publications.

Conservation, tracking environmental change, resource management or access to resources were listed as objectives in at least one publication in each Type of monitoring initiative (Fig. 3), with conservation listed in over 30% of initiatives that fell in the Type 2 category. Carbon sequestration was only included as an objective of Type 4 initiatives. Revitalization of traditional management practices was only an objective of Type 1 initiatives, and research was only included as an objective in Type 2 initiatives. For example, a key goal of Maori tribes' and families' monitoring of water was to revitalize Mataranga Maori (Maori knowledge) of cultural resources (Harmsworth et al. 2011)

Notably, asserting Indigenous governance, community well-being and/or monitoring impacts of industry were only included as objectives in Type 1 and 2 initiatives. This can be linked to the strong involvement of Indigenous peoples in their initiation, design and execution. Adapting to climate change and/or technical capacity building were listed as objectives only in Type 2 and Type 3 initiatives, both of which involve partnerships between Indigenous and non-Indigenous researchers.

Monitoring methods using Indigenous knowledge

Many methods for documenting and communicating Indigenous knowledge for monitoring purposes were described within the literature. We categorized the methods into 11 groups (Fig. 3). Several programs used multiple methods. The most commonly reported method was semi-structured interviews (n=32, used in 57% publications) (e.g., Krupnik and Jolly 2002, Tremblay et al. 2008). This method was especially prevalent in Type 1 and Type 2 initiatives (Fig. 3).

The second most commonly reported method was spending culturally-directed time on the land (n=14, 25%). Activities such as hunting, travelling or patrolling allow those involved to assess a variety of indicators. Numerous Type 1 initiatives explicitly reported these activities as methods of monitoring, while fewer Type 2 and Type 3 initiatives reported time on the land as a method of monitoring. No Type 4 initiatives included this method as part of their monitoring scheme (Fig. 3).

Participatory mapping and focus groups/workshops were reported in 20% (n=11) and 21% (n=12) of reviewed publications, respectively. Focus groups and workshops were found in Type 2 initiatives and Type 1 initiatives only. Participatory mapping was used by Type 1, Type 2 and Type 3 initiatives. Scientific surveys were also commonly reported (n=11, 20%). Some publications reported joint surveys (e.g. Roba and Oba 2009a), or were conducted by Indigenous peoples trained as technicians by external agencies (e.g. Torres et al. 2014). Scientific surveys were included in the methods of Type 2, 3 and 4 initiatives, though they were most prevalent in Type 4 initiatives (Fig. 3). Digital self-reporting methods such as logging observations or hunting success in field computers (e.g. Gearheard et al. 2011, Kennett et al. 2010) and mapping land use change using drones (Paneque-Galvez et al. 2017) were reported in 13% of publications. Paper-based self-recording such as harvest logs or diaries were reported in 11% of publications.

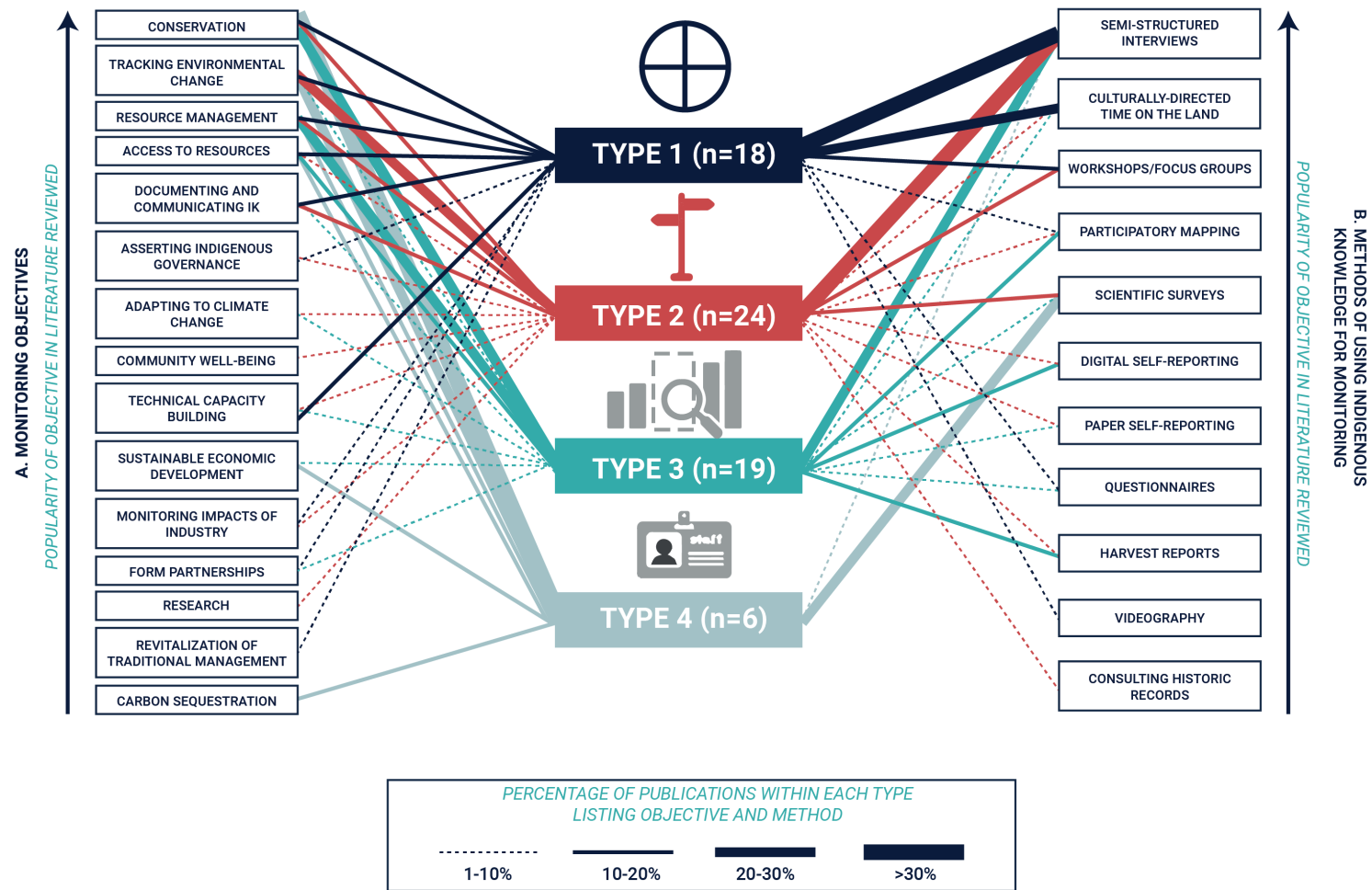


Figure 3. Associations between types of involvement of Indigenous knowledge in published CBM projects, monitoring objectives, and methods of Indigenous knowledge documentation. Arrow width represents the percentage of publications that explicitly associated with a specific objective or method. The types are: Type 1. Indigenous processes as monitoring; Type 2. Indigenous values guiding scientific monitoring; Type 3. Indigenous knowledge filling gaps of scientific monitoring; and Type 4. Indigenous people employed as external monitoring technicians by external groups.

Monitoring indicators

We considered the prevalence of ecological, social and linked social-ecological indicators in each type of monitoring initiative. Ecological indicators, such as abundance of focal species, water quality, and weather patterns, were mentioned in 75-100% of papers regardless of initiative Type. 80% (n=4) of Level 4 initiatives monitored ecological indicators only, while the majority of Type 1, 2 and 3 initiatives considered them alongside social and/or linked social-ecological indicators (Fig. 4). Indicators that provided insight into the linked nature of social and ecological well-being, such as levels of harvesting activities and resource use, were also considered in initiatives within each category, but were much more frequent in Level 1 initiatives (83%, n=15) of publications (Fig. 4). The majority (58%, n=11) of Level 3 initiatives also included linked social-ecological indicators, and these were most often monitored alongside purely ecological indicators (Fig. 4). Social indicators, such as spirituality and prevalence of knowledge sharing within a community (e.g. Lyver et al. 2017, Parlee et al. 2005), only appeared in Level 1 and 2 initiatives. Social indicators were always listed alongside ecological and/or linked social-ecological indicators (Fig. 4).

Monitoring systems that involved Indigenous peoples and their knowledge in their initiation, design and decision-making outcomes (Types 1 and 2) tended to include a robust set of social, ecological, and linked social-ecological indicators (Fig. 4).

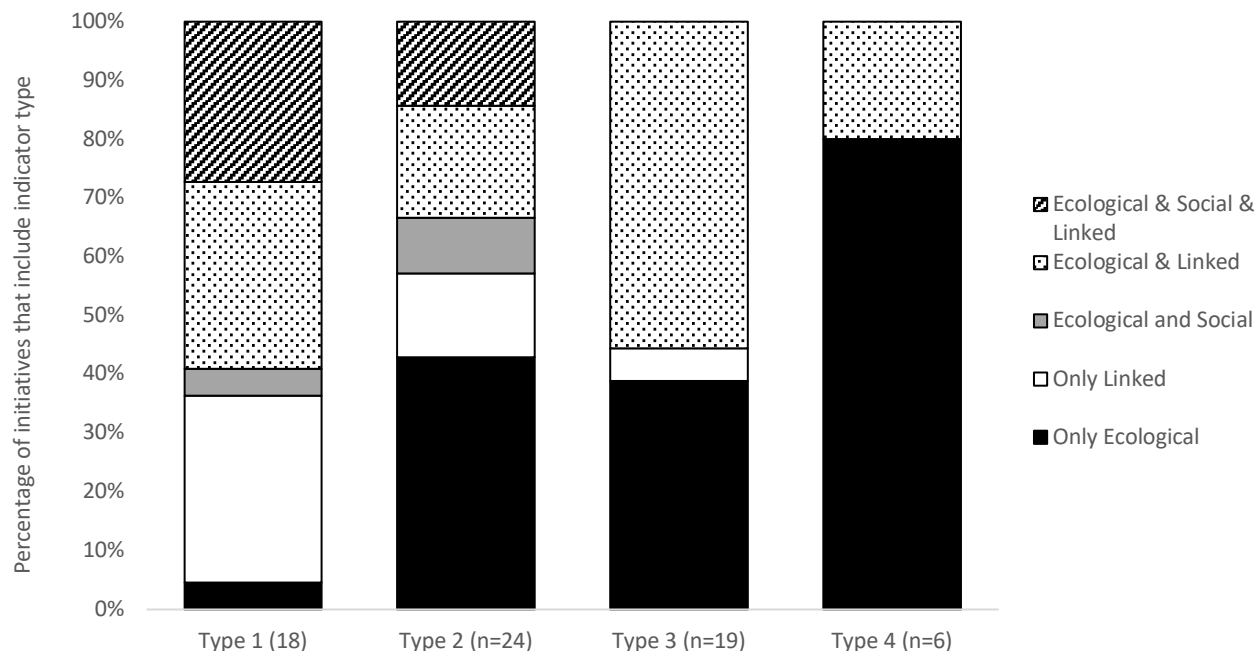


Figure 4. Prevalence of indicator categories listed in publications sorted by types of monitoring initiatives involving Indigenous peoples and their knowledge. The types are: Type 1. Indigenous processes as monitoring; Type 2. Indigenous values guiding scientific monitoring; Type 3. Indigenous knowledge filling gaps of scientific monitoring; and Type 4. Indigenous people employed as external monitoring technicians by external groups.

Common Challenges

We found that common issues can be categorized as financial, logistical, challenges in building and maintaining partnerships and engaging community members, and challenges communicating Indigenous knowledge to non-Indigenous stakeholders. An additional challenge specific to Indigenous involvement in monitoring was the threat of physical violence that some monitors may experience while conducting surveys and patrols, particularly when monitoring impacts of industry or illegal resource extraction activities (Paneque-Galvez et al. 2017, Turreira-García et al. 2018).

Financial challenges

As with CBM initiatives at large, one of the most commonly reported challenges faced by CBM projects reviewed here was the paucity of long-term funding (e.g. Aswani and Weiant 2004, Bell and Harwood 2012). Without secure sources of funding, many projects were unable to train

individuals in monitoring techniques and data management protocols, hire local technicians, continue systematic surveys, or repair gear and technology required for monitoring.

Logistical challenges

The literature we reviewed highlighted logistical challenges in CBM initiatives that include Indigenous knowledge as pertaining to travel and time constraints, use and maintenance of digital monitoring technology, and data accuracy and management. For example, given that Indigenous monitoring indicators were often collected using qualitative methods such as semi-structured interviews, some researchers worried that the motives of interviewees could bias responses (Parry and Peres, 2015), or that shyness, lack of confidence, or lack of trust in the interviewer could lead community members to claim ignorance or inability to provide information (Sheil et al. 2015). Group interviews may also lead some community members to not provide information because of different opinions and views within the same community (Lauer and Aswani, 2010). Further, concerns about sampling biases were raised in projects using hunter reporting to monitor wildlife in the Arctic, where answering questions about populations of young marine mammals was more difficult since hunters typically target older individuals (Bell and Harwood, 2012).

Building and maintaining partnerships and community engagement

Overcoming the challenge of building and maintaining trust between potential monitoring partners was particularly important. Given historical and ongoing colonial wrongdoings enacted through research and government, some communities and/or individuals were hesitant to provide information, or decided to not participate at all (Danielsen et al. 2005, Wiseman and Bardsley 2016). Indigenous peoples can also be critical of technology when its role becomes dominant in monitoring initiatives (Johnson et al. 2015), and some hunters felt ignored when technological or statistical logistics discouraged external researchers from following their advice (Fernandez-Gimenez, et al. 2006).

Another commonly mentioned challenge was matching the goals of Indigenous peoples and external agencies, especially when both groups have pre-established priorities (Runk, 2014).

While external agencies typically placed high value on biodiversity conservation, Indigenous peoples were often more interested in community well-being, which can include economic benefits and the continuation of traditional practices (Garcia and Lescuyer 2008, Sheil et al. 2015). A mismatch in goals can lead to differences in which environmental indicators were considered important to monitor. For example, (Riseth et al. 2011) reported that Sami herders closely monitored specific weather conditions such as the first durable snow falls, since it directly impacts their caribous' ability to graze in the winter, while these weather conditions were often overlooked by climate change research scientists. However, rather than being divisive, these mismatches in priorities can present opportunities for two-way learning and the development of holistic monitoring partnerships (e.g. Polfus et al. 2016, Shaffer 2014)

Finally, we found that building and maintaining internal and external capacity for holistic monitoring was also a common challenge. Increasingly cash-based economies, the industrial commercialization of the natural world, and colonial assimilation policies have posed barriers to Indigenous people who wish to raise younger generations with the skills and knowledge necessary to read and interpret their changing environments (Sheil et al. 2015), leading also to a shift the collective understanding of ecological baselines (Ziembicki et al. 2013). Non-Indigenous scientists and policy makers must also grow their capacity to appreciate and understand interdisciplinary methods, including Indigenous methods of monitoring and management (Johnson et al. 2015, Roba and Oba 2009b).

Externally communicating Indigenous knowledge

Appropriately communicating Indigenous knowledge to non-Indigenous partners was highlighted in the literature as a critical challenge. Challenges included translating Indigenous taxonomic classifications, or nuanced technical terms of ecosystems components, into terms that were understood by scientists and/or decision makers who were not local (Nichols et al. 2004, Ziembicki et al. 2013). Single mediums such as tabular databases, written reports or maps often fell short of representing the complex relationships and belief systems that underpin many Indigenous knowledge systems (Bonny and Berkes 2008, Fidel et al. 2012, Pulsifer et al. 2012, Dobbs 2016). Fernandez-Gimenez et al. (2006) warns that isolating Indigenous knowledge from its social and cultural contexts and interpreting it through only a scientific lens constitutes yet

another form of colonial exploitation and extraction. Finally, some elements of Indigenous knowledge that may be desirable for environmental monitoring may be culturally sensitive and not appropriate to share at all (Ziembicki et al. 2013).

Beyond publishing findings in the academic and grey literature, a range of methods of externally communicating Indigenous knowledge involved in CBM were evidenced within the literature reviewed. Many programs used a combination of methods in order to communicate results to community members and external stakeholders (e.g. Krupnik and Jolly, 2002). The most popular method of relaying monitoring results to the communities involved were community meetings (e.g. Dobbs et al. 2016), followed by data summary reports (e.g. Priest and Usher, 2004). Maps were also commonly used to represent spatial data collected through monitoring (Velazquez et al. 2001). The results of some CBM projects were relayed to external stakeholders and government agencies through conferences (Tremblay et al. 2008). Websites including spatial, audio and video data were also employed in many projects in order to engage a range of audiences, including younger generations within Indigenous communities, government agencies, and the public at large (Gill et al. 2014, Krupnik and Jolly 2002).

The literature we reviewed also described barriers to non-Indigenous agencies considering Indigenous knowledge in environmental decision-making. Despite a growing recognition that Indigenous peoples and their knowledge provide an enriched understanding of the natural world, in some cases the bias against monitoring done by local “non-experts” was amplified by the perspective that the validity of Indigenous methodologies are lesser than scientific techniques (Johnson et al. 2015, Pulsifer et al. 2012, Wiseman and Bardsley 2016). Further, there is often a disconnect between the information coming from community monitoring and the information needs of centralized decision makers (Knopp et al. 2013). Remote communities involved and/or interested in monitoring often also lack the power to influence centralized decision makers (Sheil et al. 2015). Without the results of monitoring visibly influencing management decisions, communities tended to lose the motivation to create or share irreplaceable monitoring information (Garcia and Lescuyer 2008).

Characteristics of successful Indigenous knowledge-based CBM projects

Success is subjective to the goals of each individual project. Thus, here we define success broadly as having overcome some of the challenges described above, namely: communicating Indigenous knowledge to inform management decisions, engaging and maintaining community participation, project longevity, and community empowerment. According to the literature reviewed, successful CBM projects involving Indigenous knowledge have the following characteristics: High level of community involvement throughout all phases of monitoring; Partnerships with external agencies based on mutual trust and respect for multiple knowledge systems; Use of multiple methods to document and communicate Indigenous knowledge; and Indigenous rights to manage local resources.

High level of community involvement

Many successful and long-lived programs avoided imposing objectives and indicators that appeared irrelevant to local populations by seeking high degrees of participation and direction from Indigenous partners at all phases of the monitoring program: from design, to data collection, to interpretation of results, and communication. At the design phase, this was reported to help align the monitoring program with relevant local priorities (Wiseman and Bardsley, 2016). During data collection and analysis phases, community engagement and reflexive evaluation allowed building internal capacity necessary for long term monitoring, as well as for adaptive changes to be made to monitoring methods (e.g. Aswani and Weiant 2004, Constantino et al. 2012, Setty et al. 2008). Frequent reporting of results to community members also allowed for transparency and empowerment (Constantino et al. 2008), especially when done by community monitors themselves. At the interpretation phase, it allowed for a more holistic interpretation of results (Roba and Oba, 2009b), and empowered local people to take part in decision making. Facilitating the space for Indigenous peoples to then communicate their own knowledge and monitoring results reduced the chances of misinterpretation and misappropriation, and can bolster local concerns being heard on broader political stages (Bonny and Berkes 2008, Krupnik and Jolly 2002).

Initiatives that retained long-term community participation involved monitoring activities that did not disrupt pre-existing day-to-day activities of local people. In the case of the Igliniit project, which had been running for five years at the time of writing, this was done by enabling harvesters to document their observations while out on the land (Gearheard et al. 2011). Another example is the Arctic Borderlands Ecological Knowledge Co-op, which started in 1996, where harvester interviews conducted after harvesting activities were finished allowed for data collection to include minimal disruption to day-to-day activities (Eamer, 2006).

Mutual trust and respect in monitoring partnerships

Monitoring projects often involved partnerships between Indigenous peoples and external researchers and/or governments. The literature reviewed demonstrated that partnerships built on mutual trust and respect for multiple knowledge systems can be fostered through early and ongoing dialogue, and early delineation of the roles, responsibilities, intellectual property rights and data sharing agreements (Alessa et al. 2016, Bell and Harwood 2012, Grech et al. 2014, Johnson et al. n.d.). Taking the time necessary to build these relationships also allowed for the development of monitoring methods that are culturally appropriate (Bell and Harwood, 2012), and to challenge power inequalities (Grech et al. 2014).

Two-way learning through these partnerships was also key to the success of the programs reviewed. Not only did Indigenous peoples build internal technical capacity with enduring training and support from external researchers (Brook et al. 2009, Grech et al. 2014), but forming respectful partnerships and working relationships also encouraged non-Indigenous partners to develop a better appreciation of the methods, processes, and cultural underpinning of Indigenous knowledge systems (Dobbs et al. 2016, Grech et al. 2014, Harmsworth et al. 2011, Roba and Oba 2009a). Earnest two-way learning has the potential to soften communication and decision making barriers that otherwise impede effective monitoring.

Using multiple methods to document and communicate Indigenous knowledge

Another shared characteristic of successful monitoring programs was the use of multiple methods to collect and communicate Indigenous knowledge for monitoring purposes. For

example, combining interviews with field surveys (Lyver and Lutsel K'e Dene First Nation, 2005), or field diaries with focus groups (Danielsen et al. 2005), allowed for triangulation of information and internal reliability assessments. Further, using digital technologies and written form enabled rapid outreach and communication across younger generations (Brammer et al. 2016; Gill et al. 2014). Using multiple mediums to communicate the results of monitoring based in Indigenous knowledge also contributed to the success of programs. Audio and video mediums were helpful for communicating the context and nuances of Indigenous knowledge systems to diverse audiences (Gill et al. 2014), and have been complemented by written documents such as reports and books as well as maps (Berkes et al. 2007; Gill et al. 2014). Focus group discussions and poster presentations have also served as an effective way to communicate findings and promote collaborative decision making (Danielsen et al. 2005).

Management rights

Finally, and crucially, monitoring programs that were enriched by Indigenous knowledge systems had a direct involvement in decision making when Indigenous people had rights to manage and steward their ancestral lands. Linking monitoring data to decision-making is key to meeting the potential for monitoring to inform management (Danielsen et al. 2005). Given the complexities of communicating Indigenous knowledge to non-Indigenous decision makers within settler-colonial governments, this is most achievable when Indigenous people themselves manage the resources monitored. Indeed, co-management agreements, or established and respected land tenure, have enabled some effective monitoring initiatives in the Canadian Arctic (Berkes et al. 2007, The Joint Secretariat 2003), Northern Australia (Grech et al. 2014), the Solomon Islands (Aswani and Weiant, 2004), and New Zealand (Harmsworth et al. 2011).

Study limitations

Several limitations were inherent in our study. To make the literature review tractable, we focused on generic search terms, rather than specific Indigenous groups. Including the most common specific Indigenous groups (Inuit, Maori, Aboriginal, and Sami) encountered in our review indicated that we missed only three papers. Thus, while not fully comprehensive, our

literature review captured key papers and themes. We reviewed relevant grey literature that was cited in peer-reviewed articles, therefore likely under-sampling reports. This was a necessary limitation to keep the review tractable. Further, it is likely that many other autonomous CBM programs using Indigenous knowledge exists but have not been written about.

Details pertaining to methods, challenges, and successes were often not included within published work, thus only a portion of the works reviewed here could be used to infer successes and challenges. Future research should strive to report on technical as well as epistemological challenges encountered while designing and implementing CBMs, as these details will enable communities, conservation and resource management practitioners, policy makers and academics to avoid repeating common mistakes. Further, unless Indigenous community members are active participants in the writing and publication process, published materials are more likely to portray the opinions of academic research partners than the Indigenous peoples involved in monitoring. Interviews with researchers and community members involved in the project can help to fill gaps about perceived benefits and room for improvement within monitoring schemes. Nevertheless, this review plays an important role in providing a summary of the current state of Indigenous knowledge-based CBM initiatives.

Recommendations for current and future monitoring initiatives

Based on our review of the literature we offer the following suggestions to parties interested in initiating monitoring projects that engage Indigenous knowledge. We recommend that non-Indigenous researchers and stakeholders receive training to work in cross-cultural settings (i.e. Bartlett 2005, Center for Cultural Competence Australia n.d., Indigenous Perspectives Society, 2017), and more importantly, that they take the time that is necessary to develop relationships with Indigenous partners based in mutual trust and appreciation of multiple knowledge systems. Such formal and informal experiences can also help to avoid objectives mis-match, and to allow for bi-directional learning whereby non-Indigenous experts learn the nuances of traditional indicators and Indigenous knowledge, and local people learn technical monitoring techniques to serve their monitoring objectives. Open and bi-directional learning would also encourage the combined use of cross-disciplinary and cross-cultural monitoring methods, and is more likely to lead to enduring partnerships. Care should be taken to ensure that the Indigenous knowledge that

is contributed to monitoring efforts is communicated with the consent of knowledge holders and centers its connection to Indigenous social and cultural contexts. Given that the cultural contexts of indicators and observations provided through Indigenous monitoring are best understood by knowledge holders themselves, they should ultimately decide how their knowledge be communicated. Partners should be prepared to use a combination of written, audio and visual methods.

We also suggest that new monitoring initiatives should prioritize supporting, learning from, and complementing pre-existing Indigenous monitoring systems rather than replace them. The scope of monitoring indicators tends to be broadened when Indigenous land-based processes and governance guide monitoring schemes (Lyver et al. 2017, Parlee et al. 2005). Monitoring a range of indicators, including ecological units, social processes and linked social-ecological interactions, is most relevant for informing adaptation and resilience in complex systems (Ostrom, 2009; Folke et al. 2010). Indigenous knowledge systems, including monitoring, have been informing resilience and adaptation to changes over millennia (Berkes 2012, Turner and Berkes 2006).

Conclusion

We reviewed the available literature in order to elucidate the ways that Indigenous peoples and their knowledge have been involved in community-based monitoring initiatives, document common challenges encountered by these programs, and identify characteristics of successful initiatives. Our analysis demonstrated that Indigenous knowledge has been involved in environmental monitoring in a number of ways from Indigenous technicians administering scientific monitoring methods to Indigenous processes as monitoring, and that monitoring objectives, methods and indicators vary according to these types of involvement. Common challenges were reported as related to logistical issues; challenges in building and maintaining partnerships and engaging community members; and challenges communicating Indigenous knowledge to non-Indigenous stakeholders in order to inform management decisions. Monitoring programs that were successful at overcoming these challenges had high level of community involvement throughout all phases of monitoring; involved partnerships with external agencies

based on mutual trust and respect for multiple knowledge systems; used multiple methods to document and communicate Indigenous knowledge; and recognized Indigenous rights to manage local resources.

Though many publications emphasized the empowerment of Indigenous peoples through their involvement in community-based monitoring, relatively few critically discussed themes such as the impacts of colonialism on Indigenous knowledge systems, decolonizing and Indigenous methodologies, or power imbalances that may be found in the design and execution of environmental monitoring (Nadasdy 1999, Simpson 2000, Simpson 2017, Smith 2008). A review by Bohensky and Maru (2011) emphasizes that there continues to be a need for non-Indigenous conservation and resource-management efforts to critically evaluate and reframe the process of combining scientific and Indigenous knowledge. We strongly encourage future monitoring initiatives that seek to include Indigenous knowledge, especially those initiated by non-Indigenous groups, to embed their work in a critical reflection on these themes as they design, carry out and report on their efforts.

Chapter 3: “We monitor by living here”: Community-based actualization of an environmental monitoring program grounded in Indigenous knowledge

Introduction

Communities and ecosystems worldwide are experiencing the effects of climatic and other environmental changes, such as unseasonal temperatures, sea level rise, species' range shifts, and unpredictable weather (IPCC, 2014). The ability to respond, and adapt to change is a key component of resilient social-ecological systems (Berkes & Turner, 2006; Folke et al., 2010) and relies on effective monitoring systems. A monitoring system includes routine observation of ecological and/or social phenomena, analysis of these observations and communication of patterns and abnormalities to inform adaptation and mitigation decisions (Alessa et al., 2016; Pulsifer et al., 2012). Community-based monitoring, which has been described as “monitoring of natural systems by local stakeholders, using their resources and in relation to aims and objectives that make sense to them” (Danielsen et al., 2014), has been recognized as a useful component of natural resource management and can help build local compliance to management and adaptation decisions (Danielsen et al., 2009). Thanks to longstanding relationships with their ancestral territories Indigenous peoples have developed knowledge that has guided the monitoring, management, and adaptation to environmental changes in their territories over millennia (Hebda & Mathewes, 2014; Lepofsky & Caldwell, 2013; Turner & Berkes, 2006).

Natural and social scientists within academia and government have taken interest in leveraging Indigenous knowledge to create more complete understandings of ecological and social-ecological systems (Berkes et al., 2000, United Nations Conference on Environment and Development, 1992; Fisheries and Oceans Canada, 2016). It is now well established that scientific and Indigenous ways of knowing provide different yet complementary information that can lead to enriched understandings of ecological health (Eckert et al., 2017; Moller et al., 2004; Bohensky & Maru, 2011). Much academic work has been done to explore how to combine or “integrate” knowledge generated by a scientific method premised on objectivity and positivism with information generated by Indigenous ways of knowing, which are explicitly rooted in longstanding relationships with the land and in many cases provide a time depth otherwise

unavailable (Bohensky & Maru, 2011; Eckert et al., 2017; Frid et al. 2016). There are many motivations for combining indigenous and scientific knowledge, including better understanding ecological systems and encouraging indigenous sovereignty and self-determination (Bohensky & Maru, 2011). However, in many regions that have been subjected to European colonialism, Indigenous knowledge is still often validated according to scientific paradigms, which perpetuates colonial power imbalances (Nadasdy, 1999). In order for true integration of knowledge systems to occur, Indigenous knowledge holders must have the same power as scientists in the process of validating and combining knowledge borne of two different systems (Irlbacher-Fox, 2014; Simpson, 2017).

Over the last two decades a growing number of environmental monitoring programs have sought to involve Indigenous knowledge (Thompson et al. 2018, *In review*). These efforts have ranged from local Indigenous technicians administering scientific methods (eg. Bellfield et al., 2015) to Indigenous land-based activities providing monitoring indicators (eg. Heaslip, 2008; Lyver et al., 2008). Many programs have included partnerships between Indigenous peoples and non-Indigenous external agencies, sometimes leading to challenges in matching local and external objectives, retaining community involvement, and appropriately interpreting and applying Indigenous knowledge in decision-making (Thompson et al. 2018, *In review*). A recent review (Thompson et al. 2018, *In review*) indicates that programs that were able to overcome these challenges featured Indigenous leadership during project design and administration, trust and respect of multiple knowledge systems, the use of multiple methods for documenting knowledge such as trips on the land and semi-structured interviews (eg. Gill et al., 2014), and directly informed institutions tasked with management actions (eg. Berkes et al., 2007; Harmsworth et al., 2011).

When monitoring programs that involve Indigenous peoples and their knowledge are not entirely autonomous, the collaborative process of initiating and designing the program is central to ensuring that the monitoring objectives and methods are locally appropriate and relevant (e.g. Eamer, 2006). However, these processes are rarely documented in detail. Here we describe and reflect on the design and actualization of a monitoring program rooted in the knowledge of Gitga'at harvesters, jointly designed by Gitga'at community researchers, harvesters, and

researchers from the University of Victoria. The intention of this research was to center the vision and voices of Gitga'at harvesters in the design, execution, and reporting of a monitoring program based in their knowledge. The design process and resulting monitoring program provides a detailed case study that can be used by other Indigenous groups looking to pursue similar initiatives.

Methods

Case Study Description

The Gitga'at are a Tsimshian tribal group whose people have occupied and cared for their lands and waters on the North Coast of British Columbia, Canada, since time immemorial (Figure 1). The waters within Gitga'at territory include diverse and productive ecosystems (Macdonald, 1983; Gitga'at First Nation, 2011). Despite colonial cultural assimilation and land dispossession policies, and a changing social-ecological landscape, many Gitga'at people continue to consume traditional foods harvested from their lands and waters on a daily-basis (Fediuk & Reid, 2014). The home community of Gitga'at people is Hartley Bay (Txałgiu), where approximately 140 people live year round. Another 400 Gitga'at people reside in Prince Rupert, located approximately 140 km northwest of Hartley Bay, and other cities across North America. In ancestral times, the leaders of each Gitga'at house group (waaps) oversaw the local stewardship, allocation and management of resources according to their intimate knowledge of ecosystems, foundational oral histories (adawx) and laws (ayaawx). These principles continue to underlie contemporary Gitga'at territorial management activities, which also leverage the methods and technology offered by science (Gitga'at First Nation, 2011). Gitga'at stewardship activities and research endeavors include annual stock assessments of important traditional foods including dungeness crab and salmon species, biotoxin assessments of shellfish, analysis of petroleum products in shellfish (Thompson et al., 2015), oceanographic surveys, marine mammal population assessments (Ashe et al., 2013; Keen et al., 2017), and acoustic baseline monitoring (Ritts et al., 2016). Contemporary stewardship of Gitga'at is led by Gitga'at Leadership (hereditary and elected leaders), with advice provided by the Gitga'at Oceans and Lands Department (GOLD).

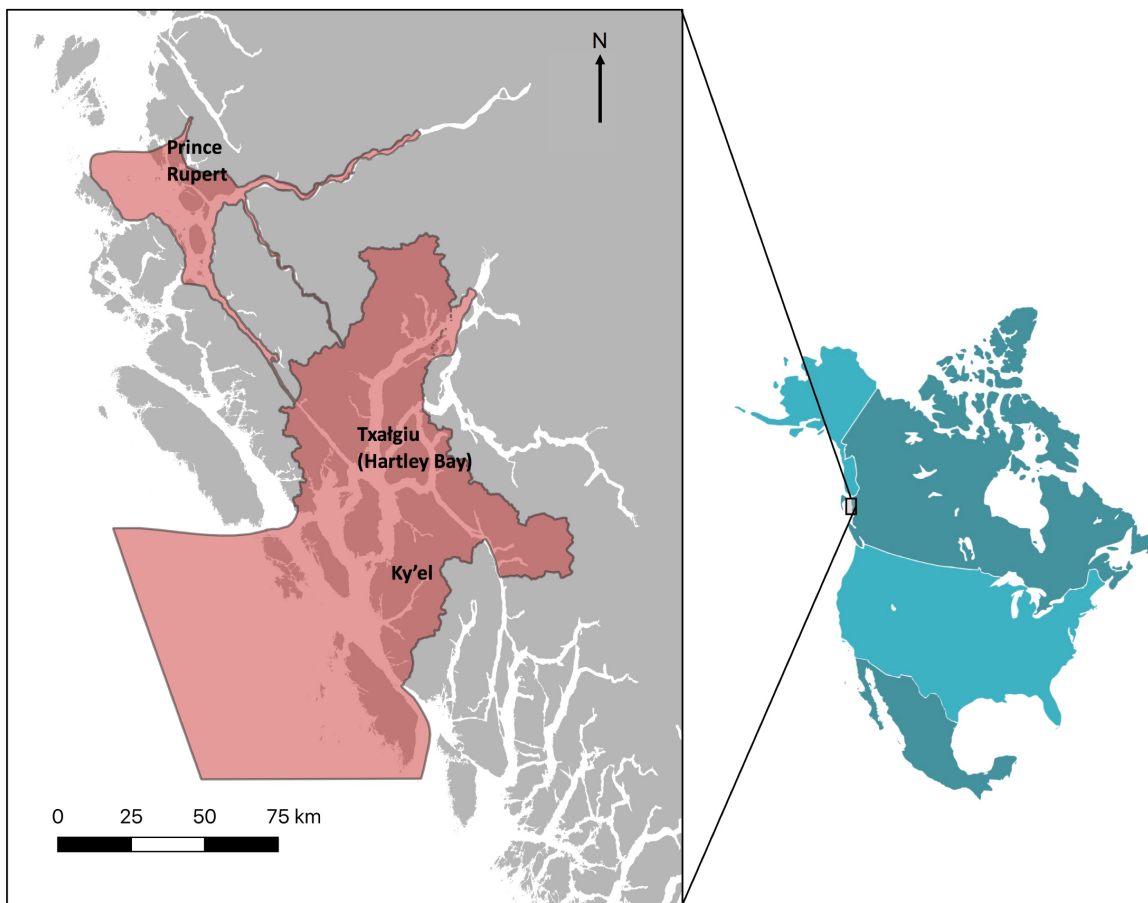


Figure 1. Map of Gitga'at Traditional Territory showing the location of Prince Rupert, Txałgiu (Hartley Bay) and Ky'el.

Initiating the Research

The idea of initiating a program to document harvesters' observations of change was spurred by the director of the Gitga'at Oceans and Lands Department in early 2016 when he and several Gitga'at harvesters witnessed abnormalities in Gitga'at territory including sea star wasting syndrome, increasing red tides, and high levels of biotoxins in clams. The idea had also been previously suggested by ethnoecologists and climate scientists who had documented some of the longer term changes experienced by Gitga'at people (Lamontagne, 2016; Turner et al., 2013; Turner & Clifton, 2009). The idea of a program to document harvesters' observations was suggested in order to enhance the systematic monitoring that has been officially conducted by the Gitga'at Guardian Watchmen program since 2010. To assist with designing the program, a

partnership was formed with researchers from the University of Victoria. Gitga'at co-researchers were an integral component in designing and testing the program by ensuring that methods were culturally appropriate and relevant, testing methods, entering and managing data, making suggestions to improve the data collection process, and by reporting on findings in community meetings and conference venues. The participatory nature of the research was built into a protocol agreement that was signed between researchers at the University of Victoria and the Gitga'at First Nation prior to the beginning of any research activities. The protocol agreement also included data sharing agreements that included details regarding intellectual property rights. The project was designed to have three phases: (1) determining monitoring program objectives, (2) designing data collection tools, and (3) iteratively testing and revising the tools through two harvesting seasons (Spring and Fall/Winter) (Figure 2).

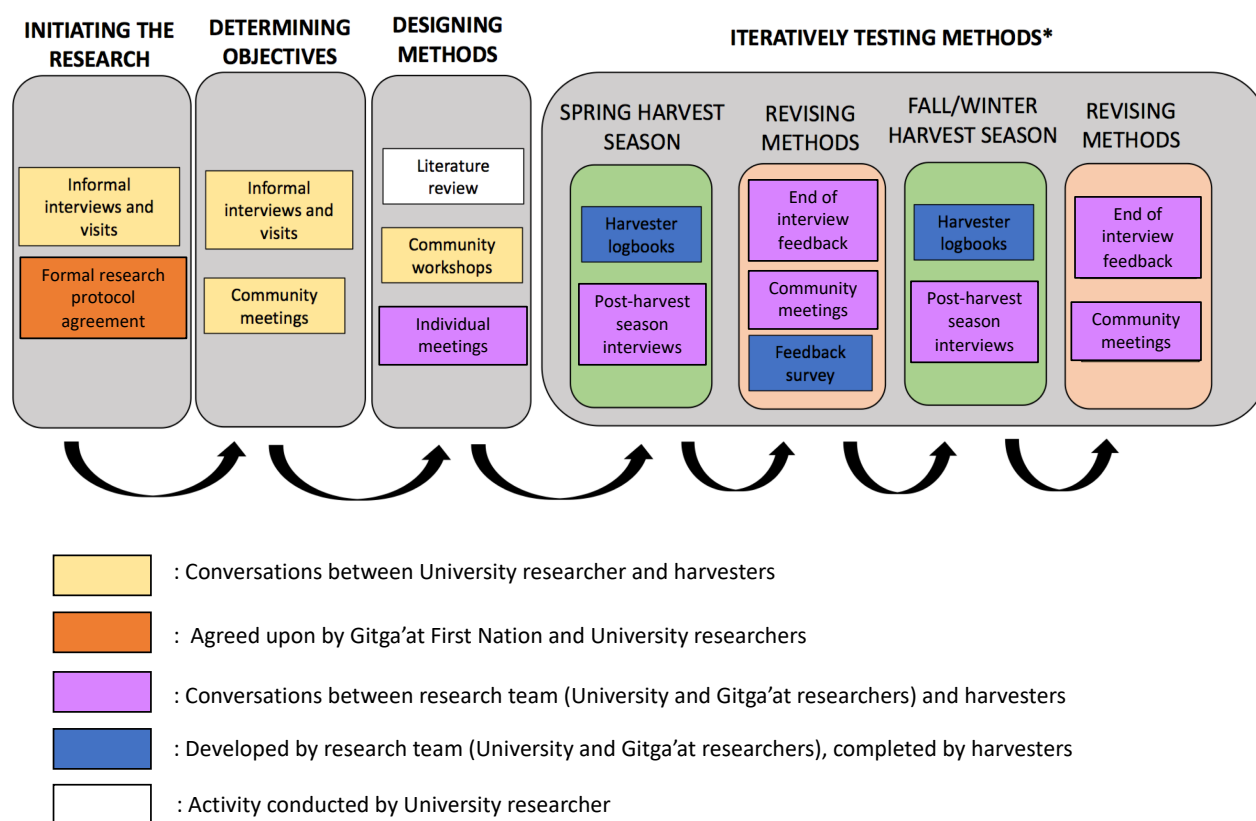


Figure 2. Flowchart showing research activities conducted to initiate research and monitoring project, determine objectives, design, and test data collection methods.

* Methods will continue to be re-iteratively tested and adjusted as the program continues into the future.

Determining Monitoring Program Objectives

The first step of this research was to determine whether a monitoring program based in Gitga'at knowledge would be important and of interest to Gitga'at harvesters. We visited with 36 Gitga'at harvesters and knowledge holders in Hartley Bay and Prince Rupert in October and December 2016 to conduct informal interviews (Reilly, 2005). We started with people we knew to be active harvester and knowledge holders, and then used a chain-referral-sampling approach, interviewing people who had been recommended by previous participants (Heckathorn, 2011). Questions we asked included: How could Gitga'at monitoring of the marine environment incorporate the knowledge of those who harvest, hunt, and/or fish? How can this knowledge be used to inform decisions about management and protection of the marine environment in Gitga'at territory? Would you be interested in sharing your knowledge and observations? Would it be okay to document your knowledge? If so, how would you like to see your knowledge documented? How would you like to see your knowledge used?

In March 2017, we held community meetings in Hartley Bay and Prince Rupert to discuss program objectives that were suggested during informal interviews and to begin designing data collection tools. Posters advertising the meetings were posted on an online forum and in the Band Administration building. Potential tools discussed during these meetings were inspired by suggestions from harvesters and Elders and from a review of the literature describing other community-based monitoring programs that include Indigenous knowledge (Thompson et al., 2018, *In review.*)

We began meetings in both Gitga'at communities with a brief presentation about common themes that emerged from informal interviews, followed by round table discussions. In Hartley Bay, attendees broke into several smaller groups, while all attendees in Prince Rupert participated in a single group discussion. Following the meetings in Hartley Bay and Prince Rupert, interested community members were invited to smaller workshops to discuss data collection methods in more detail. Due to conflicting schedules, some would-be workshop attendees opted for individual meetings; a combined total of 12 meetings were held.

Designing Data Collection Tools

Given that the informal interviews and community meetings reaffirmed that Gitga'at people were in fact monitoring their territory while practicing land- and sea-based activities such as harvesting or travelling, and were interested in collating their observations, we sought to design tools for recording observations made by harvesters. We brought data collection tools that we drafted based on suggestions made during informal interviews and inspired by methods described in the literature (harvest logbooks and interview guide, see results) to individual meetings to make changes that would ensure that they were customized to Gitga'at activities and goals. During group and individual meetings, participants workshopped the tools so that they would have a user-friendly layout, and include culturally relevant indicators. Participants also advised us to synchronize the distribution and collection of logbooks with relevant times in the seasonal harvest rounds. We further reviewed the tools to ensure that they reflected relevant and culturally sensitive indicators, and included accurate translations into sm'algyax, the native language of Tsimshian people.

The draft logbook was comprised of a page for every day between April 23 and June 30, 2017 where participants could record the following information: which species they harvested, location of harvest, quantity of harvest, the quality of their harvest, and with whom they shared their harvest (Figure 3). Logbooks also included a tide table, a page introducing the project objectives, and a map of Gitga'at Territory with sm'algyax place names.

Example Day

	ta'ask (seaweed)	txaw (halibut)	ts'mhoon (red snapper)	yea (spring salmon)	other __gyanti__	other __	other __
Time of Harvest	12:00pm			5:00pm	3 pm		
Location	Kagaas (campania)	The location you enter can be as general or specific as you'd like. A map with Gitga'ata place names is provided on Pages 6-7.		Behind kiel	kiel		
Who harvested?	Me and Dad			Uncle __	Me		
Who prepared?	Me and Granny	Please include the unit (for example; totes, sacs, number of fish, weight, etc) that you use to measure how much you harvested.		Me	Uncle		
Quantity (units)	2 totes			2, 20lbs and 15lbs	10		
Quality (Low- Average- High)	High	Quality and harvest success are based on your own standards. You may, specify what made a harvest successful or not, and quality high or not in the "Other Notes/Observations" section.		Average (worms)	High		
Successful harvest? (Yes/No)	Yes			Yes	Yes		
Shared with:	Aunty and Uncle	Please enter "Yes" if you have photos or videos of your harvest that you are comfortable sharing.		Family			
Photos or Videos? (Yes/No)	No			Yes	No		

Today's weather:
Sunny, about 10 degrees,
wind 0-10 NW

Other Notes/Observations:
- 3 humpback whales near Alexander
- Salmon had a worm on the outside of its stomach
- The gyanti was delicious!

Figure 3. Example logbook page with instructions for documenting observations.

The interview guide (Appendix B) included a section with questions focused on each main spring food species (Table 1), weather patterns, and other ecological changes. Food species sections were subdivided into sections with questions about observations of changing quality and quantity of food species following four key themes: harvest, preparation, eating, and sharing. Questions relating to harvesting included three subsections: 1. level of experience harvesting (asked during the first interview only); 2. quantity of the food species, including how much was harvested, whether abundance had changed, and whether harvesting needs had been met; and 3; location of harvest.

Table 1. Focal food species harvested by Gitga’at people and included in the interviews and logbooks.

Harvest Season	Common name	Sm’algayax name	Scientific name
Spring	Red laver seaweed	Ła’ask	<i>Pyropia abbotiae</i>
	Yellow eye rockfish	Ts’mhoon	<i>Sebastes ruberrimus</i>
	Giant red sea cucumber	Gyenti	<i>Parastichopus californicus</i>
	Gumboot chiton	Ts’ak	<i>Cryptochiton stelleri</i>
	Black katy chiton	‘Yaans	<i>Katharina tunicata</i>
	California mussel	Hagwn	<i>Mytilus californianus</i>
	Sea urchin	Dsik’wi’its	<i>Strongylocentrotus franciscanus</i>
Spring/Fall/Winter	Dungeness crab	K’almoos	<i>Cancer magister</i>
	Harbour seal	Üüla	<i>Phoca vitulina</i>
	Rock sole	Da_xs	<i>Lepidopsetta bilineata</i>
	Pacific halibut	Txaw	<i>Hippoglossus stenolepis</i>
Summer/ Fall	Coho	Üüx	<i>Onchorhynchus kisutch</i>
Fall/Winter	Nuttal’s cockle	Ga_boox	<i>Clinocardium nuttallii</i>
	Butter clams	Ts’a’ax	<i>Saxidomus giganteus</i>
	Moose	Wüdzii	<i>Alces alces</i>
	Blue mussels	Gyels	<i>Mytilus edulis</i>
	Golden eye ducks	Ts’aas	<i>Bucephala</i> spp.
	Surf scoter	Amgyiik	<i>Melanitta</i> spp.
Winter/Spring	Chinook salmon	Yee	<i>Oncorhynchus tshawytscha</i>

Iteratively testing and revising the objectives and tools through two harvesting seasons

Spring Harvest Pilot Season

We tested the data collection tools during the spring harvest season. For many generations, Gitga’at people have travelled to Ky’el, a seasonal village located in the southern portions of Gitga’at Territory, to use as a central point of spring harvesting activities (Figure 4a.). Families typically move to Ky’el in May and stay as late as the end of June.

Prior to the beginning of Ky’el activities, we distributed one of the data collection tools, harvest logbooks, to 30 active harvesters. Then, with permission from the Sm’oogyits (hereditary leaders), we spent two weeks at Ky’el to be participant observers and to keep notes on how to potentially improve logbooks to better suit camp life (Gillham, 2000). Once spring harvesting ended, we collected and photocopied logbook entries. Original books were returned to

participants for their personal records. We entered logbook data into Microsoft Excel spreadsheets and calculated the total number of each species harvested per month, and by location.

We concurrently organized post-harvest season interviews with knowledgeable Gitga'at harvesters and people with lifetimes handling, preserving and/or preparing traditional foods. Interviews were conducted in the location of the participant's choice, were voluntary, and were recorded with permission of the participant. We interviewed 23 participants including 15 men and 8 women, with ages ranging from 25-92. Participants were given an honorarium following the Gitga'at First Nation's protocols. Interviews were semi-structured and followed the interview guide we designed during meetings and workshops (Appendix B), and were done with individuals or pairs of participants. They also included a participatory mapping exercise during which the harvester indicated their harvesting location using Google Earth or on a laminated chart, depending on the participant's level of comfort with each mapping platform. At the end of the interview, we invited harvesters share their thoughts on whether they enjoyed completing the logbook and interview process, and to provide suggestions for improving data collection methods for future harvest seasons.

We transcribed interviews with the help of two Hartley Bay School senior students, and coded responses and according to themes set in the interview guide as well as other un-planned but reoccurring themes (Table 2) using Microsoft Excel. Responses to each question were then categorized and tallied. At the request of harvesters, answers were also grouped by the number of years of harvest experience for each species, and number of harvesters by species. Photos of harvesting areas marked on laminated charts were georeferenced and Google Earth files transferred using QGIS software (QGIS Development Team, 2017).

Table 2. Other themes discussed during semi-structured post-harvest season interviews

Themes
Vision of monitoring program in the future
Geographic areas of concern
Species of special concern
Opinions on partnership with provincial and federal government of Canada, or other First Nations
Reasons needs for food were not met
How harvesting used to be done
Transitions from past to present harvest and preservation techniques and technologies
Harvesting practices of younger generation
Historical sharing and trading
Harvesting narratives

Assessing Spring Harvest Pilot Season

Results from the spring harvest season, excluding harvest location maps and food sharing networks, were summarized in a report. The report was included in a “participant package” that was given to each person who had completed a logbook and/or participated in an interview. The package also included a map of harvesting locations indicated by the individual participant, a copy of their interview transcription, and a feedback survey form (Appendix D). Community meetings were then held in Hartley Bay and Prince Rupert to discuss the results of the spring harvest season. Summary reports and feedback surveys were handed out to all meeting attendees.

Spring results summary reports were also sent to directors of The Gitga’at Oceans and Lands Department, the Gitga’at Health Department, Hartley Bay School, and the Gitga’at Treaty Office. We then conducted semi-structured interviews with representatives of each department, with two goals. First, we asked them to assess whether the spring pilot season met their data requirements, including whether there were other types of data they would like to see documented in future harvest seasons, and appropriate data formatting for each department. Second, we asked them to describe how they envision the data collection program proceeding in the future, including potential job creation and skills training.

Fall 2017/Winter 2018 Harvest Season

Data collection tools were modified according to feedback received from the spring, 2017 harvest season and tested again during the fall/winter 2017 harvest season, which focuses primarily on the harvest of shellfish species (Table 1, Figure 4b.). Results from the fall/winter harvest season were analyzed and reviewed by the community in the same way as for the spring harvest season.



Figure 4. A) Ky'el spring harvest camp; B) Fall/Winter shellfish harvesting in Gitga'at territory (photos: Kim-Ly Thompson)

Results

Determining Program Objectives

All active harvesters and Elders who took part in preliminary informal interviews demonstrated a strong interest in a potential Gitga’at knowledge-based monitoring program, with one participant saying “*It’s too bad something like this wasn’t happening when my dad was alive*”. Albert Clifton, Sm’oogyit Wahmoodmx, encouraged our efforts to document the observations and knowledge of Gitga’at land and sea users when he said, “*A monitoring project?... We monitor by living here.*” Several harvesters suggested we begin documenting observations as soon as possible due to the large number of unusual occurrences observed in the year prior to the interviews (2016). These observations included large and frequent red tides (visible blooms of phytoplankton), poor seaweed growth, and a paucity of kelp. Harvesters also stressed the importance of the confidentiality of culturally sensitive information.

Four key and interrelated objectives emerged from conversations with harvesters regarding the ways they wanted to see their knowledge and observations used:

1. Track changes occurring in Gitga’at Territory to inform stewardship decisions and adaptation measures;
2. Encourage youth to learn about their traditional foods and how the territory is changing;
3. Strengthen the case for Gitga’at Rights and Title; and
4. Inform health and wellness programming.

During the informal interviews and subsequent community meetings, participants suggested indicators and methods for documenting their knowledge and observations of change within these indicators. Many suggested self-reporting tools such a harvesting logbook, while other, typically younger, harvesters suggested creating a digital app that could be used on mobile phones. They stressed that whatever the tool, it would be important to outline exactly which pieces of information harvesters were supposed to record. Another commonly suggested method was the use of interviews during or following a harvest season. Many suggested combining methods, meeting in groups to discuss their observations as this would “*...jog their memories about the harvest season.*” (anonymous) Many people also restated that confidentiality of

culturally sensitive information was critical when sharing results. However, many hoped that program results would be shared with the community on an ongoing basis through regular meetings and/or password protected website.

Throughout the conversations, most participants mentioned several species that they would like to see monitored as part of this project. These included food species that had recently changed in abundance and/or quality, and related ecosystem changes. One harvester, who preferred to remain anonymous, said “*If you’re going to talk about salmon you need to talk about the berries too.*”

Spring Harvest Pilot Season

Logbooks

Data reported in logbooks reflect only a small fraction of all harvesting activities and harvesters’ observations from spring 2017. Six of 30 participants returned completed logbooks. An additional 3 harvesters filled in their logbooks, but reported misplacing them. Of the 6 who returned their logbooks, 4 reported that they had used their memory to fill it in the day prior to the interview. All harvesters who completed and returned logbooks also participated in interviews. In total, 80 logbook entries were made. Most entries included information about quantities harvested, who harvested, location of harvest, and harvest success. Few harvesters completed fields about the quality of their harvest, who they shared food with or weather conditions.



Figure 5. Isabelle Eaton working on dried halibut with Spring 2017 harvest logbook at Ky'el (photo: Kim-Ly Thompson)

Interviews

Semi-structured interviews lasted between 30 minutes and 3 hours, as decided by participants. Information documented during interviews included knowledge about changes in abundance and quality of food species, observations of environmental change including weather patterns, harvesting locations, food and skill sharing networks, and whether harvesters had met their needs for food in Spring 2017 (Table 3). For each food species, harvesters were also asked about their harvest effort during that season, how many years of harvest experience they have for that particular species, where they harvested during the season, and the quantity they harvested. Participants also reflected on past harvest seasons, stories, and changing harvest practices (see Table 2).

Table 3. Main themes of post-harvest interview guide and number of data points collected along those themes during the spring, 2017 and fall/winter 2017/18 interviews.

Main Post-Harvest Season Interview Guide Themes		Total number of observations*	
		Spring (12 species, 23 participants)	Fall/Winter (11 species, 27 participants)
For each food species	Changes in abundance	104	88
	Reasons for changes in abundance	67	39
	Changes in quality	77	96
	Reasons for changes in quality	46	33
	Whether needs were met	98	57
	Sharing and trading	130	139
Changes in the weather		22	18
Other ecological changes		33	56

* Each time a participant made an observation about each theme, including when the participants observed no changes. Lack of observations are not included (reasons for not responding included not harvesting a given species that season, preferring to keep information confidential, or omission of the guiding question)

Assessing the Spring Harvest Pilot Season

End of Interview feedback

Fourteen participants provided feedback regarding the logbooks during their interviews. Participants who did not use the logbook explained that they were either too busy, had recorded their harvests and observations in other places, had not brought their logbook out on their harvesting trips because it was too bulky and not waterproof, or had simply forgotten to fill in their logbooks because they were not used to recording their observations on paper. As one anonymous harvester explained, while pointing to their head: *“It’s all up in here. Whether I remember and pull it out later, it’s all up in here.”* Some harvesters suggested changes to make to the logbook for subsequent harvest seasons. These included making the logbook smaller and waterproof to bring out while harvesting, reducing the number of fields to fill out, and creating one logbook that could include entries over the course of an entire year (Table 4). 95% (n=22) of participants said that they would be willing to participate in another similar interview in the future, while 5% (n=1) said it would depend on their availability and interest at that time. Responses to the interview process were largely positive. Jessel Bolton, echoed the

thoughts of others when he said *“I don’t mind doing it. Well if it’s to help out, to figure out and keep track of everything that’s happening, that’s fine with me.”* Some harvesters also suggested ways to improve the interview process like bringing recall tools such as their logbooks or photos and conducting interviews as soon as possible after every harvest season. Another harvester, Marven Robinson, suggested including a section within the interview to ask the reasons why harvesters did not harvest certain species that harvest season (Table 4).

Several participants also made suggestions about ways to improve data collection and overall program structure. For example, Mary Reece said:

“Just maybe I’d suggest to do it every harvest season. See sockeye’s coming up. It would be good to do one in there... Because there’s always something different for each month... Everything that’s harvested, it would be good to do in an interview. ‘Cause then if you want to go back and do something within three months, then they’re going to have to try to remember what they did. ”

Community meeting feedback forms

21 community members attended the meeting to discuss the results of the spring pilot season in Hartley Bay, and another six attended the meeting in Prince Rupert. 11 completed feedback forms were received. 10 respondents were happy with the amount of information presented in the summary report while one suggested that future seasons *“Include more species, ie. salmon, root, berry, ungulates.”* All respondents agreed that they would like to see the Gitga’at First Nation collect this kind of information in future harvest seasons, with 82% percent saying they strongly agreed that harvester’s observations should continue to be collected. Two anonymous commenters added that *“It will be helpful in the future.”* and *“Any information is good.”* 91% of respondents agreed that they would like to see this kind of information used to make decisions about how to steward Gitga’at Territory, with 64% strongly agreeing. One anonymous participant felt neutral about whether or not such information should be used to make stewardship decisions adding *“Not if it means they tell me what and when I harvest.”*

Most participants agreed that multiple methods should be used to communicate monitoring results, including summary reports, a website, and community and individual meetings. However, some participants strongly disagreed with using a website to communicate findings.

Table 4. Participant feedback about logbooks and interviews

Data collection method	Suggestions for improvement
Logbooks	<ul style="list-style-type: none"> Make smaller and portable. Make waterproof. Reduce number of fields. Year-round book rather than one book per season. Include more species (marine and terrestrial).
Interviews	<ul style="list-style-type: none"> Encourage participants to bring photos and logbooks to interviews as recall tools. Include questions about participants' reasons for not harvesting a given species. Conduct interviews as soon as possible after every harvest season. Include more species (marine and terrestrial)

Departmental feedback

During their interviews, representatives of the Gitga'at Ocean and Lands Department, the Hartley Bay School, the Gitga'at Health Department, and the Gitga'at Treaty Office suggested ways to ensure that the data collection process that would yield information that would further enhance their decision-making. These suggestions included conducting yearly check-ins with each department in regards to their information needs, and adjusting logbooks and interview questions accordingly on an annual basis. For example, Paul Paterson, the lead Treaty Negotiator for Gitga'at suggested including questions in future interviews about how harvesting decisions are made would be helpful to strengthen the case for Gitga'at Rights and Title. Similarly, Christa Meuter, the Gitga'at Health Director requested that future logbooks and interview guides include questions specific to the harvest and use of traditional medicines (Table 5).

Departmental representatives also reflected on the format of data that would be most easily used by their departments. Gitga'at Ocean and Lands Department representatives preferred raw data files in an Excel spreadsheet and the Treaty team was most interested in spatial data and

requested these in an ESRI-compatible geodatabase. The Health Department requested that data be summarized in a report, and provided as raw data so they could explore other potential research questions. The Principal of the Hartley Bay School said that an interactive presentation with senior students would be the best way to share results with youth.

As harvesters and community members themselves, some representatives also suggested other methods to communicate results to Gitga'at people effectively in the future. Christa Meuter, suggested that a summary of future seasonal results could be communicated in password-protected videos and uploaded to a website where data could be downloaded in real-time by end-users as well as Gitga'at members. Cameron Hill, the Hartley Bay School principal, said that the summary report was good, however:

"... the simpler, the better. I think there's a lot of people I know that... kind of get turned off when there's multitudes of pages and numbers. And trying to follow columns and things like that. So I like the way it was laid out and I think, for me, the reason why I wanted to read it was because it's about us. So, you know, I want to see those numbers. "

Each department also shared their long-term visions for the data collection program including how to transition to an entirely Gitga'at-run program and how to further involve youth. Cameron Hill echoed other department leaders' sentiments about the importance of long term monitoring when he said *"I think ten years, to me, would be a drop in the bucket. That's a generation. So you got to keep that going."* All department representatives envisioned that the program would grow to involve all community members and Gitga'at Oceans and Lands Department representatives suggested that this could be facilitated by funding Gitga'at Guardian vessels to bring harvesters out to harvest regularly. All agreed that in order for the program to continue, a permanent ongoing position to collect, analyze and report on data, would need to be created in an existing Gitga'at department. Many envisioned that this should be included into the Ocean and Lands Department, while another participant suggested running the program through the Health Department. Representatives of the Hartley Bay School and of the Ocean and Lands Department emphasised that university researchers should dedicate the time necessary to transfer data

collection, analysis and reporting skills to future program staff. Highlighting this sentiment, Cameron Hill said:

“I think it would be really beneficial for us if you [K.L. Thompson] were still there in the coming year. Not just to turn it over right away. ‘Cause I’m not so sure that it will keep on happening if there wasn’t somebody like yourself to sort of spearhead it. So I wanted to encourage you in that respect... I think it would be really good if you were able to do it again and then mentor somebody.”

Cameron Hill also suggested that the program include youth on the land and sea, and that they participate in interviewing family members who are experienced harvesters. Emphasizing the vision to encourage youth to participate in food harvesting and the data collection program going forward, he said:

“I think the key for the school is to get the kids out there doing it. They got to get out doing and then paying attention to what we’re getting. Not just how we’re doing it and when we’re doing it, but what we’re getting, what we’re doing with it and to be able to contribute that to a data base with which we’d be able to monitor our needs and where they’re going... also to gain an understanding of the cultural part of it; taking what you need and using what you take, but also making sure that we’re understanding what the changes are that are happening around us and how good solid science can combine with traditional knowledge so we can gain an understanding of what we’re losing.”

Table 5. Overview of Gitga'at institutions' linkages to monitoring program objectives and suggestions for improvement

Monitoring objectives	Related elements of pilot monitoring program	Gitga'at Institutions Interviewed*	Suggested ways to improve program to meet monitoring objectives
Track changes occurring in Gitga'at Territory to inform stewardship decisions and adaptation measures	Harvesters' observations about changes in quality and quality of traditional foods, weather, and other ecological changes	Gitga'at Oceans and Lands Department	Engage larger proportion of knowledge holders in monitoring program; Retention of University researchers to transfer necessary skills to program staff
Encourage Youth to learn about their traditional foods and how the territory is changing	Interviews conducted and transcribed by youth	Hartley Bay School	Facilitate youth participation in harvesting activities; Presentations of seasonal results to Hartley Bay School students; Retention of University researchers to transfer necessary skills to program staff
Strengthen the case for Gitga'at Rights to and Title	Information and spatial data about contemporary use of Gitga'at territory	Gitga'at Treaty team	Engage larger proportion of knowledge holders in monitoring program; Include questions about how harvesting decisions are made
Inform Health and wellness programming	Information about needs for traditional foods; Data about how many people are engaging in harvest activities	Health Department	Engage larger proportion of knowledge holders in monitoring program; Collect data specific to traditional medicines

* Note that, though they oversee the administration of activities related to the monitoring objectives, these departments are all advised by and report to Gitga'at hereditary and elected leaders.

Fall 2017/ Winter 2018 Harvest Season

Logbooks

Based on feedback received from harvesters, we adjusted the harvest logbooks to be pocket-sized, water-proof, and with fewer fields for harvesters to fill in. Further, rather than including one page per day, the revised logbooks were composed of a section per harvest species in order

to allow harvesters to report year-round harvesting activities and observations. The new logbooks include two pages per species for every commonly harvested food species (Figure 4). Additional pages were available at the end of the book for entries related to other foods or medicines, as well as overflow entries and notes. In the fall/winter, twenty harvesters were given logbooks, though only 2 participants completed and returned their logbooks. Following the interviews some participants suggested that regular reminders, posted to social media, would encourage harvesters to fill in their logbooks.

gabox / cockles (EXAMPLE)								
Date	Where Harvested	Amount	Quality (1: Lowest, 5: Highest)					Notes
			1	2	3	4	5	
December 10, 2017	Location A	1.5 buckets		X				A bit of green left in the gut
January 18, 2018	Location B	2 buckets				X		

Locations entered can be as general or specific as you would like

Please enter units! (for example, buckets, sacks, pounds)

Use your own judgement of quality and check the box that applies. The "Notes" section is available for further description.

Figure 4. Example page of harvesting logbook produced for harvest spanning Fall 2017 to Fall 2018

Interview Process

Interview guides were also modified to incorporate suggestions made following data collection in spring, 2017 (Appendix C). The main changes included a question to prompt harvesters to explain the reasons why they may not have harvested certain food species that year, as well as prompting harvesters to say when the quantity, quality or weather patterns were “normal” if they had experienced changes in the interview year. Twenty-seven participants were interviewed. 93% of fall/winter participants said they would be willing to participate in future interviews, while the remainder said it would depend on their availability and whether they had a chance to harvest.

Table 6. Comparison of logbooks and interviews as methods for documenting Gitga'at monitoring observations

	Harvest Logbook	Post-harvest season Interview
	6/30	23
Number of participants Spring 2017		
Number of participants Fall/Winter 2017/18	2/20	27
Quantitative Data	<ul style="list-style-type: none"> • Quantity of food harvested • General harvest locations • Month of harvest 	<ul style="list-style-type: none"> • Quantity of food harvested • Years of harvesting experience • Specific harvest locations • Month of harvest
Qualitative Data	<ul style="list-style-type: none"> • Overall quality of harvest • Food sharing • Skill sharing 	<ul style="list-style-type: none"> • Specific indicators of food quality • Skill sharing • Food sharing • Food receiving • Perceived changes in abundance • Perceived changes in quality • Perceived changes in weather patterns • Whether harvesting needs were met • Food species' phenology • Harvesting narratives
Advantages	<ul style="list-style-type: none"> • Quick reporting and data entry • Observations documented during or soon after harvest 	<ul style="list-style-type: none"> • Anchors data in context • Interviewer learns while listening • Builds relationship between interviewer and participants • Many willing participants
Disadvantages	<ul style="list-style-type: none"> • Data may lack context and nuance • Few participants 	<ul style="list-style-type: none"> • Time consuming to collect, transcribe, and analyze • Relies on accuracy of harvesters' memory

Discussion

While there is a growing number of monitoring programs that involve Indigenous peoples and their knowledge (Thompson, et al., 2018, *In review*), few publications have focused on the steps taken to actualize these programs (e.g. Parlee & Lutsel K'e Dene First Nation, 1998).

Documenting and reflecting on this design process is especially important in the case of monitoring programs that involve a collaboration between Indigenous and non-Indigenous partners. This study details the steps taken to initiate, design and test a monitoring program based

in the knowledge and observations of Gitga'at land and sea users, designed collaboratively with Gitga'at resource users and researchers from the University of Victoria. In as much, our reflections aim to lend insight into the practice of collaboratively designing monitoring programs that involve Indigenous knowledge. Lessons learned and the resulting monitoring methods can also act as a template to be used or adapted by other groups considering similar initiatives.

We designed and tested two data collection tools: a harvest logbook and an interview guide, each with advantages and disadvantages. Completing and entering data from logbooks is relatively quick for harvesters and researchers, respectively, but low logbook returns suggest that relational methods of information collection (ie. interviews) are important for monitoring for multiple interrelated community objectives. Yet organizing, conducting, and analyzing interviews is more time consuming for researchers and program staff, and more demanding of harvesters' time, than logbooks. Still, the conversational nature of semi-structured interviews records the nuanced ways in which change is occurring and being experienced, and makes room for oral histories and narratives. This approach also fosters opportunities for the interviewer to learn directly from the participant, thus creating additional space for potential intergenerational knowledge transfer. Community-based environmental monitoring initiatives in the Arctic have also prioritized intergenerational knowledge transfer within their data-collection processes by pairing Indigenous youth with knowledge holders to document observations of change during regular trips out on the land (Bennett & Lantz, 2014; Gill et al., 2014). Early in the planning process of our project, some participants suggested building digital platforms for self-reporting, such as an app that could be installed onto their smart phones, which might increase participation as many harvesters of younger generations carry their phones with them while travelling and harvesting. The success of digital self-reporting tools in other communities (e.g. Gearheard et al., 2011) is further motivation for our team to design an app as an option to use instead of paper logbooks in the future, though digital apps are considerably more expensive to develop and maintain. We strongly recommend retaining opportunities for direct knowledge transfer alongside any future self-reporting tools.

In Canada, other Indigenous communities have led the development of long-term monitoring programs to suit their needs and assert governance over their territories – one of the key

objectives that emerged from our study – using various monitoring approaches (Wilson et al. 2018; Kotaska, 2013). For example, the Coastal Stewardship Network, which employs Guardian Watchmen from 7 First Nations communities in coastal British Columbia, has been in operation since 2010 . The Lsetsul K’e Dene First Nation have run a similar program called Ni Hat’ni Dene (“Dene Watchers of the Land) since 2008 (Lutsel K’e Dene First Nation, n.d.). Both of these programs employ monitors (Guardians) who regularly survey their lands and waters to collect scientific indicators, protect cultural sites, and inform visitors about their territory. The Arctic Borderlands Ecological Knowledge Co-op (ABEKC), has been in operation since 1996 and includes 8 Gwich’in and Inuvialuit communities with local monitors who conduct annual interviews with harvesters, similar to the ones we have tested here (Eamer, 2006). The observations and knowledge documented by monitors serve alongside scientific research to inform resource co-management decisions (Russell et al., 2013). These monitoring programs were developed iteratively with ongoing rounds of feedback from monitors, community members and leaders, in order to re-assess and refine monitoring objectives, indicators and methods (Eamer, 2006; Coastal First Nations, 2017), which encourages us to continue along a same path. The Gitga’at First Nation is part of the Coastal Stewardship Network described above and has a team of Guardian Watchmen who conduct regular patrols of Gitga’at territory, but to date they have not explicitly noted harvesters’ observations. By integrating the Gitga’at knowledge monitoring program with the Gitga’at Guardian program within the Gitga’at Oceans and Lands Department, as suggested by department leaders, the Gitga’at First Nation can enhance its monitoring with the observations of land and sea users. This is an opportunity that exists for other First Nations and Indigenous groups with pre-existing monitoring programs.

As Gitga’at department leaders emphasized, a key way to enhance the monitoring program we piloted would be to increase the number of participants. We estimate that approximately 58% and 68% of harvesters shared their observations from the spring and fall/winter harvest seasons, respectively. Uneven ability or willingness to participate is a challenge within participatory and community-based work in general (Natcher & Hickey 2002). While we are generally happy about our response rates and representation of different groups (men, women and a range of age and family groups), some opinions and observations were still likely missed. We are encouraged by the positive feedback received following the spring harvest pilot season that the number of

interview participants was higher in the fall/winter season. Higher levels of participation will increase the ability for diverse contributions, while also increasing the power of shared observations. Heterogeneity of communities in terms of participation, status, and family groups also means that it is essential that participating harvesters be able to establish how widely they want their knowledge shared, since some pieces of knowledge are strictly confidential to family groups or clans, while others are openly shared within and outside of the community (Chambers et al., 2017; Pulsifer et al., 2012). Setting clear protocols about which observations and pieces of knowledge may be shared and with whom is crucial, and more work is warranted to design appropriate data management systems.

Initiating and designing a Gitga'at knowledge-based monitoring program highlighted the importance of building capacity to ensure the continuation of the program. Department leaders emphasized that in order to create a self-sustaining program, university researchers should invest the necessary time into transferring data collection and management skills to Gitga'at people. In as much, we echo Coombes et al. (2014) in saying that collaborative research should not be judged by its primary outputs but rather its capacity to transition skills to host communities so that they become bases for continued independent research. We have obtained funding for a transition period to further train Gitga'at researchers so that the monitoring program can be fully self-sufficient. We encourage academic and funding institutions to recognize the time it takes to establish good relationships and for bi-directional transfer of research skills in participatory and/or community-based research settings.

The iterative and participatory design process we have detailed here, and the resulting tools for documenting Indigenous harvesters' observations and knowledge can serve as templates for other Indigenous groups that wish to create similar initiatives. The iterative and community-informed process we used allowed us to design a monitoring approach with tools tailored to Gitga'at objectives and harvesting practices. This process is an adaptable approach that other Indigenous groups may find useful for designing their own monitoring programs. Further, we invite other interested Indigenous groups to modify the logbook and interview guides we tested here to suit their own social-ecological context and generate information that would be useful to their own specific needs and objectives .

Chapter 4: Indigenous food harvesting as social-ecological monitoring: A case study with the Gitga'at First Nation

Introduction

Indigenous peoples around the world have been monitoring and managing the natural resources in their homelands and waters for millennia (Lepofsky et al., 2009; Turner & Berkes, 2006). Scholarship within sustainability sciences and resilience thinking has come to recognize the capacity of place-based and Indigenous knowledge systems to enable adaptive management and resilience (Berkes et al., 2000). Resilience can be defined as the capacity for a social-ecological system to respond and adapt to change while maintain its core identity (Folke, 2006; Ostrom, 2009). In recent decades, partnerships between scientists and Indigenous peoples have also embraced opportunities to refer to both Indigenous and scientific knowledges in order to better understand and manage ecological systems (Eckert et al. 2017; Housty et al., 2014; Moller et al., 2004).

An increasing number of non-Indigenous monitoring programs have also begun to solicit the knowledge of Indigenous peoples in order to better manage natural resources, conserve biodiversity and adapt to climate change (Thompson et al. 2018, *In Review*). These initiatives have involved varying degrees of partnerships, ranging from externally-driven initiatives with local Indigenous data collectors employed to administer a specific methodology, to autonomous Indigenous place-based activities as methods of monitoring (Thompson et al. *In Review*, Danielsen et al., 2009; Wilson et al. 2018). These different levels of partnership are often reflected in the monitoring indicators that are used. Monitoring initiatives driven by external agencies tend to focus primarily on ecological indicators (e.g. Bellfield et al. 2015), while those led by Indigenous peoples tend to include a more holistic suite indicators including social, ecological, social-ecological and spiritual indicators (e.g. Lyver et al., 2017; Parlee et al. 2005).

Whether externally- or locally-driven, monitoring initiatives that involve Indigenous peoples and their knowledge are occurring in a time of unprecedented rates of social and ecological change (IPCC, 2018) and imperial and colonial policies continue to politically, economically and socially marginalize Indigenous peoples throughout the world (e.g. Dhillon, 2015). Colonial

pressures are often compounded by the effects of climate change, making Indigenous lifeways among the most threatened (Ford et al., 2016; Savo et al., 2016). Indeed, much work has been dedicated to exposing the multiple ecological changes experienced by Indigenous communities due to rapid climate change (Krupnik & Jolly, 2002; Shaffer, 2014; Turner & Clifton, 2009). In spite of these challenges, Indigenous peoples are currently at the forefront of a resurgence movement that includes a reclamation of language, culture and rights to manage their lands and waters (Corntassel, 2012; Simpson, 2017). Several communities have decided to partner with academic researchers to seek ways of documenting environmental changes in order to inform adaptation on their own terms (e.g. Bennett & Lantz, 2014; Gearheard et al., 2011)

The purpose of this research is to showcase an example of autonomous Indigenous monitoring in northern British Columbia, Canada. Based on the conversations and interviews conducted as part of developing a monitoring program based in Indigenous knowledge in collaboration with researchers from the University of Victoria (described in Chapter 3) we outline a conceptual framework – (i.e. a set of interrelated concepts and their relationships (Jabareen, 2009)) – which illustrates how Gitga’at people monitor their territory through continued use and occupancy. As with other Indigenous peoples (e.g. Lyver et al., 2017), a large portion of Gitga’at identity and relationship with the land and sea is centered around food harvesting activities, including travelling, harvesting, preparation and preservation (Cuerrier et al. 2015; Garibaldi & Turner, 2004). Thus, the analysis and resulting framework described in this paper focus on food species that play an important role in the cultural identity of Gitga’at people. The framework describes the interconnected social and ecological elements and indicators that Gitga’at people use to monitor while participating in harvesting activities and is illustrated by changes observed by Gitga’at harvesters over the course of two harvest seasons. This work adds to a growing body of literature describing Indigenous methods of caring for land/sea and people. We hope that this work will inform discussions of future resource management and governance initiatives in coastal British Columbia Canada and elsewhere.

Context

The Gitga'at are a Tsimshian tribal group whose people have occupied and cared for their lands and waters (Figure 1) on the Northwest coast of North America for several thousand years. Despite colonial policies of cultural assimilation and land dispossession, many Gitga'at people continue to harvest and consume traditional foods on a daily-basis (Fediuk & Reid, 2014). The traditional language of the Gitga'at is Sm'algyax, although English is now the main language used. The home community of Gitga'at people is Hartley Bay (Txałgiu in Sm'algyax), where approximately 140 people live year-round. Another 400 Gitga'at citizens reside in Prince Rupert, located 140 km northwest of Hartley Bay, and other cities across North America. The leaders of each Gitga'at house group (waap) oversees the stewardship, allocation and management of resources based on an intimate knowledge of their territories, adaawx (oral histories), and ayaawx (laws derived from those histories). Gitga'at territorial management activities now also largely embrace the methods and technology offered by science (e.g. Keen et al., 2017; Ritts et al. 2016). Contemporary stewardship of Gitga'at territory is led by hereditary leaders and spokespeople, with advice and technical administration provided by the Gitga'at Oceans and Lands Department and Gitga'at Guardians (Gitga'at First Nation, 2011).

The idea of initiating a program to document Gitga'at harvesters' observations of change was spurred by the director of the Gitga'at Oceans and Lands Department in early 2016 when he and several harvesters witnessed abnormalities in Gitga'at territory including sea star wasting syndrome, increasing red tides, and high levels of biotoxins in clams (Thompson & Picard, 2015). The idea had also been previously suggested by ethnoecologists and climate scientists who had documented some of the longer term changes experienced by Gitga'at people (Turner et al., 2013). To assist with designing a Gitga'at monitoring program, a partnership was formed with researchers at the University of Victoria. To ensure Gitga'at knowledge was reflected in the design Gitga'at co-researchers were an integral component and the project was designed to be highly participatory (see Chapter 3). The principles of this reciprocal relationship were built into a protocol agreement that was signed between researchers at the University of Victoria and the Gitga'at First Nation prior to the beginning of any research activities.

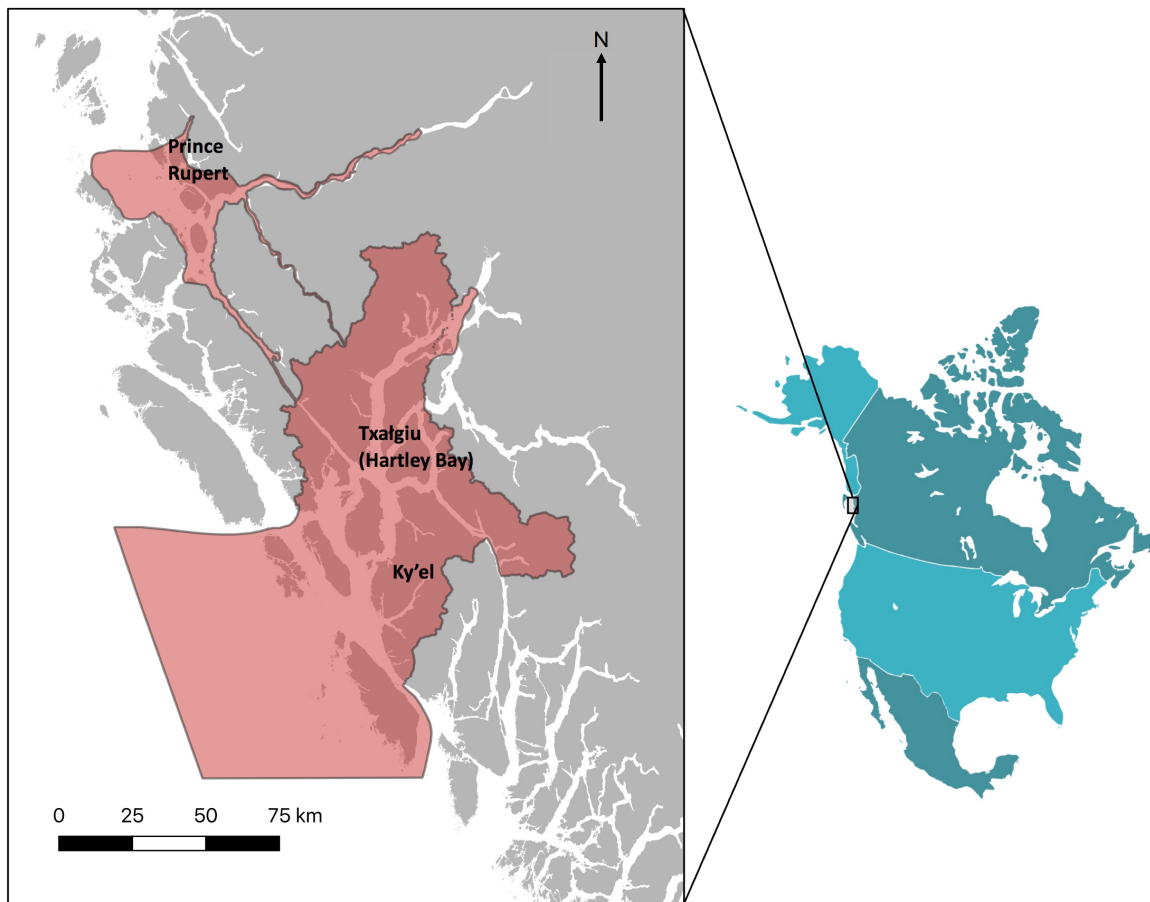


Figure 1. Red shading indicates Gitga'at traditional territory and harvest areas

Methods

We iteratively developed a conceptual framework of how Gitga'at people monitor through harvesting traditional foods with Gitga'at harvesters and knowledge holders, and we focused primarily on marine foods species. First we conducted informal interviews (as described in Bernard, 2006) with 36 land/sea users and Elders about whether a monitoring program based in their knowledge and observations was of interest, and if so what the objectives of the program should be. We held interviews in October and December of 2016 in the participants' preferred location and notes were taken following these conversations to summarize the ideas that had been discussed. We then organized community meetings in the Gitga'at communities of Hartley Bay and Prince Rupert in March 2017. Informal interviews and community meetings were followed by workshops where harvesters were invited to help design tools to document their

observations of change. These tools included a harvesters' logbook and a post-harvest season interview guide that would be used to guide semi-structured interviews. For a more detailed discussion of the steps taken to initiate, design, and test the Gitga'at monitoring program see Chapter 3.

We conducted semi-structured interviews with harvesters and knowledge holders following the spring and fall/winter harvest seasons of 2017/8. Spring harvesting typically occurs in the southern waters of Gitga'at territory and centers around Ky'el, a seasonal village. At Ky'el harvesters travel out during the day to fish for halibut (txaw, *Hippoglossus stenolepis*) and spring salmon (yee, *Oncorhynchus tshawytscha*), and to pick seaweed (fa'ask, *Pyropia abbotiae*) and other intertidal resources. Fall and winter harvesting is mostly spread throughout the central and northern parts of the territory and is focused on bivalves such as Nuttals cockles (gaboox, *Clinocardium nuttallii*) and butter clams (t'sa'ax, *Saxidomus giganteus*), and seasonally available salmon species. Interviews included individuals who, though they may not have participated in the harvest, have lifetimes of experience preparing, preserving and cooking traditional foods. Participants were selected based on our personal knowledge of active harvesters and based on recommendations made by participants. The interview guide, developed collaboratively with Gitga'at harvesters, included questions to prompt participants to speak about harvest intensity, whether their needs for traditional foods were met, changes in the abundance and quality of traditional foods, trading and sharing activities, as well as changes in weather patterns, in the landscape and/or water (Appendix B). Interviews were digitally recorded and transcribed with permission from participants.

We analyzed informal interviews, community workshop and meeting discussions, and the post-harvest interviews using a conceptual framework analysis approach (Jabareen, 2009). This qualitative method involves categorizing and connecting concepts from different sources of data to create a conceptual framework. The method requires researchers to familiarize themselves with the data, identify concepts and themes within them, then organizing them in relation to one another to synthesize a framework. The framework is then validated, and revised as new inputs are added. In our case, the data sources included notes and transcripts from informal interviews, community-meetings and workshops, and post-harvest season interviews. We reviewed notes

and transcripts to code overarching concepts and themes (e.g. access to resources, cultural continuity, habitat quality) and specific monitoring indicators that were described by participants using NVivo software. We listed all monitoring concepts, then connected these to specific indicators that harvesters had spoken about. We then connected concepts based on how participants described their feedbacks and visualized the emerging pattern using Visual Understanding Environment software (Tufts University, 2015). Our validation process included review and revisions to the framework made by knowledgeable harvesters and community leaders.

To illustrate the kind of information that can be provided from a Gitga'at harvesters' observations-based monitoring program, we analyzed the content of interviews for observations of change in the quantity and quality of traditional foods by coding these themes, then organizing the data using Microsoft Excel. We focused this analysis on observations made by Gitga'at harvesters and Elders during systematic post-harvest season interviews about the species most commonly harvested (i.e. with the highest number of interviewees having harvested that species in the two focal harvest seasons). We used this data to calculate the proportion of participants who had observed positive or negative trends in quality and quantity of each food species, and whether they were meeting their needs for that species. We then convened community meetings to discuss this synthesis.

Results

All active harvesters and Elders who took part in informal interviews demonstrated a strong interest in a potential monitoring program based in Gitga'at harvesters' observations and knowledge. Four key and interrelated objectives emerged from conversations regarding how harvesters wanted to see their knowledge and observations used to track changes occurring in Gitga'at Territory. These objectives were to:

1. Inform stewardship decisions and adaptation measures;
2. Encourage youth to learn about their traditional foods and how the territory is changing;
3. Strengthen the case for Gitga'at rights to manage resources in their territory; and,
4. Inform health and wellness programming.

We conducted post-harvest season semi-structured interviews with 42 individuals after the spring and fall/winter harvest seasons between June 2017 and March 2018. Twenty-three individuals were interviewed after the spring harvest season and 29 were interviewed following the fall/winter harvest season, with 10 interviewees participating in both seasons. Participants' age ranged from 24 to 92 years, with an average of 56, and 67% being between 40 and 79 years old. 71% of participants were men and 29% were women. Active harvesters who were interviewed had anywhere between 1 and 68 years of harvest experience with any given species, with an average of 29 years of experience, and 67% of harvesters had at least 20 years of experience harvesting focal species (Table 1). Not all participants answered all questions, thus sample sizes vary for each question.

Table 1. Common seasonal food species, number of participants and years of harvest experience. "NA" indicates where the years of harvest experience were not disclosed by the participant.

Harvest Season	Food Species			Number of harvesters interviewed	Harvest Experience	
	<i>Sm'algyax name</i>	<i>English name</i>	<i>Scientific name</i>		<i>Minimum (years)</i>	<i>Maximum (years)</i>
Spring 2017	Ła'ask	red laver seaweed	<i>Pyropia abbotiae</i>	16	2	68
	Yee	Chinook salmon	<i>Oncorhynchus tshawytscha</i>	13	17	50
	Txaw	Pacific halibut	<i>Hippoglossus stenolepis</i>	11	2	47
	'Yaans	Black katy chitons	<i>Katharina tunicata</i>	7	16	30
	Dsik'wi'its	Red sea urchins	<i>Mesocentrotus franciscanus</i>	7	4	33
	Üüla	Harbour seal	<i>Phoca vitulina</i>	7	5	48
	Ts'mhoon	Yellow-eye rockfish	<i>Sebastes ruberrimus</i>	3	30	45
	Gyenti	Giant red sea cucumber	<i>Parastichopus californicus</i>	3	1	45
	Ts'ak	Gumboot Chiton	<i>Cryptochiton stelleri</i>	3	3	50
	Hagwn	California mussel	<i>Mytilus californianus</i>	2	20	48

Table 1 (cont'd). Common seasonal food species, number of participants and years of harvest experience. “NA” indicates where the years of harvest experience were not disclosed by the participant.

Harvest Season	Food Species			Number of harvesters interviewed	Harvest Experience	
	<i>Sm'algyax name</i>	<i>English name</i>	<i>Scientific name</i>		<i>Minimum (years)</i>	<i>Maximum (years)</i>
Fall/Winter 2017	Gąboox	Nuttal's cockle	<i>Clinocardium nuttallii</i>	12	6	52
	Ts'a'ax	Butter clam	<i>Saxidomus giganteus</i>	8	25	52
	Üüx	Coho salmon	<i>Onchorynchus Kisutch</i>	8	25	41
	K'almooos	Dungeness crab	<i>Cancer magister</i>	7	18	50
	Üüla	Harbour seal	<i>Phoca vitulina</i>	5	4	42
	Yee	(Winter) Spring Salmon	<i>Oncorhynchus tshawytscha</i>	5	NA	68
	Wüdzii	Moose	<i>Alces alces</i>	5	7	27
	Wan	Black tail deer	<i>Odocoileus columbianus</i>	4	NA	NA
	Amgyiik	Surf Scoter	<i>Melanitta spp.</i>	2	14	44

Conceptual framework of Gitga'at monitoring by harvesting

Our conceptual framework analysis of participants' observations of change revealed ten elements that are monitored through Gitga'at harvesting activities: food species abundance; food species quality; habitat quality; harvest intensity; cultural continuity; sharing and trading institutions; external factors; and abnormal species and landscape features. Participants described using several indicators to assess change within each of these elements (Table 2). These elements are ecological, social and social-ecological in nature and many participants described feedbacks between different elements, which are represented by the arrows in Figure 2. Indicators used to monitor each element and feedbacks between elements, as described by participants, are further detailed in the next sections.

Table 2. Concepts and indicators that Gitga'at people described monitoring during harvesting activities

Concepts monitored by Gitga'at people through harvesting activities	Indicators
Abundance of food species	<ul style="list-style-type: none"> - Catch per unit effort (CPUE) - Spatial distribution of species - Associated species - Cyclical patterns of abundance
Quality of food species	<ul style="list-style-type: none"> - Texture - Size - Smell - Colour - Taste - Ease of harvest - Signs of illness
Habitat quality	<ul style="list-style-type: none"> - Water clarity - Smell - Species diversity and abundance - Sediment texture - General feeling - Presence of supernatural beings
Food harvest intensity	<ul style="list-style-type: none"> - Prevalence of traditional management practices - Spatial harvest intensity - Amount harvested
Sharing and trading institutions	<ul style="list-style-type: none"> - Number of people giving and receiving foods - Age of people giving and receiving foods - Geographic spread of shared or traded foods
Accessibility	<ul style="list-style-type: none"> - Physical barriers to harvesting - Physical barriers to travelling - Cost of fuel - Availability of time
Weather	<ul style="list-style-type: none"> - Wind strength - Wind direction - Relative number of sunny days - Relative number of rain or snow days - Air temperature - Water temperature
Cultural continuity	<ul style="list-style-type: none"> - Knowledge of territory - Use of Sm'algyax - Knowledge of harvest protocols - Number of young people on the land - Prevalence of ceremony

Table 2 (cont'd). Concepts and indicators monitored by Gitga'at people while participating in harvesting activities

Concepts monitored by Gitga'at people through harvesting activities	Indicators
External pressures	<ul style="list-style-type: none"> - Predators - Pollutants - Commercial harvest - Recreational harvest - Illegal fisheries
Abnormal species and landscape features	<ul style="list-style-type: none"> - Invasive species - Strange animal behaviour - Unusual phenology - Landslides

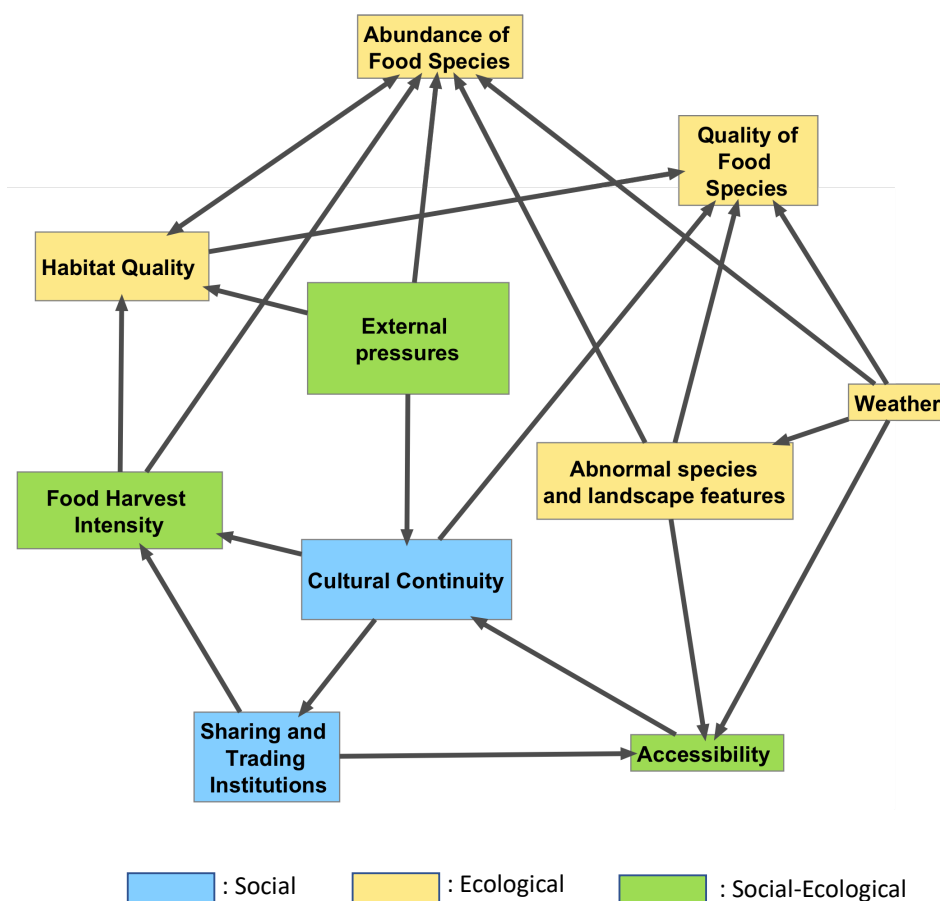


Figure 2. Conceptual framework representing Gitga'at peoples' description of monitoring through traditional food harvesting. Each box represents a social, ecological, or social-ecological concept monitored by Gitga'at harvesters. Arrows represent Gitga'at knowledge of the interrelationships among these different concepts. Specific indicators used to monitor each concept are listed in Table 2.

Abundance

Harvesters described changes in the abundance of food species by noting changes in the quantity harvested relative to the effort invested (catch per unit effort). For example, cockles are deemed to be decreasing in abundance (Figure 3) since harvesters must dig for longer periods of time relative to the past before finding cockles at their preferred beaches. As one harvester, who preferred to remain anonymous, put it, *“It used to be that with one rake 4 or 5 cockles would come out. Now one rake and it's just dirt, sand and a rock. You gotta go hunt and find them”*. The abundance of food species can also be estimated and monitored based on the abundance of other species that may have an ecological or phenological relationships with the focal species. For example, some knowledge holders said that they estimated the abundance of returning salmon based on the abundance of berries the previous summer. Many participants also said that, since they know what some food species’ spatial distribution is normally like during different seasons, they are able to evaluate whether food species abundance has changed. For example, when speaking about their observations of changing seaweed abundance and spatial growth patterns on rocks (Figure 2), one seaweed harvester explained:

“It’s different now. It used to be the whole beach would be the same condition. Like if you had to trim the ends [of seaweed], you’d be doing that the whole way through. But now you find a rock [where the seaweed is] completely rotten, the next one you can salvage a bit, and the next one is absolutely perfect. And so last year I picked like that and I was salvaging some and they were pretty good, and I had to work like hell for half a sac or something, then I found one little place that filled a sac and a half, and I’m done.... Yeah. The thicker patches seemed to be going rotten, but you’d find small patches that were perfect.”

Quality

Participants indicated that the quality of food species is monitored via several traditional indicators at different phases of the harvesting process. For example, when harvesting seaweed, the length, texture, and colour of fronds are used to judge quality. In addition, the ease of harvest of seaweed is used to judge quality; the harder the seaweed is to pull off the rocks, the higher its

quality. Quality is judged during the drying phase based on its colour, and texture. The taste of fresh and dried seaweed is also used to judge its quality. For most food species, harvesters are quick to note any abnormalities or signs of illness. Mona Danes, now an Elder herself, relayed: *“I was working with the Elders for over 20 years, and to hear their stories... Everybody knew good clams good cockles and stuff like that. There was no one around to tell them it wasn't good. They went by red tide that was it. That was all we ever heard.”*

Habitat Quality

The quality and abundance of food species are dependent on habitat quality, which is traditionally monitored based on a number of indicators. In the case of clam or cockle beaches, the smell of the beach and texture of the sediment are considered. The diversity of other species is also indicative of the health and productivity of a shellfish beach. For example, the spread of tube worms (*Sabellidae spp.*) is increasing at some cockle beaches, which diminishes cockle habitat and makes it difficult for harvesters to dig there. Many harvesters also spoke of a feeling of unease harvesting in certain places that are inhabited by supernatural beings, or from places that have been subjected to pollution in the past (i.e. the sinking of the *M.V. Queen of the North*, a BC Ferries ship that sunk near clam beaches in 2006).

Harvest intensity

Harvesters indicated that food species abundance and habitat quality are both influenced by harvest intensity at any given harvest site. Harvesters are aware of how many others have been using the same sites. Many interviewees expressed concerns that younger generations are no longer practicing sustainable harvesting techniques. These techniques include not harvesting juvenile mollusks in order to allow them time to reproduce and replenish harvest sites, and rotating areas of harvest to avoid depleting certain areas. One participant, who has been digging cockles for over thirty years, remembered a time when cockles were larger and more abundant (Figure 5) and said, *“That's when there weren't much young people going out there. Mostly all elders...”*. Tony Eaton, who has been digging cockles for over fifty years echoed this sentiment

when he said *“We all say to ourselves that some young people harvest some of the ones that are too small... So that's why they're not giving them enough time to get bigger.”*

Harvesters are also aware of shifting harvest intensities at different locations. For example, most harvesters have not been able to harvest butter clams from their preferred clam beach due to biotoxin (saxitoxin) levels being higher than recommended by the Canadian Food Inspection Agency and persisting through the entire harvesting season. Instead, they must harvest from other, less popular, beaches. Many harvesters have noticed that increasing pressures at these beaches are diminishing the harvest returns (Figure 3). George Fisher, who has harvested at these beaches the past several years, noted that *“We all hit that beach every tide pretty much... Everybody did good there that year. But within the past couple years, yeah it's been lower”*. Marshall Reece, who has been harvesting clams for nearly 5 decades, remembers that *“They used to bring us out and we'd get 11 sacs of clams a night. You know those 11lbs sacs? 11 in a night! That was crazy. Now you work hard to get 2 or 3 buckets. For 11 sacs, that's 22 buckets in one night.”*

However, participants also expressed an understanding that a certain intensity of usage must be maintained in order to encourage productivity of several species for future harvest seasons. Echoing a sentiment expressed by several other Elders, Allan Robinson said, *“If you don't use it, you lose it.”* He and others illustrated this with cockle and clam beaches that have not been dug in several generations, which now only yield small amounts of shellfish and are beginning to be overgrown with tubeworms. As Donald Reece said, *“They used to harvest so much of that stuff and they said that it kept the beds healthy 'cause they were harvesting all the time. And if you don't harvest it will turn toxic. If we don't start harvesting out at [our main harvest site] it'll be so toxic, we won't ever be able to touch it.”* The same concept is thought to apply to seaweed, which *“...grows like a tree, it grows better when it's pruned.”* (Albert Clifton).

Cultural continuity

Harvesters described that, by participating in harvesting activities, they are encouraging Tsimshian and Gitga'at cultural continuity and described how harvesting according to what their

Elders have taught them allows for sustainability. For example, many participants described the teaching of only harvesting mature individuals fish or shellfish species. However, some participants attributed some ecological changes in Gitga'at territory to a rupture in the practice of traditional harvesting practices and protocols to younger generations. For example, they stressed that the erosion of knowledge about traditional harvesting protocols and of the location of harvesting areas has led to potential unsustainable levels of harvest at some shellfish beaches. Many expressed a desire to see more young people participating in harvesting activities alongside more experienced harvesters in order to learn. Others stressed that access to harvesting areas and having the time available to harvest are crucial to ensuring cultural continuity.

Some participants also linked these physical changes to a decline in traditional ceremonial practices and forgetting the lessons held in oral histories. As explained by Spencer Greening when reflecting on possible reasons for decreasing abundance of spring salmon, which also included industrial fishing, climate change and mismanagement (Figure 4):

“So many of our stories, and some of our most prevalent stories that exist in almost all of our [Tsimshian] communities, are that when you stop taking care of them [the salmon] and honoring them they start to die out. And it happened ten thousand years ago when we came out of Temlaxam, and it's happening now. And I think it relates to, not only is there a level of physical earth changing, there's an ancestral spiritual level that we should be singing to them when the first salmon shows up and we should be honoring them when we do the hatchery even. But there isn't that. We're not singing to them, were not talking to them in a spiritual way.”

Sharing and Trading Institutions

During the design phase of this study, several harvesters stressed the importance of documenting how traditional foods are being shared since sharing and trading institutions continue to be an important facet of Gitga'at livelihoods. For millennia, trading and sharing have been key to building and maintaining personal and political relationships within and between different villages and tribal groups. This trading and sharing system also has links to sustainability of

harvesting, and the ability to meet needs for traditional foods. One harvester, who preferred to remain anonymous, said:

"One thing I learned from the old people. When you go out you get lots of clams, you share it. Give it to people that can't go out... So I helped a lot of old people, eh. I was taught that by my parents and my grandparents. And the old man used to say that when you do that, you have no trouble the next time you go out there. No trouble getting food."

Accessibility

Participants often brought up issues of access when discussing observations of change and requested that post-harvest season interviews include a question to prompt harvesters to reflect on the reasons why they may not have harvested certain species. Up to half of interviewees felt that their needs for certain traditional foods weren't being met, and up to 33% more felt that, though their personal needs may have been met, they were not able to harvest enough to share (Figures 4 and 5). Given that we interviewed people we knew to be involved in food harvesting activities, we estimate that these are conservative figures.

Several participants described how their involvement in the wage economy reduced the amount of time available to participate in harvesting activities. A reduction of available time has resulted in the reliance on travel by speedboats to reach harvest sites quickly, as opposed to slower gillnetters or small rowboats. The cost of fuel to power speedboats requires harvesters to have a cash income, reinforcing the need to be involved in the wage economy. Other participants spoke of physical barriers to harvesting, such as the tubeworms impeding cockle harvesting.

Weather

Many participants said that they pay close attention to the relative air temperature and amount of precipitation since these factors influence the growth, quality and abundance of several cultural keystone species including salmon and seaweed. Weather also plays a crucial role in the ability access to coastal and marine resources. Thus, many harvesters said they pay particularly close

attention to weather conditions such as the strength and direction of winds. In an interview after the spring harvest season Cameron Hill said:

“The wind’s been pretty bad. Not storm-wise, but just windy enough to make it, I’d say treacherous to get your stuff... As a kid I always remember the outflow winds happening in the morning, and then it calms and it stays calm, and hot, and that’s how our late spring and early summer was. But for the last few years that southerly wind that happens down in Ky’el has been making its way further this way.”

External Factors

Many participants stressed the importance of monitoring external factors that exert pressure on key elements of the system and have the potential to compound changes caused by changing weather patterns. For example, the combined pressures of commercial, recreational, and illegal fisheries directly impact the abundance and availability of several traditional food species. In particular, harvesters said they were intent on preventing the repetition the mismanagement of commercial harvest and subsequent illegal fisheries that led depletion of northern abalone (bilhaa, *Haliotis kamtschatkana*) under the watch of the Canadian Department of Fisheries and Oceans (DFO). While traditional harvesting followed strict protocols, including not harvesting immature individuals and only harvesting during low tides in the spring months without diving, commercial harvesting occurred year-round and included subtidal harvest. This led to rapid depletion and a moratorium on all harvesting, including for Indigenous food, social, or ceremonial purposes. Many participants were concerned that a similar scenario might unfold with decreasing numbers and quality (size) of coho and chinook salmon (Figures 4 and 5).

Participants also described unbalanced predator-prey dynamics as an external pressure on harvested species. Harvesters are also concerned about the effects of man-made pollutants including polycyclic aromatic hydrocarbons from fossil fuel spills and combustion, plastics and microplastics, and radiation released by the tsunami that hit nuclear reactors in Fukushima, Japan in 2011, on their ability to consume traditional foods.

Abnormal species and landscape features

Finally, harvesters described abnormalities in species composition and behaviour, and components of the landscape that were noteworthy to interviewees as features of monitoring. These include non-native and invasive species, such as tent caterpillars that devastate pacific crab apple trees (sgan moolks, *Malus fusca*), and unusual animal behaviour such as the large numbers of bears entering the village of Hartley Bay in the Fall of 2017 (Figure 5a and b).

Harvesters also noted an unusually high number of landslides in the fall of 2017, which impacted their ability to travel safely due to large quantities of woody debris in the water (Figure 5c). Such abnormalities may potentially impact access to traditional foods, habitat quality, and the abundance and quality of traditional food species.

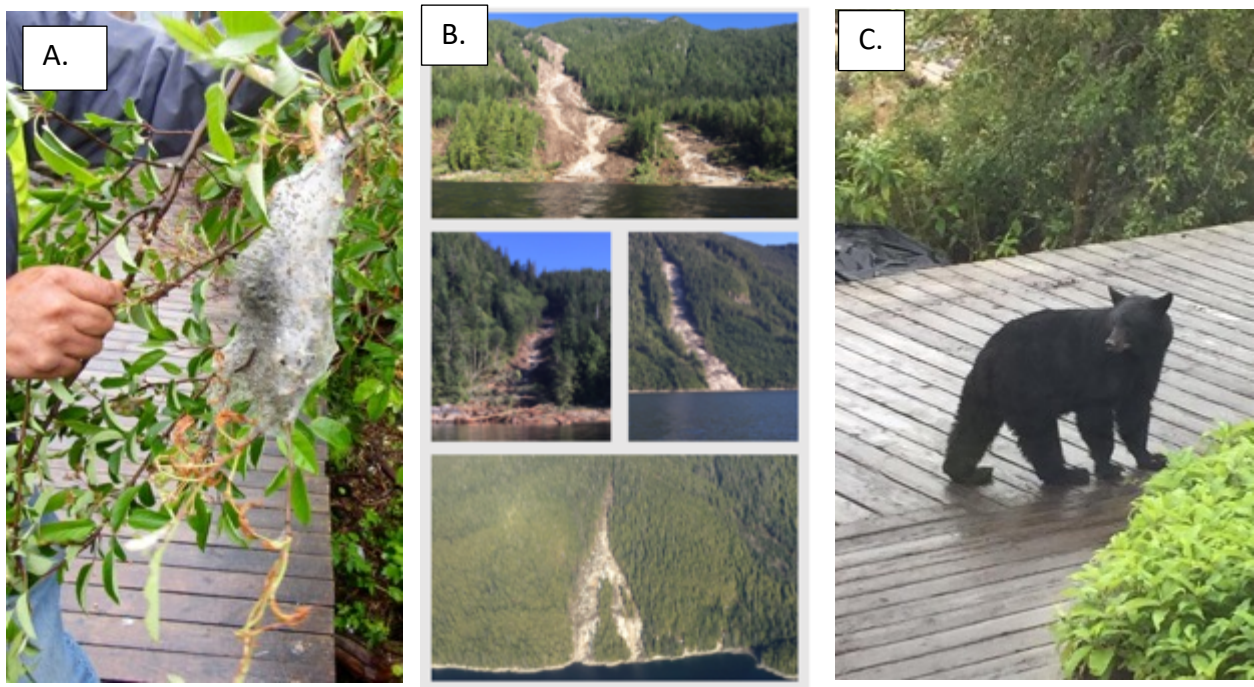


Figure 3. Species and landscape abnormalities observed in Gitga'at territory during the spring, fall and winter 2017. A) Ian Eaton with non-native tent caterpillars on pacific crab-apple tree (photo: Kim-Ly Thompson); B) Numerous landslides in Gitga'at territory (photos: Bruce Reece, Chris Picard, Donald Reece); C) Black bear entering Hartley Bay to forage in September 2017 (photo: Angela Clifton)

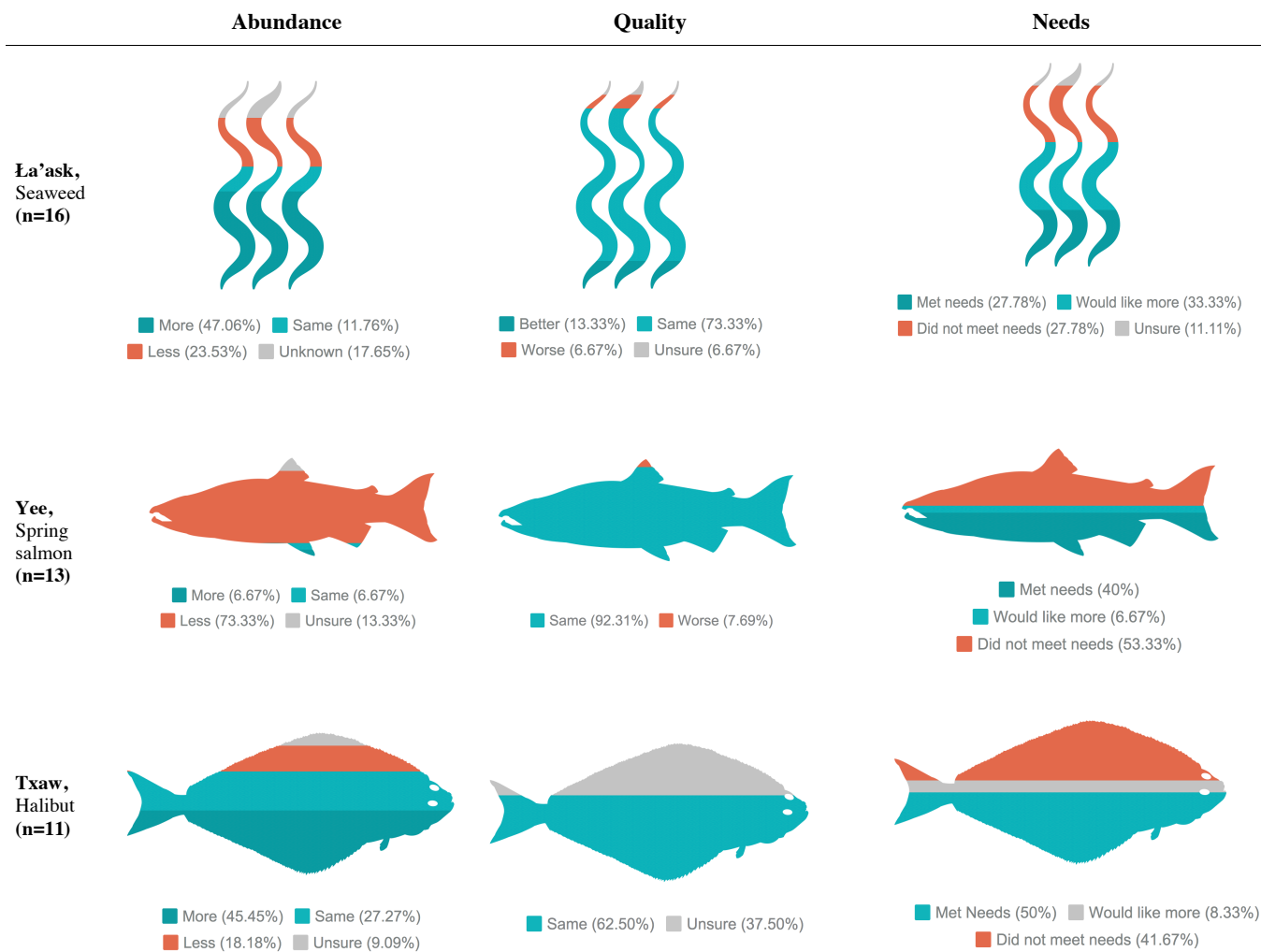


Figure 4. Harvesters' observations of the change in abundance and quality of the three most commonly harvested traditional foods in the Spring of 2017, and whether harvesters are able to meet their needs for those foods.

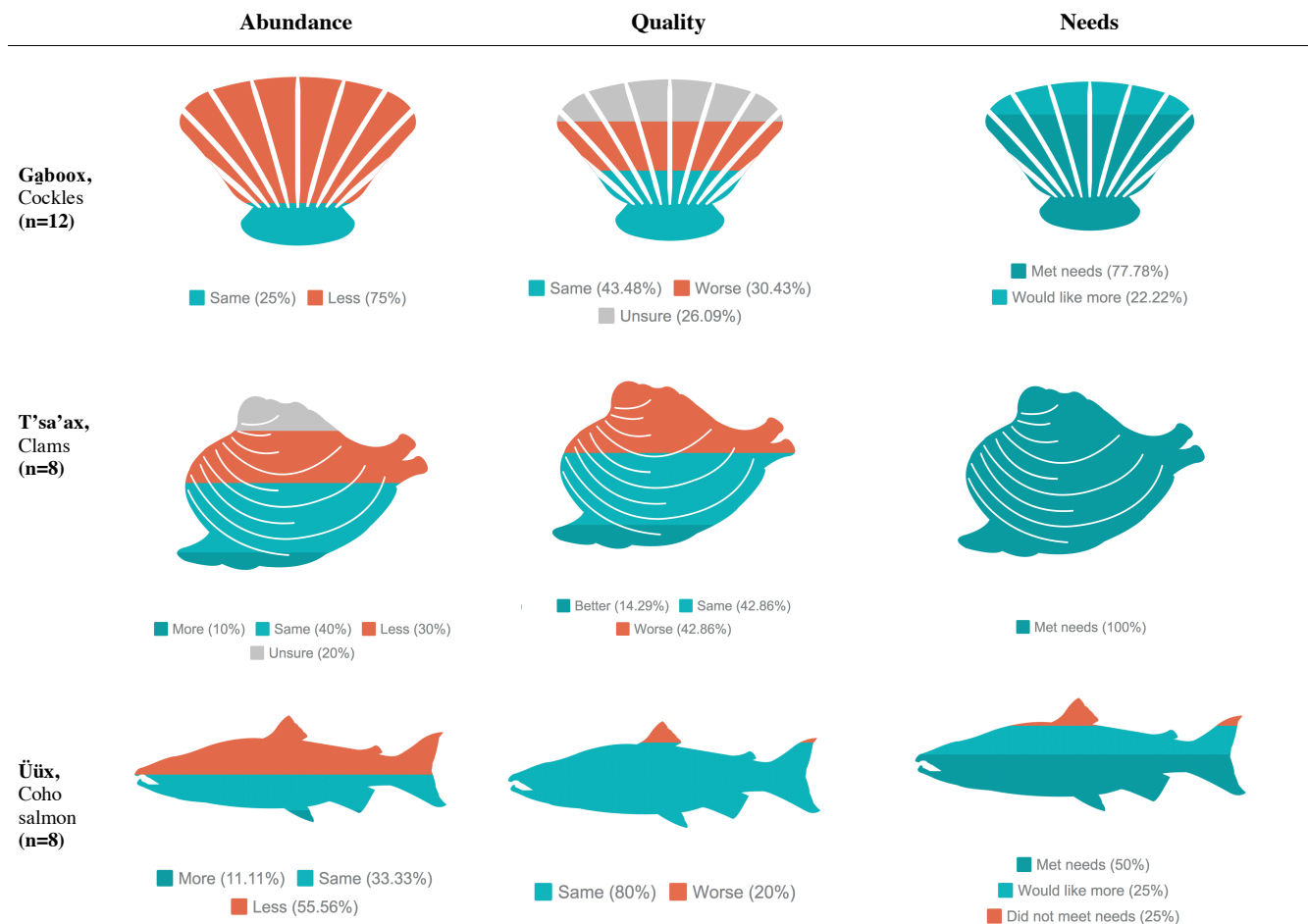


Figure 5. Harvesters' observations of the change in abundance and quality of the three most commonly harvested traditional foods in the Fall and Winter of 2017, and whether harvesters are able to meet their needs for those foods.

Discussion

In this case study, we analyzed Gitga'at harvesters' observations of change in their territory to outline the elements and indicators they monitor through harvesting. Our analysis revealed that interlinked social and ecological elements are monitored by Gitga'at land and sea users. It is important to note that the distinction between social and ecological elements of the monitoring framework was not made by Gitga'at participants, as occurrences in the spiritual and social-political world and the natural world are understood as inseparable. In fact, when we first designed the framework we did not see the necessity of delineating social from ecological or

social-ecological components. We have since chosen to make this distinction to demonstrate its relevance to the broader body of social-ecological systems literature. The framework of Gitga'at understandings of monitoring-through-harvesting that we have developed adds to examples from other Indigenous groups. Together these examples can further the discussion on the development of appropriate regional and global indicators of social-ecological resilience, and can help to situate the appropriate inclusion of scientific methodologies within Indigenous approaches to monitoring. Further, our framework highlights the connections between cultural continuity and sustainable management of resource, thus encouraging efforts to revitalize Indigenous knowledge. We discuss these points further in the paragraphs that follow.

Our findings that Gitga'at harvesters monitor social and ecological indicators through land- and sea-based practices is similar to reports from other Indigenous communities. For example, Māori in New Zealand monitor forest health and community well-being using indicators that include prevalence of certain species, sounds associated with the forest, intensity of weather, and the strength of people's connection to the forest (Lyver et al., 2017). In northern Canada, Denésôfiné hunters monitor barren ground caribou migrations using physical indicators such as body condition and population size as well as spiritual indicators to explain variability in migration patterns (Parlee et al., 2005). Such culturally-grounded indicators are well suited to trace the effects of human processes on ecological outcomes and vice-versa (see. Bird & Nimmo, 2018). While the culturally-specific nature of Indigenous indicators can present challenges of comparability across scales, starting with local cultural perspectives and recognizing feedbacks between ecological and human well-being can help link regional, national, and global decision-making to local realities (Sterling et al., 2017). The Tracking Change project conducted with communities across the Mackenzie, Mekong, and Amazon River basins is demonstrating this potential by building local monitoring indicators, and networking knowledge gained (Michell et al., 2018; Parlee & Mahoney, 2017). Given the scale and rate of global environmental change, complex systems and resilience scholars have been stressing the need for such social-ecological monitoring (Anderies et al., 2004; Caillon et al. 2017).

There are some key differences between the approaches taken by Indigenous monitoring-through-resource-use and other types of monitoring that are prevalent in Indigenous territories

(for example, scientific monitoring for wildlife conservation). First, the objectives set by Gitga'at participants for a monitoring program based in their knowledge and observations of change ultimately about community well-being and survival. Further, monitoring through harvesting activities is anchored within longstanding place-based knowledge which includes social and ecological elements. On the other hand, the objectives of scientific monitoring for conservation or climate change are set at larger scales, often across regional, national, or international scales (e.g. Bellfield et al., 2015). In as much, conservation indicators are generally quantifiable and standardized across scales. However, they rarely take social or linked social-ecological indicators into account (Thompson et al. 2018, *In review*), thus potentially missing important connections and feedback loops. There is, however, some overlap between indicators monitored by Gitga'at harvesters and scientific conservation efforts, such as species abundance and distribution. This can create opportunities for Indigenous groups to seek out scientific methods in order to enrich ecological understanding by complementing the place-based nature and longer historical baselines of Indigenous monitoring methods (for example, Gitga'at harvesters' knowledge of places in their territory where food species are typically abundant) with the larger spatial scales and quantitative nature of scientific ones (Ban et al., 2018; Moller et al., 2004).

Describing how interconnected social and ecological elements and indicators are monitored through Indigenous harvesting activities, centers Indigenous approaches to monitoring while demonstrating that scientific approaches can be leveraged where appropriate. Bohensky & Maru (2011, p.10) describe the integration of scientific and Indigenous monitoring methods as "... a process in which the originality and core identity of each individual knowledge system remains valuable in itself and is not diluted through integration with other types of knowledge." A key part of this process is to frame objectives within local Indigenous values, identify the pre-existing Indigenous methods of generating knowledge, then seeking relevant scientific knowledge to enhance research and monitoring (Ban et al., 2018). Using this approach, several Indigenous communities have leveraged scientific approaches to meet their needs. Notably the Heiltsuk, Kitsaoo/Xais Xais, Nuxalk, and Wuikinuxv Nations have joined to create the Central Coast Resource Alliance (CCIRA) which partners with ecologists to conduct marine monitoring and research projects based in local needs (Eckert et al., 2017; Frid et al. 2016). These Nations and the Gitga'at Nation have also partnered with scientists to monitor bear populations on the

central coast by anchoring their objectives in local needs and using Indigenous knowledge and scientific methods to conduct their projects (Housty et al., 2014; Service et al., 2014). The Haida Nation pioneered a Guardian Watchmen program to employ their own people to monitor important cultural resources and sites in their territories. This monitoring has since expanded to other Coastal First Nations and now includes standardized scientific methods applied through the Coastal First Nations Regional Monitoring System (Coastal First Nations, 2017). These examples are most familiar to us thanks their geographic proximity to our own work, though we recognize that such equitable and enriching partnerships which anchor scientific methods in Indigenous values likely exist in other communities as well, notably Arctic communities (e.g. Adams et al., 1993).

There are some limitations to our study. We interviewed a subset of harvesters and knowledge holders (approximately 58% of harvesters in the spring and 68% of harvesters in the fall/winter) and are thus likely to have missed perspectives and indicators. For this reason, the list of species and indicators we have compiled is not comprehensive. However, it serves as a good starting point to discuss other Gitga'at-specific indicators. Another limitation is that participants' answers to questions about changing abundance and quality were rarely unanimous, and thus we cannot yet conclusively comment on directionality of changes. Some aspects of the lack of unanimity can be attributed to participants' broad range of harvest experience, and that younger harvesters may not be aware of past ecological conditions (i.e., shifting ecological baseline syndrome) (Papworth et al. 2009). Furthermore, there may be a generational difference in the needs for traditional foods as store bought food become more readily accessible and diets shift (Kuhnlein & Receveur, 1996). Parsing and comparing observations by age group can identify opportunities for Elders to share their knowledge of ecological (i.e. abundance of food species) and social-ecological (i.e. how often traditional foods were consumed) baselines with younger generations. However, intragenerational differences in observations of change may point to the fact that some participants may be more knowledgeable in some areas than others. This difference in specific knowledge can be attributed to gendered roles (for example, women may be more knowledgeable about indicators of quality that can be observed while preparing and preserving foods) or expertise in harvesting and preparing specific food species and not others (Butler, 2004). The identification of experts by Gitga'at peers and community members for each

indicator and element of the monitoring framework is an important next-step for the proposed monitoring program (Davis & Wagner, 2003).

Participants' emphasis on harvesting as an act of cultural continuity and the role of traditional harvesting protocols in ensuring sustainability highlights the importance revitalizing and promoting Indigenous ways of knowing as an avenue for the restoration and resilience of ecological systems (Corntassel & Bryce, 2012; Kimmerer, 2000). Longstanding experience and monitoring of human-nature interactions can lead to incremental learning of how to best live sustainably, and lessons are often perpetuated and strengthened through worldview, oral histories, and social institutions (Turner & Berkes, 2006). This is the case in Tsimshian society where traditional harvesting practices and governance has built in checks and balances to guide sustainable resource use, including harvest protocols and management rights and responsibilities of clan and house leaders (Gitga'at First Nation, 2011). These protocols and teachings, which have developed over thousands of years of occupancy, are alive in the Tsimshian *adaawx* (true-tellings or oral histories) and the *ayaawx* (law) (Greening, 2017). However, as with many other Indigenous communities, some of these teachings have been eroded due to colonization and assimilationist policies (e.g. residential schools and the Indian Act in Canada) (Simpson, 2017; Truth and Reconciliation Commission, 2015). Thus, there are moral and practical obligations for settler governments to support efforts of Indigenous resurgence. In addition to ensuring the physical sustenance of coastal Indigenous peoples, the revitalization of Indigenous knowledge systems necessitates access to the traditional territories and the resources within them as well as the rights to exercise knowledge through management. In as much, Indigenous access to territory and resources needs to have a central place in governance, resource management, and policy discussions (Bennett et al., 2018). Given that Indigenous languages themselves often hold social-ecological knowledge and history (Maffi, 2005), we also encourage efforts to revitalize and investigate the links between language and land.

Chapter 5: Conclusion

Introduction

With the overarching objective of informing the creation of a monitoring program based in the knowledge of Gitga'at harvesters, this thesis examined Indigenous knowledge in relation to monitoring by asking three questions: 1. How has Indigenous knowledge been involved in community-based monitoring programs, and what are the characteristics of self-sustaining programs?; 2. Which methods of documenting Gitga'at observations of change are best suited for the objectives of the Gitga'at First Nation?; and 3. How does ongoing use of Gitga'at territory inform monitoring? This chapter serves to synthesize how I have answered those questions and how each question was a stepping stone towards informing the overarching objective of this study. In this chapter, I reflect on the academic contributions and practical applications of this research within and beyond Gitga'at territory, its limitations, and recommend future research directions.

Question 1: How has Indigenous knowledge been involved in community-based monitoring programs, and what are the characteristics of self-sustaining programs?

In order to inform the development of a Gitga'at-specific community-based monitoring program, I began by conducting a review of the literature pertaining to existing projects. Though this began as an effort to learn what had and had not worked for other communities, it led to a deeper analysis of the ways that Indigenous peoples and their knowledge have been engaged in shaping the programs themselves. Such a review had not been done previously, and serves as an important contribution to the academic analysis of the consideration of Indigenous knowledge in environmental issues. I analyzed 67 publications about initiatives occurring on every continent according to Danielsen et al.'s (2009) levels of community engagement in monitoring and Wilson et al.'s (2018) levels of Indigenous governance in monitoring. I also inspected the monitoring objectives, methods and indicators associated with each initiative.

A pattern emerged whereby monitoring initiatives could be classified into four types; 1. Indigenous processes as monitoring; 2. Indigenous knowledge guiding scientific monitoring; 3. Indigenous knowledge filling gaps in scientific data; and 4. Externally driven monitoring employing Indigenous technicians. There were commonalities among these types including monitoring objectives predominantly being conservation, tracking environmental change and/or resource management, and a preference for methods such as semi-structured interviews for documenting Indigenous knowledge. However, some types were more highly associated with specific objectives and methods than others. For example, Type 1 and 2 initiatives were unique in having revitalization of traditional management, research, community well-being and/or monitoring of industry within their objectives. Further, the range of indicators monitored varied by type; Type 1 initiatives were most likely to include a broad array of social-ecological indicators, while Type 4 initiatives were most likely to only use ecological indicators. Linking monitoring objectives, methods, and indicators to levels of Indigenous participation and governance through this typology allows for a synthesis of the literature which can lead groups, including the Gitga'at First Nation, to consider which methods and indicators may be best suited to their objectives.

The synthesis of challenges and characteristics of successful monitoring programs is also helpful for the Gitga'at First Nation and other groups. Main challenges were building and maintaining cross-cultural partnerships, and communicating Indigenous knowledge appropriately. Projects that were able to overcome these challenges involved high levels of community participation or direction, were built on partnerships based in trust and respect for various knowledge systems, used multiple methods to document and communicate Indigenous knowledge, and had institutional links between monitoring and management bodies.

Question 2: What methods of documenting Gitga'at observations of change are best suited for the objectives of the Gitga'at First Nation?

Answering this question was most directly linked to the primary objective of this thesis, and the process taken to answer it was informed by the previous research question. I achieved high levels of community participation within the initiation, design, and testing phases by using participatory

methods. Given that the documentation program was meant to be self-sustaining, we – Gitga’at research partners, my supervisor, and I – decided early on that designing the program needed to involve close and regular collaboration with Gitga’at harvesters, Gitga’at decision-makers. Thanks to the previous analysis, we aimed for community direction, linking Gitga’at decision-makers to the monitoring design process, and sought to test multiple methods.

Our process began with informal interviews with knowledge holders. Then we convened community meetings to establish community monitoring objectives. These objectives were to: 1. Track changes occurring in Gitga’at territory to inform stewardship decisions and adaptation measures; 2. Encourage youth to learn about their traditional foods and how the territory is changing; 3. Strengthen the case for Gitga’at rights and title; and 4. Inform health and wellness programming. We then held workshops to collaboratively design two methods for knowledge documentation: a logbook and a post-harvest season interview guide. We tested and revised these over the course of two harvest seasons. We solicited suggestions from harvesters for improving the data collection methods at the end of post-harvest season interviews, by convening post-harvest season community meetings, and by interviewing leaders within Gitga’at departments tasked with the oversight of each of the community goals.

This chapter adds to the academic literature by detailing the process of developing community-based monitoring program based in Indigenous knowledge, which is rarely done. In doing so, it provides insight to other Indigenous groups who may be interested in leveraging the knowledge of their land and/or sea users in a similar way. The tools that we collaboratively designed (logbook and post-harvest season interview guide) are available for other interested groups to adapt according to their communities’ lifeways and objectives. The findings in this chapter lead me to especially encourage relational methods of data collection, such as young people interviewing more experienced harvesters, in order to meet multiple community objectives including intergenerational teaching.

Question 3: How does ongoing use and occupancy of Gitga'at territory inform community-based monitoring?

Over the course of determining the best ways to document Gitga'at observations of change, we listened to participants talk about changes they have been observing. Beyond listing the changes they had observed, they often spoke about why these changes were occurring and explained the many ways in which they keep track of changes in their territory. Hearing these explanations led to my third research question, which I sought to formally answer by using a conceptual framework analysis approach. Leaders of the Gitga'at First Nation also encouraged me to write about the ways “things are done here”. By analyzing transcripts and notes from the informal interviews, community meetings, and post-harvest season interviews, an interconnected set of concepts and indicators that are monitored by Gitga'at harvesters emerged.

The concepts and indicators were social, social-ecological, and ecological in nature. Such social-ecological monitoring through traditional use has also been documented in Maōri and Denésôliné case studies (Lyver et al., 2017; Parlee et al. 2005). My research in this chapter adds to these case studies and furthers the discussion on the development of appropriate regional and global indicators of social-ecological resilience. The framework I developed with Gitga'at harvesters also highlights that, rather than Indigenous knowledge being inserted into a scientific framework, scientific methods can be sought within Indigenous frameworks that are less reductionist. For example, Gitga'at harvesters emphasized the connections between cultural continuity and sustainable management of resources. Since not all Gitga'at knowledge holders and land/sea users were interviewed over the course of this thesis, the framework is a living concept with room for more input and expansion. However, it does serve to demonstrate that Gitga'at people are involved in social-ecological monitoring through their harvesting practices, which adds to the importance of maintaining Indigenous peoples' governance and access to their territories and resources.

Applications within and beyond Gitga'at territory

This research provides the Gitga'at First Nation with foundations from which to pursue ongoing documentation of knowledge gained through harvesting activities as social-ecological monitoring to meet Gitga'at objectives. Fall/winter 2018 marks the program's fourth harvest season since its inception (spring 2017, fall/winter 2017, spring 2018, fall/winter 2018). Several Gitga'at members have been trained in carrying out data collection and analysis, and students from the Hartley Bay school have also been involved. Though land and sea users have been monitoring individually prior to the initiation of this project, systematically summarizing their observations on a seasonal basis can point to overarching trends about resource use and availability, and social-ecological feedback loops, and provides information for Gitga'at departments to enhance their decisions vis-à-vis stewardship, education, rights and title, and health and well-being. With the increasing likelihood of shipping liquified natural gas (LNG) through Gitga'at territory (LNG Canada, 2018), monitoring social-ecological impacts through the lens of Gitga'at land and sea users may be more important than ever in order to prevent insidious and unwanted changes to Gitga'at territory and way of life.

The research process that this thesis outlines and the tools that we developed can serve as guides for other Indigenous peoples that wish to embark on similar social-ecological monitoring initiatives. In coastal British Columbia, several First Nations are engaged in ecological monitoring in their traditional territories. Alongside regional ecological monitoring initiatives, expanding social-ecological monitoring programs to other communities could help to point out social-ecological patterns across regional scales. Documenting harvesters' observation and knowledge alongside these ecological programs has the potential to increase the scope of information available to Indigenous governments, empower resource users and knowledge holders, and further amplify governance and management authority.

Academic Contributions

Beyond contributing to the objectives of the Gitga'at First Nation and providing a guide for the initiation of similar monitoring projects elsewhere, my thesis adds to the existing literature on Indigenous knowledge and community-based monitoring. First, as Indigenous peoples and their knowledge continues to be featured more prominently in the literature about community-based monitoring, it provides a timely summary of the various ways in Indigenous peoples have been engaged. The literature review also provides a synthesis of the challenges encountered by these initiatives and characteristics that could lead to more equitable and effective monitoring partnerships. Despite an increasing number of publications on Indigenous knowledge in community-based monitoring, few have detailed the process of designing such monitoring programs. This thesis helps to fill that gap by describing in detail the process of initiating, designing and testing a monitoring program for the Gitga'at First Nation anchored in the knowledge and observations of Gitga'at harvesters. Finally, my thesis adds to the ongoing discussion of combining scientific and Indigenous approaches to monitoring by suggesting that, where appropriate and desired by Indigenous peoples in whose territory the monitoring is occurring, scientific monitoring can be embedded within pre-existing Indigenous monitoring frameworks.

Study Limitations

An overarching limitation of this thesis is its focus on marine species. Though many of the cultural keystone species of Gitga'at people are marine, terrestrial resources such as ungulates, berries, and many other plant species are important and commonly harvested (Lambert et al. 2004). Focusing on marine species was a necessary scope restriction to make this Master's thesis and interviews tractable. It did, however, present a limitation since several participants wanted to talk about marine and terrestrial species. Similarly, this research was limited to spring, fall and winter harvesting. Thus, it excluded harvester's observations and knowledge about species that are harvested primarily in the summer (such as sockeye salmon, misoo) and about summer weather patterns. Finally - though Chapters 2, 3 and 4 of this thesis were reviewed by Gitga'at co-researchers and methods aimed to be anticolonial and participatory - this work is ultimately

written from my perspective as someone raised in settler society, and thus it should not be interpreted as a Gitga'at or Indigenous perspective. Nevertheless, as work initiated by the Gitga'at First Nation, this research is a first step towards building a monitoring program based in the observations and knowledge of Gitga'at land and sea users while also contributing to the academic literature and providing a case study that other groups can refer to.

As the program enters its next season of data collection, there are opportunities for ensuring that it continues in a self-sustaining way and expands to include more species and summer harvesting. We have secured funding for two and a half more years of data collection and for transitioning all the necessary data collection and management skills to Gitga'at community researchers. Ensuring that there is continuity in the methods of data collection and management may be challenging since staff will change over time. One way to ensure memory within the program will be to develop a handbook to guide future staff in data collection and management methods. There is also room to explore options for developing digital platforms for documenting, managing and communicating observations, as suggested by harvesters and department leaders.

Suggestions for future research

This thesis highlights future research avenues that would be relevant for the Gitga'at First Nation and beyond. Continued Indigenous social-ecological monitoring could provide empirical data with which to model different scenarios in the face of industrial development and climate change. A recent study with Inupiat and Athapascan Gwich'in communities has suggested that social changes impact community robustness more than resource depletion (Baggio et al., 2016). Modelling the impacts of social change and climate change can build understandings about the robustness of social ecological system, which can then inform policy and adaptive management actions. Similarly, investigating the effects of eco-cultural revitalization efforts (e.g. Augustine & Dearden, 2014; Joseph 2012; Corntassel & Bryce, 2012) can help to better detail if and how Indigenous management strategies can help to mitigate the effects of change. Pursuing these research avenues could help to further highlight Indigenous peoples' position as leaders in social-ecological monitoring and adaptive management as we collectively move forward in a world experiencing unprecedented rates of ecological change (IPCC, 2018).

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Appendix A: Supplementary Material

Table 1. Indigenous peoples who have been involved in community-based monitoring initiatives

Indigenous Peoples	Location/Jurisdictions	References
Sami, Inupiat, Inuit, Th̄ ch̄ Dene, Sahtu Dene, Denesoline, Gwich'in, Lutsel K'e Dene, Inuvialuit, Nenets, Aleut, Chuchki, Cup'ik/Yup'ik, Koryak, Kamchadal, Itelman, Siberian/St-Lawrence Yupik, Carcross/Tagish, Kluane, Selkirk, <u>Tr'ondëk Hwëch'in</u> , Tlingit, Komi, Mansi, Khanty, Silkup, Ket, Evenki, Dolgan, Nganasan, Todzh, Tuvan, Dukha, Eveny, Yakut, Yugakir, Chuvans, Koryak	Arctic and sub-Arctic (Canada, Alaska, Scandinavia, Russia, Greenland)	Alessa et al. 2016, Bell and Harwood 2012, Berkes et al. 2007, Bonny and Berkes 2008, Brammer et al. 2016, Brook et al. 2009, Dowsley 2009, Eamer 2006, Fernandez-Gimenez et al. 2006, Gearheard et al. 2011, Gill et al. 2014, Johnson et al. 2015, Kouril et al. 2016, Lyver and Lutsel K'e Dene First Nation 2005, Nichols et al. 2004, Parlee et al. 2005, Riseth et al. 2011, The Joint Secretariat, 2003, Danielsen et al. 2009, Fidel et al. 2012, Krupnik and Jolly 2002, Nunavut Wildlife Management Board 2000, Oskal et al. 2010, Priest and Usher 2004, Russell et al. 2013, Tremblay et al. 2008, Wilson et al. 2018, Kouril et al. 2016, Knopp et al. 2013, Mustonen 2002, Moller et al. 2004, Krupnik et al. 2010
Ariaal, Vezo, San, Chekereni, Makurunge, Mlingotini, Rendille	Africa (Kenya, Madagascar, Namibia, Tanzania, Cameroon, Ethiopia, Ghana)	Liebenberg et al. 1998, Roba and Oba, 2008, 2009a, 2009b, Shaffer 2014, Brammer et al. 2016
Miriwoong, Nyul Nyul, Yanyuwa, Anangu, Aboriginal Australians, Roviana, Indigenous Fijians, Tuawhenua Maori, Maori	Oceania (Australia, New Zealand, Solomon Islands, Fiji, Papua New Guinea)	Brammer et al. 2016, Dobbs et al. 2016, Ens et al. 2010, Grech et al. 2014, Kennett et al. 2010, Kouril et al. 2016, Leonard et al. 2013, Prober et al. 2011, Wiseman and Bardsley 2016, Aswani and Weiant 2004, Lauer and Aswani 2010, Harmsworth et al. 2011, Lyver et al. 2008, Lyver et al. 2017, Kouril et al. 2016, Ziembicki et al. 2013, Moller et al. 2004
Isoso-Guarani, Kaxinawa, Rau, Ribeirinho, Baniwa, Bare, Kuripaco, Warekena, Yeral, Achuar, Makushi, Cofan, Wapishiana, Kukama, Kukamiria, Harakmbut, Embera-Wounaan, Mestizo, Nahua, Otomi, Purepecha, Kichwa	South-Central America (Mexico, Bolivia, Peru, Guyana, Brazil, Venezuela, Ecuador, Colombia, Panama)	Noss et al. 2005, Bellfield et al. 2015, Kouril et al. 2016, Constantino, et al. 2008, Olivero et al. 2016, Parry and Peres 2015, Constantino et al. 2012, Chambers et al. 2017, Cummings et al. 2017, Oviedo and Bursztyn 2017, Pacheco-Cobos et al. 2015, Velazquez et al. 2001, Kouril et al. 2016, Torres et al. 2014, Paneque-Galvez et al. 2017
Kwakwa'kwakw, Cree, Takla Lake First Nation, First Nations	Canada (Temperate regions)	Berkes et al. 2007, Bonny and Berkes 2008, Brammer et al. 2016, Heaslip 2008, Kouril et al. 2016, McKay and Johnson 2017
Soliga, Nepali	South Asia (India, Nepal)	Kouril et al. 2016, Setty et al. 2008, Shrestha and Lapeyre 2018
Karewa, Kwera, Paito, Torweja, Wekerig, Kuy, Khmer, Sama-Bajau Adivasi	South East Asia (Indonesia, Philippines, Cambodia)	Sheil et al. 2015, Kouril et al. 2016, Turreira-García et al. 2018

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Appendix B: Spring 2017 post-harvest season interview guide

Gitga'at Spring Harvest Interview

Thank you for taking the time to meet today!

Before we start, I need to let you know that this interview is a part of a project that I (Kim-Ly) am (is) undertaking as a graduate student at the University of Victoria. As you may already know, the project is about how to document what Gitga'at people who maintain a close relationship with the land might notice about potential changes in the quality of and abundance of important Gitga'at foods and the surrounding environment. The project will help the Gitga'at Department of Lands and Marine Resource decide how to collect this information in the long run, and the information itself will help leadership make decisions about resource management and climate change adaptation. This spring some community members tested out logbooks as one way of documenting this kind of information. This interview is another way that was suggested during community meetings in the fall and winter.

You've been suggested as an interviewee because of your experience harvesting, fishing, and/or preparing traditional Gitga'at foods. We have a participant consent form here that says a bit more about the project and how the information from the interview will be used. Please take your time reading it, and sign only if you agree to participate.

Gitga'at Knowledge in Marine Monitoring

You are invited to participate in a study entitled "Gitga'at Knowledge in Marine Monitoring" that is being conducted by Master's Student Kim-Ly Thompson. This is a collaborative project between the University of Victoria and the Gitga'at First Nation.

Kim-Ly is a Graduate Student in the School of Environmental Studies at the University of Victoria and you may contact her at 438-883-9131 or kthompson@uvic.ca if you have any questions or comments. Her project is being conducted under the supervision of Dr. Natalie Ban. You may contact her at nban@uvic.ca.

Purpose and Objectives

This project has been developed together with the Gitga'at Department of Lands and Marine Resources. The purpose is to examine how Gitga'at Traditional Ecological Knowledge (TEK) can be used to guide marine monitoring and management in an ongoing way. The information will be used to design a monitoring framework that will strengthen the Gitga'at First Nation's management of marine resources.

The project has several objectives:

- 1) Identify ways in which community members would like to see their knowledge used for monitoring purposes.
- 2) Design a monitoring framework that combines Gitga'at TEK with scientific information being collected in Gitga'at territory.
- 3) Enable resource users to report abnormalities and observations made while fishing, hunting, harvesting, etc.

Importance of this Research

Developing a monitoring framework that integrates Gitga'at TEK will contribute to Gitga'at First Nation's goal of strengthening the health of their community and regain control of their lands and waters. It will also support the conservation of economically, ecologically, and culturally significant species.

Participants Selection

You are being invited to participate in this study because of your long history of experiences with marine ecosystems and resources.

What is involved

If you consent to participate in this research, your participation will include a 1-4 hour interview in a location that is comfortable and convenient for you. The interview will inquire about your experiences harvesting, preparing and eating foods from Gitga'at territory and your vision for a monitoring framework that utilizes your knowledge. You will also be asked about your observations of changes in the marine ecosystem and key harvest species.

Audio-tapes, written notes and observations will be taken; a transcription will be made and you will receive a copy

Inconvenience, risks, and benefits

Participation in this study may cause some inconvenience to you, including the time committed to the interview. There are no known or anticipated risks to you by participating in this research. The potential benefits of your participation in this research include being able to share your knowledge to inform marine use planning in Gitga'at Territory.

Compensation

As a way to compensate you for any inconvenience related to your participation, you will be given a financial honorarium of \$25/hour or up to \$200/day. If you consent to participate in this study, this form of compensation to you must not be coercive. It is unethical to provide undue compensation or inducements to research participants. If you would not participate if the compensation was not offered, then you should decline.

Voluntary Participation

Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at **any time** without any consequences or any explanation. If you do withdraw from the study your data will be used only with permission and your compensation adjusted to match time contributed fairly.

Anonymity and Confidentiality

Your name will remain unlisted and data provided anonymous unless you otherwise consent to the use of your name in research outputs or photos. Your confidentiality and the confidentiality of the data will be protected by password protected computers and the use of encrypted back-up files.

Dissemination of Results

It is anticipated that the results of this study will be shared with others in the following ways: through community workshops, directly to participants, in Kim-Ly Thompson's Thesis project, scientific journal publications, scholarly presentations and meetings, the Gitga'at Resources website, community newsletter, presentations to policy-makers, social media, and potentially through community education materials.

Disposal of Data

Data from this study will be disposed through paper shredding and deletion of all digital data, should you ask to have your data disposed. If participants allow, data will be stored by the Gitga'at Department of Lands and Marine Resources and at the University of Victoria Marine Ethnoecology Lab under password protection or encryption.

Contacts

Individuals that may be contacted regarding this study include Kim-Ly Thompson, Dr. Natalie Ban, Spencer Greening and Chris Picard. Refer to the beginning of this consent form for their contact information. In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

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

Name of Participant

Signature

Date

Visually Recorded Images/Data Participant to provide initials, *only if you consent*:

- Photos may be taken of me for: Analysis _____ Dissemination* _____

*Even if no names are used, you may be recognizable if visual images are shown in the results.

PLEASE SELECT STATEMENT only if you consent:

I consent to be identified by name / credited in the results of the study: _____ (Participant to provide initials)

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

Future Use of Data *PLEASE SELECT STATEMENT:*

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

I **do not** consent to the use of my data in future research: _____ (Participant to provide initials)

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

Data sharing

I consent to having a copy of my data shared with the Gitga'at First Nation
_____ (Participant to provide initials)

A copy of this consent will be left with you, and a copy will be taken by the researcher.

SECTION A: Interview Background

Date of Interview: _____

Name of Interviewee: _____

Gender: _____

Age: _____

SECTION B: ʔa'ask (seaweed)

B.1. SEAWEED HARVEST

1. Did you harvest any seaweed this year?

If no go to section B.2

Experience

2. How many days did you spend picking seaweed this spring?
3. How old were you when you first picked seaweed? For how many years have you been picking seaweed since then?
4. Did you harvest seaweed with other people this spring? If yes, with whom?

Phenology

5. When was the seaweed ready to pick this year?
6. When did the seaweed begin to go "blonde"/be less good to pick?

Abundance

7. How much seaweed did you harvest this spring? (*please ask interviewee to specify whether amount was in large or small sacs*)
8. Would you say that there was more, less, or the same amount of seaweed available to harvest this year?
 - 7.1. *If there was more or less seaweed than usual: Why do you think there was less (or more) seaweed than usual?*
 - 7.2. Have you changed the way you harvest to adapt to the change in abundance?
9. Did you meet your needs for seaweed this year?
 - 9.1. (*If no to question 11*), When was the last time you were able to meet your needs for seaweed?

Quality

10. When you were picking this year, was the quality of seaweed better, worse, or the same as normal?
 - 10.1. *If the seaweed quality was different: Has the seaweed been like this before? For how long has the seaweed been this way?*
 - 10.2. Why do you think the quality of seaweed is different this year?
 - 10.3. Have you changed the way you harvest to adapt to the change in quality?

Location

11. If you're comfortable sharing, could you show me on a map where you picked seaweed?

B.2. PREPARING SEAWEED

12. Did you dry or prepare any seaweed this year?

If no, go to section B.3.
13. Did anyone else help you prepare your seaweed this year? If yes, who?
14. Did you have to make any changes to the way you prepared seaweed this year, due to weather or seaweed quality?

B.3. EATING SEAWEED

15. Have you eaten any of this year's seaweed?

If no go to section C

16. Compared to how normal, did the seaweed taste better, worse or average this year?

16.1. *If taste was different:* Has seaweed tasted like that before? For how long has it been this way?

16.2. Why do you think it tasted different this year?

B.4. SHARING/TRADING NETWORKS

17. Did you share or trade your seaweed this spring? If yes, with whom?

18. Did you receive or trade for any seaweed this spring? If yes, from who?

B.5. OVERVIEW

19. Overall, would you say that this was a good year for seaweed? Why or why not?

SECTION C: Txaw (halibut)**C.1. HALIBUT HARVEST**

20. Did you catch any halibut this spring?

If no go to section C.2

Experience

21. How many days did you go out fishing for halibut this spring?

22. What kind of gear did you use?

23. Did you go halibut fishing with other people this spring? If yes, with whom?

24. How old were you when you first went halibut fishing? For how many years have you been fishing for halibut since then?

Phenology

25. When was the halibut good to be caught this year?

26. When did you catch your first halibut this spring?

Abundance

27. Would you say that there was more, less, or the same amount of halibut available to catch this year?

27.1. *(If there was more or less halibut than usual: Why do you think there was less (or more) halibut than usual?*

27.2. Have you changed the way you fish to adapt to the change in abundance?

28. How many halibut did you catch?

29. Did you meet your needs for halibut this year?

29.1. If no, when was the last time you were able to meet your needs for halibut?

Location

30. If you're comfortable sharing, could you show me on a map where went fishing for halibut this year?

C.2. PREPARING HALIBUT

31. Did you prepare any halibut from this year?

If no, go to section C.3.

32. How did you prepare it? What parts of the fish did you prepare?

33. Did anyone else help you prepare your halibut this year? If yes, who?
34. Did you have to make any changes to the way you prepared seaweed this year, due to weather or quality of halibut?

C.3. EATING HALIBUT

35. Have you eaten any of this year's halibut?
If no go to section D.
36. What parts of the fish did you eat?
37. How was it prepared when you ate it?
38. Compared to usual, did the halibut taste better, worse or average this year?
 - 38.1. (If the halibut tasted different), Has halibut tasted that way before? For how long has it tasted that way?
 - 38.2. Why do you think it tasted different?

C.4. SHARING/TRADING NETWORKS

39. Did you share or trade your halibut this spring? If yes, with whom?
40. Did you receive or trade for any halibut this spring? If yes, from who?

C.5. OVERVIEW

41. Overall, would you say that this was a good year for halibut? Why or why not?

SECTION D: Yee (Spring Salmon)

D.1. SPRING SALMON HARVEST

42. Did you catch any spring salmon this spring?
If no go to section D.2

Experience

43. How many days did you go fishing for spring salmon this spring?
44. What kind of gear did you use?
45. Did you go fishing with other people this spring? If yes, with whom?
46. How old were you when you first went fishing for springs? For how many years have you been fishing since then?

Phenology

47. When did the springs arrive this year?
48. When did you catch your first spring this year?

Abundance

49. Would you say that there was more, less, or the same amount of spring salmon available to catch this year?
 - 49.1. *If there was more or less than usual, why do you think there was less (or more) than usual?*
 - 49.2. Have you changed the way you fish to adapt to the change in abundance?
50. How many springs did you catch this spring?
51. Did you meet your needs for springs this year?
 - 51.1. If no, when was the last time you were able to meet your needs for springs?

Location

52. If you're comfortable sharing, could you show me on a map where you went fishing for springs this year?

D.2. PREPARING SPRING SALMON

53. Did you prepare any springs from this year? (*If no, go to section D.3.*)
 54. How did you prepare it? Which parts of the fish did you prepare?
 55. Did anyone else help you prepare your halibut this year? If yes, who?
 56. Did you have to make any changes to the way you prepared spring salmon this year, due to weather or quality of the fish?

D.3. EATING SPRING SALMON

57. Have you eaten any of this year's spring salmon?
If no go to section E.
 58. How was it prepared when you ate it?
 59. Compared to how usual, did the halibut taste better, worse or average this year?
 59.1. (If the halibut tasted different), Has halibut tasted that way before? For how long has it tasted that way?
 59.2. Why do you think it tasted different?

D.4. SHARING/TRADING NETWORKS

60. Did you share or trade your springs from this year? If yes, with whom?
 61. Did you receive or trade for any springs from this year? If yes, from who?

D.5. OVERVIEW

62. Overall, would you say that this was a good year for springs? Why or why not?

SECTION E: Ts'mhoon ("Red Snapper", Yellow Eye Rockfish)

E.1. RED SNAPPER HARVEST

63. Did you catch any red snapper this spring?
If no go to section E.2.

Experience

64. How many days did you go out fishing for red snapper this spring?
 65. What kind of gear did you use?
 66. Did you go fishing for red snapper with other people this spring? If yes, with whom?
 67. How old were you when you first went fishing for red snapper? For how many years have you been fishing for them since then?
 68. When did you catch your first red snapper this year?

Abundance

69. Would you say that there was more, less, or the same amount of red snapper available to catch this year?
 28.1. (*If there was more or less than usual: Why do you think there was less (or more) than usual?*)
 28.2. Have you changed the way you fish to adapt to the change in abundance?
 70. How many did you catch this spring?
 71. Did you meet your needs for red snapper this year?

30.1. If no, when was the last time you were able to meet your needs for springs?

Location

72. If you're comfortable sharing, could you show me on a map where you went fishing for red snappers this spring?

E.2. PREPARING RED SNAPPER

73. Did you prepare any red snapper from this year? (*If no, go to section E.3.*)

74. How did you prepare it? Which parts of the fish did you prepare?

75. Did anyone else help you prepare your red snapper this year? If yes, who?

76. Did you have to make any changes to the way you prepared red snapper this year, due to weather or quality of the fish?

E.3. EATING RED SNAPPER

77. Have you eaten any red snapper caught this year?

If no go to section F.

78. How was it prepared when you ate it?

79. Compared to how usual, did the red snapper taste better, worse or average this year?

79.1. (If different), Has red snapper tasted that way before? For how long has it tasted that way?

79.2. Why do you think it tasted different?

D.4. SHARING/TRADING NETWORKS

80. Did you share or trade your red snapper from this year? If yes, with whom?

81. Did you receive or trade for any red snapper from this year? If yes, from who?

D.5. OVERVIEW

82. Overall, would you say that this was a good year for red snapper? Why or why not?

SECTION F: Gyenti (Sea cucumber)

F.1. GYENTI HARVEST

83. Did you pick any gyenti this spring?

If no go to section G.2

Experience

84. How many days did you go out picking gyenti this spring?

85. Did you go picking with other people this spring? If yes, with whom?

86. How old were you when you first went to pick gyenti? For how many years have you been fishing for them since then?

Abundance

87. Would you say that there was more, less, or the same amount of gyenti available to pick this year?

104.1. *(If there was more or less than usual: Why do you think there was less (or more) than usual?*

104.2. Have you changed the way you pick to adapt to the change in abundance?

88. How much gyenti did you pick this spring? (May have to ask to specify totes or sacs)

89. Did you meet your needs for gyenti this year?

106.1. If no, when was the last time you were able to meet your needs for gyenti?

Location

90. If you're comfortable sharing, could you show me on a map where you went gyenti picking this spring?

F.2. PREPARING GYENTI

91. Did you prepare any gyenti from this year? *(If no, go to section G.3.)*

92. How did you prepare it?

93. Did anyone else help you prepare gyenti this year? If yes, who?

94. Did you have to make any changes to the way you prepared gyenti this year, due to weather or quality of the gyenti?

F.3. EATING GYENTI

95. Have you eaten any gyenti picked this year?

If no go to section H.

96. How was it prepared when you ate it?

97. Compared to how usual, did it taste better, worse or the same?

114.1. (If different) Has gyenti tasted that way before? For how long has it tasted that way?

114.2. Why do you think it tasted different?

F.4. SHARING/TRADING NETWORKS

98. Did you share or trade gyenti from this year? If yes, with whom?

99. Did you receive or trade for any gyenti from this year? If yes, from who?

F.5. OVERVIEW

100. Overall, would you say that this was a good year for gyenti? Why or why not?

SECTION G: Ts'ak (Chinese slippers/Giant chitons)

G.1. CHINESE SLIPPER HARVEST

101. Did you pick any Chinese slipper this spring?

If no go to section H.2

Experience

102. How many days did you go out picking Chinese slipper this spring?

103. Did you go picking with other people this spring? If yes, with whom?

104. How old were you when you first went to pick Chinese slipper? For how many years have you been picked them since?

Abundance

105. Would you say that there was more, less, or the same amount of Chinese slipper available to pick this year?

122.1. *If there was more or less than usual: Why do you think there was less (or more) than usual?*

122.2. Have you changed the way you pick to adapt to the change in abundance?

106. How much Chinese slipper did you pick this spring? (May have to ask to specify totes or sacs)
 107. Did you meet your needs for Chinese slipper this year?
 124.1. If no, when was the last time you were able to meet your needs for gyenti?

Location

108. If you're comfortable sharing, could you show me on a map where you went Chinese slipper picking this spring?

G.2. PREPARING CHINESE SLIPPER

109. Did you prepare any Chinese slipper from this year? (*If no, go to section F.3.*)
 110. How did you prepare it?
 111. Did anyone else help you prepare Chinese slipper this year? If yes, who?
 112. Did you have to make any changes to the way you prepared Chinese slipper this year, due to weather or quality of the Chinese slipper?

G.3. EATING CHINESE SLIPPER

113. Have you eaten any Chinese slipper picked this year?
If no go to section I.
 114. How was it prepared when you ate it?
 115. Compared to how usual, did it taste better, worse or the same?
 37.1. (If different) Has Chinese slipper tasted that way before? For how long has it tasted that way?
 37.2. Why do you think it tasted different?

G.4. SHARING/TRADING NETWORKS

116. Did you share or trade Chinese slipper from this year? If yes, with whom?
 117. Did you receive or trade for any Chinese slipper from this year? If yes, from who?

G.5. OVERVIEW

118. Overall, would you say that this was a good year for Chinese slipper? Why or why not?

SECTION H: 'Yaans (Sea prunes/black katy chitons)

H.1. 'YAANS HARVEST

119. Did you pick any 'yaans this spring?
If no go to section I.2

Experience

120. How many days did you go out picking 'yaans this spring?
 121. Did you go picking with other people this spring? If yes, with whom?
 122. How old were you when you first went to pick 'yaans? For how many years have you been picking them since then?

Abundance

123. Would you say that there was more, less, or the same amount of 'yaans available to pick this year?
 140.1. (*If there was more or less than usual*): Why do you think there was less (or more) than usual?
 140.2. Have you changed the way you pick to adapt to the change in abundance?
 124. How many 'yaans did you pick this spring? (May have to ask to specify totes or sacs)

125. Did you meet your needs for 'yaans this year?
 142.1. If no, when was the last time you were able to meet your needs for 'yaans?

Location

126. If you're comfortable sharing, could you show me on a map where you went gyenti picking this spring?

H.2. PREPARING 'YAANS

127. Did you prepare any 'yaans from this year? (*If no, go to section I.3.*)
 128. How did you prepare it?
 129. Did anyone else help you prepare 'yaans this year? If yes, who?
 130. Did you have to make any changes to the way you prepared 'yaans this year, due to weather or quality of the 'yaans?

H.3. EATING 'YAANS

131. Have you eaten any 'yaans picked this year?
If no go to section J.
 132. How was it prepared when you ate it?
 133. Compared to usual, did it taste better, worse or the same?
 150.1. (If different) Have 'yaans tasted this way before? For how long have they tasted that way?
 150.2. Why do you think they tasted different?

H.4. SHARING/TRADING NETWORKS

134. Did you share or trade 'yaans from this year? If yes, with whom?
 135. Did you receive or trade for any 'yaans from this year? If yes, from who?

H.5. OVERVIEW

136. Overall, would you say that this was a good year for 'yaans? Why or why not?
 137.

SECTION I: Hak'wn (horse mussels)

I.1. HAK'WN HARVEST

138. Did you pick any hak'wn this spring?
If no go to section J.2

Experience

139. How many days did you go out picking hak'wn this spring?
 140. Did you go picking with other people this spring? If yes, with whom?
 141. How old were you when you first went to pick hak'wn? For how many years have you been picking them since then?

Abundance

142. Would you say that there was more, less, or the same amount of hak'wn available to pick this year?
 158.1. (*If there was more or less than usual*): Why do you think there was less (or more) than usual?
 158.2. Have you changed the way you pick to adapt to the change in abundance?
 143. How many hak'wn did you pick this spring?
 144. Did you meet your needs for hak'wn this year?
 160.1. If no, when was the last time you were able to meet your needs for hak'wn?

Location

145. If you're comfortable sharing, could you show me on a map where you went to pick gyenti this spring?

I.2. PREPARING HAK'WN

146. Did you prepare any hak'wn from this year? (*If no, go to section J.3.*)
 147. How did you prepare it?
 148. Did anyone else help you prepare hak'wn this year? If yes, who?
 149. Did you have to make any changes to the way you prepared hak'wn this year, due to weather or quality of the hak'wn?

I.3. EATING HAK'WN

150. Have you eaten any hak'wn that was picked this spring?
If no go to section K.
 151. How was it prepared when you ate it?
 152. Compared to usual, did it taste better, worse or the same?
 168.1. (If different) Have hak'wn tasted this way before? For how long have they tasted that way?
 168.2. Why do you think they tasted different?

I.4. SHARING/TRADING NETWORKS

153. Did you share or trade hak'wn from this year? If yes, with whom?
 154. Did you receive or trade for any hak'wn from this year? If yes, from who?

I.5. OVERVIEW

155. Overall, would you say that this was a good year for hak'wn? Why or why not?

SECTION J: Dzik'wi'its (red/purple sea urchins)**J.1. URCHIN HARVEST**

156. Did you pick any urchins this spring?
If no go to section K.2.

Experience

157. How many days did you go out picking urchins this spring?
 158. Did you go picking with other people this spring? If yes, with whom?
 159. How old were you when you first went to pick urchins? For how many years have you been picking them since then?

Abundance

160. Would you say that there was more, less, or the same amount of urchins available to pick this year?
 176.1. (*If there was more or less than usual*): Why do you think there was less (or more) than usual?
 176.2. Have you changed the way you pick to adapt to the change in urchin abundance?
 161. How many urchins did you pick this spring?
 162. Did you meet your needs for urchins this year?
 178.1. If no, when was the last time you were able to meet your needs for urchins?

Location

163. If you're comfortable sharing, could you show me on a map where you went urchin picking this spring?

J.2. PREPARING URCHINS

164. Did you prepare any urchins from this year? (*If no, go to section F.3.*)
 165. How did you prepare it?
 166. Did anyone else help you prepare urchins this year? If yes, who?
 167. Did you have to make any changes to the way you prepared urchin this year, due to weather or quality of the urchins?

J.3. EATING URCHINS

168. Have you eaten any urchins picked this year?
If no go to section K.
 169. How was it prepared when you ate it?
 170. Compared to usual, did it taste better, worse or the same?
 186.1. (If different) Have urchins tasted this way before? For how long have they tasted that way?
 186.2. Why do you think they tasted different?

J.4. SHARING/TRADING NETWORKS

171. Did you share or trade urchins from this year? If yes, with whom?
 172. Did you receive or trade for any urchins from this year? If yes, from who?

J.5. OVERVIEW

173. Overall, would you say that this was a good year for urchins? Why or why not?

SECTION K: Oola (Seal)**K.1. SEAL HARVEST**

174. Did you hunt any seal this spring?
If no go to section L.2

Experience

175. How many days did you go out seal hunting this spring?
 176. Did you go hunting with other people? If yes, with whom?
 177. How old were you when you first went seal hunting? For how many years have you been hunting seal since then?

Abundance

178. Would you say that there was more, less, or the same amount of seal available to hunt this year?
 194.1. (*If there was more or less than usual*): Why do you think there was less (or more) than usual?
 194.2. Have you changed the way you hunt to adapt to the change in abundance?
 179. How many seals did you hunt this spring?
 180. Did you meet your needs for seal this year?
 196.1. If no, when was the last time you were able to meet your needs for seals?

Location

181. If you're comfortable sharing, could you show me on a map where you went urchin hunting this spring?

K.2. PREPARING SEAL

182. Did you prepare any seals from this year? *(If no, go to section L.3.)*
 183. How did you prepare it? Which parts of the seal did you prepare?
 184. Did anyone else help you prepare seals this year? If yes, who?
 185. Did you have to make any changes to the way you prepared seals this year, due to weather or quality of the seal?

K.3. EATING GYENTI

186. Have you eaten any seal from this year?
If no go to section M.
 187. How was it prepared when you ate it? Which parts of the seal did you eat?
 188. Compared to usual, did it taste better, worse or the same?
 204.1. (If different) Has seal tasted this way before? For how long has it tasted that way?
 204.2. Why do you think they tasted different?

K.4. SHARING/TRADING NETWORKS

189. Did you share or trade seal from this year? If yes, with whom?
 190. Did you receive or trade for any seal from this year? If yes, from who?

K.5. OVERVIEW

191. Overall, would you say that this was a good year for seals? Why or why not?

SECTION L: Other Traditional Foods**L.1. HARVEST**

192. Did you harvest any seal other traditional foods this spring? If yes, which ones?
If no go to section G.2
If the interviewee lists more than one other traditional food, repeat questions in order as necessary.

Experience

193. How many days did you go out harvesting _____ this spring?
 194. Did you go harvesting with other people? If yes, with whom?
 195. How old were you when you first harvested _____? For how many years have you been harvesting _____ since then?

Abundance

196. Would you say that there was more, less, or the same amount of _____ available to harvest this year?
 212.1. *(If there was more or less than usual):* Why do you think there was less (or more) than usual?
 212.2. Have you changed the way you harvest to adapt to the change in abundance?
 197. How much _____ did you harvest this spring?
 198. Did you meet your needs for _____ this year?

214.1. If no, when was the last time you were able to meet your needs for _____?

Location

199. If you're comfortable sharing, could you show me on a map where you went harvested _____ this spring?

L.2. PREPARING _____

200. Did you prepare any _____ from this spring?

(If no, go to section K.3.)

201. How did you prepare _____? Which parts did you prepare?

202. Did anyone else help you prepare _____ this year? If yes, who?

203. Did you have to make any changes to the way you prepared _____ this year, due to weather or quality of the _____?

L.3. EATING _____

204. Have you eaten any _____ from this spring?

If no go to section L.

205. How was it prepared when you ate it? Which parts did you eat?

206. Compared to usual, did _____ taste better, worse or the same?

222.1. (If different) Has _____ tasted this way before? For how long has _____ tasted that way?

222.2. Why do you think they tasted different?

L.4. SHARING/TRADING NETWORKS

207. Did you share or trade any _____ from this spring? If yes, with whom?

208. Did you receive or trade for any _____ from this spring? If yes, from whom?

L.5. OVERVIEW

209. Overall, would you say that this was a good year for _____? Why or why not?

Section M: Weather and Environment

210. Did you notice anything unusual about the weather this spring? If yes, what was different?

226.1. *If the weather was different*, Have you heard of the weather being this way in the past? What year did it start being different?

211. Did you notice any changes in the landscape or water this spring (for example: new landslides, red tide...)

212. Did you notice any unusual plants or animals? If yes, what were they?

213. Did you notice any unusual animal behaviour? If yes, can you describe it?

SECTION N: Interview and log book experience

214. What was your overall experience participating in this interview?
- Excellent (I would like to participate in future harvest season interviews) [3pts]
 - Good [2pts]
 - Poor (I did not enjoy the experience, and would prefer to not participate in the future) [0pts]
 - Neutral [1pt]
215. What changes would you suggest to improve this interview in the future?
216. Did you use a logbook?
If not, why not?
217. What was your overall experience completing the logbook?
- Excellent (I would like to complete another one in the future) [3pts]
 - Good [2pts]
 - Poor (I did not enjoy the experience, and would prefer to not participate in the future) [0pts]
 - Neutral [1pt]
218. What changes would you suggest to improve the logbook in the future?

Thank you very much for participating in this pilot study!

Appendix C: Fall/Winter 2017 post-harvest season interview guide

Gitga'at Harvest Interview Guide – Fall/Winter 2017

Thank you for taking the time to meet today!

Before we start, I need to let you know that this interview is a part of a project by Gitga'at First Nation, in partnership with the University of Victoria, to document what Gitga'at people who maintain a close relationship with the land and sea might notice about changes in the quality of and abundance of important Gitga'at foods and the surrounding environment. The information will help with decisions about stewardship, climate change adaptation, Rights and Title, and health and wellness.

I'll start by asking you some questions about the different foods you harvested, then we'll talk about the environment and other plants and animals. Here we go!

SECTION A: Interviewee Background

Date of Interview: _____

Name of Interviewee: _____

Gender: _____

Age: _____

SECTION B: Food Species

COCKLES (gaboox)

HARVEST

Experience

1. Did you harvest any cockles this year?
 - 1.1. If no, why not?
(Skip to question 11)
2. How many days did you go out digging for cockles?
3. Did you harvest with other people? If yes, with whom?
4. How old were you when you first harvested cockles?
5. For how many years have you been harvesting cockles since then?

Location

6. If you're comfortable sharing, could you show me on a map where you went harvested cockles this year?

Abundance

7. From what you could tell while harvesting, was the abundance of cockles more or less than usual this year?
 - 7.1. *(If there was more or less than usual)* What year did you first notice this change in abundance? What year was a typical year?
 - 7.2. Why do you think there was less (or more) than usual?
 - 7.3. Did you harvest differently to adjust to the change in abundance?
8. How many buckets of cockles did you harvest this year? How much do you usually aim to get?
9. Did you meet your needs for cockles this year?
 - 9.1. If no, when was the last time you were able to meet your needs for cockles?

SHARING/TRADING NETWORKS

10. Did you share or trade any cockles this year? If yes, who did you share/trade with?
11. Did you receive any cockles this year? If yes, who did you receive from?

PRESERVING

12. Did you preserve any cockles this year? *(If no, skip to question 15)*
13. How did you preserve them?
 - 2.1. Did you make any changes to how you preserved them? If yes, why?
14. Did anyone help you to preserve cockles?

COOKING

15. Did you cook any cockles this year? *(If no, skip to question 18)*
16. How did you cook them?
 - 16.1. Did you make any changes to how you cooked them? If yes, why?
17. Did anyone else help you cook them?

EATING

18. Have you eaten any cockles from this year? *(If no, skip to question 20)*
19. How was it prepared when you ate it?

QUALITY

20. Can you describe to me what a high quality cockle is like? *(for example, size, shape, colour, smell, taste...)*
21. Was the quality of cockles different than usual this year?
 - 21.1. If yes, what were they like? Did this make them better or worse?
 - 21.2. Why do you think the quality changed?
 - 21.3. Have you seen them this way before?

OVERVIEW

22. Overall, would you say that this was a good year for cockles? Why or why not?
-

CLAMS (ts'a'ax)

HARVEST

Experience

23. Did you harvest any clams this year?
 - 23.1. If no, why not?
(If no, skip to question 33)
24. How many days did you go out digging for clams?
25. Did you harvest with other people? If yes, with whom?
26. How old were you when you first harvested clams?
27. For how many years have you been harvesting clams since then?

Location

28. If you're comfortable sharing, could you show me on a map where you went harvested clams this year?

Abundance

29. From what you could tell while harvesting, was the abundance of clams more or less than usual this year?
 - 29.1. (If there was more or less than usual) What year did you first notice this change in abundance? What year was a typical year?
 - 29.2. Why do you think there was less (or more) than usual?
 - 29.3. Did you harvest differently to adjust to the change in abundance?
30. How many buckets of clams did you harvest this year? How much do you usually aim to get?
31. Did you meet your needs for clams this year?
 - 8.1. If no, when was the last time you were able to meet your needs for clams?

SHARING/TRADING NETWORKS

32. Did you share or trade any clams this year? If yes, who did you share/trade with?
33. Did you receive any clams this year? If yes, who did you receive from?

PRESERVING

34. Did you preserve any clams this year? (If no, skip to question 37)
35. How did you preserve them?
 - 35.1. Did you make any changes to how you preserved them? If yes, why?
36. Did anyone help you to preserve clams?

COOKING

37. Did you cook any clams this year? (If no, skip to question 40)
38. How did you cook them?
 - 38.1. Did you make any changes to how you cooked them? If yes, why?
39. Did anyone else help you cook them?

EATING

40. Have you eaten any clams from this year? (If no, skip to question 42)
41. How was it prepared when you ate it?

QUALITY

42. Can you describe to me what a high quality clam is like? (*for example, size, shape, colour, smell, taste...*)
43. Was the quality of clams different than usual this year?
- 43.1. If yes, what were they like? Did this make them better or worse?
- 43.2. Why do you think the quality changed?
- 43.3. Have you seen them this way before?

OVERVIEW

44. Overall, would you say that this was a good year for clams? Why or why not?

MUSSELS (gyels)**HARVEST***Experience*

45. Did you harvest any mussels this year?
- 45.1. If no, why not?
(*If no, skip to question 55*)
46. How many days did you go out for mussels?
47. Did you harvest with other people? If yes, with whom?
48. How old were you when you first harvested mussels?
49. For how many years have you been harvesting mussels since then?

Location

50. If you're comfortable sharing, could you show me on a map where you went harvested mussels this year?

Abundance

51. From what you could tell while harvesting, was the abundance of mussels different this year?
- 51.1. (*If there was more or less than usual*) What year did you first notice this change in abundance? What year was a typical year?
- 51.2. Why do you think there was less (or more) than usual?
- 51.3. Did you harvest differently to adjust to the change in abundance?
52. How many mussels did you harvest this year? How much do you usually aim to get?
53. Did you meet your needs for mussels this year?
- 53.1 If no, when was the last time you were able to meet your needs for mussels?

SHARING/TRADING NETWORKS

54. Did you share or trade any mussels this year? If yes, who did you share/trade with?
55. Did you receive any mussels this year? If yes, who did you receive from?

PRESERVING

56. Did you preserve any mussels this year? (*If no, skip to question 59*)
57. How did you preserve them?
- 57.1. Did you make any changes to how you preserved them? If yes, why?

58. Did anyone help you to preserve mussels?

COOKING

59. Did you cook any mussels this year? *(If no, skip to question 62)*

60. How did you cook them?

60.1. Did you make any changes to how you cooked them? If yes, why?

61. Did anyone else help you cook them?

EATING

62. Have you eaten any mussels from this year? *(If no, skip to question 64)*

63. How was it prepared when you ate it?

QUALITY

64. Can you describe to me what a high quality mussel is like? *(for example, size, shape, colour, smell, taste...)*

65. Was the quality of mussels different than usual this year?

65.1. If yes, what were they like? Did this make them better or worse?

65.2. Why do you think the quality changed?

65.3. Have you seen them this way before?

OVERVIEW

66. Overall, would you say that this was a good year for mussels? Why or why not?

DUNGENESS CRAB (galmoos)

HARVEST

Experience

67. Did you harvest any Dungeness crab this year?

67.1. If no, why not?

(If no, skip to question 77)

68. How many days did you go out for crabs?

69. Did you harvest with other people? If yes, with whom?

70. How old were you when you first harvested crabs?

71. For how many years have you been harvesting crabs since then?

Location

72. If you're comfortable sharing, could you show me on a map where you went harvested crabs this year?

Abundance

73. From what you could tell while harvesting, was the abundance of crabs different this year?

73.1. *(If there was more or less than usual)* In what year did you first notice this change in abundance? What year was a typical year?

73.2. Why do you think there was less (or more) than usual?

73.3. Did you harvest differently to adjust to the change in abundance?

74. How many crabs did you harvest this year? How much do you usually aim to get?
 75. Did you meet your needs for crabs this year?
 75.1. If no, when was the last time you were able to meet your needs for crabs?

SHARING/TRADING NETWORKS

76. Did you share or trade any crabs this year? If yes, who did you share/trade with?
 77. Did you receive any crabs this year? If yes, who did you receive from?

PRESERVING

78. Did you preserve any crabs this year? *(If no, skip to question 81)*
 79. How did you preserve them?
 79.1. Did you make any changes to how you preserved them? If yes, why?
 80. Did anyone help you to preserve crabs?

COOKING

81. Did you cook any crabs this year? *(If no, skip to question 84)*
 82. How did you cook them?
 82.1. Did you make any changes to how you cooked them? If yes, why?
 83. Did anyone else help you cook them?

EATING

84. Have you eaten any crabs from this year?
 85. How was it prepared when you ate it?

QUALITY

86. Can you describe to me what a high quality crab is like? *(for example, size, shape, colour, smell, taste...)*
 87. Was the quality of crabs different than usual this year?
 87.1. If yes, what were they like? Did this make them better or worse?
 87.2. Why do you think the quality changed?
 87.3. Have you seen them this way before?

OVERVIEW

88. Overall, would you say that this was a good year for crabs? Why or why not?

GOLDEN EYE DUCKS (t'saas) or SURF SCOTERS/BLACK DUCKS (amgiik)

HARVEST

Experience

89. Did you hunt any ducks this year?
 89.1. If yes, were they golden eye ducks or black ducks (scoters)?
 89.2. If no, why not?
(If no, skip to question 99)
 90. How many days did you go out for ducks?
 91. Did you harvest with other people? If yes, with whom?

92. How old were you when you first hunted ducks?
93. For how many years have you been hunting ducks since then?

Location

94. If you're comfortable sharing, could you show me on a map where you went hunted ducks this year?

Abundance

95. From what you could tell while hunting, was the abundance of ducks different this year?
 - 95.1. *(If there was more or less than usual)* In what year did you notice this change in abundance? What year was a typical year?
 - 95.2. Why do you think there was less (or more) than usual?
 - 95.3. Did you harvest differently to adjust to the change in abundance?
96. How many ducks did you harvest this year? How much do you usually aim to get?
97. Did you meet your needs for ducks this year?
 - 97.1. If no, when was the last time you were able to meet your needs for ducks?

SHARING/TRADING NETWORKS

98. Did you share or trade any ducks this year? If yes, who did you share/trade with?
99. Did you receive any ducks this year? If yes, who did you receive from?

PRESERVING

101. Did you preserve any ducks this year? *(If no, skip to question 104)*
102. How did you preserve them?
 - 102.1. Did you make any changes to how you preserved them? If yes, why?
103. Did anyone help you to preserve ducks?

COOKING

104. Did you cook any ducks this year? *(If no, skip to question 107)*
105. How did you cook them?
 - 105.1. Did you make any changes to how you cooked them? If yes, why?
106. Did anyone else help you cook them?

EATING

107. Have you eaten any ducks from this year? *(If no, skip to question 109)*
108. How was it prepared when you ate it?

QUALITY

109. Can you describe to me what a high quality duck is like? *(for example, size, colour of meat, smell, taste...)*
- 110.
111. Was the quality of the ducks different than usual this year?
 - 110.1. If yes, what were they like? Did this make them better or worse?
 - 110.2. Why do you think the quality changed?
 - 110.2. Have you seen them this way before?

OVERVIEW

112. Overall, would you say that this was a good year for ducks? Why or why not?
-

MOOSE (wudzii)

HARVEST

Experience

- 113. Did you hunt any moose this year?
 - 112.1. If no, why not?
(If no, skip to question 122)
- 114. How many days did you go out for moose?
- 115. Did you harvest with other people? If yes, with whom?
- 116. How old were you when you first hunted moose?
- 117. For how many years have you been hunting moose since then?

Location

- 118. If you're comfortable sharing, could you show me on a map where you hunted moose this year?

Abundance

- 119. From what you could tell while hunting, was the abundance of moose different this year?
 - 95.1. (If there was more or less than usual) In what year did you first notice this change in abundance? What year was a typical year?
 - 95.2. Why do you think there was less (or more) than usual?
 - 95.3. Did you harvest differently to adjust to the change in abundance?
- 120. How many moose did you harvest this year? How much do you usually aim to get?
- 121. Did you meet your needs for moose this year?
 - 97.2. If no, when was the last time you were able to meet your needs for moose?

SHARING/TRADING NETWORKS

- 122. Did you share or trade any moose this year? If yes, who did you share/trade with?
- 123. Did you receive any moose this year? If yes, who did you receive from?

PRESERVING

- 124. Did you preserve any moose this year? (If no, skip to question 126)
- 125. How did you preserve them?
 - 101.2. Did you make any changes to how you preserved them? If yes, why?
- 126. Did anyone help you to preserve moose?

COOKING

- 127. Did you cook any moose this year? (If no, skip to question 129)
- 128. How did you cook it?
 - 105.1. Did you make any changes to how you cooked it? If yes, why?
- 129. Did anyone else help you cook them?

EATING

- 130. Have you eaten any moose from this year? (If no, skip to question 131)
- 131. How was it prepared when you ate it?

QUALITY

132. Can you describe to me what a high quality moose is like? (*for example, size, colour of meat, smell, taste...*)
133. Was the quality of the moose different than usual this year?
- 133.1. If yes, what were they like? Did this make them better or worse
- 133.2. Why do you think the quality changed
- 133.3. Have you seen them this way before?

OVERVIEW

134. Overall, would you say that this was a good year for moose? Why or why not?

SEAL (uula)

HARVEST

Experience

135. Did you hunt any seal this fall or winter?
- 135.1. If no, why not?
(*If no, skip to question 145*)
136. How many days did you go out for seal?
137. Did you harvest with other people? If yes, with whom?
138. How old were you when you first hunted seal?
139. For how many years have you been hunting seal since then?

Location

140. If you're comfortable sharing, could you show me on a map where you hunted seal this year?

Abundance

141. From what you could tell while hunting, was the abundance of seal different this year?
- 95.1. (*If there was more or less than usual*) In what year did you first notice this change in abundance? What year was a typical year?
- 95.2. Why do you think there was less (or more) than usual?
- 95.3. Did you harvest differently to adjust to the change in abundance?
142. How many seal did you harvest this fall and winter? How much do you usually aim to get?
143. Did you meet your needs for seal this year?
- 97.3. If no, when was the last time you were able to meet your needs for seal?

SHARING/TRADING NETWORKS

144. Did you share or trade any seal this year? If yes, who did you share/trade with?
145. Did you receive any moose this year? If yes, who did you receive from?

PRESERVING

146. Did you preserve any seal this year? (*If no, skip to question 126*)
147. How did you preserve it?
- 101.3. Did you make any changes to how you preserved them? If yes, why?
148. Did anyone help you to preserve seal?

COOKING

149. Did you cook any seal this year? *(If no, skip to question 129)*
150. How did you cook it?
- 105.1. Did you make any changes to how you cooked it? If yes, why?
151. Did anyone else help you cook them?

EATING

152. Have you eaten any seal from this year? *(If no, skip to question 131)*
153. How was it prepared when you ate it?

QUALITY

154. Can you describe to me what a high quality seal is like? *(for example, size, colour of meat, smell, taste...)*
155. Was the quality of the seal different than usual this year?
- 135.2. If yes, what were they like? Did this make them better or worse
- 135.3. Why do you think the quality changed
- 135.4. Have you seen them this way before?

OVERVIEW

156. Overall, would you say that this was a good year for seal? Why or why not?

SALMON SPECIES**HARVEST***Experience*

157. Did you fish for any salmon this fall or winter? If yes, which species *(May have to repeat questions 158 -178 for more than one species of salmon)*
- 157.1.1. If no, why not?
- (If no, skip to question 167)*
158. How many days did you go out for _____?
159. Did you harvest with other people? If yes, with whom?
160. How old were you when you first fished for _____?
161. For how many years have you been fishing for _____ since then?

Location

162. If you're comfortable sharing, could you show me on a map where you got _____ this year?

Abundance

163. From what you could tell while hunting, was the abundance of _____ different this year?
- 95.1. *(If there was more or less than usual)* In what year did you first notice this change in abundance? What year was a typical year?
- 95.2. Why do you think there was less (or more) than usual?
- 95.3. Did you harvest differently to adjust to the change in abundance?
164. How many _____ did you harvest this fall and winter? How much do you usually aim to get?
165. Did you meet your needs for _____ this year?

97.4. If no, when was the last time you were able to meet your needs for _____?

SHARING/TRADING NETWORKS

166. Did you share or trade any _____ this year? If yes, who did you share/trade with?
 167. Did you receive any _____ this year? If yes, who did you receive from?

PRESERVING

168. Did you preserve any _____ this year? *(If no, skip to question 126)*
 169. How did you preserve it?
 101.4. Did you make any changes to how you preserved them? If yes, why?
 170. Did anyone help you to preserve _____?

COOKING

171. Did you cook any _____ this year? *(If no, skip to question 129)*
 172. How did you cook it?
 105.1. Did you make any changes to how you cooked it? If yes, why?
 173. Did anyone else help you cook them?

EATING

174. Have you eaten any _____ from this year? *(If no, skip to question 131)*
 175. How was it prepared when you ate it?

QUALITY

176. Can you describe to me what a high quality _____ is like? *(for example, size, colour of meat, smell, taste...)*
 177. Was the quality of the _____ different than usual this year?
 178. If yes, what were they like? Did this make them better or worse
 178.1. Why do you think the quality changed
 178.2. Have you seen them this way before?

OVERVIEW

179. Overall, would you say that this was a good year for _____? Why or why not?

OTHER FOODS OR MEDICINES

HARVEST

Experience

180. Did you harvest any other foods or medicines this fall or winter? *(If YES, repeat questions 135-155 for each species. If NO, skip to Section C)*
 181. How many days did you go out for _____?
 182. Did you harvest with other people? If yes, with whom?
 183. How old were you when you first harvested _____?
 184. For how many years have you been harvesting _____ since then?

Location

185. If you're comfortable sharing, could you show me on a map where you harvested _____ this year?

Abundance

186. From what you could tell while harvesting, was the abundance of _____ different this year?
 185.1. *(If there was more or less than usual)* In what year did you first notice this change in abundance? What year was typical year?
 185.2. Why do you think there was less (or more) than usual?
 185.3. Did you harvest differently to adjust to the change in abundance?
187. How much _____ did you harvest this year? How much do you usually aim to get?
188. Did you meet your needs for _____ this year?
 187.1. If no, when was the last time you were able to meet your needs for _____ ?

SHARING/TRADING NETWORKS

189. Did you share or trade any _____ this year? If yes, who did you share/trade with?
 190. Did you receive any _____ this year? If yes, who did you receive from?

PRESERVING

191. Did you preserve any _____ this year? *(If no, skip to question 148)*
 192. How did you preserve them?
 191.1. Did you make any changes to how you preserved them? If yes, why?
 193. Did anyone help you to preserve _____ ?

COOKING

194. Did you cook any _____ this year? *(If no, skip to question 151)*
 195. How did you cook it?
 194.1. Did you make any changes to how you cooked it? If yes, why?
 196. Did anyone else help you cook them?

EATING

197. Have you eaten any _____ from this year? *(If no, skip to question 153)*
 198. How was it prepared when you ate it?

QUALITY

199. Can you describe to me what a high quality _____ is like? *(for example, size, colour, smell, taste...)*
 200. Was the quality of the _____ different than usual this year?
 199.1. If yes, what were they like? Did this make them better or worse?
 199.2. Why do you think the quality changed?
 199.3. Have you seen them this way before?

OVERVIEW

201. Overall, would you say that this was a good year for _____ ? Why or why not?

Section C: Weather and Landscape

202. Did you notice anything unusual about the weather this Fall or Winter? If yes, what was different?
- 201.1. *If the weather was different*, have you heard of the Fall/Winter weather being this way in the past? What year did it start being different?
203. Did you notice any changes in the landscape or water this Fall/Winter (for example: new landslides, red tide...)
204. Did you notice any unusual plants or animals this Fall/Winter? If yes, what were they?

Section D: Feedback

205. Did you document your Fall/Winter harvesting in a logbook?
- a. If no, why not?
 - b. How could the logbook be improved?
206. Would you be willing to do another similar interview in the future?
- a. How could the interview be improved?

Thank you very much for participating!

Appendix D: Community meeting feedback form

GITGA'AT ENVIRONMENTAL KNOWLEDGE PROJECT FEEDBACK SURVEY

After reading the Gitga'at Environmental Project Spring 2017 Summary Report and/or attending a community meeting to discuss results, we would like to invite you to provide some feedback about the information that was presented to you. Your feedback will help to guide how this kind of information is documented and communicated in future harvest seasons.

Please complete and return this form to Kim-Ly Thompson **by November 10th, 2017**. You can arrange to return this form to her in person by calling 438-883-9131, or it can be mailed to her at:

205 Crestview Drive,
Prince Rupert, BC
V8J 2Z6.

Thank you for your time. Your participation and ideas are greatly appreciated!!

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#### **1. How have you participated in this project so far?** (Please circle all that apply)

- a. I completed a harvest logbook
- b. I completed an interview
- c. I helped to design the study
- d. I have attended a meeting to discuss this study
- e. Other: \_\_\_\_\_

Comments:

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**2. Please circle one of the following:**

- a. Not enough information presented in the Spring 2017 Summary Report.
- b. I am happy with how much information was presented in the Spring 2017 Summary Report.
- c. Too much information was presented in the Spring 2017 Summary Report.

If you circled **a.**, what type of information would you like to see added?

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If you circled **c.**, what type of information should be removed?

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**3. The best way to communicate results of future harvest seasons is...**

(Please rate each option with one of the following: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree. You may use the same rating twice)

- a. A summary report \_\_\_\_\_
- b. A website \_\_\_\_\_
- c. Community meetings \_\_\_\_\_
- d. Individual meetings \_\_\_\_\_
- e. All of the above \_\_\_\_\_
- f. Other: \_\_\_\_\_

Comments:

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**4. I would like to see this kind of information collected for the Gitga’at First Nation in future harvest seasons.**

(Please circle the statement that applies to you).

- a. Strongly agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly disagree

Comments:

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**5. I would like to see this kind of information used to make decisions about how to steward Gitga’at Territory** (Please circle the statement that applies to you).

- a. Strongly agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly disagree

Comments:

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**6. Other comments and suggestions:**

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