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RESEARCH ARTICLE

"We monitor by living here": community-driven actualization of a social-ecological monitoring program based in the knowledge of Indigenous harvesters

Kim-Ly Thompson[a]*, Nikkita Reece[b], Nicole Robinson[b], Havana-Jae Fisher[b], Natalie C. Ban[a], and Chris R. Picard[b]

[a]School of Environmental Studies, University of Victoria, Victoria, BC V8W 2Y2, Canada; [b]Gitga'at Oceans and Lands Department, Gitga'at First Nation, Hartley Bay, BC V0V 1A0, Canada

*kthompson@uvic.ca

Abstract

Researchers and government agencies are increasingly embracing Indigenous knowledge to inform ecological monitoring. However, there are few detailed accounts of designing monitoring methods based in Indigenous knowledge to meet Indigenous objectives. This research details the design of a program initiated by the Gitga'at First Nation to document the knowledge and observations of their harvesters as a contemporary monitoring initiative. We, Gitga'at and academic researchers, first conducted informal interviews with knowledge holders to gauge interest and to establish community objectives. We then convened community meetings and workshops to design methods to document harvesters' knowledge and observations. We tested and revised these methods (a post-harvest season interview guide, and a logbook to be completed by harvesters) over the course of two harvest seasons. Semi-structured interviews were more successful than the logbooks in meeting multiple community monitoring objectives. However, we were encouraged by younger participants' suggestions to develop a digital app based on the logbook to encourage future participation. Our work can serve as a guide to other Indigenous peoples and collaborators who wish to leverage the knowledge of their land and (or) sea users, and the methods we develop are available to adapt to other cultural, social-ecological, and political contexts.

Key words: Indigenous knowledge, community-based monitoring, participatory research, social-ecological monitoring, adaptive management

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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 and Turner 2004; 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 (Pulsifer et al. 2012; Alessa et al. 2016). 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, p. 5), 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 and Mathewes 1984; Turner and Berkes 2006; Lepofsky and Caldwell 2013).

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 (United Nations Division for Sustainable Development 1992; Berkes et al. 2000; Fisheries and Oceans Canada 2019). 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 (Moller et al. 2004; Bohensky and Maru 2011; Eckert et al. 2018). 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 and Maru 2011; Frid et al. 2016; Eckert et al. 2018). There are many motivations for combining Indigenous and scientific knowledge, including better understanding ecological systems and encouraging Indigenous sovereignty and self-determination (Bohensky and Maru 2011). However, in many regions that have been subjected to European colonialism, Indigenous knowledge is still often validated according to western scientific paradigms, which perpetuates colonial power imbalances (Nadasdy 1999). 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 (Simpson 2004; Irlbacher-Fox 2014).

Over the last two decades a growing number of environmental monitoring programs have also sought to involve Indigenous knowledge (Thompson et al., submitted). These efforts have ranged from local Indigenous technicians administering scientific methods (e.g., Bellfield et al. 2015) to Indigenous subsistence and cultural activities providing monitoring indicators (e.g., Heaslip 2008; Lyver et al. 2008). Many monitoring 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., submitted). A recent review (Thompson et al. 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 (e.g., Gill and Lantz 2014), and directly informed institutions tasked with management actions (e.g., Berkes et al. 2007; Harmsworth et al. 2011).

Studies of Indigenous subsistence harvests are another area of research that has engaged Indigenous knowledge for monitoring purposes. Long-term harvest studies have predominantly been conducted to inform fisheries and wildlife monitoring and are often a part of co-management agreements (e.g., Inuvialuit Final Agreement) to ensure that enough catch is set aside for Indigenous harvesters' livelihoods. Harvest studies have been conducted since the 1970s following the James Bay and Northern Quebec Agreement (Usher and Wenzel 1987), which typically ask harvesters to recall their harvests on a regular basis and focus on the size, timing, and composition of hunter harvests (The Joint Secretariat 2003; Priest and Usher 2004). Through collaborative field work the harvested animals have also been leveraged for fisheries and wildlife monitoring purposes by providing an

opportunity for the collection of biological samples and data (Bell and Harwood 2012). Huntington (1998, 2000) detailed several methods including semi-structured interviews, questionnaires, and analytic workshops that can be applied to elicit and document Indigenous knowledge to inform ecological management and research.

The inclusion of Indigenous harvesters' knowledge and catch data in fisheries and wildlife management can be interpreted as a method of empowering Indigenous peoples (Fernandez-Gimenez et al. 2006) or as a form of further exercise of colonial power over Indigenous peoples. This is especially true when the outcomes of monitoring result in management actions that negatively impact Indigenous people's ability to use and access their traditional resources (Ellis 2005), thus hindering the place-based and culturally informed processes necessary to form and transmit Indigenous knowledge to begin with (Wilson 2001; Berkes 2009; Simpson 2014). Further, Indigenous knowledge is still often validated according to western scientific paradigms, which perpetuates colonial power imbalances (Nadasdy 1999). For true integration of knowledge systems to occur, Indigenous knowledge holders must have the same power as scientists in the process of documenting, validating, and combining knowledge borne of different systems (Simpson 2004; Irlbacher-Fox 2014).

In this paper, we move beyond harvest studies to describe and reflect on the design and actualization of a monitoring program meant to inform local ecological, social, and political objectives based in harvesters' knowledge jointly designed by Gitga'at harvesters, community researchers, and researchers from the University of Victoria. The intention of this research was to center the vision and voices of Gitga'at harvesters in setting the objectives and designing data collection and reporting methods 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 suited to their own political, social, and ecological contexts. 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. We describe the chronological steps of our research to enable other Indigenous peoples to adapt and build upon them.

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 (**Fig. 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 and Reid 2014). The home community of Gitga'at people is Hartley Bay (Txałgiu), where approximately 140 people live year round. Approximately 400 Gitga'at people reside in Prince Rupert, located approximately 140 km northwest of Hartley Bay, and many live in other cities across North America. The leaders of each Gitga'at house group (waaps) oversee the local stewardship, allocation, and management of resources according to their intimate knowledge of ecosystems, foundational oral histories (adawx), and laws (ayaawx). These principles 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 and Picard 2015), oceanographic surveys, marine mammal population assessments (Ashe et al. 2013; Keen et al. 2017), and acoustic baseline monitoring

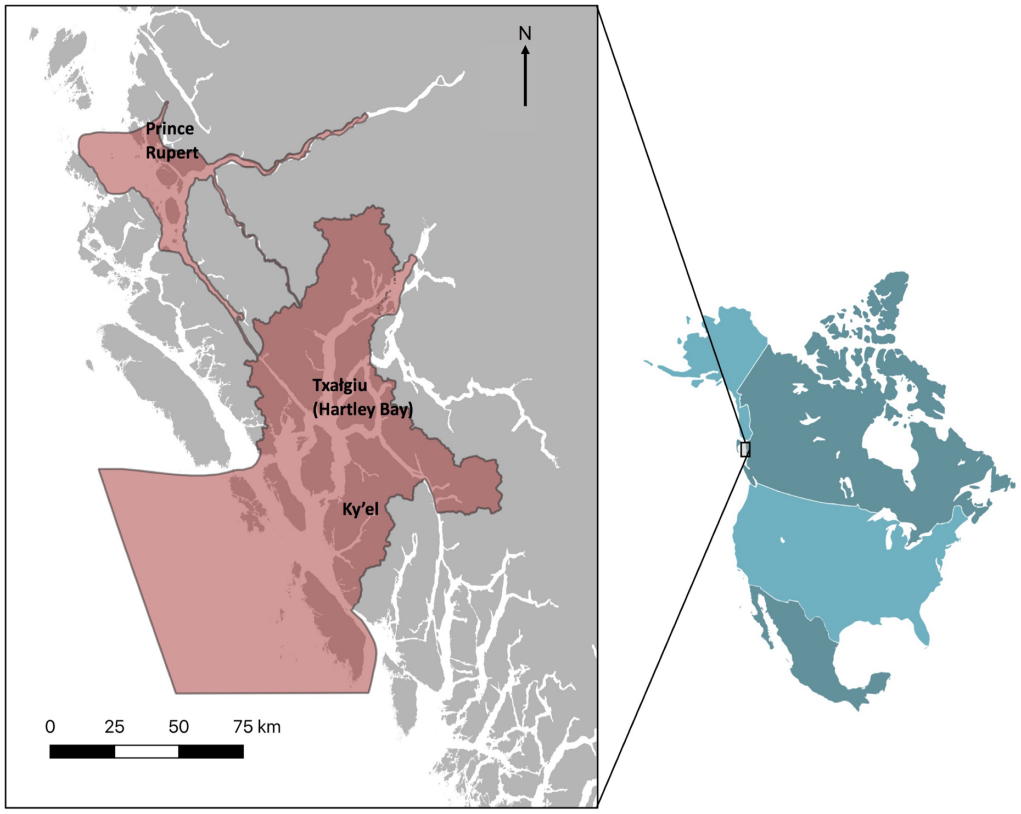

Fig. 1. Map of Gitga'at Traditional Territory showing the location of Prince Rupert, Txałgiu (Hartley Bay), and Ky'el. Map was produced by KL Thompson using QGIS software (QGIS Development Team 2017) with data from British Columbia Data Catalogue (catalogue.data.gov.bc.ca) and Gitga'at First Nation Ocean and Lands Department (gitgaatnation.ca/oceans-lands).

(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.

Initiating the research

The Gitga'at Oceans and Lands department invited University of Victoria researchers to assist with designing a program to document harvesters' observations to enhance the systematic monitoring that has been officially conducted by the Gitga'at Guardian Watchmen program since 2010. Gitga'at coresearchers, together with University of Victoria researchers, were an integral component in designing and testing the program by ensuring that methods were culturally appropriate and relevant, testing the methods, entering and managing data, making suggestions to improve the data collection process, and 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 project was designed to have three phases: (*i*) determining monitoring program objectives, (*ii*) designing data collection tools, and (*iii*) iteratively testing and revising the tools through two harvesting seasons (spring and fall/winter) (**Fig. 2**).

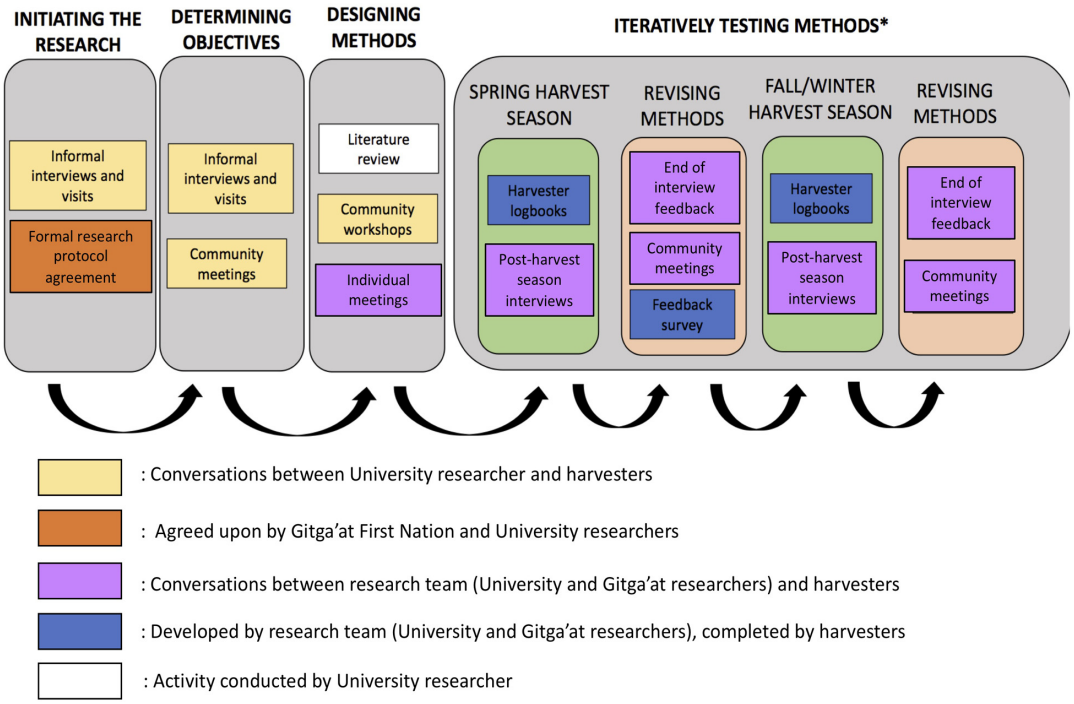

Fig. 2. Flowchart showing research activities conducted to initiate research and monitoring project, determine objectives, design, and test data collection methods. *Methods will continue to be re-iteratively tested and adjusted as the program continues into the future.

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. 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. Following the meetings in Hartley Bay and Prince Rupert, interested community members were invited to smaller workshops to discuss data collection

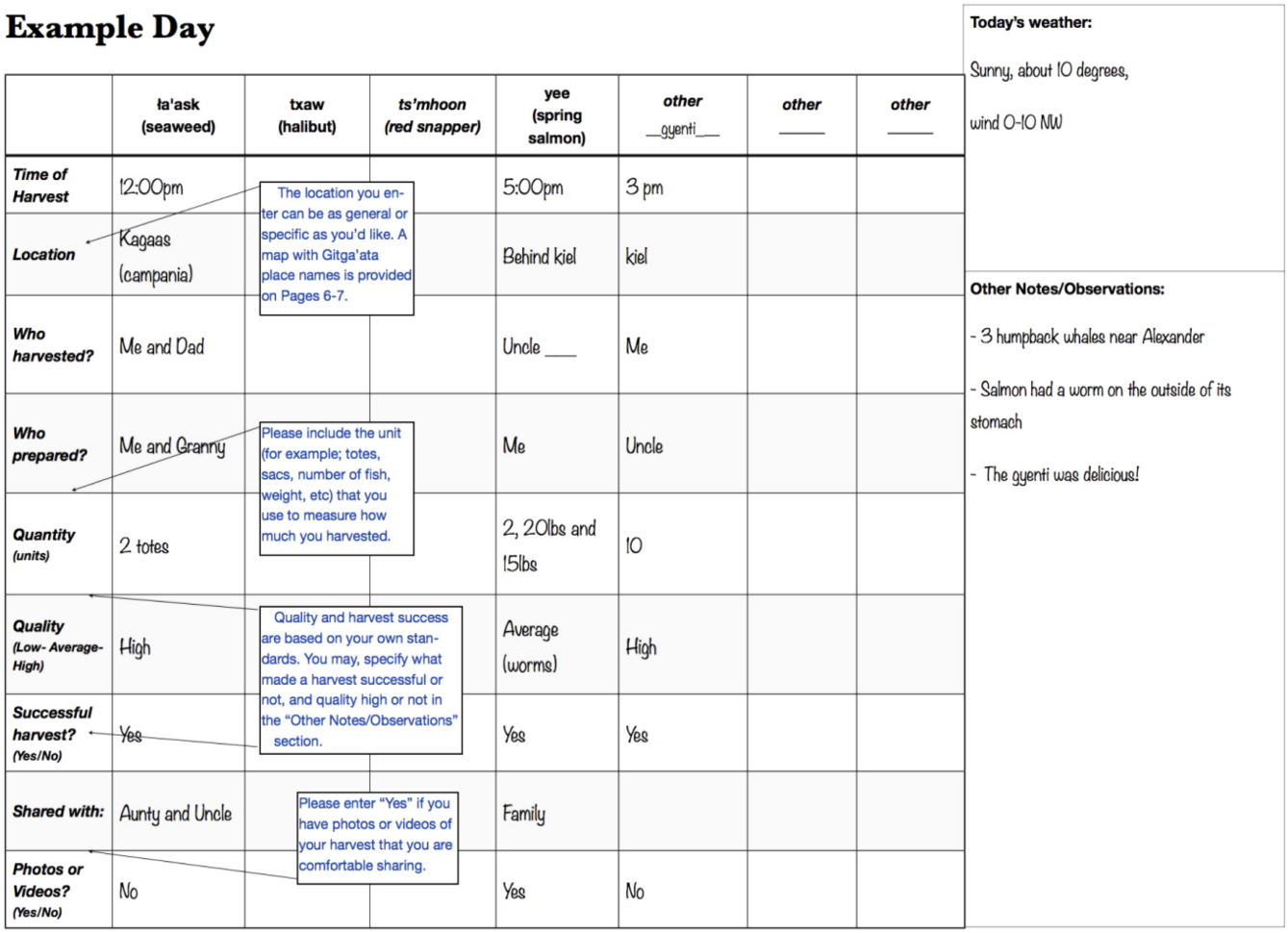

Fig. 3. Example logbook page with instructions for documenting observations.

methods in more detail. Because of conflicting schedules, some would-be workshop attendees opted for individual meetings; a combined total of 12 meetings were held.

Collaborative design of data collection tools

Having received unanimous positive interest in collating Gitga'at harvesters' observations, we sought to design appropriate methods for doing so. 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. 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.

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

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

The draft logbook was comprised of a page for every day between 23 April and 30 June 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 (Fig. 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.

The interview guide (Supplementary Material 1) 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: (*i*) level of experience harvesting (asked during the first interview only); (*ii*) quantity of the food species, including how much was harvested, whether abundance had changed, and whether harvesting needs had been met; and (*ii*) location of harvest.

Iteratively testing and revising data collection and reporting methods over two harvesting seasons

Spring harvest pilot season

We first tested the data collection tools during the spring harvest season of 2017. 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.

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

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 to 92 years. 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 (**Supplementary Material 1**) and were conducted individually or in 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 unplanned 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).

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 (**Supplementary Material 2**). 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.

Second pilot season: fall 2017/winter 2018

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**). Results from the fall/winter harvest season were analyzed and reviewed by the community in the same way as for the spring harvest season.

Results

Community-informed 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
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, whereas 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) a 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

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 three harvesters filled in their logbooks but reported misplacing them. Of the six who returned their logbooks, four 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.

Semi-structured interviews lasted between 30 min and 3 h, 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).

Community assessments of 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).

Ninety-five percent ($n = 22$) of participants said that they would be willing to participate in another similar interview in the future, whereas 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

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 2017/2018 interviews.

Main post-harvest season interview guide themes		Total number of observations[a]	
		Spring (12 species, 23 participants)	Fall/winter (11 species, 27 participants)
Across all 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

[a]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).

Table 4. Participant feedback about logbooks and interviews.

Data collection method	Suggestions for improvement
Logbooks	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	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)

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 doing 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

Twenty-one 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. Eleven completed feedback forms were received. Ten respondents were happy with the amount of information presented in the summary report and one suggested that future seasons "Include more species, i.e., 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% 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." Ninety-one percent 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.

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 for their information needs and adjusting logbooks and interview questions accordingly on an annual basis. For example, the lead Treaty Negotiator for Gitga'at suggested that 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, 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 Environmental Systems Research Institute 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, the Gitga'at Health Director, 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

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[a]	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

[a]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.

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 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, whereas 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… 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.

Applying community suggestions

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 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. 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, 20 harvesters were given logbooks, though only two participants completed and returned their logbooks. Despite the low return rate initially, participants still suggested keeping the logbooks as a data gathering tool. Following the interviews, some participants suggested that regular reminders, posted to social media, would encourage harvesters to fill in their logbooks.

Interview guides were also modified to incorporate suggestions made following data collection in spring 2017 (**Supplementary Material 3**). 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, whereas the remainder said it would depend on their availability and whether they had a chance to harvest.

Discussion

Although there is a growing number of monitoring programs that involve Indigenous peoples and their knowledge (Thompson et al. In review), few studies have focused on the steps taken to actualize these programs (e.g., Parlee and Lutsel K'e Dene First Nation 1998; Eamer 2006). Documenting and reflecting on this design process are 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. Our reflections aim to lend insight into the practice of collaboratively designing monitoring programs that are led by Indigenous people and their 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 (**Table 6**). Completing and entering data from logbooks is relatively quick for harvesters and researchers, respectively, but low logbook returns suggest that relational

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

	Harvest logbook	Post-harvest season interview
Number of participants (spring 2017)	6/30	23
Number of participants (fall/winter 2017/2018)	2/20	27
Quantitative data	Quantity of food harvested, general harvest locations, month of harvest	Quantity of food harvested, years of harvesting experience, specific harvest locations, month of harvest
Qualitative data	Overall quality of harvest, food sharing, skill sharing	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	Quick reporting and data entry, observations documented during or soon after harvest	Anchors data in context, interviewer learns while listening, builds relationship between interviewer and participants, many willing participants
Disadvantages	Data may lack context and nuance, few participants	Time consuming to collect, transcribe, and analyze; relies on accuracy of harvesters' memory

methods of information collection (i.e., 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 experienced, and it 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 and Lantz 2014; Gill and Lantz 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), alongside our own participants' initial recommendation to make self-reporting tools available, are further motivation for our team to design an app as an option to use instead of paper logbooks in the future. However, 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.

The monitoring program resulting from the design process we describe here differs in some important ways from harvest studies that have been conducted in other regions. The objectives differ due to the community-informed nature of the program design. While most harvest studies focus primarily on fisheries and wildlife management, the objectives for this program set by Gitga'at harvesters also explicitly included social and political components (i.e., asserting Rights and Title, intergenerational knowledge transfer, and health and wellness). Given the social-ecological nature of Gitga'at objectives, the information documented goes beyond amounts harvested, body condition, or location of harvest, which are often the focus of harvest studies (e.g., The Joint Secretariat 2003; Priest and Usher 2004). Rather, the information we have begun documenting on a seasonal basis includes how foods are

shared, who is engaged in learning and teaching harvesting and preparation techniques, harvesting narratives, and perceived changes of social and ecological change. Regular community meetings and assessments conducted by Gitga'at harvesters, knowledge holders, and departments were intentionally worked into its design to ensure that the program is able to meet community objectives while remaining flexible to needs and priorities that will surely shift over time. The program and the information collected will inform multiple forms of decision-making in a setting undergoing rapid and complex social-ecological changes. We contend that including these components emphasizes the link between social and cultural processes of acquiring and transmitting Indigenous knowledge rather than its content alone and that this program contains these elements given its design led by and for Gitga'at harvesters and institutions.

By explicitly including the observations of Indigenous harvesters in ongoing social-ecological monitoring, the program we describe builds on the efforts of other Indigenous communities that have developed 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 (Kotaska 2013; Wilson et al. 2018). For example, the Coastal Stewardship Network, which employs Guardian Watchmen from seven 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 Gitga'at First Nation is part of the Coastal Stewardship Network 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. Meanwhile, the Arctic Borderlands Ecological Knowledge Co-op, has been in operation since 1996 and includes eight 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 comanagement decisions (Russell et al. 2013). By integrating the Gitga'at harvesters' 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 are challenges within participatory and community-based work in general (Natcher and Hickey 2002). While we were 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, whereas others are openly shared within and outside of the community (Pulsifer et al. 2012; Chambers et al. 2017). 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 to create a self-sustaining program, university researchers should invest the necessary time into transferring data collection and management skills to Gitga'at people. We echo Coombes et al. (2014) in saying that collaborative research should not be judged by its primary outputs but rather by 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 bidirectional 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 to suit their own social-ecological context and generate information that would be useful to their own specific needs and objectives.

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Author contributions

K-LT, NCB, and CRP conceived and designed the study. K-LT, NR, NR, and H-JF performed the experiments/collected the data. K-LT, NR, NR, and H-JF analyzed and interpreted the data. NCB and CRP contributed resources. K-LT, NCB, and CRP drafted or revised the manuscript.

Competing interests

The authors have declared that no competing interests exist.

Data availability statement

All relevant data are within the paper and in the Supplementary Material.

Supplementary materials

The following Supplementary Material is available with the article through the journal website at doi:10.1139/facets-2019-0006.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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