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Knowledge Mobilization in Community-based Arctic Research

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ABSTRACT. Knowledge mobilization (KMb) is widely recognized as being essential to research, but there is limited academic guidance on how to do this well. This paper builds on the growing body of literature to develop a framework of key principles for KMb focused on Indigenous communities in the North American Arctic. We used a literature search and coding of identified good practice from both the grey and peer-reviewed literature (n = 80), alongside semi-structured interviews (n = 24) with key stakeholders to determine a framework of key principles and to contextualize and identify gaps or challenges. We found that effective KMb occurs throughout the research process and varies widely across regions and by researcher and community. Ultimately, there is no checklist of specific actions to ensure effective KMb, nor would such a list be desirable given the need to tailor KMb to specific contexts. However, we have identified three key principles of effective KMb: 1) respect, 2) mutual understanding, and 3) researcher responsibility. Underlying these principles is the consideration of trust and relationship building. Though these notions are based on subtle and nuanced context and vary from place to place, they all involve the consideration of formal and informal processes of KMb with Arctic research. By highlighting these key principles, we provide a framework to increase effectiveness of KMb across environmental change research within Arctic communities.

Key words: knowledge mobilization; environmental change research; Arctic; Indigenous; community-based research

RÉSUMÉ. La mobilisation des connaissances est grandement reconnue comme une composante essentielle de la recherche, bien que du point de vue universitaire, il existe peu de conseils sur la façon de bien s'y prendre. Cet article porte sur la documentation de plus en plus prépondérante concernant l'élaboration d'un cadre de référence de principes clés pour la mobilisation des connaissances, cadre étant axé sur les collectivités autochtones de l'Arctique nord-américain. Nous nous sommes appuyés sur le dépouillement de documents et le codage des bonnes pratiques dégagées de la littérature grise et de la documentation évaluée par les pairs (n = 80), en plus d'entrevues semi-structurées (n = 24) avec les principales parties prenantes pour déterminer le cadre de principes clés ainsi que pour mettre en contexte et déterminer les écarts ou les difficultés. Nous avons constaté qu'il y a mobilisation efficace des connaissances dans le cadre des recherches, et que celle-ci varie beaucoup d'une région à l'autre, d'un chercheur à l'autre et d'une collectivité à l'autre. Au bout du compte, il n'existe pas de liste de mesures à prendre pour donner lieu à la mobilisation efficace des connaissances. Une telle liste ne serait également pas souhaitable compte tenu de la nécessité de personnaliser la mobilisation des connaissances en fonction des contextes. Nous avons toutefois cerné trois principes clés menant à une mobilisation efficace des connaissances : 1) le respect; 2) une compréhension mutuelle; et 3) la responsabilité du chercheur. La confiance et le renforcement des relations sont également sous-jacents à ces principes. Bien que ces notions soient fondées sur un contexte subtil et nuancé et qu'elles varient d'un endroit à l'autre, elles font toutes appel à des processus officiels et officieux de mobilisation des connaissances en matière de recherche dans l'Arctique. En mettant ces principes clés en évidence, nous aboutissons à un cadre de référence permettant d'améliorer l'efficacité de la mobilisation des connaissances à l'échelle des recherches portant sur les changements environnementaux dans les collectivités de l'Arctique.

Mots clés : mobilisation des connaissances; recherche sur les changements environnementaux; Arctique; Autochtone; recherches communautaires

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INTRODUCTION

Living in the Anthropocene, we find ourselves in a world of unprecedented change where complex global problems linked to environmental change require rapid global solutions (IPCC, 2015, 2018). In this context, researchers are engaged in new and novel ways of producing knowledge with increased attention and focus on the creation of usable science that provides policy impact and outlines solutions (Lemos et al., 2012; Jones et al., 2018; Harvey et al., 2019). The Arctic will see some of the greatest impacts globally of climate change (IPCC, 2018). Reflecting this, the last decade has witnessed a rapid development of research focusing on environmental change impacts, vulnerability, and resilience across the circumpolar North, much of it seeking to inform decision making on risk reduction (AC, 2016; Ford et al., 2016). Such work commonly advocates the need to work closely with community members and decision makers to create "usable science" (Pearce et al., 2009; Cochran et al., 2013; Knapp and Trainor, 2013), in which outreach efforts, such as presentations, policy briefs, workshops, and posters aim to influence policy and adaptation options and are noted as key steps in translating research into practice. The usability of this information, however, depends in part on how it is shared or translated to decision makers (Reed et al., 2014; Ensor and Harvey, 2015; Ensor et al., 2018; Harvey et al., 2019). Despite this global shift towards increased solutions-focused scientific inquiry and significant attention and effort to improving the usability of Arctic science in particular, a number of studies argue that there is a continued and persistent disconnect between the producers and users of research and question the efficacy of outreach efforts (Ford et al., 2013, 2016; McDonald et al., 2016; David-Chavez and Gavin, 2018).

As a result of this increased call for more usable science, academics have a growing interest in exploring knowledge mobilization (KMb) as a mechanism to improve efficacy of research. KMb is defined as "The reciprocal and complementary flow and uptake of research knowledge between researchers, knowledge brokers and knowledge users—both within and beyond academia—in such a way that may benefit users and create positive impacts…" (SSHRC, 2012). The focus and interest in effective KMb align with broader shifts in Arctic research, including greater advocacy for co-production and community-based approaches. Knowledge co-production requires working collaboratively with users and holders of knowledge, bringing together different forms of knowledge to address or further understand defined problems. This process occurs throughout the gathering, sharing, integration, interpretation, and application of that knowledge (Dale and Armitage, 2011). Additionally, community-based adaptation is a community-led process based on communities' priorities, needs, knowledge and capacities, which seeks to empower people to plan for and cope with the impacts of environmental change (Reid, 2009; Ford et al., 2018). These approaches build on participatory methodologies, but focus on collaborative research processes alongside community research partners in planning for future risks of environmental change and policy interventions (Ford et al., 2016). We view KMb to be about how researchers co-produce and collaborate with knowledge users on the research process as a whole, from idea creation through to and indeed beyond project completion.

Academic research on KMb spans the fields of health, environment, Indigenous or Native studies, and pedagogy. The terminology of KMb varies across disciplines (Graham et al., 2006); in some cases, the predominant terminology used in some academic disciplines has been critiqued as being underpinned by positivist epistemologies and often unidirectional in process (Anderson and McLachlan, 2016). In response to this critique, we use the term KMb to capture the notion of momentum, iteration, and reciprocity—the moving of knowledge from what we know to using research to affect change. Arctic KMb research varies widely, which reflects diverse research disciplines. The field of health research is actively engaged with Arctic KMb work (often referred to as *knowledge translation* or *transfer*) on issues such as water (Castleden et al., 2017), suicide (Wexler et al., 2016), maternal health (Claude et al., 2012), and tobacco use (Dawson et al., 2013). In environmental literature, the term *knowledge exchange* is commonly used to explore coastal management (Butler et al., 2015; Cvitanovic et al., 2015a) and resource management (Stokes et al., 2015; Toomey, 2016). The subfield of climate services focuses on the provision of climate information to decision makers through the production of tools, products, websites, or bulletins (Vaughan and Dessai, 2014; Pulsifer et al., 2018). Additionally, Indigenous studies investigate research relationships and protocols through the consideration of cultural values (Bates, 2007; Wilson, 2008; Kimmerer, 2013), epistemological background (Cajete, 2004; Castleden et al., 2017), different ways of knowing (Natcher et al., 2007; Kovach, 2010), bridging knowledge systems (Rathwell et al., 2015), and the colonial history of Indigenous research (Smith, 1999; Cameron, 2012).

Crucial KMb research also exists in grey literature spanning regional, national, and international levels. Key documents include territorial guidelines outlining appropriate community engagement practices (NWTCIM, 2013) and national guidelines for research with Indigenous communities (Creighton and Creighton, Inc., 2000; Panel on Research Ethics, 2016; IARPC and NSF, 2018; NHMRC, 2018). Indigenous organizations have also produced guideline documents such as the recent release of a national Inuit strategy on research (ITK and NRI, 2006; ITK, 2018). Guidelines also exist for ensuring respectful conduct with Elders and respect for cultural knowledge (Assembly of Alaska Native Educators, 2000; NAHO, 2009). Alongside this work are recent guidelines and good practice documents focused on community-based monitoring work (Johnson et al., 2016) and key protocols for scientific research with Inuit (ICC, 2002).

Presently, few studies have critically examined and synthesized these bodies of work to provide a comprehensive picture of KMb work in Arctic communities. This problem is not exclusive to Arctic environmental research; recently there have been attempts to combine key methodologies of KMb practice in environmental research globally (e.g., Reed et al., 2014; Vaughan and Dessai, 2014). These studies hold broad lessons for work in Arctic communities. However, Indigenous Arctic communities offer unique contexts and challenges in terms of sharing research results and building relationships, including language differences, remoteness of communities, lack of technological equipment for communication, different ways of knowing rooted in Indigenous worldviews, and the history and ongoing experience of colonization (Pearce et al., 2009). These factors impact KMb and influence the success of environmental change research in Arctic communities (Ford et al., 2013).

We build on this growing body of literature to develop a framework of key principles for effective KMb of environmental change research in Arctic Indigenous communities. The framework was created through a literature search and coding of identified good practice from both grey and peer-reviewed literature (n = 80), drawing on a broad array of disciplines including Indigenous studies, environmental management, climate services, the usable science field, health studies, and international development. This information is utilized alongside semi-structured interviews (n = 24) with key stakeholders to contextualize and identify gaps or challenges to create a framework of key principles in KMb in Arctic community research.

CONCEPTUALIZING KNOWLEDGE IN AN INDIGENOUS ARCTIC RESEARCH CONTEXT

The history of research in Arctic regions is deeply embedded in colonialism, from early explorers of the 18th century who arrived in the area to explore, own, exploit, and claim Arctic regions (Martin and Armston-Sheret, 2019) to ethnographers of the 1880s who arrived to observe the Inuit, while removing culturally sacred artifacts and, in some cases, bringing Inuit back to Europe as living artifacts (Rivet, 2014; Rondot and Goldade, 2016). Researchers played a pivotal role in justifying assimilation policies within Arctic regions, applying Darwinism to imply weakness in Indigenous cultures and using colonies as research labs for Western science to explore native and non-native plant species and diseases (Smith, 1999). This legacy continues today through paternalistic funding models, which provide funding to Western universities for research that is not a priority for local communities (Cochran et al., 2008; ITK, 2018); the lack of acknowledgement for the work and wisdom shared by local research assistants and guides, thereby allowing Western researchers to build research careers based on the knowledge of others (Smith, 1999); the cherry-picking of Indigenous knowledge to fit with Western data; and the dismissal of Indigenous observations as anecdotal until validated by Western data collection methods (Wilson, 2008; Castleden et al., 2017).

In studying KMb, it is important to first consider what forms of knowledge are being discussed, a pertinent consideration when working within a region where Western and Indigenous knowledge systems are present (Kovach, 2010). Historically, discourse on Western and Indigenous knowledge systems has oversimplified both, describing Western epistemologies as focused on explicit knowledge, through the empirical examination of research hypotheses and siloed scientific disciplines. Meanwhile Indigenous epistemology has been described as tacit knowledge of a "non-fragmented, holistic nature, focusing on the metaphysical and pragmatic, on language and place, and on values and relationships" (Kovach, 2010:85).

Nevertheless, Indigenous knowledge systems also include longitudinal observation and empirical testing of theory and hypotheses, while Western knowledge utilizes systems designed to explore holistic connections (Riedlinger and Berkes, 2001; Krupnik and Jolly, 2002; Wenzel, 2004; Gearheard et al., 2010). The binary distinction is neither helpful nor accurate and risks privileging one knowledge system over another, through suggesting, for instance, that Western science is more rigorous, repeatable, and therefore more valid than Indigenous ways of knowing (Kovach, 2010). Both knowledge systems date back centuries—indeed, Indigenous knowledge dates back to time immemorial—both have their own cultural underpinnings, norms, and values that shape and control what is or is not seen as legitimate knowledge, with such values shifting and evolving over time (Ziman, 2002; Rosenberg, 2011).

Though we recognize that Western knowledge is heterogenous with varied ontological backgrounds, in general terms, Western science privileges perceptive ways of coming to know (i.e., through seeing or hearing a specific thing) over recognized Indigenous ways of coming to know such as dreams, visions, cellular memory, and intuition (Cardinal, 2001; Kovach, 2010). Kovach (2010) states that this sacred knowledge is not fully accepted in Western research, with limited respect given to metaphysical notions of Indigenous knowledge.

Scholars continue to debate and grapple with how best to ethically bridge these knowledge systems (Huntington et al., 2011; Friendship and Furgal, 2012; Kimmerer, 2013; Alessa et al., 2016; Johnson et al., 2016; Whyte et al., 2016; Abu et al., 2019). There are many terms currently used to describe types of knowledge systems present in Arctic research. Here we provide a short definition of some of the most frequently used terminology in environmental change research; we note that a series of research papers and books could be devoted to providing more detailed and nuanced definitions of these terms (see Wilson, 2008; Kovach, 2010; Whyte, 2013; UNESCO, 2017). The term *local knowledge* applies to land-based observations contextually specific to a place and time. The frequently used term *traditional ecological knowledge* (TEK) refers to observations and

historical accounts of observed phenomena of a particular place. The term, Inuit knowledge—known as Inuit *Qaujimajatuqangit* in Nunavut—can be seen to have an increased complexity and depth and refers to societal values relating to social norms within Inuit regions. Finally, the broadest term is *Indigenous knowledge* (IK), which is a contextually based body of knowledge with its own epistemological, ontological, and methodological unique ways of knowing. This knowledge is not homogenous across Indigenous groups worldwide, but some shared characteristics in the various ontological and epistemological approaches are evident.

Arctic environmental change research is often concerned with the TEK type of Indigenous knowledge. Whyte (2013) outlines three prevalent academic understandings of TEK and its relation to Western science. The first approach states that the two systems are separate and should remain so. The second approach believes TEK and Western science are two complementary systems. The final approach posits that TEK cannot be distinguished from science; they are part of the same system. Environmental change research has primarily embraced the second of Whyte's approaches, applying TEK as a body of knowledge that can add further understanding of environmental change in an Arctic context (Pearce et al., 2009; Huntington et al., 2011). In this case, researchers are working to identify and highlight areas of connection and collaboration between the two knowledge systems to allow both to be applied to policy and decision making (Huntington, 2000; Riedlinger and Berkes, 2001; AC, 2016). We believe that TEK defined in this way has its place within the literature, but are concerned that this more narrow definition may lead to attempts to integrate IK systems into Western science, a notion that has colonial undertones and has led, in some cases, to the cherry picking of Indigenous knowledge and the application of data by Western scientists without important surrounding context (Smith, 1999; Bielawski, 2003; Kovach, 2010).

The way that researchers choose to engage with these terms and how they understand the link between Western and Indigenous knowledge systems impacts those living in Arctic regions through scientific research papers and reports feeding into decision making within the region. Indeed, in some Arctic land claims agreements (for example, in Nunavut), governments and organizations are mandated to include Inuit *Qaujimajatuqangit* into decision-making. There is no clear framework for how to do this, however, some have interpreted this mandate to mean the collection and addition of local observations (i.e., TEK) into environmental impact assessments in Arctic regions. This relatively narrow way of considering IK reduces it to observed phenomena with limited ability to consider cultural and spiritual components into decision-making processes (e.g., considering lack of desire to have housing located close to the local cemetery and ancestors; Flynn et al., 2019).

Therefore, in this paper, we refer to the broader notion of IK systems rather than TEK. We use the UNESCO (2017) definition of IK, which was decided in consultation with Indigenous peoples:

> Local and indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For rural and indigenous peoples, local knowledge informs decision-making about fundamental aspects of day-to-day life.
>
> This knowledge is integral to a cultural complex that also encompasses language, systems of classification, resource use practices, social interactions, ritual and spirituality.

We recognize that IK is not one homogenous form of knowledge; it varies widely across the globe and also within Arctic regions and cultures. Indigenous peoples were traditionally located across vast and often isolated regions. As a result, these knowledge systems, which are continually evolving, were created in highly contextual situations. Thus, while we refer to IK throughout this paper, we recognize that the term describes myriad unique Indigenous knowledge systems.

METHODS

Study Region

This study focuses on all communities in the North American Arctic defined through the guidelines set out in the Arctic Human Development Report, which considers Alaska and Canada north of 60° N, plus Nunatsiavut (Einarsson et al., 2004). This area includes Yukon, the Northwest Territories, and the four regions of Inuit Nunangat (Inuit homeland in Canada): the Inuvialuit Settlement Region (northern Northwest Territories), Nunavut, Nunavik (northern Quebec), and Nunatsiavut (Labrador) (Fig. 1). These regions have a mixed economy of subsistence hunting, trapping, and harvesting, alongside income-based employment in the extractive industry and the public sector (Larsen and Fondahl, 2015). The use of Indigenous languages varies by region with a wide array of languages spoken across the North American Arctic. Inuktitut is the most predominantly spoken Indigenous language, with high percentages of the population still utilizing this language, particularly in the regions of Nunavut and Nunavik. Table S1 in the supplementary file provides further information on Indigenous populations located in these regions and key languages spoken.

Data Collection

Data collection followed a two-step abductive process. First, from the existing literature, we catalogued and synthesized key principles of KMb, which were then coded

FIG. 1. The North American Arctic as defined by the Arctic Human Development Report (Einarsson et al., 2004). Created using QGIS, version 3.2, 2018.

and categorized to create a framework of key principles of effective KMb in Indigenous communities with a focus on environmental research. To refine and expand the framework, we conducted in-depth semi-structured interviews with key stakeholders to gain insight into the challenges and lessons learned for effective KMb in Indigenous Arctic communities.

The scoping literature review component of data collection identified current methodologies for KMb in both Indigenous communities globally and in literature from the past decade on KMb in environmental fields. The review process was iterative: initially, grey and peer-reviewed literature was located through Web of Science™ and Google using the search terms: "knowledge translation" OR "knowledge exchange" OR "knowledge mobilization," and "environmental change" and "Indigenous." We excluded conference abstracts and book reviews from our results. Because of researcher limitations, we only reviewed English language papers. Literature sources were included if their content comprised information on research practices in an Indigenous setting or discussed research practices in relation to environmental change. Examples include research guidelines from Indigenous or government organizations, evaluations of results dissemination methods, and meta-analysis of knowledge exchange in environmental management. Following our initial searches, snowball sampling of reference lists and expert-recommended documents gathered during the interview process were added. Finally, additional hand searching was conducted in order to increase Indigenous scholar representation in the final literature sources. We identified and coded 80 literature sources (Table S2), stopping when theoretical saturation occurred and new documents were no longer yielding new insights (Glaser and Strauss, 1967; Corbin and Strauss, 1990; Bowen, 2008).

Semi-structured interviews (n = 24) with experts in Arctic environmental research were conducted, including with a representative of a research funding agency (n = 1), bridging organizations working in northern research (n = 6), research licensing agencies in the northern territories (n = 3), principal investigators of projects with an Arctic focus (n = 8), and Indigenous rights holders (including Indigenous researchers and organizations representing communities) (n = 6). Interviewees were those that worked with, for, or in Arctic communities and, in some cases, lived in northern communities. Interviewees included a mix of Indigenous and non-Indigenous community residents, we did not ask interviewees to identify themselves as one or the other. Interviews lasted approximately one hour and took place over the phone. Initial interviewees were selected using purposive sampling of key Arctic researchers and organizations. Snowball sampling of initial interviewees was used to recruit additional interviewees whom participants felt would have pertinent information to add to the project. Interviewees worked across the study area, with seven in Alaska, two from Yukon, two from the Northwest Territories, four from Nunavut, three from Nunavik, four from Nunatsiavut, and two representatives of Canada-wide organizations. Questions were based on the key themes identified through the literature review and were used to refine and expand upon the information collected from literature codes. The interviews also provided an opportunity to collect personal experiences and identify enabling factors, projects or organizations using good practice and to highlight key challenges in effective KMb in Arctic community work (see Table 1).

Data Analysis

From the literature review, 80 documents were retained for analysis (see Table S2 in the supplementary file). A survey was created to systematically extract qualitative data based on three key categories: (1) key document information including title and authorship, (2) basic trends, including the location of the study and the date it took place, and (3) key principles or frameworks for KMb, including any information on advice, lessons learned, or other evaluations done within the projects. This database was exported into Microsoft Excel and manually coded, using initial coding that involved reading and assigning descriptive codes to small sections (one or two lines) of extracted text on key principles identified in the documents. This coding method is open and offers a good starting point for identifying analytic leads and similarities and differences for further exploration (Saldaña, 2013). Initial coding of the literature created 49 codes relating to KMb principles; these were recoded and categorized through theoretical coding into nine codes: communication tools, context, cultural values, engagement, institutional, inclusive knowledge, learning and reflection, planning, and usable science (Table S3 in the supplementary file gives a detailed overview of the coding method).

Interviews were coded, with the first round coding recording content, followed by a second round of coding that grouped the content into the nine broad themes identified through the theoretical coding of literature

TABLE 1. Key themes identified during the literature review, examples, and sample interview questions.

Themes	Examples	Sample interview questions
Planning:		
• Consideration of KMb at the design stages of the research	• KMb is integrated throughout the research process	• When do you usually begin planning KMb activities? • Is there specific funding ring-fenced for KMb activities? • Does your organization list any specific KMb requirements in funding applications?
Institutional:		
• The coordination and formal processes linked to KMb	• Research protocols, funding or organizational requirements for KMb, incentives for KMb (academic or career)	• Have large projects influenced the way KMb happens do you think?
Engagement:		
• Identifying the correct stakeholders to involve in KMb	• The discussion of research participation and careful of stakeholder mix	• Do you think that you have good participation from desired stakeholder groups? • Are there any missing stakeholders in your KMb activities?
Communication tools:		
• Descriptions of styles and modes of communication	• Simple communication style, local language translation, two-way interaction	• What KMb methods do you often use in Arctic community projects? (i.e. tools used) • How do you determine the correct form of KMb to use in the project?
Context:		
• Locally grounding knowledge	• Local validation of results, place-based	• Do you adapt your KMb outputs for local communities? If so how?
Usable science:		• If so, what impact do you think that had on the KMb?
• Providing information which can be used easily by end-users	• End user discussions, providing timely information to decision makers	• Is this a challenging task? • What are your partners (e.g., communities, decision makers) requesting in terms of KMb?
Cultural values:		
• Consideration of key culturally appropriate communication and messaging	• Recognition of self-governing rights of Indigenous people, culturally adapted programs	• How do you address different worldviews during KMb? • Is there any guidance out there that you find useful in helping you to address different ways of knowing?
Inclusive knowledge:		
• Research that incorporates different worldviews and knowledges	• Inclusion of Indigenous worldviews	• Have you ever experienced contrasting viewpoints on KMb of results?
Learning and reflection:		
• Research projects that encourage learning during or post-project	• Social learning components, reflection and feedback	• Do you use feedback or monitoring and evaluation of your KMb? • Do you require any evaluation or reporting back on KMb from funded projects? • What are the key challenges you feel need to be overcome to ensure effective KMb in Arctic communities? • How well do you think researchers are doing on a scale of 1 – 10 in providing culturally appropriate KMb? (1 = Not well at all, 10 = Very well)

outlined above. During interview coding, two additional themes were identified and added. The code "shift," was defined for content identifying a change or shift in KMb over time, and the code "they just get it" was added to represent interviewees who identified individual researchers, stakeholders or rights holders who they felt had an innate understanding of how to do effective KMb.

Interview transcripts were also subject to magnitude coding, which assigned statements with (+) positive, (−) negative, (NEU) neutral, or (R) recommendation (Saldaña, 2013). We used these codes to add context to the categories and identify key enabling factors or challenges in Arctic KMb. An additional category was added to these standard magnitude codes: EX was used to identify when an interviewee had provided an example of a project, individual, or organization working on an issue in the Arctic. These were used to add good practice examples for the key themes identified.

In addition to these key principles, interview transcripts were also subject to magnitude coding, which assigned statements with (+) positive, (−) negative, (NEU) neutral, or (R) recommendation (Saldaña, 2013). We used these codes to add context to the categories and identify key enabling factors or challenges in Arctic KMb. An additional category was added to these standard magnitude codes; (EX) this was used to identify when an interviewee had provided an example of a project, individual, or organization working on an issue in the Arctic. These were used to add good practice examples for the key themes identified.

RESULTS

Following the iterative coding of both the literature (n = 80) and the interviews (n = 24), we refined the 11 codes into six key themes: understand protocol, create

TABLE 2. Overview of key principles and themes of effective knowledge mobilization (KMb) based on interviews (n = 24) and literature review (n = 80).

Key principles	Theme
Respect	Understand protocol: – Both formal and informal research protocol exists in Arctic community research. Both are important. Create meaningful relationships: – Early engagement of the community in the research design can improve Knowledge mobilization and alignment with community priorities.
Mutual understanding	Adapt communication modes: – Include different knowledge systems. – There is increased recognition of the value, importance, and necessity of connecting different ways of knowing in research. – Modes of communication should be tailored to community needs. – Researchers require soft skills and knowledge of the medium.
Researcher responsibility	Acknowledge the value of KMb: – Academic institutions have been slow to recognize the importance of knowledge mobilization in research. – Doing a good job often involves going above and beyond traditional academic outputs. Reconcile research: – Researchers have not always behaved in a respectful, ethical or trustworthy way in Arctic communities, which has damaged our relationship within some Arctic communities.

meaningful relationships, adapt communication modes, incorporate different knowledge systems, acknowledge the value of KMb, and reconcile research. We grouped these themes into three overarching principles of effective KMb: begin respectfully, improve mutual understanding, and be accountable for your research (Table 2).

Principle of Respect

Researchers and communities are entering an intimate and unique relationship of trust when they work together (ICC, 2002; Raymond et al., 2010; Hamel et al., 2012; Rychetnik et al., 2012; Reed et al., 2014; Cvitanovic et al., 2015b; Han and Stenhouse, 2015; ICC-Alaska, 2015; Kalafatis et al., 2015). It is important that both parties understand the probable and possible outcomes of the relationship. This understanding is especially pertinent where those involved in the relationship come from different disciplinary, geographical or cultural backgrounds (Reed et al., 2014; Shaffer, 2014; Robertson et al., 2015).

Understanding Protocol: Formal research processes begin at the national level through the use of research ethics boards to oversee human-linked research. Indeed, the Tri-Council of Canada and the U.S. Environmental Protection Agency have guidelines on research with Indigenous communities. Several universities offer courses on ethical research, though advice and training varies by university and country. These formal processes provide guidelines and train researchers on ethical conduct. Many research boards and institutional organizations have produced documentation stating that the treatment of Indigenous communities as passive subjects in research is unacceptable (ITK, 2018). Despite this high-level, formalized stance on research, the literature suggests that research on rather than with Indigenous peoples still occurs (Koster et al., 2012; Alcock et al., 2017).

At the regional level, formal and informal processes of linking researchers with communities vary across the North American Arctic. The use of formal research licences in some Canadian regions (e.g., Nunavut, Yukon, and the Northwest Territories) ensures, at the least, a minimal amount of community consultation prior to a research licence being issued. The process involves a formal application to an organization based in the region; nevertheless, the application is focused primarily on risk assessment rather than on ensuring that the community benefits from the research. However, there are also informal or less formal systems in place in Nunatsiavut and Nunavik. In Nunatsiavut, research is channeled through the Nunatsiavut Government Research Advisory Committee. In Nunavik, research is channeled through the Makivik Corporation or through the Nunavik Nutrition and Health Committee, depending on the research topic. This is a process of approval and feedback on a project rather than an application for a scientific research licence. Interviewees from these regions understand the process well and feel it is working. Of note here is that Nunavik and Nunatsiavut have low numbers of communities (14 and 5, respectively). This less formalized system may not work as well for larger territories or regions. In Alaska, interviewees noted the existence of very limited formal processes for research approval. Instead, research is often channeled through well-known key individuals or stakeholder organizations (Interviewees 14, 15 and 20, bridging organizations and Interviewee 22, researcher). These key stakeholders act as liaisons to community research and may act as a vetting system for incoming researchers.

Research protocols at the community level generally consist of informal research consultations and partnerships. Some formalized community protocols originate from community-led funding, where communities hire researchers to help with a project. In these situations, the community directs the research as it is providing the money and the research questions. Two examples are Health Canada's Program for Climate Change and Health Adaptation in Northern First Nation and Inuit

Communities (McClymont Peace and Myers, 2012) and, in Alaska, the National Science Foundation–funded Yup'ik Environmental Knowledge Project (Fienup-Riordan, 2014). Interviewees discussed the existence of informal research protocols in communities such as researchers approaching specific community groups at the beginning of a project to discuss the research and community expectations, and receive community permission to undertake research. Guidance on whom to approach in a community was obtained from previous researchers who had worked in the area and by reaching out to stakeholders in the community whom researchers believed might have an interest in or link to the research topic.

Although some literature advocates for the increased formalization of ethical protocol across national, regional, and community scales (e.g., through the use of a memorandum of understanding or a formal vision statement) to improve Indigenous community and research relationships (Alcock et al., 2017), interviewees expressed mixed opinions on the formal process of research licencing. One interviewee felt that formalizing the process provided accountability and institutionalized the process to make sure that community consultation and cooperation were received from the beginning of the project (Interviewee 24, Indigenous organization). Others (n = 2) believed that research licence approval organizations acted as excellent resources, sounding boards, and bridging organizations to help avoid community research fatigue and to guide researchers through the process of ensuring respectful and ethical research (Interviewees 5 and 21, research licencing organization and researcher, respectively). Finally, one interviewee felt that the process was not well linked with communities and, even if formal protocols and research contracts do exist, it is not always the case that those impacted by the research had any say on the agreements (Interviewee 17, researcher), potentially undermining those informal community protocols.

Create Meaningful Relationships: Planning for KMb and establishing contact with community members from the start of the research process were identified in the literature reviewed (n = 13) as components of a key enabler for KMb. This finding was confirmed by interviewees (n = 16):

> More consideration for the knowledge translation at the front end of the research design for projects is absolutely the key.
>
> (Interviewee 1, research licencing organization)

This way, researchers and community members design research that is culturally appropriate and addresses a desired community need:

> Right from the beginning it's set up to be culturally appropriate because the leaders of the project are Inuit … And I think that that's one of the real keys to knowledge uptake too.
>
> (Interviewee 3, researcher)

Nevertheless, there are challenges linked to connecting with community-based research partners at the beginning of a project. An interviewee explained it was not always obvious whom to contact at the beginning stages of the research process (Interviewee 17, researcher). For example, a Hunter and Trapper Organization may have a strong preference to be involved in research in one community, but another community may require that the municipal government be consulted regarding research. These subtle nuances can be unclear to those beginning their research relationships (Interviewee 16, researcher). These barriers are likely to be most significant for graduate researchers who are less likely to have funding available for scoping trips to visit communities prior to co-designing their research to align research priorities. Creating a book or guideline to identify or formalize contact people was deemed an ineffective way to remedy this situation, as any document would be subject to frequent change and may not capture each unique context well enough (Interviewee 19, research licencing organization). Providing funding structures that include a budget for scoping trips and encourage extended multiyear projects might help new researchers build upon pre-established community contacts (made via supervisors or other members of the research team) to aid in connection and sustained community input into a project.

Multiyear projects were also felt to improve KMb outputs. Interviewees believed that usable products did not result from an individual project but from the continued interaction of researchers and communities over time. Interviewees provided examples of where continued interactions following the completion of projects (e.g., due to living in the region or through meeting frequently) had helped to identify new opportunities to apply older research through listening to community questions or suggestions as to how to make these products more accessible or suitable (Interviewees 12 and 13, researchers).

> Sometimes the best communication comes out of times where we haven't gone up for a specific project. Maybe a meeting is happening that we're going to and you'll be having a conversation with someone and then you realize that one of your projects would really help them with something they're doing right now, ongoing connections.
>
> (Interviewees 12 and 13, researchers)

This continued relationship throughout the research process, from research design to post-research completion, is difficult and heavily favours those researchers who are living within a community or have significant funding, which makes this challenge particularly pertinent for graduate students hoping to work within the region. Interviewees, however, suggested alternative mechanisms to achieve this ongoing relationship and interaction. One such mechanism was having research infrastructure located within communities, for example the Canadian High Arctic Research Station in Cambridge Bay, the Rigolet

Storytelling and Digital Media Lab, and the Nunatsiavut Research Centre (Interviewees 3, 7, 8, researchers). These types of infrastructure provide an explicit research base in the community and act as an entry point for researchers. Some centres also provide discounted accommodation to help reduce the financial burden on graduate researchers in particular. Graduate students may also be able to reach out in some regions to the Inuit research advisor or other locally based organizations to be put in contact with those impacted by their planned research. Additionally, multiyear funded research projects allow for sustained relationships and a building upon what has come before (Interviewees 4, 6, Indigenous organizations, and Interviewee 20, bridging organization). For example, the Northern Contaminants Programme (NCP) in Canada has been ongoing for over 25 years, which has meant that researchers have had the chance to build long-term meaningful relationships. Despite significant challenges in earlier years (Friendship and Furgal, 2012), Inuit are now represented at all levels of the NCP, and community monitoring and liaison are key components of the program.

Principle of Mutual Understanding

Include Different Knowledge Systems: In some regions (e.g., Nunavut), integration of Indigenous perspectives into research and decision-making is legally required through land claims agreements. Additionally, in December 2016, a joint statement was released by Prime Minister Trudeau and President Obama in which they committed to conserving Arctic biodiversity through science-based decision making; incorporating Indigenous science and traditional knowledge into decision-making; building a sustainable Arctic economy through low impact shipping corridors, abundant Arctic fish, and a science-based approach to oil and gas; and supporting strong Arctic communities (Trudeau, 2016). Finally, in the 29 September 2016 press release at the White House Arctic Science Ministerial, the Inuit Circumpolar Council chair, Okalik Eegeesiak, stressed the need for equity to form the foundation of Arctic research and stated that it was time for Arctic science to fully encompass Indigenous knowledge in setting and carrying out research agendas in Inuit regions.

The literature extensively discusses different ways of knowing and the importance of inclusive knowledge (n = 27). It highlights the complementary nature of Indigenous and Western knowledge systems, stating that Elders and local community members maintain a deep connection and understanding of their land and systems knowledge, often providing additional context and depth and significant historical information alongside Western science observations (Huntington, 2000; ICC-Alaska, 2015).

Interviewees identified a wide range of options being employed to conduct research that is inclusive of different ways of knowing. Some were narrow in scope, such as the collection of TEK from local community members to contextualize a research finding. Others involved the dissemination of research results back to a community through a local research partner. There were also several broader or holistic practices in incorporating different ways of knowing into research, for example, the continued consultation with community members regarding important research questions and key priorities identified by the community. Some interviewees discussed collaborative projects that involved Indigenous organizations and researchers as research partners. Through including Indigenous research partners and having them co-design the project, interviewees believed that:

> Right from the beginning it's set up to be culturally appropriate because the leaders of the project are Inuit. And they guide that process right from like how are you going to gather that data in a culturally appropriate way, to how are you going to analyze it, how are you going to disseminate it … [I]t's not taking research results and trying to figure out how to make it culturally appropriate. It is making sure that everything is culturally appropriate right from the beginning.
>
> (Interviewee 3, researcher)

Other interviewees mentioned innovative research projects utilizing good practices of inclusive knowledge and producing excellent research, including *The Sea Ice for Walrus Outlook* (ARCUS, 2016) and the LEO network (ANTHC and RDI, n.d.). Both interviewees and the literature identified projects run entirely by Indigenous peoples and organizations, such as the "Alaskan Inuit food security conceptual framework: How to assess the Arctic from an Inuit perspective," which had 146 Inuit contributing authors. Despite interviewees and the literature both advocating for increased co-development and Indigenous partnerships in projects, and advocacy from country leaders and key Indigenous organizations, challenges still exist in the integration of Indigenous knowledge into Arctic research (Labbé et al., 2017; Flynn et al., 2019).

The literature provided insightful critique on current research practice of incorporating different ways of knowing into research, including a consideration of the orientalization of IK in Arctic environmental change research and a limited engagement of researchers in considering the impact of colonialism in current research (Cameron, 2012). Orientalisation refers to the Western conceptualization of the East as the exotic "other" in order to exert power and control over colonized peoples (Said, 1978). In an Arctic context, the term refers to the interpretation and definition of IK and peoples by Western researchers, a modern day "othering" of Arctic peoples that allows continued colonial practices to occur in northern regions. Some literature and interviewees discussed the way that Indigenous knowledge is used by Western science in disrespectful ways; for example, knowledge only being considered as expert knowledge if it is collected in Western scientifically recognized ways (Quinney, 2016); the cherry picking of Indigenous knowledge by

researchers (Interviewee 24, Indigenous organization); and the lack of reporting back to communities on the end results (Interviewee 1, research licencing organization; Interviewee 10, bridging organization). In some cases, research resulted in a restriction in Inuit diet through poorly communicated advice about contaminants (Interviewee 4, Indigenous organization). Castleden et al. (2017) describe how the dichotomies of language used to describe Western knowledge (rigorous or universal) and Indigenous knowledge (holistic or anecdotal) place Western science above other forms of knowing. Interviewees and the literature called for an increased use of recognized Indigenous methodologies, for example, the use of a talking circle to collect research questions (Knapp and Trainor, 2013), the use of storytelling to provide observations on changing Inuit health (Harper et al., 2012; Willox et al., 2013), and the creation of conceptual models that capture the broader system and respect the linkages, connectivity and cumulative impacts at play (ICC-Alaska, 2015). Three interviewees (1, 3, and 24) described those doing a good job in KMb through the phrase "he, she, or they just get it." Those described by their peers as doing excellent work in the field combine a personal research philosophy of genuine, prolonged, and meaningful engagement with their beliefs about what makes a good researcher and how to conduct ethical and equitable research with northern partners.

Adapt Communication Modes: In discussing the range of communication tools used in KMb, interviewees emphasized that there is no "silver bullet" for communication tools. What is clearly expressed by both interviewees and the national and international literature is that communities, at minimum, like to see researchers return to present their results in the community. These result-sharing sessions happened in different ways; and interviewees had had success using open houses, plain language summaries, visual posters, photo books, fashion shows, and storytelling workshops. Although these types of events serve to raise awareness of a project and its findings, they do not provide the in-depth data or the personal links to be able to access and follow-up on this science with other questions. In some cases, KMb is limited to less interactive, more unidirectional communication channels such as radio stations, posters and physical copies of short data summaries. Even when local communities are in possession of the data, one interviewee (17, researcher) commented that plain language summaries often went unused. Another interviewee (21, researcher) stated that, in some communities, research and archives were being inadequately stored, which resulted in them becoming damaged and unusable.

Generally, interviewees believed that communication methods should be tailored to fit the needs of the community. Interviewees have mixed opinions of communication tools based on their past experience, their research philosophies, and the preferences of the communities they work with. Some interviewees believe that open houses provide an accessible and engaging outreach tool (Interviewees 3, researcher, and 9, Indigenous organization). One interviewee questioned the use of honorariums and prizes to encourage engagement in the research process, believing that this practice perpetuated inequity and colonialism in community research (Interviewee 21, researcher). Instead, this interviewee suggests that research should be about buy-in, with additional money used to hire local people to be a part of the research, for example, through monitoring and data collection or through results dissemination.

The remoteness of Arctic regions was often stated as a challenge due to prohibitive costs for frequent travel to and from communities, which limited the ability for face-to-face interactions between community members and researchers. Cost notwithstanding, the climate change research community has also faced criticism for its perceived hypocrisy, considering the high carbon emissions of air travel (Kjellman, 2019). A suggested solution to reduce the need for frequent travel to the region is the utilization of online technologies. Interviewees frequently discussed the use of social media in research and generally felt it had a positive impact (n = 11). Researchers are using social media outlets such as Facebook, Youtube, and Twitter for a variety of reasons: to invite people to meetings or open house consultations (n = 3), to collect data (n = 3), and to disseminate results (n = 5). Interviewees noted several advantages to using these platforms, such as their wide distribution and use in northern communities and the intergenerational use of social media (in particular, Facebook). The low bandwidth of Facebook was also mentioned as an advantage over other online means of communication (Interviewee 14, funding organization). However, interviewees did express some apprehension to using social media because of the difficulty in keeping momentum going if new content was not frequently posted (Interviewee 17, researcher), the receipt of negative comments on posts (Interviewees 9 and 23, Indigenous organizations), and difficulty in validating the information (Interviewee 7, researcher). One interviewee (21, researcher) suggested that the use of social media has a gender bias, because in certain communities more women than men seemed to use Facebook.

A key challenge of online communication and engagement in the Arctic is data accessibility. Many parts of the region have limited Internet bandwidth and some community members may have limited technological expertise, which makes it difficult to share and disseminate material electronically (McCann et al., 2016). Despite this, interviewees felt that the use of online databases as a communication tool held promising opportunities for Arctic KMb. The literature also implies a number of potential opportunities in using online databases, including the ability to store multimedia data, which would add context to knowledge (e.g., through georeferenced locations), or allow the use of video or audio recording in Indigenous languages without the need to translate into English (Pulsifer et al., 2012; McCann et al., 2016). The

LEO network, a database of Indigenous and scientific knowledge on environmental observations in Alaska, spatially maps environmental occurrences and links local observers with topic experts to "share knowledge about unusual animal, environment, and weather events" (ANTHC and RDI, n.d.). Several databases already exist, so the question is whether these databases are providing information that is perceived as usable or if the ideal database has not yet been created (Interviewee 1, research licensing organization). For example, two interviewees (11 and 24, Indigenous organizations) discussed a community desire to have recordings of Elder Indigenous knowledge available in a tiered access system. A tiered database such as the Bering Sea Sub-network (Pulsifer et al., 2012) allows certain members of the team and local community members to access different levels of data, although data access in this form has ethical implications. Indeed, interviewee 24, while advocating for this type of database, also notes that further internal decisions need to be made by Indigenous knowledge holders as to who could access this data, how it could be accessed, and how it could be used in a respectful way. The web-based sea ice observation database SIZOnet tries to account for these risks by issuing an ethical agreement to those who wish to access the data (NSIDC, n.d.). Other challenges in providing access to data via an online database include potential limited computer literacy among Elders and limited internet connectivity and bandwidth in some communities, potentially making these databases more useful to researchers than to local community members (Eisner et al., 2012; McCann et al., 2016).

Finally, language barriers potentially exist across Arctic regions and translation of research into local languages (e.g., Inuktitut) can be limited or slow (Interviewee 16, bridging organization). In some cases, plain language documents are available but may not be in a locally understandable language. Where documents are translated into local languages, interviewees explained that there should be additional focus on the translation of environmental terminology (Interviewees 1 and 16, research licencing organization and bridging organization, respectively). The translation of environmental terminology is far more nuanced than exchanging like for like. For example, Inuit languages often rely heavily on context in order to convey meaning. The literature on the use of the Indigenous term *sila* within environmental research outlines this challenge, explaining that without knowing the context, like-for-like translations can obscure the key message or even change the meaning of a term (Leduc, 2007; Marino and Schweitzer, 2009; Cameron et al., 2015). The increased training and use of highly skilled local translators, who are able to work closely with researchers on environmental topics over an extended period of time, would provide a greater opportunity to appropriately and meaningfully translate words across languages (Mallon, 1993).

Principle of Researcher Responsibility

Interviewees note an increased advocacy for better engagement between researchers and Arctic communities and an improved uptake of KMb-related activities such as knowledge co-production and community research partnerships. However, interviewees believe that we still have a long way to go in creating effective KMb. Interviewees and the literature highlight a number of barriers to KMb. At the community level, we note a reluctance to engage in research, partly due to historical legacies of colonialism in Arctic research. At the institutional level, academic reward systems often place limited value on KMb, thus decreasing the amount of time researchers feel they can dedicate to KMb.

Reconcile Research: Power differentials and historical legacy are discussed extensively in the reviewed literature, including the colonial links to research (Harvey et al., 2012a; Rychetnik et al., 2012; Kulig and Westlund, 2015; Meadow et al., 2015; Stacey et al., 2015; Quinney, 2016; Whyte et al., 2016) and the perceived power scientists hold when entering a community (Marino and Schweitzer, 2009; Hamel et al., 2012; Lemos et al., 2012; Wheater and Gober, 2013; Ensor and Harvey, 2015; ICC-Alaska, 2015; Kalafatis et al., 2015; McDonald, 2015; Meadow et al., 2015; Johnson et al., 2016). Power and colonial history in Indigenous research are discussed overtly in the literature, in particular, the way that environmental change can be interpreted as colonization, where Western exploitation of environment is causing disproportionate impacts on Indigenous peoples, their lands, and livelihoods (Whyte, 2017). However, the discussion of the topic was far more nuanced among the interviewees who commented on research formerly being a bad word and noted instances of unclear decision making and questionable use of Indigenous knowledge in research (n = 4).

Building equitable relationships and addressing power dynamics to enable effective KMb is a continuous process. Recognition of the colonial histories of research and the power imbalances that occur between communities and researchers would facilitate this process (Interviewee 24, Indigenous organization; Whyte et al., 2016). Social justice and equity research consider how colonial history and past oppression impact current power dynamics. Masuda et al. (2014) describe a five-step process for improving social justice equity in knowledge translation: situating yourself, inclusivity, transparency, humility, and reasoned action. These notions of how to increase research equity were echoed during interviews:

> Don't come in and think you know everything when really you don't know anything about our community, you might have read a lot of stuff about our community but you don't know what it's really like … You need actually just like step back and let us tell you how it's done.
>
> (Interviewee 9, Indigenous organization)

Interviewees suggested that with the shift in research seen in the last few decades, community opinion of research may also be shifting:

> We are seeing a lot less sort of colonialism in research and a lot more cooperative engagement with Indigenous groups throughout the North.
>
> (Interviewee 4, Indigenous organization)

Interviewees believe that researchers see a higher value in meaningful engagement at the community level and are attempting to move away from older styles of research (n = 5).

> There's more recognition about this body of past work that wasn't done in the best way that's being talked about more. I feel like there's a lot more conversation around that than there used to be.
>
> (Interviewees 12 and 13, researchers)

Interviewees (n = 7) suggested that some of this shift might relate to communities and Indigenous organizations advocating for more involvement in the research process. Additionally, some suggested a shift in what communities expect from the research process:

> I think a couple generations ago, people were content with science recognizing Indigenous knowledge and recognizing the importance of it and then allowing it to be translated into science, and now people are saying, no that's not okay … wanting it to be recognized that there are methodologies and that it's a systematic way of knowing.
>
> (Interviewee 24, Indigenous organization)

This shift in sentiment may also be linked to high-level, high profile institutional work on Indigenous engagement. Both interviewees and the reviewed literature referenced the land claims agreements (Interviewees 4 and 24, Indigenous organizations) and the Truth and Reconciliation Commission of Canada (Interviewees 3 and 24; Whyte et al., 2016) as important steps in acknowledging and addressing the colonial legacy in Arctic communities. President Obama's visit to Alaska in 2015 was felt to have raised the public profile of Arctic people's experiences with environmental change (Interviewee 14, bridging organization). Finally, interviewees also note a shift to funding bodies looking for KMb in research proposals, requiring community research partners in funding applications and in some cases providing funding directly to Arctic communities. Interviewees felt this type of funding structure was effective in improving KMb and increasing research equity (Interviewees 21 and 24).

Acknowledging the value of KMb: Building strong working relationships takes time and often requires additional visits to communities to allow for collaboration on research methods, research partner feedback, and results verification. Advocates of KMb for research cite its strengths: increased applicability of the work, improved context, the generation of new and more appropriate research questions, and the creation of science that is useful to the people living in that environment (ICC, 2002; NAHO, 2009; Hamel et al., 2012; Harvey et al., 2012a, b; Shaffer, 2014; Vaughan and Dessai, 2014; ICC-Alaska, 2015; Castleden et al., 2017). However, interviewees felt that there were still major barriers to implementing effective KMb in Arctic research:

> But I would say that has been challenging to implement because a lot of people in my field just aren't, it takes a bit of time to see the potential value of doing [KMb]
>
> (Interviewee 22, researcher)

> Okay you're a fantastic knowledge broker … and then I'm going to throw you back into an organization that doesn't have a culture that promotes that lens, or you have no resources or no authority or credibility or legitimacy. Even if you're a fantastic individual, I don't know if you could rise to a situation that is so complex.
>
> (Interviewee 2, funding organization)

Interviewees also believed that there were barriers to receiving funding for proposals with KMb engagement as a major focus (although this does depend on the type of funding available). We recognize that this is not true for all funding bodies.

> To put it another way, I've never seen a proposal reviewed where they've said, you know the scientific merit is okay but boy, your broader impacts are fantastic, we ought to fund this. You do often see hey, the intellectual merit is really strong and the broader impacts are adequate so yeah, good enough, and I think that gives an idea of the relative importance.
>
> (Interviewee 17, researcher)

> Actually, it has been a challenge to find U.S. funders to fund what they would not consider pure science.
>
> (Interviewee 14, bridging organization)

Challenges remain in institutional reward systems and valuation of academic achievement (Knapp and Trainor, 2013; Anderson and McLachlan, 2016). Interviewees stated that researchers within the university system are generally evaluated by their publications and rarely by their meaningful engagement with communities and ability to have productive partnerships with communities (Interviewees 3, 12, and 13, researchers). This time spent on creating meaningful relationships may represent an opportunity loss to the individual academic when attempting to procure grants or funding opportunities as this additional time and engagement could have been spent strengthening the academic résumé through additional publications or conference talks:

> If you do successful [KMb] people think oh good job, but it isn't valued the same as putting out a publication.
>
> (Interviewee 3, researcher)

Not all researchers face this drawback; three interviewees highlighted that some federal government organizations and state universities have a mandate to create science with usable outputs for communities and ensure community consultation and co-production. Thus, they can justify the additional time spent on these activities.

Interviewees (n = 16) believed a shift in academic valuing of KMb work was occurring and, over the past decade, have seen a push for including it as a consideration in work:

> [KMb is] much more common. I think we're at a critical juncture, are we giving a lot of lip service to this? Do we know how to do this well? Is there the funding available to do this? … But definitely there has been a cultural shift.
>
> (Interviewee 14, bridging organization)

Three interviewees highlighted the shift in importance of KMb in academia, noting, for example, that the International Polar Year's (IPY) theme was "Knowledge to Action." Despite this theme, many IPY projects did not actually achieve this objective (Ford et al., 2013). Nevertheless, many funders are now asking researchers to improve KMb practices within their work. The Canadian Institutes for Health Research, Social Sciences and Humanities Research Council in Canada, and Ouranos were all mentioned by interviewees (n = 3) as funders with an interest in effective KMb. Some felt that this acknowledgment was a step in the right direction (n = 2), and that the increased focus that funders place on explicitly including KMb in funding applications, alongside the strong leadership and direction given by Indigenous organizations such as ITK and regional licencing boards, indicates a shift in the academic valuing of KMb in Arctic research. However, it is important to note that these incentives do not exist across the board and in some cases, were seen as merely lip service (n = 3).

DISCUSSION

This research identified a number of challenges to effective KMb, including building trust and respect, a shortage of time and resources to be able to engage in KMb, a lack of appropriate skills and capacity to effectively engage in KMb and inadequate empirical evaluation of KMb in Arctic research. Much has been written previously on the difficulty of trust-building in research within an Indigenous context and the limitations of research funding and time are frequently cited in research project shortcomings (Sullivan et al., 2001; Christopher et al., 2008). As a result, our discussion focuses on the development of skill sets and capacity, and limited empirical evaluations.

Developing Skill Sets and Capacity

A key challenge to create meaningful KMb in Arctic communities is capacity. At the local level, a push for consultation and engagement of local community members was noted in many interviews and much of the literature reviewed. In some cases, this consultation is a legal right of Indigenous persons (ICC, 2002; Huntington et al., 2012; ITK, 2018; Justice Laws, 2020). Nevertheless, researchers should reflect on how, why and in what way they engage with community members. Community capacity to consult on research projects is stretched and some have argued that the burden put upon communities is significant, while the influence that their contribution has on final decisions is unclear (Huntington et al., 2012). Research consultation requires a considerable time input from community members. As a result, availability for research consultation often relies on community members prioritizing that research topic (Interviewees 1 and 19, research licencing organizations). The availability of community members to engage in consultation may fluctuate due to seasonal hunting patterns (Interviewee 8, researcher; Interviewees 9 and 11, Indigenous organizations). Interviewees (n = 4) discussed the research fatigue that communities felt in being required to take part in so many projects. The literature advocates aligning research with community interests and priorities through co-creating research projects with community members or including community members as legitimate research partners (Ford and Pearce, 2012; Pulsifer et al., 2012; Ford et al., 2016; Adlard et al., 2018). The goal should be on meaningful engagement with the process rather than token consultation sessions. Local research capacity is being built, particularly in relation to young community members. A number of programs are aimed at engaging Indigenous youth with Western science and research practices: the kANGIDLUASUk student program engages Inuit youth in experiential learning about culture, science, and outdoor adventure in the Torngat Mountains of Labrador (kANGIDLUASUk Student Program, n.d.); youth are trained to monitor ocean microplastics in Pond Inlet (Westdal and Solomon, 2019); and Indigenous youth participate in the annual Students on Ice program (Students on Ice, 2020).

The literature and interviewees (n = 8) also highlight limited researcher capacity or capability in developing the soft skills required to build respectful and meaningful relationships at the community level (Rychetnik et al., 2012; Meadow et al., 2015). Soft skills required by researchers include an ability to co-produce knowledge and work with others (Interviewee 20, bridging organization), the ability to behave in culturally respectful ways (Interviewees 15 and 24, researcher and Indigenous organization, respectively), the ability to build rapport (Interviewee 19, research licencing organization), and an ability to create

accessible outputs, for example, YouTube videos and op-ed pieces (Interviewees 2 and 17, funding organization and researcher, respectively). However, some interviewees believed that a new generation of scientists across the social, health, and physical science fields were increasingly engaged in meaningful KMb, and that some of the increase was due to additional training in those soft skills provided through organizations such as the Association of Polar Early Career Scientists and the Permafrost Young Researchers Network (Interviewees 12 and 13, researchers). Brugger et al. (2016) identify key skills for climate science integrators: be a good listener, understand and respect the people you work with, understand the decision-making context, be humble, maintain credibility, enjoy interacting with people, be curious, be patient, and reflect on what you are doing. Researchers may ask if these skills can be learned or are personality traits. Moser (2008) considers the question of positionality and personality in research and suggests that while much has been written about the importance of researchers reflecting on their own context in terms of ethnicity, gender, and other privileges, we rarely reflect on how our personality interacts with our research. Despite the lack of researcher reflection on personality traits, Moser (2008) observed that aspects of her own personality and conduct were the main criteria by which she was judged by community members. She suggested that graduate students should be given academic training in emotional intelligence in order to consider and reflect on how their personality will affect their research process and outcomes.

Bridging Indigenous and Western Knowledge

The discussion of how and indeed if Western academics should integrate, bridge, or connect these two knowledge systems is ongoing. While decolonization and reconciliation are increasingly visible in academia and Western institutions, research has the potential to act as a continuation of colonization in Indigenous communities, through structural racism, power dynamics, and researcher/researched mentality (Cochran et al., 2008; Castleden et al., 2017; ITK, 2018). These power dynamics play out in a multitude of ways during the research process through decisions on research methodology, choice of how and where to disseminate results and, most notably, in the collection and analysis of data. One interviewee (3, researcher) felt that inclusion of Indigenous persons into the research team would help with this bridging and connection through grounding projects in local priorities. Others believe that living within the region and being able to have continued and long relationships help build trust and allow for continued and meaningful partnerships on projects (Interviewees 12, 13, and 22, researchers). Others rebuked the assumption that IK could be collected and analyzed using Western systems at all:

> I have a biological degree, it would not be appropriate for me to look at a database of physics and write up a report … I don't have the expertise needed to evaluate that information and we feel it's the same way with Indigenous knowledge.
>
> (Interviewee 24, Indigenous organization)

In environmental research in particular, we should think carefully about the responsibilities we have in shaping Arctic narratives to closely align with the ways that Indigenous communities would like to be represented and be aware of our position of power on these global platforms (Cameron, 2012). The National Inuit Research Strategy of Canada (ITK, 2018) does not suggest that Western systems do not have a place in northern research, but outlines five ways that researchers and Inuit can work together respectfully on research in Inuit Nunangat: 1) advance Inuit governance in research, 2) enhance the ethical conduct of research, 3) align funding with Inuit research priorities, 4) ensure Inuit access, ownership, and control over data and information, and 5) build capacity in Inuit Nunangat research. These guiding directives from a national Indigenous organization outline a clear place for non-Indigenous researchers in northern research, as part of a working partnership creating high-quality knowledge and increasing self-determination in Arctic research.

Learning from and Improving KMb

The literature identified the importance of monitoring and evaluation (M&E) in knowledge mobilization (KMb) to learn lessons and improve projects and to help tailor future projects (Lightfoot et al., 2008; Harvey et al., 2012a; Ford et al., 2013; Hammill et al., 2013; Ensor and Harvey, 2015; GC, 2016). There is a strong M&E KMb discipline linked to public health, but interviewees (n = 6) noted limited evaluation work in the field of KMb in an Arctic context. Though many interviewees had engaged at one point or another in M&E of their KMb work (n = 18), consistent formalized feedback of KMb projects was limited. Most interviewees discussed one-off projects with a significant M&E component. Some interviewees discussed formal evaluations they had been a part of linked to funding requirements, for example Health Canada research (Interviewees 15, 20 and 21, researchers). In other cases, the research group had developed an internal process without outside incentive (Interviewee 3, researcher; Interviewee 6, Indigenous organization). These yearly or end-of-project evaluations provide little opportunity to learn from and adapt evaluation findings to influence or improve the ongoing project.

Methods of evaluation were varied but often included surveying participants to ask what they had learned from the evaluation and if they felt it was useful (process indicators). Other techniques included monitoring online analytics to determine the number of people viewing results dissemination videos or other data online (output indicators). The outputs of the M&E exercises were rarely made publicly available, though some M&E reports were available online

in research reports, thesis documents, or through funder websites. Interviewees shared their views on why there was limited formal M&E of Arctic projects. First, a lack of planning and consideration of M&E from the beginning of the project meant that time or funds were not available by the end of the project and the correct baseline data had not been collected from the beginning of the project to allow for effective M&E (n = 4). Second, finding appropriate indicators for evaluation was difficult (n = 4). Finally, some interviewees questioned whether a full formal M&E process was always necessary since their continued engagement with community research partners through the process meant that informal feedback and tweaking of projects were done frequently and formal evaluation was unnecessary.

CONCLUSION

This research synthesized a broad body of literature and interviewed key stakeholders to identify and describe some of the key principles of KMb in an Arctic setting when considering environmental change. We found that KMb runs throughout the research process and varies widely across regions and by researcher and community. Ultimately, there is no checklist of specific actions to ensure effective KMb, nor would such a list be desirable given the need to tailor KMb to specific contexts. We have, however, identified three key principles of effective KMb: respect, mutual understanding, and researcher responsibility. Underlying these principles is the consideration of trust and relationship building. Though these notions are based on subtle and nuanced context and vary from place to place, they all involve the consideration of formal and informal processes of KMb in Arctic research.

Formal mechanisms include funding and research proposal requirements, the research licence and ethical approval of research within communities, and the recognition of the value of KMb by academic institutions. Formal mechanisms also involve high-level political engagement, such as official acknowledgement of land rights at public events, identification of Indigenous peoples as rights holders rather than stakeholders, and the establishment of a reconciliation committee. These formal mechanisms are important in holding researchers and collaborators to account, providing at least a basic level of acceptable research behavior, and acknowledging Indigenous peoples sovereign rights and legitimacy. Formal mechanisms provide a first, most basic step in improving trust and respect within Arctic research community relationships and also set the stage for informal behaviours within KMb that take place at the micro-scale between individuals within the research process. A degree of informal relationship building is required in any community-based research. Informal behaviours include researcher reflections on their positionality within research and how they address equity in their everyday interactions. These informal researcher behaviours can be the difference between having research partners and research subjects. These informal mechanisms also determine how researchers behave and build relationships during the research process, how researchers design projects and determine research questions, how meaningful ways for community members to engage in research are created, and how researchers work with local partners to consider what results they are or are not qualified to comment on as non-Indigenous researchers. Currently, it appears that much of this informal information is transferred via those already embedded in the research and in the communities, as recorded by interviewees' use of the phrase "he, she, they just get it." This informality meant that many of the researchers we spoke with had gained their KMb skills through mentorship throughout their career. Indeed, many felt they were still learning and improving; very few discussed formal training or guidance on these matters. However, given the relatively high turnover we see in Arctic governments and the short timeframe of some research projects, we should consider what is being lost through the lack of formal systems in place for research protocol or for recording lessons learned in a project in regard to KMb.

This paper provides a formalized framework for considering effective KMb within the research process and increases the likelihood that these informal processes of relationship building, and respectful and meaningful engagement will occur. Our findings are encouraging and suggest that the field of KMb in Arctic environmental change research is receiving increased attention from funders, communities, Indigenous organizations, and researchers alike. Future research in the field on Arctic KMb should consider creating formal evaluations and reviews of projects and, in making these publicly available, to learn from each other to continue to move the conversation on effective KMb forward. As non-Indigenous, Western researchers, which the authors of this paper are and indeed many of its readers may be, we are ill equipped to interpret some components of Indigenous knowledge systems; thus, increased work with Indigenous research partners both formally and informally on understanding and interpretation of different knowledge systems is of paramount importance throughout the research process.

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