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"Learning Together": Braiding Indigenous and Western Knowledge Systems to Understand Freshwater Mussel Health in the Lower Athabasca Region of Alberta, Canada

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Abstract. Fort McMurray Métis Elders and land users have observed a decrease in the population density of freshwater mussels (known locally as clams; Unionidae) in the lower Athabasca region (LAR) in recent decades. A community-based participatory research (CBPR) approach, braided with Indigenous Knowledge, is used as a guiding framework to facilitate partnerships and create safe, ethical spaces across diverse knowledge systems to address questions about freshwater mussel health in a locally relevant and culturally appropriate way. Opportunities for Elders and land users to travel along the Athabasca and Clearwater rivers in search of freshwater mussels allowed for the renewal of personal and cultural relationships to place that was braided with the study of parameters relevant to Western science. Our search revealed the presence of fat muckets (*Lampsilis siliquoidea*), with a limited number of giant floaters (*Anodonta grandis*), in our study area. However, delineating the types of species present is only the beginning of our work to understand freshwater mussel health in the LAR. We present a methodological discussion that demonstrates the importance of prioritizing Indigenous Knowledge to answer questions that may not have been considered within Western knowledge systems and shows how diverse ways of knowing can be braided to create new learnings together. "Learning together," in practice, means recognizing that each person has knowledge and skills to contribute, which also involves shared decision making. We maintain that by "learning together," complex problems can be understood in ways that are more meaningful and insightful than they would be if Indigenous communities, government scientists, or research consultants studied them alone.

Keywords: Indigenous Knowledge, Métis, community-based participatory research, mussel, lower Athabasca region

Introduction

"Where are the freshwater clams?" asked Elder Harvey Sykes, the project lead. Sykes is a member of the Fort McMurray Métis Local 1935 (McMurray Métis), a local chapter of the Métis Nation of Alberta representing an Indigenous community located in Fort McMurray, Alberta, Canada. Oral history shared by the McMurray Métis and other Indigenous Knowledge (or Traditional Knowledge) holders in Alberta indicate that the gathering and eating of freshwater clams (mussels, under biological nomenclature; Unionidae) have historically been part of traditional cultural practices. However, Indigenous Knowledge holders have noticed that the freshwater mussel populations have declined and, in some areas, disappeared from the lower Athabasca region (LAR) over the past 20–40 years. Sykes explained that "there was an abundance [of mussels] at one time. I remember swimming in the Clearwater River where you couldn't

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go swimming without stepping on them" (Hopkins et al. 2018). Similarly, Elder John Grant stated that he is often "wishing there were more clams [mussels] on the Athabasca River" (field video, August 29, 2017). For Indigenous Knowledge holders, freshwater mussels are an important strand that is necessary to the web of life: "if you don't see clams [mussels], you know something is wrong with the water or with the fish. Everything is bound together and connects. If you mess with one, you mess with the other" (Waniandy, meeting notes, November 8, 2018). McMurray Métis and other Indigenous communities in the LAR express a growing concern that the observed diminished populations of freshwater mussels are a signal from Mother Nature that something is not right. (Hansen, meeting notes, February 26, 2019).

Internationally, Nobel et al. (2016) note that freshwater mussels were a plentiful food source for Indigenous peoples in North America, New Zealand, and Australia for more than 60,000 years, supporting Indigenous spiritual and cultural connections to freshwaters. Western science-based studies show that freshwater mussels are now one of the most threatened biological groups on the planet, with populations declining globally (Lopes-Lima et al. 2018). In North America, Williams et al. (1993) confirm diminishing populations, estimating that approximately 72% of freshwater mussels are considered threatened, endangered, or extinct, and 65% of the 50 species found in Canada are in need of conservation (Metcalfe-Smith and Cudmore-Vokey 2004; Metcalfe-Smith et al. 2012). Few Western science studies are able to pinpoint the specific causes of the global declines (Haag and Williams 2014; Hornbach et al. 2018). In Alberta, there are only a limited number of Western science freshwater bivalve research studies (Convey et al. 1989; Hanson et al. 1988a, 1988b; Jansen and Hanson 1991; Pilote et al. 2018). In the LAR, Pilote et al. (2018) show significant oil sands mining-related metal contaminant loading in caged freshwater mussels exposed in situ on the Steepbank River (a tributary of the Athabasca River).

Over the past 15 years invertebrate monitoring in Alberta, which includes freshwater mussels, has been undertaken by government and other agencies (ABMI 2018; AEP 2018; NRBS 1996). However, Western science-based monitoring has produced nominal data specific to native freshwater mussels, as currently practiced invertebrate sampling techniques are not well suited to their collection. From a Western science perspective, current distributions of freshwater mussels populations in Alberta are largely unknown with a large-scale survey last occurring in the 1960s (Clarke 1973; Clifford 1991). Conversely, it is important to acknowledge that Indigenous Knowledge holders most likely hold the only record of historical freshwater mussels distributions and population health in Alberta.

Clarke (1973) and Clifford (1991) indicate that there are typically two freshwater bivalve families present in Alberta: Sphaeriidae (pea/fingernail freshwater clams) and Unionidae (mussels). As directed by the McMurray Métis, our research focuses on the larger Unionidae, rather than the smaller Sphaeriidae freshwater bivalve family. The Unionidae are known locally by Indigenous communities in the LAR as freshwater clams, rather than by the Western science term of mussels. Typically, our practice is to employ the terms communities use for species but, given the ethnobiological knowledge of the audience of this paper, we use the term "mussel" to avoid confusion and retain the term "clam" when used by Indigenous Knowledge holders in quotes or references or when referring to the Clam Team.

In this paper, we share the journey and partnership between a diverse group of people that have come together to study the question posed by the McMurray Métis, "Where are the freshwater clams?"

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(Figure 1). Our research journey serves as an example of how applying a community-based participatory research (CBPR) approach, braided with Indigenous Knowledge, can facilitate partnerships and create safe, ethical spaces across diverse knowledge systems to address questions about freshwater mussel health in a locally relevant and culturally appropriate way. We first introduce the McMurray Métis and describe their connection to the study area and their interactions with freshwater mussels. This is followed by our approach, where we describe CBPR and how we braid Indigenous and Western knowledge systems into a guiding framework; our methods, providing examples of how we operationalize our guiding framework with the idea of finding common ground through the braiding of research methods from two knowledge systems; and our methodological discussion, highlighting the importance of reflexivity and braiding of two distinct ways of knowing by learning together. It is our hope that others will learn with us and be encouraged to undertake similar research using a CBPR approach, braided with Indigenous knowledge as a guiding framework.

McMurray Métis Connection to the Study Area

The lower Athabasca region (LAR) is in northeastern Alberta, Canada (Figure 2). The region is mostly covered with boreal forest, inhabited by a diversity of plants and animals, including fish, song birds, wolves, waterfowl, moose, deer, black bears, lynx, otters, muskrat, beavers, and fishers (Cichowski and Dzus 2010; Fisher and Burton 2016; Gilbert and Nancekivell 1982; Robichaud and Boyce 2010; Sharp et al. 1975), and more than 500 vascular plant species (Nielsen et al. 2017). In the LAR, there are two large river systems: the Athabasca River and the Clearwater River. The Clearwater River flows into the Athabasca River, which runs through the center of the region before draining into the Peace Athabasca Delta and Lake Athabasca. The largest urban center in the LAR is Fort McMurray and there are also smaller rural and Indigenous communities in the region. The LAR is part of the

Figure 1. The Clam Team - (left to right) Harvey Sykes, Debra Hopkins, John Grant, Almer Waniandy, Leonard Hansen, Lorrie Gallagher, and Kaitlyn Wall (not pictured: Tara Joly, Michelle Bailey; photo credit: Tara Joly).

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McMurray Métis homeland and Treaty 8 territory, home to Cree, Dene (Chipewyan), and Métis peoples. The river systems are a source of water for the urban, rural, and Indigenous communities that inhabit this area, as well as for the oil sands industry that often defines this region within Alberta and globally. Alberta's oil sands deposit is the third largest petroleum reserve in the world, and much of it lies beneath the LAR (NRC 2016).

Living in the LAR, the McMurray Métis are a community with over 400 members, mostly located in Fort McMurray. They describe Métis culture as being closely connected to the land and requiring healthy places where they can unrestrictedly practice a Métis way of life (Clark and McMurray Métis 2017). The history and culture of the McMurray Métis are intimately tied to the waterways around Fort McMurray. A Métis knowledge holder explained that "the first thing that come[s] to mind [when I was asked] what do you associate the Métis people with? It's the river systems" (Clark and McMurray Métis 2017:50).

McMurray Métis families have worked on the rivers for generations, navigating waterways for European explorers, transporting goods for the Hudson's Bay Company, and, more recently, working for the Northern Transportation Company Limited and the Department of Transportation. Métis people teach their children water navigation and, historically, the members of younger generations often obtained work in the same outfit as their parents (Clark and McMurray Métis 2017:68). Further, the "traditional economic activities of the river-lot system connected Métis families in the McMurray sub-regional community that extended from Willow Lake and the House River down the Athabasca River towards Fort Chipewyan" (Clark and McMurray Métis 2017:83). A Métis Elder explained that the river lots "were along right from McMurray all the way down the river…Used to be every four or five miles on side of the river there'd be a house, other side would be a house, other side would be a house" (Clark and McMurray Métis 2017:69). Elder Lorrie Gallagher, a Clam Project team member, explained that all the people who lived on the river used it as their road and depended on it for their way of life (meeting notes, November 9, 2018). Gallagher also mentioned that "a lot of families with children were educated by parents through correspondence. Lessons were sent to them by float plane, boat, and dog team in the winter" (meeting notes, January 16, 2019). The Athabasca, Clearwater, Hangingstone, Horse, and Christina rivers provided transportation links regionally, connected Métis families, and supported sources of subsistence, including fish, ungulates, bears, and freshwater mussels. The McMurray Métis have maintained relations with the waterways around Fort McMurray for generations, accessing harvesting territories, fishing, and maintaining familial connections. The waterways are, thus, a significant part of Métis cultural history and continue to support a Métis way of life that involves regional kinship ties and subsistence harvesting.

Métis people have constitutionally protected rights to harvest subsistence foods in Canada, which is a fundamental part of maintaining a way of life that involves relationships with the land and waterways. However, these rights and land-based practices have diminished in recent decades due to the legacy of policies, including the residential school system, Sixties Scoop, Métis Scrip, wildlife regulations, rapid industrial expansion on Indigenous lands, displacement, and competing economies. While the Clam Team was on the Athabasca River in 2018, Sykes and Clam Team member Leonard Hansen (also a McMurray Métis Elder) reflected on these colonial processes and explained that the Canadian government worked hard in an attempt to change Métis ways of life and tell Indigenous peoples how to live. Yet, despite these efforts, Sykes reflected, "we are still here" (field notes, August 30, 2018).

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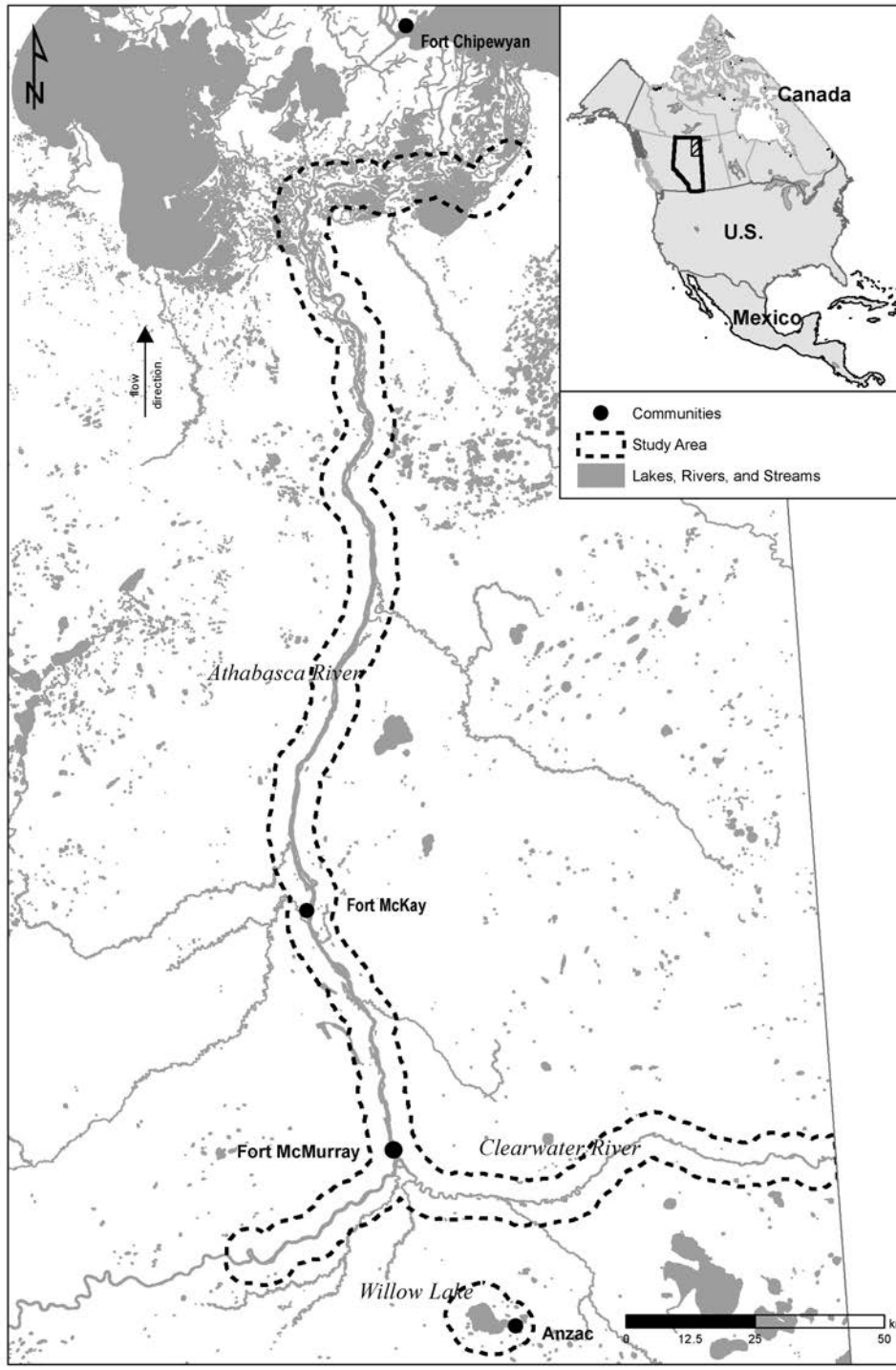

Figure 2. LAR study area (map credit: Alberta Environment and Parks).

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For Indigenous peoples, harvesting activities are social processes (Nadasdy 2003). This sociality indicates that the site or moment of harvest, such as a kill site of a moose, is not the only place or moment of importance: rather, the whole host of relationships and practices that surround the harvest, such as preparation, traveling the land, and processing and sharing the kill, contribute to maintaining relationships with the land and the community. The same is true for collecting freshwater mussels. When the Clam Team travels the rivers together, Elders talk about how they used to find and collect freshwater clams for subsistence while doing other activities, such as traveling, fishing, visiting relatives, or working on commercial boats (meeting notes, October, 2017). Gallagher explained that clams were a delicacy, not a food source the community depended on (meeting notes, November 9, 2018). At first glance, freshwater mussel harvesting may be understood as a secondary activity to the primary work of fishing or traveling on the river—in fact, collecting and even simply encountering freshwater mussels contributes to the holistic experience of being on and engaging with the river for Métis community members.

Our study area centers on the Athabasca and Clearwater rivers (Figure 2). The McMurray Métis direct the selections of our site locations on these two rivers, and the Fort McMurray First Nation does so on Willow Lake (within their traditional territory). To protect Indigenous Knowledge, no specific site locations are presented here. Generally, our sites encompass zones of influence with negligible anthropogenic sources (i.e., oil and gas, urban development, and agriculture) to zones that contain a large number of anthropogenic sources.

Approach

For this study, a community-based participatory research (CBPR) approach is used as a guiding framework to braid Indigenous Knowledge with Western science. CBPR is a Western-based approach and we acknowledge that this research cannot completely escape its associated Eurocentric biases. We also recognize the contradiction of the communication of Indigenous Knowledge, a knowledge system that has been transmitted orally and experientially from generation to generation, in written form. That said, CBPR has the ability to "build alliances across differences" (Minkler and Wallerstein 2008:101), thereby appreciating the heterogeneity of knowledge systems and allowing space for locating and, in our case, prioritizing Indigenous ways of knowing in our research, making it a useful and inclusive means of doing research with Indigenous communities. CBPR promotes a broader definition of research that goes beyond just protecting the participant to also protecting the community (Glass and Kaufert 2007).

Our study is shaped by the following fundamental principles of CBPR (Cargo and Mercer 2008; Castleden et al. 2012; Ledwith and Springett 2010; McOliver et al. 2015):

- democratizing the research process to remove power inequities and ensure that the research is culturally safe;
- creation of a safe, ethical space where different world views can be respected and explored in a way that is meaningful to participants;
- establishing, developing, and nurturing mutual respect, empathy, and trust;
- being authentic to self and others, while listening to all voices;
- do no harm;
- "cultivating awkwardness" in recognition that not everyone is going to agree all the time (Ledwith and Springett 2010:219);
- ensuring sustained partnerships and adequate resources.

We harmonized CBPR by applying Ledwith and Springett's (2010:128) interpretation of

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dialogue as "at best an interactive process of learning together whereby mutual value is enhanced through the process of meaning making." This dialogue "embodies human dignity and respect, encouraging people to relate to each other in ways that are mutual, reciprocal, trusting and cooperative" (Ledwith and Springett 2010:135). This approach contributes to the development of a safe, ethical space to braid Indigenous ways of knowing and practices with Western science knowledge systems (Bannister 2018).

Given that CBPR is a Western research approach, we altered our guiding framework to better support culturally relevant constructs. Braided into our framework and significant to the McMurray Métis are the Seven Sacred Teachings that lead to "a good way" of life, guiding us in how we treat ourselves and others. These teachings encompass the values of love, humility, courage, wisdom, honesty, respect, and truth (from a poster hanging in McMurray Métis Local 1935; Flicker et al. 2015). Research done in "a good way" is a sacred endeavor that highlights Indigenous connections between spiritual and physical worlds, honoring both tradition and spirit (Flicker et al. 2015). By undertaking research "in a good way," we are able to work to decolonize the research process. The CBPR approach, braided with Indigenous Knowledge, is used as our guiding framework.

Finding Common Ground between Indigenous and Western Science Methods

CBPR, braided with Indigenous Knowledge, invites multiple ways of knowing into the same space of inquiry, collectively generating a braided understanding of freshwater mussel health in the LAR. Reflecting on how we developed and implemented our study, in this section, we show how we braided together Indigenous and Western science methods. We emphasize how Indigenous and Western ways of knowing can complement, support, and enrich one another, ultimately working to lift each other up. We operationalize our guiding framework with the idea of finding common ground through our methods, which we present in a linear story narrative, as follows:

- The Beginning of Our Story—Building Knowledge, Trust, and Relationships;
- The Middle of Our Story—Being on the Land and the Water;
- Sharing our Story—Collaborative Dissemination.

No ending to our research story has been provided, since it is growing and changing as the study moves into its third year.

The Beginning of Our Story—Building Knowledge, Trust, and Relationships

For over a decade, McMurray Métis Elder Harvey Sykes advocated at multi-stakeholder, government, and consultation meetings for a project investigating the disappearance of freshwater mussels from the water systems in the LAR. In 2017, Alberta Environment and Parks (AEP) became better situated to fund this research through its Innovation Funding Program and, later, through the Oil Sands Monitoring Program. Consequently, Alberta Government scientist Debra Hopkins approached Sykes to see if he would be interested in working together to understand freshwater mussel health in the LAR. Hopkins and Sykes arranged for the McMurray Métis to be the lead on the research project, with active support provided by the AEP and a research consulting company that had worked with the community for a decade. We co-developed a proposal outlining mutually agreed upon research questions, which also outlined a commitment to work together, using Indigenous Knowledge and Western science to understand the freshwater mussel story in the LAR in a way that is significant to both the McMurray Métis and AEP. Critical to this proposal was the acknowledgment that the McMurray Métis would meaning-

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fully participate in all phases of this work, predicated on mutual ownership of the research process and products, as well as shared decision making. This project was not to be an exercise in non-participation and tokenism, where powerholders (e.g., government) make all of the decisions with only a one-way flow of information from powerholders to the community (Arnstein 1969). As well, we wanted to create a research project where government scientists and research consultants are actively involved with the community. Van de Ven and Johnson (2006) state that, by leveraging distinct competencies, diverse research groups have the potential to ground and understand complex problems in ways that are more penetrating and insightful than they would be if Indigenous communities, government scientists, or research consultants studied them alone.

Once funding was in place in May 2017, the Clam Team gathered at our first official joint meeting to: (1) learn more about each other; (2) share what we knew about freshwater mussels in the LAR through the lens of Indigenous Knowledge and Western science; (3) exchange ideas; and (4) discuss how we wanted to move forward together to answer our research questions. In the meeting, McMurray Métis Elders and land users outlined that Indigenous Knowledge included ceremonial protocols (e.g., prayer, tobacco, and smudging), and shared McMurray Métis history, culture, and context in which we would undertake this research. McMurray Métis Elders and land users also articulated Indigenous methods, oral history, and current knowledge of freshwater mussels. As part of our discussion, we undertook a community mapping exercise to share understanding of past and present freshwater mussel site locations from both an Indigenous Knowledge and Western science perspective (Figure 3). The Western science component included sharing the paucity of information about freshwater mussels in the LAR, while drawing from relevant scientific information sourced from areas outside of Alberta. Application of Western science methods to understand contaminant loading in various environmental media pertinent to this research were explored together.

Figure 3. Community mapping with the Clam Team (photo credit: Peter Fortna).

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With the McMurray Métis leading this research, supported by government scientists and research consultants, we agreed to co-produce an approach to answer three mutually agreed upon research questions:

1. Where were the freshwater clams [mussels] in the past?
2. Where are the freshwater clams [mussels] now?
3. Why are the freshwater clams [mussels] not where they were in the past?

Since the project kick-off meeting in May 2017, we have held more than 20 face-to-face meetings, where shared meaning-making has resulted in a mutually agreed upon approach for our research, braiding both Indigenous Knowledge and Western science pedagogies. Field work on rivers and water bodies took place in the summer and early autumn of 2017 and 2018, four and 12.5 days, respectively. Our meetings and field trips always begin with a prayer and an offering by an Elder, following Indigenous Knowledge protocols outlined by McMurray Métis Clam Team members. Environment and Climate Change Canada (ECCC) also joined our team in 2018, as well as two other Indigenous communities in the LAR.

The Middle of Our Story—Being on the Land and the Water

The importance of using the method called Ground Truthing (or land-based interviews) as part of our research was highlighted at the first meeting in May 2017. This method involves going on the land and water with McMurray Métis Elders and land users to sites where they have seen freshwater clams in the past or present, or to other locations of cultural relevance. At these sites, the entire Clam Team listens to place-based stories and lived experiences shared by the Elders and land users. With permission, these conversations during fieldwork and office-based meetings are documented through written field notes, photographs, a voice recorder, and/or video. All the information collected is used as part of an ethnographic method to highlight key themes and narratives that are braided into our research.

Before going onto the water, the Clam Team typically has discussions to establish the freshwater mussel search area; however, McMurray Métis Elders and land users also select specific field sites in real-time once we are on the river or waterbody. Global positioning system (GPS) is used to record localities, along with pictures. At each of the study sites, we discuss and document site characteristics using co-developed field data sheets, supplemented with site-specific pictures. The field sheet information is collected by both Sykes and Hopkins, which allows each person to have a copy of the data in real-time (Supplement 1). The information we document at the sites includes: date, time, weather conditions, past and current land uses, freshwater mussel description (e.g., mussels present or absent, were mussels here historically, are shells at the site, how many, location), vegetation (e.g., type and amount of growth), qualitative water parameters (e.g., color, flow), and riverbed characteristics (e.g., rocky, silty). We also collect basic water quality parameters using a citizen science water testing kit (pH, dissolved oxygen, temperature, turbidity) and/or the Hydrolab MiniSonde® 5 multiprobe (pH, dissolved oxygen, temperature, turbidity, conductivity) (Figure 4). The multiprobe is calibrated before each sampling field trip (Hatch Company 2006). The citizen science water testing kit was useful in the beginning of this research to familiarize the Clam Team and build shared knowledge about Western science water quality parameters. The water testing kit was used for our first few field days in 2017; however, as our knowledge grew, the water testing kit was abandoned in favor of the multiprobe, which we used for all remaining field work.

At each sampling site, the Clam Team typically does a quick scan (approximately

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Figure 4. Clam Team Members working together in the field (photo credit: Kaitlyn Wall, Tara Joly).

15 minutes) of the area to find live freshwater mussels or shells. If these items are observed, we utilize a timed search survey method: a qualitative approach to help delineate abundance and population density (Metcalfe-Smith et al. 2000; Reid 2016). Our sampling method typically involves two to four members of the Clam Team who visually inspect the shoreline and two to four members in the water using clear bottom viewers or tactile searches (i.e., sifting about 2–30 cm into the river substrate). There was no fixed pattern to our searching and not all of the habitat was covered (Reid 2016). Depending on the size of the site, the search typically takes up to two hours. Site sizes vary from a 10 to 50 m stretch, with a wadable width of 2 to 10 m. If live freshwater mussels or their shells are found at a site, they are identified to the species level.

To build on Indigenous Knowledge and continue to explore potential factors that could influence freshwater mussel health, the Clam Team decided that environmental media (freshwater mussel tissue, sediment, and water) be collected for the purposes of chemical analysis (i.e., metals, non-alkylated polycyclic aromatic hydrocarbons, and basic water quality parameters). Freshwater mussel tissue, sediment, and water sample collection followed the protocols outlined in AE (2006), Mitchell (2006), and ECCC (2018). All environmental samples were sent to a Canadian Association for Laboratory Accredited (CALA) test center for analyte analysis. Chain of custody forms and field notebooks were also utilized to document information. We have not provided an exhaustive description in accordance with the sampling protocols or lab analysis since we are not presenting the results as part of this paper. However, the Clam Team completed the field work together and will co-author a subsequent paper discussing the findings.

Sharing Our Story—Collaborative Dissemination

As our research is grounded in shared decision making and data ownership, dissemination occurs once information is validated by the Clam Team and in such a way that it is mutually beneficial. From this sentiment, we created a community-based booklet that is a living document, containing all of the information we collected to date, overlaid with pictures. It is updated as information becomes available and is populated only with information rendered permissible to share by the McMurray

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Métis. The first iteration of the booklet was well received by McMurray Métis leadership and members and we continue to use it to inform the public about the project (McMurray Métis and AEP 2017). Indigenous Knowledge documented as part of this research is consolidated and stewarded by the McMurray Métis and stored in their Community Knowledge Keeper database.

Social media tools, such as the McMurray Métis Facebook page and Twitter account, are utilized to seek feedback on potential freshwater mussel site locations, as well as to communicate information about the study both to the McMurray Métis and the broader digital community. When the Clam Team was in the field, we utilized these tools to communicate through live video, inviting participation from the McMurray Métis in real-time and sharing our experiences more broadly. AEP would often retweet McMurray Métis' tweets on its account. Additionally, we shared information about our study at the Métis Festival (an annual event highlighting Métis culture hosted by the McMurray Métis, attended by Métis members and hundreds of youth from Fort McMurray).

Knowledge translation continues through community workshops and presentations, layperson reports, internal provincial government presentations, presentations at scientific conferences, and publication in peer-reviewed journals. In addition, we have been invited to visit secondary schools to talk about this research project. Indigenous youth continue to be involved with our research, especially during field work seasons.

Braiding Methodologies through Reflexivity and "Learning Together"

Considering this paper is methodological in nature, we have chosen not to focus deeply on the quantitative results specific to freshwater mussel health in the LAR. However, our preliminary findings show that the most common species of freshwater mussel in our study area are the fat mucket (*Lampsilis siliquoidea*), with a very limited number of giant floaters (*Anodonta grandis*). The freshwater mussel species we observed are in alignment with the Clarke (1973) and Clifford (1991) dated characterization of five Unionidae clam species expected to be found in Alberta: *Anodonta grandis* (giant floater), *Anodonta kennerlyi* (western floater), *Lasmigona compressa* (creek/brook heelsplitter), *Lasmigona complanata* (white heelsplitter), and *Lampsilis siliquoidea* (fat mucket). Delineating the types of species present is only the beginning of our work to understand freshwater mussel health in the LAR. The next phase of our research is to examine contaminant loading in freshwater clam tissue collected during the 2017 and 2018 summer and fall field sampling seasons, braided with Indigenous Knowledge, using CBPR as a guiding framework.

The remainder of this section describes reflexivity regarding our knowledge systems as foundational to this project, followed by a discussion of the ethic of "learning together," which emerged as a key methodological principle and research finding.

Reflexivity of Our Knowledge Systems

Our braiding began by looking beyond our distinct ways of knowing. Through the creation of a safe, ethical space, we chose to work together collaboratively with open minds and hearts to learn from each other and jointly begin to tell the story of freshwater mussels in the LAR. Our shared goal has been to learn together to better understand freshwater mussel health through our physical, mental, emotional, and spiritual connections to life around us. Our study is about much more than just freshwater mussels, it is also about understanding "the expression of the vibrant relationships between people, their ecosystems and the other living beings and spirits that share their lands" (Battiste and Youngblood Henderson 2000:42). Our journey demonstrates what it means to build mutually respectful and inclusive relationships with integrity, an essential foundation to braid

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Indigenous and Western science knowledge systems.

The Clam Project is grounded in Indigenous Knowledge, which is uniquely defined by Indigenous communities. Generally, Indigenous pedagogies value different ways of knowing that inherently acknowledge the heterogeneity of knowledge (Martin-Hill and Soucy 2007). McMurray Métis Elders from the Clam Team speak of Indigenous Knowledge as a way of knowing rooted in intergenerational experiences and relationships to the land and all its inhabitants. McMurray Métis members maintain intergenerational relations with the landscape in the LAR, and the waterways hold special spiritual and cultural significance. For example, Elder Almer Waniandy explained the relationships between place, identity, learning, and all beings as follows:

> That's a big thing for identity, to be down there [at the river] at five o'clock in the morning, sometimes six, putting in my hook and catching the fish. If I got a nephew or a niece that wants to come down and learn how to do this, I'll be glad to do it. And that's a tradition of mine that went down from my older brothers down to me, to learn how to fish, learn how to get the water out, how to respect the river. To be able to sit there and listen to the birds, watch this beaver come in, a duck swimming by you and quacking. It's just—with nature itself. Or see a fox come and ask for that fish that you just caught. You give it to him because you know he needs it more than you. It's just—it hits you here, and here you're in peace…It's respect, it's all there. It's all combined. Respect for the land and respect for the people. (Clark and McMurray Métis 2017:49–50)

Waniandy highlights the importance of apprenticeship on the land, practice, and respect as components of Indigenous Knowledge. He also speaks about relationships between all beings in a "web of life" (field notes, October 23, 2018), reminding Clam Team members that the water in which we work is connected worldwide, linking the Athabasca watershed to the oceans and back again. Relationships between people, animals, and landscape are also entangled through a spiritual connection to Mother Earth. To maintain good relationships means to engage with Mother Earth and all her creatures in respectful and reciprocal ways (Adese 2014). This engagement includes, but is not limited to, navigating the river carefully, traveling lightly, following harvesting protocols, and practicing ceremonies (Ghostkeeper 2007; Joly 2017). As articulated above, harvesting, interacting with, or simply encountering non-human beings and landscape features contribute to maintaining relationships, which are inherent to Métis culture and way of life. The diminished population of freshwater mussels in the LAR thus impacts Métis ways of life and experiences of place.

Indigenous ways of knowing contrast with that of Western scientists who are trained in the natural and social sciences, who offer their insights at the invitation of the McMurray Métis. The Western scientists on the Clam Team employ both quantitative and qualitative methodologies and each are rooted in colonial legacy. Quantitative methodologies include the following problematic qualities: mechanistic, materialistic, reductionist, empirical, rational, decontextualized, mathematically idealized, ideological, masculine, competitive, and exploitative (Datta 2018; Kelly et al. 1993). Qualitative methods, such as ethnography, share related colonial inheritances: anthropology in North America, for example, "accorded with the imperatives of Empire and in this, specific technologies of rule that sought to obtain space and resources" (Simpson 2014:95). Western science, specifically quantitative methods, has led to a system of knowledge hierarchies where positivism reigns supreme, pluralism is invalid, and only observable, measured phenomenon matter. Consequently, Indig-

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enous Knowledge has been de-legitimized and misinterpreted by Western society (Hill 2009). Often, it is treated by scientists and bureaucrats as a "trinket" (Hunt 2014:30), "extracted" from Indigenous communities and used in ways that counter their goals (Baker and Westman 2018). Thus, these tensions contribute to a mistrust of scientific research. These problematic qualities can also create a dissonance between Western science and Indigenous Knowledge, which Leroy Little Bear (2000) calls "jagged world-views colliding."

Despite this history, braiding these distinct, but not incommensurable, ways of knowing (Todd 2016) is a continued practice in how we work together and an important outcome of the Clam Project. Sykes stated, in October 2017, that "this project, what we're doing here, is a prime example how traditional knowledge and Western science can work together and get results." The project follows Indigenous scholars who argue that "what counts as science is culturally relative, that Indigenous knowledge should be better incorporated into what counts as science, and that it is important that Indigenous interests are protected in the production of scientific knowledge" (Hoover 2017:125; Kimmerer 2013; TallBear 2013).

McMurray Métis Elders and land users often participate in research projects about environmental health and community well-being in the LAR. However, many of these projects do not involve Indigenous communities until the reporting phase, which can lead to a lack of utility and mistrust of research results. The Clam Project attempts to work against this trend, involving all members, from research design to writing and reporting, which contributes to a sense of ownership for the project and supports braiding of knowledge systems. As well, CBPR (as applied by the Clam Team) brings humanity back to the research process, subverting the tendency in which government research is often depersonalized and disconnected from communities. By beginning with reflexivity regarding our knowledge systems, including the ways in which they may collide or converge, the Clam Team creates a safe, ethical space in which we "learn together" about freshwater mussel health.

"Learning Together"

As Sykes stated about the Clam Project, in meeting notes from October, 2017, "each and every one of us is learning and that's the great thing about it." Similarly, Grant expressed, "Well, you work together and you're learning all at the same time, so it's all good, all good things, it all works" (meeting notes, October, 2017). The methodological concept of "learning together" is echoed by each member of the Clam Team as a primary reason for the success of the project (Sykes, meeting notes, October, 2017; Waniandy and Hansen, meeting notes, July 25, 2018). It has emerged as a means of braiding knowledge systems respectfully and is the primary methodological ethic directing the Clam Team and a central principle to our guiding framework. The ethic of "learning together" was integrated into our guiding framework to better support, in practice, the braiding of Indigenous and Western scientific knowledge systems as part of the Clam Project (Figure 5). Foundational to "learning together" is the co-production of knowledge and shared decision making.

Applying CBPR in this way, our guiding framework attempts to move away from a strictly conventional Western science approach seeped in intellectual colonialism by instead creating an inclusive space for locating both Indigenous methodologies and Western-constructed research processes. It is a way to develop synergies across different knowledge systems, embracing multiple lines of evidence generating insights and innovations through complementarities, using a more humanistic approach (Gaudet 2014; Tengö et al. 2014). In other words, our guiding framework allowed for opportunities to build

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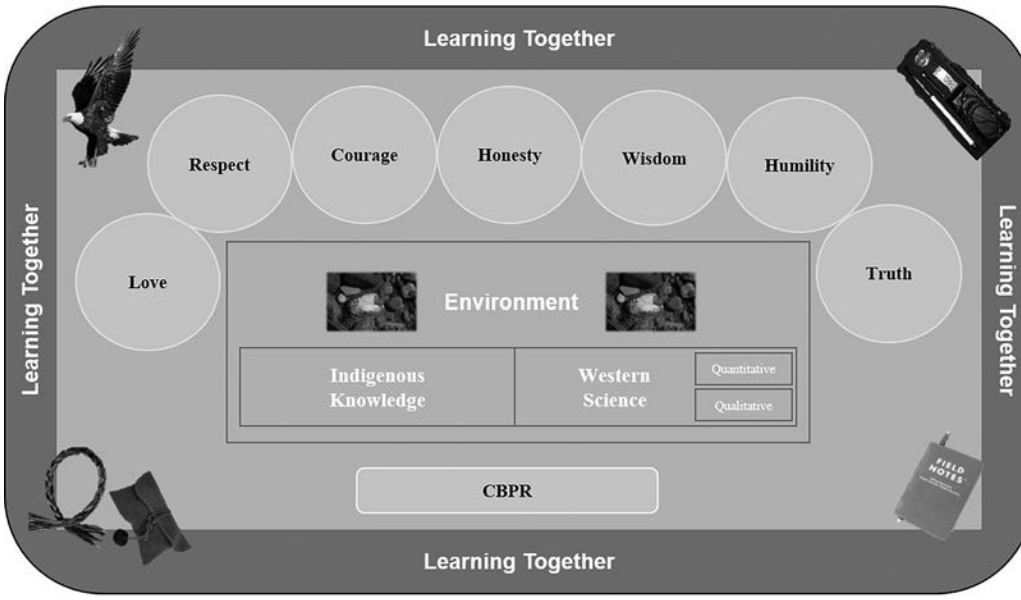

Figure 5. Final guiding framework (Bald eagle—protector; sweetgrass or sage braid and tobacco—ceremonial protocols [smudging, offering]; field notes—qualitative tools; field water quality probe—quantitative tools) (photo credits: Tara Joly, Debra Hopkins, Kaitlyn Wall, Peter Fortna).

trust and mutual respect among research participants facilitating the braiding of two knowledge systems. Through this willingness to reconceptualize our relationships and roles in the research, we came to nourish what Métis Elder and Clam Team Member Almer Waniandy calls a strong learning "circle," in which each person brings and shares what we know equally, contributing to shared feelings and sense of ownership of the research process (meeting notes, November 8, 2018). The Clam Team agreed to prioritize Indigenous ways of knowing, supported through project leadership and controlled by the McMurray Métis. This structure serves as our foundation to co-create knowledge through deliberative dialogue where natural points of confluence or braiding between Indigenous Knowledge and Western science emerge, making our research more relevant and meaningful to all research participants. Additionally, our research dialogue includes the recognition that various ways of knowing and understanding our world may be incongruent and distinct, and in areas where we cannot braid our knowledge systems, we can still learn together, which includes a large dash of humor, laughter, and fun.

In practice, "learning together" means moving beyond attending to colonial legacies of knowledge production described above and recognizing that each Clam Team member has unique knowledge and skill to contribute to the project. It involves carrying out the methods described in this paper together, so that each member of the Clam Team has equal opportunity to contribute their knowledge and to be involved in the project's tasks. It also requires each Clam Team member to approach research in a down-to-earth way, recognizing that they always have something new to learn. Government scientists and research consultants listen and learn from Indigenous Knowledge holders, and vice versa. The government scientists and research consultants learn from Indigenous Knowledge holders about the environmental changes they have witnessed, cultural stories, history, knowledge about water

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and wildlife, cultural protocols, reading the river, and relational ethics. McMurray Métis members learn from the government scientists and research consultants about the lifecycle of freshwater mussels, their preferred habitat, different methods for finding freshwater mussels, and scientific field methods. This bi-directional learning also involves patience, as individuals adapt to and learn across knowledge systems, which sometimes leads the project to move at a different pace than that to which Clam Team members may be accustomed. By "learning together," the Clam Team embraces uncertainty and approaches research with openness and respect for others. With a commitment to "learning together," the braiding of Indigenous and Western knowledge systems develops with authenticity, integrity, and "in a good way."

The Clam Team operates with Indigenous Knowledge and Elders taking a leading role and being open to bi-directional learning opportunities promoting the complementarities of our diverse knowledge systems, which strengthens our braid. The braiding together of Indigenous Knowledge and Western science creates a more holistic and comprehensive understanding of freshwater mussel health in the LAR, as compared to when looking through the lens of each knowledge system separately. Through our guiding framework, methods, and findings, we demonstrated how we have braided two knowledge systems to better understand freshwater mussel health in the LAR. As we continue to learn together about freshwater mussel health in the LAR, we understand that Sykes' concern for freshwater mussels, rooted in Indigenous Knowledge, is also expressed by Western scientists. We have highlighted the importance of listening to Indigenous Knowledge holders who see these changes through their engagement with the river long before Western knowledge systems notice or are aware of changes. Significant is the recognition that knowledge production through storytelling is important in understanding Indigenous peoples' connection to their histories and culture, as well as their relationship with the natural environment. Moreover, we learn from Elders that, beyond humans, animals and plants act as teachers who share knowledge about the environment.

For Indigenous peoples, much more happens when traveling the river than simply looking for freshwater mussels. Métis Elders and land users make observations about river health, ecology, cultural-material histories, and read spiritual and environmental signs on the land that reinforce community cohesion and relationships with the landscape. The Clam Project also provides a chance for Elders to travel along the Athabasca and Clearwater rivers, an opportunity some have not had for decades, renewing personal and cultural relationships to place. By spending time on the river and sharing Indigenous Knowledge, the Clam Project is a conduit for cultural continuity; in other words, the Clam Project is one way for Elders to maintain, renew, and share their Indigenous Knowledge with next generations.

Another way to respect the pluralistic nature of our diverse ways of knowing and to support the braiding of our knowledge systems is through joint authorship of journal articles, presentations, and reports. Joint authorship by McMurray Métis Elders and land users with Alberta government scientists and research consultants also ensures that there is an equitable, respectful, and agreed upon sharing of information related to each knowledge system. Co-authorship includes permission from the McMurray Métis team members to share, in a written form, aspects of their Indigenous Knowledge pertinent to this study. Communication between McMurray Métis Elders, land users, and Western scientists related to the interpretation of both language and cultural content to prevent misrepresentation and misallocation of Indigenous Knowledge has been critical to the on-going success of this study (Battiste and Youngblood Henderson

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2000; Castleden et al. 2012). Ultimately, we will continue to share our study findings through the braiding of Indigenous and Western science knowledge systems.

Concluding Remarks

The success of the Clam Project can be attributed to a methodological ethic of "learning together," which we have incorporated into our CBPR approach, braided with Indigenous Knowledge, as a guiding framework. While the McMurray Métis lead the research project, they have invited the government scientists and research consultants to participate as equal partners, which is predicated on mutual ownership of the study process and products, as well as shared decision making. Rather than focusing on incompatibilities and incommensurableness, this project shows the possibilities of braiding different knowledge systems in research—the success of which may inform reconciliation between Indigenous and non-Indigenous peoples. Our work is especially pressing given the evidence from Indigenous Knowledge and Western science, more broadly, that freshwater mussel species in North America are in peril. As Sykes explains, "sometimes I think they [the mussels] have more brains than us, because they clarify the water, [and] what we do is put the stuff in the water that shouldn't be there. And they are getting stressed out. And I believe that is one reason why they are disappearing" (Hopkins et al. 2018).

Indigenous Knowledge holders have led the way in raising the issue of disappearing freshwater mussel populations in the LAR. And by "learning together," the Clam Team, composed of Indigenous Knowledge holders, government scientists, and research consultants, are beginning to unravel the story of the health of freshwater mussels in the LAR in more meaningful and insightful ways than if each group were to study them alone. Our study demonstrates the importance of prioritizing Indigenous Knowledge to answer questions that may not have been considered by Western science alone, as well as how diverse ways of knowing can be braided to create new learnings together.

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