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REVIEW

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Bridging Indigenous and Western sciences: Decision points guiding aquatic research and monitoring in Inuit Nunangat

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Abstract

When brought together, Indigenous and Western sciences offer holism that can strengthen research and monitoring, yet the practices and processes of bridging these sciences are not well understood. We sought to elucidate bridging through a systematic realist review of coastal and marine research and monitoring studies that use methods for gathering Indigenous scientific knowledges and methods for collecting natural sciences data from across Inuit Nunangat (Inuit homelands in Canada; $n = 25$ case studies). We identified three decision points that shape projects co-developed by researchers and Inuit communities: research objectives, method bundles (the totality of methods used in a case study), and method sequencing (the order of application of methods in a case study). Example case studies from the review are included to highlight some of the diversity of research pathways available. We discuss areas for further reflection, including method bundle composition, imbalances in method sequences, path dependency and research fatigue, research context, and most importantly, bridging as a relational rather than technical endeavour. We suggest that bridging sciences can, but need not be, a complex undertaking. This paper provides practical details to facilitate cross-cultural research partnerships at a time of immense environmental and social change.

KEYWORDS

aquatic, Arctic, bridging sciences, Canada, community partnership, Indigenous knowledge systems, Indigenous sciences, Inuit Nunangat, natural sciences, research and monitoring

1 | INTRODUCTION

A compelling need exists to draw upon multiple ways of knowing to understand and address complex environmental challenges (Johnson et al., 2016; McGregor, 2013; Reid et al., 2021; Riedlinger & Berkes, 2001; Wong et al., 2020). Indigenous and Western sciences, when brought together through a process of bridging[1] sciences (see Table 1 for definitions), offers holism that can strengthen conservation[2] practices and policies through research and monitoring (Ban et al., 2018; Buxton et al., 2021; Mistry & Berardi, 2016; Tengö et al., 2014; Wheeler & Root-Bernstein, 2020; Wilson et al., 2018). Specifically, bridging Indigenous and Western sciences

TABLE 1 Key terminology.

Term	Definition
Indigenous knowledge systems[a]	Indigenous knowledge systems can be defined as a "cumulative body of knowledge, practice, and belief[b], evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes, 2018, p. 8). According to McGregor (2004b), Indigenous knowledge systems "encompass [...] such aspects as spiritual experience and relationships with the land" and are expressed as a "way of life" and "something that you do" (p. 79).
Indigenous sciences[a,c]	We understand Indigenous sciences to be embedded within Indigenous knowledge systems (Henri et al., 2021; Johnson et al., 2016; Reid, 2020). Indigenous sciences have been defined as a "'multi-contextual' system of thought, action, and orientation applied by an Indigenous people through which they interpret how Nature works in 'their place'", and use similar methods as Western sciences, including classifying, inferring, questioning, observing, interpreting, predicting, monitoring, problem solving, and adapting (Johnson et al., 2016, p. 5).
Methods for gathering Indigenous scientific knowledges	The methods employed by Indigenous and/or Western-trained scientists in research or monitoring to gather and document Indigenous sciences. These methods can be carried out through oral, written, observational, experiential, or other means individually or in groups. They can also include the compilation of knowledge from secondary sources. These methods have often emerged from Western social sciences disciplines and, increasingly, from Indigenous approaches to conducting research. Methods for gathering Indigenous sciences used in the relevant case studies are found in Table 3.
Western sciences[d]	A low-context system that excludes relational connections and often involves scientists separating themselves from nature or the object of study (Cajete, 2000; Nakashima & Roué, 2002). This body of knowledge favors objectivity and reductionist methods, is anchored in Greek philosophy and the Renaissance (Mazzocchi, 2006), and includes knowledge appropriated from many cultures that was modified to conform to Eurocentric values, worldviews, metaphysics, and epistemologies (Aikenhead & Ogawa, 2007). Western sciences are not homogenous, and there are many disciplines and approaches that embrace uncertainty and complexity. For example, these sciences can encompass opportunities for collaboration through community science or Bayesian methods. While conceptually we situate natural, social, and health sciences within a broader field of Western sciences, throughout this text, we are using the term 'Western sciences' to refer specifically to Western natural sciences disciplines (e.g., ecology, biology).
Methods for collecting natural sciences data	The methods employed by Indigenous and/or Western-trained scientists in research or monitoring to collect biotic and abiotic data. These methods are typically related to Western natural sciences and can be carried out in the field or laboratory. They can also include the compilation of data from secondary sources. Methods for collecting natural sciences data used in the relevant case studies are found in Table 4.
Bridging sciences	Bridging Indigenous and Western sciences refers to a process involving the exchange of understanding for mutual learning while maintaining the integrity of the respective sciences (Rathwell et al., 2015). The term 'bridging' shares similarities with other terms, including 'braiding' and 'weaving'. In this literature review, we use a specific definition of 'bridging', where the case studies included contain both Indigenous scientific knowledges (gathered through Western social science methods or Indigenous research methods) and natural sciences data.

[a]Indigenous knowledge systems and sciences are pluralized to reflect the heterogeneity of Indigenous cultures (McGregor, 2004a).
[b]See Reo (2011) for insights into interrelationships between knowledge, practice, and belief.
[c]We use 'sciences' in alignment with influential Indigenous thinkers and teachers, among them: Yup'ik scholar Dr. Angayuqaq Oscar Kawagley (see Kawagley, 1990; Kawagley et al., 1998), Tewa scholar Dr. Gregory Cajete (see Cajete, 2000), Anishinaabe scholar Melanie Goodchild (see Goodchild, 2021) and Maya Ch'orti' and Zapotec scholar Dr. Jessica Hernandez (see Hernandez, 2022).
[d]Many Indigenous scholars are redefining Western sciences. For example, Red River Métis/Michif scholar Dr. Max Liboiron discusses 'dominant science' in place of 'Western science' (see Liboiron, 2021).

can amplify the strengths of both, which are often considered to be temporally and spatially complementary (Gagnon & Berteaux, 2009; Laidler, 2006; Moller et al., 2004; Rathwell et al., 2015). The embodiment of bridging in federal frameworks, mandates, and laws reflects its growing emphasis in Canada (e.g., CIRNAC, 2019; Department of Justice, 2021; Trudeau, 2021a, 2021b), while the expansion of bridging literature is reflective of partnerships between researchers and Indigenous communities that enable knowledge sharing and co-production (Bartlett et al., 2012; Carter et al., 2019; Chapman & Schott, 2020; Pedersen et al., 2020).

There is a long tradition of co-existence models that do not subsume Indigenous sciences into Western sciences, and can be used to guide relationships between Indigenous Peoples and settlers on environmental issues (McGregor, 2008; Ransom & Ettenger, 2001; Reid et al., 2021). First Nations-derived models that are often discussed include: *Tekani teyothata'tye kaswenta* (Two-Row Wampum), which emphasizes the equal validity of Indigenous and Western sciences and their necessary distinction (Goodchild, 2021; Hill & Coleman, 2019; Ransom & Ettenger, 2001); *Naagan ge bezhig emkwaan* or *Gidonaaganinaa* (Dish with One Spoon or Our Dish), which asserts the importance of sharing the land peacefully (Jacobs & Lytwyn, 2020); and *Etuaptmumk* (Two-Eyed Seeing), which calls for the use of the strengths of multiple perspectives (Bartlett et al., 2012). Inuit-specific models were also introduced more recently. Janet Tamalik McGrath and Mariano Aupilarjuk developed the Inuit *Qaggiq* Model based upon a qaggiq iglu, a communal iglu that serves as a gathering place for restoring relations, affirming community, and at times for reconciliation (McGrath, 2012, 2018)[3]. This conceptual space enables dialogue among Indigenous Peoples about shared values, where "qablunaat[4] can listen, experience and observe…so that they understand more clearly what they need to support" (McGrath, 2012, p. 252)[5]. Additionally, Ferrazzi et al. (2019) described *aajiiqatigiingniq*, an Inuit decision-making approach where consensus is achieved through respectful communication, narrative discourse, personal engagement, the successive addition of group members, and an unhurried meeting style. Such models elicit important insights into respectful interactions between communities and Western-trained researchers.

Bridging has become prominent in environmental sciences as researchers and Indigenous communities recognize the interconnectedness of all living beings, and share a common priority to conserve ecological integrity in the context of climate change, human activity, and development (Ban et al., 2018; Kimmerer, 2013; Wong et al., 2020). For Inuit across Inuit Nunangat (Inuit homelands in the place now called Canada)[6], threats to aquatic species (e.g., marine mammals, fishes) and habitats, combined with significant knowledge gaps (see Dey et al., 2018; Niemi et al., 2019), have resulted in heightened research and monitoring efforts. Recent systematic reviews capture the body of research on bridging in relation to aquatic ecosystems, with Castleden et al. (2017) contextualizing integrative Indigenous and Western approaches to advance water research and management, and Alexander et al. (2019, 2021) examining methods used in studies that bring together sciences in marine and freshwater research, monitoring, and management across Canada. Indigenous participation and the role of communities in environmental monitoring have also been investigated extensively (e.g., Danielsen et al., 2009; David-Chavez & Gavin, 2018; Kouril et al., 2016; Thompson et al., 2020). While these reviews help characterize the landscape in which researchers and communities engage, they do not detail the process of bridging Indigenous and Western sciences and corresponding methods. The lack of clarity into the operationalization of bridging in research and monitoring with Indigenous communities (Buxton et al., 2021; Drake et al., 2022; McGregor, 2008; Mosurska & Ford, 2020) renders it necessary for many researchers to "interpret for themselves what this means and how to do it in practice" (Pedersen et al., 2020, p. 326).

To help address this issue, we conducted a systematic realist review of marine and coastal research and monitoring in Inuit Nunangat. In this paper, we seek to identify and explore key decision points (i.e., points in a research or monitoring project where significant decisions are made that contribute to bridging) that shape projects co-implemented by researchers and Inuit communities. We then present example case studies drawn from the review to illustrate the application of these decision points together. Although bridging can occur throughout all project phases (initiation, research design, gathering, analyzing and interpreting data, and applying and disseminating findings), we focus primarily on the science documentation/data collection phase[7] as there are often opportunities for bridging through heightened Indigenous participation in field endeavours that rely upon local expertise (Dale & Armitage, 2011). By elucidating various methods and applications for gathering Indigenous scientific knowledges and methods for collecting natural sciences data, we draw attention to the diversity of research pathways available to address case study research objectives. This can help guide future aquatic research or monitoring endeavours by contributing practical details to the growing scholarship aimed at fostering mutually beneficial processes and partnerships with Indigenous communities.

2 | METHODS

2.1 | Positionality

The authors are researchers of settler descent committed to ongoing work to critically examine our own positions and to decolonize[8] our minds (sensu Trisos et al., 2021). This research is informed by our environmental and social sciences backgrounds within academia and government, and is shaped by our collective experiences conducting research in partnership with Indigenous communities. This paper builds upon the efforts of many Indigenous Peoples, communities, and organizations, and of colleagues in this field.

2.2 | Approach

We conducted a systematic realist review to identify aquatic research and monitoring studies that bridge Indigenous and Western sciences, and to examine the practices, processes, and contexts of use. This type of review is frequently used within the social sciences (Petrasek MacDonald et al., 2013), and combines both systematic and realist review characteristics. A systematic review provides a rigorous and replicable methodological approach to synthesize the state of knowledge in a subject area (Shamseer et al., 2015), and a realist review examines why, how, for whom, and in what context certain approaches function (Berrang-Ford et al., 2015; Pawson et al., 2005).

2.3 | Case study selection

The case studies included in this review were drawn from a systematic map of published studies where the bridging of Indigenous and Western sciences was discussed and/or inferred in coastal and marine research, monitoring, management, or decision-making across Canada (Alexander et al., 2019). Our intent was to examine bridging in coastal and marine ecosystems across Inuit Nunangat, and this systematic map identified the appropriate set of case studies. The systematic map used adhered to Collaboration for Environmental Evidence guidelines (CEE, 2018) and Reporting Standards for Systematic Evidence Syntheses (ROSES) (Haddaway et al., 2017), wherein records were compiled from several databases, duplicates were removed, and a title and abstract screening and full text screening were conducted. This resulted in 71 case studies included in the original systematic map (Alexander et al., 2019), published between 1993 and 2018. For the purpose and scope of this realist review, we screened the case studies to include only those that had been previously coded by Alexander et al. (2019) as 'research and monitoring' in any of the four regions of Inuit Nunangat (Figure 1 and Table 2). We did not include 'management and decision-making' case studies because bridging in collaborative research and monitoring occurs in considerably different settings and contexts than in management and decision-making. This yielded a final set of 25 case studies. See Table S1 for the relevant dataset adapted from Alexander et al. (2019).

2.4 | Biases and limitations associated with case study selection

Biases and limitations associated with the use of the database from Alexander et al. (2019) should be

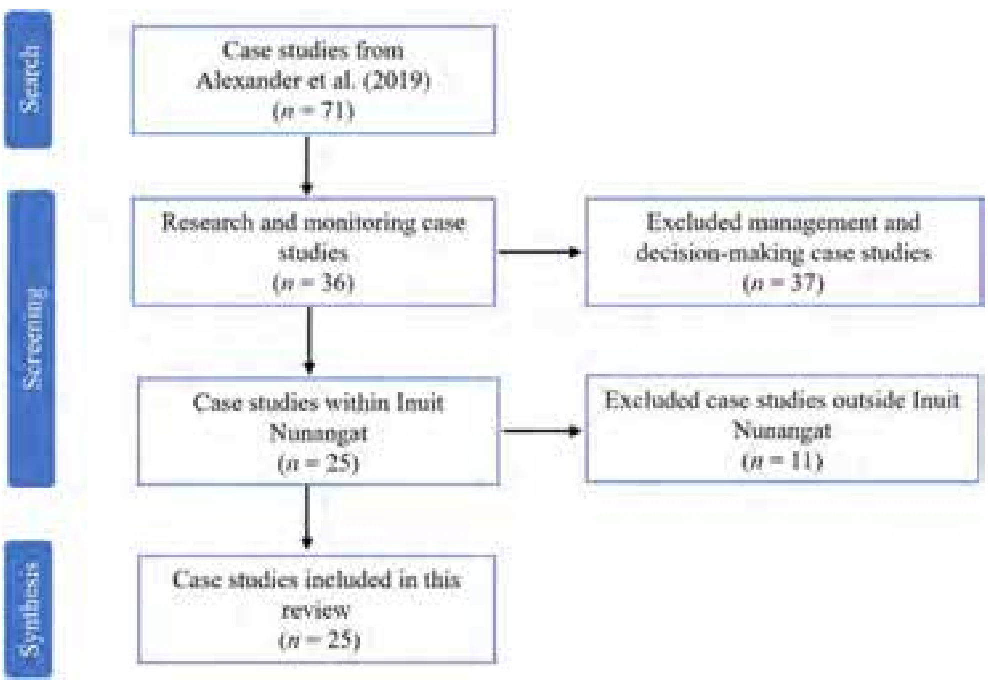


FIGURE 1 Flow chart of screening process, modified from ROSES flow diagram for systematic maps. Version 1.0.

TABLE 2 Criteria for case study inclusion.

Inclusion criteria	Alexander et al. (2019)	Additional inclusion criteria
Population	Coastal or marine habitat, ecosystems, or species (including coastal birds, diadromous fish, and polar bears).	NA
Study design	Report empirical results (qualitative or quantitative), and where bridging practices and/or methods are discussed or inferred. Case studies can include environmental or ecological research and monitoring (classified simply as 'research and monitoring') or co-management and decision-making (classified as 'management and decision-making').	Case studies must include both Indigenous scientific knowledges (gathered through Western social science methods or Indigenous research methods) and Western natural sciences data. Only research and monitoring case studies were included.
Geographical scope	Canada's three coastal and marine regions (Atlantic, Pacific, and Arctic).	Only regions within Inuit Nunangat (Inuvialuit Settlement Region, Nunavut, Nunavik, Nunatsiavut) were included.
Language	English	NA

acknowledged. As this literature review includes only case studies in the published literature, internal unpublished reports by governments and Indigenous communities or organizations are not well represented. Second, we use a specific definition of 'bridging', where the case studies included contain both Indigenous scientific knowledges (gathered through Western social science methods or Indigenous research methods) and Western natural sciences data. Case studies where research and monitoring was led by Indigenous communities with support from non-Indigenous researchers (and may only contain Indigenous scientific knowledges), or conducted by non-Indigenous researchers in partnership with Indigenous communities (and may only contain Western natural sciences data) are not incorporated here. Please refer to Alexander et al. (2019) for additional details regarding the acquisition of literature for the systematic map, and information regarding limitations of the methods used (e.g., search strategy, citation screening, semantic challenges) and limitations of the evidence base (e.g., inability to capture research found in gray literature, long-term studies, publishing time lags, case studies where different ways of knowing were brought together but not reported as such).

2.5 | Thematic analysis

We conducted a thematic analysis using the qualitative analysis software NVivo 12, which allowed for the identification, analysis, organization, description, and reporting of themes (Braun & Clarke, 2006; Nowell et al., 2017). This analysis was chosen as it is highly flexible and can provide a detailed account of data (Braun & Clarke, 2006).

The lead author reviewed each case study, focusing on examining case study objectives and details of the process of bridging Indigenous and Western sciences. We were interested in research objectives because they guide the methods chosen to gather Indigenous scientific knowledges and to collect natural sciences data, and how they are applied. We began with three thematic codes to organize these components of interest: research objectives, methods for gathering Indigenous scientific knowledges, and methods for collecting natural sciences data. The lead author further inductively coded the texts using sub-themes to categorize and extract detailed information by asking guiding questions (e.g., what specific objectives were found in case studies focused on species ecology? What methods were used to gather Indigenous scientific knowledges and collect natural sciences data, and were Indigenous and Western science methods used concurrently or sequentially? Did the findings or questions arising from one science inform the other science?). In this process, three sub-themes emerged: research objectives (containing more detail than in the initial thematic code), method bundles (the totality of methods used for gathering Indigenous scientific knowledges and collecting natural sciences data in a case study), and method sequencing (sequence in which methods were used in each case study), all of which are further described in the Results section. Methods were sorted by key characteristics (i.e., remote or in-person interactions, individual or group settings, how knowledges were shared, how data were acquired) to rectify cases where the same term

TABLE 3 Methods for gathering Indigenous scientific knowledges, examples in the case studies reviewed, and definitions for these methods.

Method[a]	Includes	Definition
Verbal knowledge sharing	Structured, semi-structured, and unstructured interviews	Verbal interchanges with participants, intended to elicit views on defined topics. Interviews primarily involve learning through conversations and listening (Shackleton et al., 2021). Structured interviews follow a predetermined list of questions and are led by the researcher, while semi-structured interviews have guiding questions but are flexible. Unstructured interviews follow themes rather than set questions, and are often led by the informant (Longhurst, 2016; Shackleton et al., 2021).
	Oral histories	Lived experience and Elders' stories, including events earlier than living memory (Berkes, 2018). The participant decides what is important to share (Shackleton et al., 2021).
	Telephone conversations, informal discussions	Opportunities for these discussions can arise unexpectedly. The informal and casual nature of these interactions can build trust and enhance participant willingness to share information (Shackleton et al., 2021).
Written knowledge sharing	Surveys, questionnaires	Sometimes used interchangeably or together (i.e., questionnaire survey). This research acquires information about a population by administering a standardized questionnaire or survey to a sample of individuals (McLafferty, 2016). Information gathered is often at the household level (e.g., demographics, ecosystem service use, livelihood activities, stressors) or individual level (e.g., related to perceptions, values, sense of place). Surveys and questionnaires are structured, and can provide quantitative and qualitative data (the latter through open-ended questions). While information is documented in a written format, surveys and questionnaires can be delivered verbally[b] (Shackleton et al., 2021).
Guided group interactions	Meetings	Occur between community members, Hunters and Trappers Organizations, researchers, government representatives, wildlife officers, management committee members, or other entities. Community members or researchers may guide these interactions. Advance preparation, clear objectives, and working towards the implementation of ideas developed during the meeting are important components (Huntington et al., 2002).
	Focus groups	Semi-structured sessions moderated by a facilitator, with guideline questions or stimuli (e.g., photos). Knowledge compilation is focused on selected topics (Carey & Asbury, 2016). Focus groups can bring participants together to generate new ideas or consensus about the interpretation of local phenomena (Shackleton et al., 2021). This method usually results in rich, detailed data, often through storytelling (Carey & Asbury, 2016). Often involve a smaller group of participants than workshops.
	Workshops	Semi-structured sessions moderated by a facilitator. Workshops can bring Indigenous and Western scientists together to discuss different perspectives, offer insights, and jointly develop research and management priorities (Huntington, 2000). Often involve a larger group of participants than focus groups.
Spatial mapping	Participatory mapping, map biographies	Practical spatial processes to understand place-based perspectives and information on ecological systems (Rathwell et al., 2015). Mapping is completed by individuals or by the community to record resources and important places in relation to one another (De Vos et al., 2021).
Participant observations	Observations of community members	Researchers immerse themselves in community life and spend time being, living, or working with people (thus becoming 'participants' in the community). Fieldnotes or video notes are used for data collection (De Vos et al., 2021; Laurier, 2016).
Document review[c]	Compilation of knowledge from secondary sources	A process of reviewing documents that can serve several purposes: provide contextual data, identify questions to be asked in research, provide supplementary data, allow for a comparison of change over time, and be used to verify findings from other sources (Bowen, 2009).

[a]Another method (technology field trials) was used only once by Gearheard et al. (2010) and thus was not included in this table.
[b]Surveys and questionnaires can be administered verbally through interviews. In these cases, both verbal and written knowledge sharing were selected.
[c]Document reviews draw upon secondary data that have been previously gathered or published, which can take many forms. This category within a case study signifies that a single or several methods used in other categories were gathered through a document review process, or a document review was conducted in addition to the other methods.

was used to refer to different science methods, or dissimilar terms were used to refer to the same method. Methods for gathering Indigenous scientific knowledges included verbal and written knowledge sharing, guided group interactions, spatial mapping, participant observations, and document review (Table 3). Methods for collecting natural sciences data included biotic and abiotic field work, tissue analysis, observational methods, maps and mapping, and document review (Table 4).

TABLE 4 Methods for collecting natural sciences data and examples in the case studies reviewed.

Method[a]	Includes
Biotic field work[b]	Wildlife monitoring, field surveys, satellite tracking. This includes fish sampling, plankton concentration (through tows), invertebrate sampling, and vegetation type.
Abiotic field work[b]	Water sampling (temperature, salinity, dissolved oxygen and other compounds, total suspended solids, organochlorine content, chlorophyll a), ice sampling and measurements (ice cores, measurements of thickness, growth, and melting).
Tissue analysis[b]	Field and/or laboratory work. Includes biological sampling and analyses (parasite examinations, stomach content analysis, blubber thickness, physiological indices), and chemical analyses (serology, histopathology, genetic analysis, analyses of stable isotopes, trace elements, persistent organic pollutants).
Observational methods	Surveys (aerial, land/shore-based surveys, boat), or photographic methods (photos, satellite imagery obtained through remote sensing).
Maps and mapping	The use of existing maps or the use of geographic and wildlife data to derive maps.
Document review[c]	Compilation of raw or secondary data, a review of literature or other documents. This process of reviewing documents can serve several purposes: provide contextual data, identify questions to be asked in research, provide supplementary data, allow for a comparison of change over time, and be used to verify findings from other sources (Bowen, 2009).

[a]Another method (developing technical equipment) was used only once by Gearheard et al. (2010) and thus was not included in this table.
[b]We have included processing (e.g., in a laboratory) because we consider it to be part of the data collection phase.
[c]Document reviews draw upon secondary data that have been previously gathered or published, which can take many forms. This category within a case study signifies that a single or several methods used in other categories were gathered through a document review process, or a document review was conducted in addition to the other methods.

3 | RESULTS

In this section, we identify and explore what we term *decision points*, which can guide the process of bridging Indigenous and Western sciences in coastal and marine research or monitoring in Inuit Nunangat. Then, we highlight these decision points using example case studies to illustrate the diversity of research pathways.

3.1 | Identifying decision points

Through thematic analysis, we identified three main subthemes, which we consider to be decision points that shape collaborative research or monitoring for researchers and Indigenous communities: research objectives, method bundles, and method sequencing. While research objectives are set at project onset, method bundles and method sequencing centre on the knowledge documentation/data collection phase. See Figure 2 for a summary and Table 5 for definitions of these decision points.

3.2 | Exploring decision points

3.2.1 | Research objectives

Research objectives are crucial since they inform and influence decisions made in subsequent research phases, including the knowledge documentation/data collection phase.

We identified five research objective categories based on objectives articulated in the case studies reviewed (Figure 3). The most extensive category (Category 1: species ecology) contained 16 case studies in six subcategories, while Category 2 (document and understand environmental change), Category 3 (harvest patterns and use), and Category 4 (mobility of environmental pollutants) contained much fewer case studies ($n = 2$, $n = 2$, and $n = 1$, respectively). Category 5 (research practices) case studies ($n = 4$) were dissimilar to other categories as an analytical lens was used to discuss research or

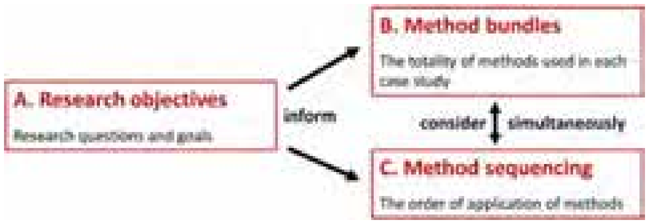


FIGURE 2 Decision points to consider in research or monitoring conducted with Indigenous communities.

TABLE 5 Definitions of decision points in research or monitoring conducted with Indigenous communities.

Decision point	Definition
A. Research objectives	Research objectives encapsulate research questions and goals, and define, direct, and place bounds on the entire research process. They inform the methods used and how they are applied (decision points B and C). These objectives should be co-defined with Indigenous partners and include topics relevant to community members (Chapman & Schott, 2020; David-Chavez & Gavin, 2018; ICC, 2021).
B. Method bundles[a]	Method bundles refer to the totality of methods used for gathering Indigenous scientific knowledges and for collecting natural sciences data in a case study. This decision point must be considered simultaneously with decision point C (method sequencing) as in practice they occur in parallel. These bundles are akin to 'mixed methods', which combine qualitative and quantitative forms of research (Creswell & Creswell, 2018).
C. Method sequencing	Method sequencing refers to the order in which methods for gathering Indigenous scientific knowledges and methods for collecting natural sciences data are applied in a case study (e.g., concurrent, sequential). There can be varied levels of complexity in sequence structure. Sequencing illuminates whether Indigenous and Western sciences inform or remain independent of one other.

[a]The term 'bundle' arose from the author team's awareness of and respect for the four sacred medicines (tobacco, sweetgrass, sage, cedar) for First Nations in the areas in which they live and work, which are dried and often bundled. This term has also been used by Rathwell et al. (2015), who suggested that a 'bundled approach' to methods can support the bridging of knowledge systems.

monitoring practices. See Table S2 for the case studies in which each research objective was found. Additionally, we found that 60% of case studies ($n = 15$) contained details surrounding project initiation, to which the development of research objectives is closely linked. Details described by some authors included who initiated the project (researcher or community or co-initiation) and co-development insights, the existence of research partnerships, and the reason for specific community engagement (e.g., frequent harvesting and reliance on a particular species, proximity to disturbed or biologically significant areas). These details should be considered as they can help place research objectives in context. In this paper, we limit our analysis of research objectives and surrounding details in order to focus on their role in informing subsequent decision points (method bundles and method sequencing).

3.2.2 | Method bundles

Research objectives can be addressed through method bundles composed of various methods for gathering Indigenous scientific knowledges and methods for collecting natural sciences data. We examine the level of complexity of method bundles and the methods comprising those bundles within case studies (Table 6)[9]. We also provide insight into repeating method combinations (i.e., methods used together in two or more case studies) that are components of more complex bundles (see Table S3).

The bundling of methods in case studies ranged from very complex bundles that combined several methods for collecting natural sciences data with several methods for gathering Indigenous scientific knowledges, to the use of a single method on each side (Table 6)[10]. The most complex bundle included five methods for collecting natural sciences data with two methods for gathering Indigenous scientific knowledges (i.e., a 5-2 bundle). Therefore, there was a maximum of five methods for collecting natural sciences data used in any individual case study. There was a similarly complex 4-2 bundle present in another case study. The presence of a 3-4 bundle (three methods for collecting natural sciences data with four methods for gathering Indigenous scientific knowledges) indicated that there were at most four methods for gathering Indigenous scientific knowledges used in any individual case study. There were also 3-3 bundles, as well as 3-2, 2-4, 2-3, 2-2, and 2-1 combinations (Table 6). The least complex method bundles included one method for collecting natural sciences data combined with several methods for gathering Indigenous scientific knowledges (e.g., 1-3, 1-2 bundles), and the use of one method on each side (i.e., 1-1 bundle). The possibilities for number of methods used for collecting natural sciences data in a study were comparable to the number of methods used for gathering Indigenous scientific knowledges, with there being five, four, three, two, and one method used for collecting natural sciences data in a given study, and four, three, two, and one method used for gathering Indigenous scientific knowledges. Interestingly, every case study had a unique set of methods used, with the exception of Gélinas (2016) and Henri et al. (2018), whose bundles were identical. In total, 24 different method bundles appeared in case studies.

It is equally important to consider the methods that compose these bundles (Table 6), and the repeated method combinations (i.e., methods used together in two or more case studies) that contribute to more complex

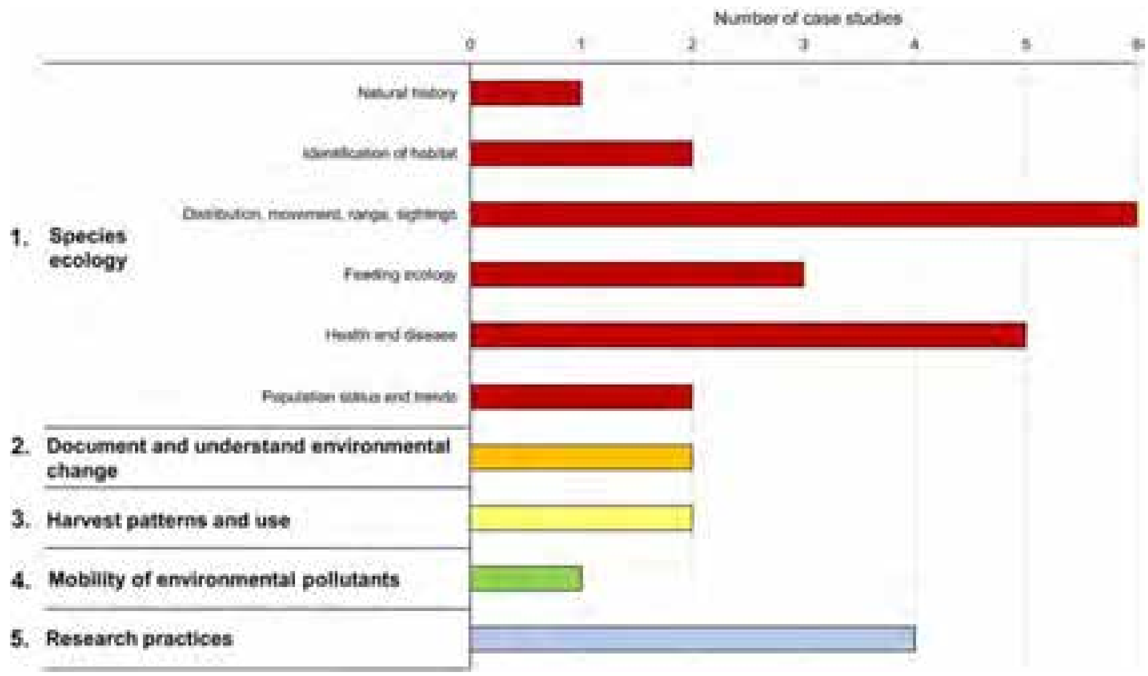


FIGURE 3 Research objective categories emerging from analysis of case studies, and the number of case studies within each category.

bundles (see Table S3). *Verbal knowledge sharing* was the most common method for gathering Indigenous scientific knowledges (i.e., appeared in 19/25 or 76% of case studies) (Table 6). This method was always bundled with at least one method for collecting natural sciences data, and was used with all six methods for collecting natural sciences data (*biotic field work*, *abiotic field work*, *tissue analysis*, *observational methods*, *maps and mapping*, *document review*) individually or in various combinations. Additionally, in 13 case studies, *verbal knowledge sharing* was bundled with at least one other method for gathering Indigenous scientific knowledges (Table 6); however, it was only used repeatedly as a component bundle with four methods for gathering Indigenous scientific knowledges: *written knowledge sharing*, *guided group interactions*, *spatial mapping*, and *document review* (see Table S3). *Guided group interactions* and *spatial mapping* similarly individually appeared in bundles of different complexities with all methods for collecting natural sciences data in various combinations, while *written knowledge sharing* and *document review* individually appeared with all methods for collecting natural sciences data apart from *maps and mapping* (Table 6). Interestingly, these methods for gathering Indigenous scientific knowledges (*guided group interactions*, *spatial mapping*, *written knowledge sharing*, *document review*) were only used with *verbal knowledge sharing* to form core components of more complex bundles (see Table S3). The least common method for gathering Indigenous scientific knowledges found in bundles was *participant observations* ($n = 2$).

Document reviews ($n = 12$), *biotic field work* ($n = 10$), *observational methods* ($n = 10$), and *tissue analysis* ($n = 9$) were commonly used methods for collecting natural sciences data within bundles (Table 6). *Document review* was most often used repeatedly as a component of bundles of increasing complexity when bundled individually with *biotic field work*, *observational methods*, and with *maps and mapping*, a less common method of collecting natural sciences data (see Table S3). Likewise, *biotic field work* and *tissue analysis* were used together to contribute to larger bundles. In contrast, *abiotic field work* was used infrequently ($n = 3$), and was not a core method contributing to complex bundling.

3.2.3 | Method sequencing

When seeking to address research objectives, the sequencing of methods (i.e., order of application of Indigenous and Western sciences) should be considered at the same time as method bundles. Five method sequences were uncovered in the case studies reviewed (Table 7). For some sequences (Sequences 2, 3, and 4), case study details enabled insight into the ways in which one science informed or did not inform the other science.

Sequence 1 ($n = 2$) is a cycle that can begin with either Indigenous or Western sciences, and is characterized by one science informing the other science in a continuous manner. This sequence is used in Carmack and MacDonald (2008), where the accounts of Elder Jimmy Jacobson (Inuit science) led researchers to conduct

TABLE 6 Methods used in case studies reviewed and their level of complexity (first number is the number of methods for collecting natural sciences data, second number is the number of methods for gathering Indigenous scientific knowledges).

	Methods for collecting natural sciences data						Methods for gathering Indigenous scientific knowledges						
Complexity	Biotic field work	Abiotic field work	Tissue analysis	Observational methods	Maps and mapping	Document review	Verbal knowledge sharing	Written knowledge sharing	Guided group interactions	Spatial mapping	Participant observations	Document review	Relevant case studies
5-2	✓	✓	✓	✓		✓		✓				✓	Paulic et al. (2014)
4-2	✓		✓	✓		✓	✓	✓					Loseto et al. (2018)
3-4				✓	✓	✓	✓		✓	✓	✓		Fox (2004)
3-3	✓			✓		✓	✓		✓			✓	York et al. (2016)
3-2			✓	✓		✓	✓					✓	Finley (2001)
2-4	✓					✓	✓	✓		✓	✓		Usher (2000)
2-3	✓		✓				✓	✓		✓			Mallory et al. (2006)
2-2	✓		✓				✓		✓				Pellerin & Grondin (1998)
					✓	✓	✓			✓			Kowalchuk (2010)
2-1	✓		✓				✓						Iverson et al. (2016)
	✓		✓						✓				Dunmall and Reist (2018)
	✓			✓			✓						Westdal et al. (2010)
				✓		✓	✓						Higdon and Ferguson (2011)
				✓		✓						✓	Wheeler et al. (2012)
1-3				✓			✓		✓			✓	Meier et al. (2006)
						✓	✓	✓	✓				Ostertag et al. (2018)

TABLE 6 (Continued)

	Methods for collecting natural sciences data						Methods for gathering Indigenous scientific knowledges						
Complexity	Biotic field work	Abiotic field work	Tissue analysis	Observational methods	Maps and mapping	Document review	Verbal knowledge sharing	Written knowledge sharing	Guided group interactions	Spatial mapping	Participant observations	Document review	Relevant case studies
1-2	✓						✓	✓					Brewster et al. (2016)
		✓							✓	✓			Huntington et al. (2011)
			✓				✓			✓			Gélinas (2016) and Henri et al. (2018)
				✓			✓			✓			Mallory et al. (2003)
						✓	✓			✓			Ferguson et al. (2012)
1-1		✓					✓						Carmack and MacDonald (2008)
					✓				✓				Gearheard et al. (2010)
						✓						✓	Higdon (2010)

TABLE 7 Indigenous science (IS) and Western science (WS) method sequences and the case studies in which they appear.

Sequence	Description		Case studies[a]
1	Interactions between IS and WS are cyclical, and the sciences build off each other		Carmack and MacDonald (2008), Gearheard et al. (2010)
2	IS followed by WS (sequential)	IS informed WS	Huntington et al. (2011), Iverson et al. (2016), Dunmall and Reist (2018)
		IS did not inform WS	Mallory et al. (2003)
3	WS followed by IS (sequential)	WS informed IS	Ferguson et al. (2012), Gélinas (2016), Brewster et al. (2016), Ostertag et al. (2018)
		WS did not inform IS	Pellerin and Grondin (1998)
		WS verified/supported using IS	Wheeler et al. (2012), York et al. (2016)
4	IS and WS conducted concurrently	For a more complete understanding	Fox (2004), Meier et al. (2006), Westdal et al. (2010), Higdon and Ferguson (2011)
		To compare sciences	Fox (2004), Kowalchuk (2010)
		To support the other science	Henri et al. (2018)[b]
		One science shaped the other	Mallory et al. (2006)[c]
5	Document reviews for IS and WS		Finley (2001), Usher (2000), Higdon (2010), Paulic et al. (2014), Loseto et al. (2018)

[a]This column totals 26 rather than 25 case studies because one case study (Fox, 2004) used Indigenous and Western sciences for two purposes: to form a more complete understanding, and to compare sciences (Sequence 4).
[b]In this case study, Indigenous (Inuit) science supported Western science.
[c]In this case study, Indigenous (Inuit) science shaped Western science.

surveys (Western science) to explore hypotheses formed from Jimmy's observations. Their findings spurred further conversations (Inuit science) and additional oceanographic research (Western science). Sequence 2 ($n = 4$) consists of Indigenous sciences followed by Western sciences, while Sequence 3 ($n = 7$) begins with Western sciences followed by Indigenous sciences. Both sequences contain case studies in which the first science informed the second, and where the sciences remained independent of each other. Sequence 3 included an additional process, where Indigenous sciences were used to verify Western sciences. Sequence 4 ($n = 8$) is the most common sequence, and is defined by the concurrent use of Indigenous and Western sciences for the following purposes: for a more complete understanding, to compare sciences, to support the other science, and to shape the other science[11]. Also note that these purposes are not mutually exclusive. For example, Fox (2004) wove sciences through concurrent and independent use of both Inuit and Western science methods to compare sciences, and for a greater understanding of environmental change. Sequence 5 ($n = 5$) is characterized by a document review process that uses raw or secondary data.

3.2.4 | Example pathways

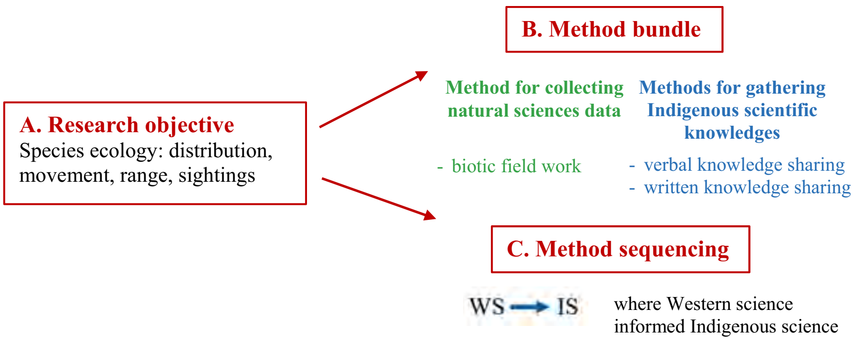
The use of different research objectives, method bundles, and method sequencing shape countless research pathways for bridging Indigenous and Western sciences in research or monitoring. Here, in the figures, we present three examples from the case studies reviewed to walk readers through possible applications of decision points. These case studies were chosen because they are illustrative of varied pathways. They focus on fishes (Figure 4), birds (Figure 5), and environmental change (Figure 6), all of which are critical to the wellbeing of Inuit communities.

4 | DISCUSSION

Through the identification and exploration of three key decision points in case studies that bridge Indigenous and Western sciences in Inuit Nunangat, this review draws attention to the plethora of pathways available in research and monitoring undertaken with Indigenous communities. Among the case studies, we identified five categories of *research objectives* that can be addressed through 24 *method bundles* composed of various numbers and combinations of methods for gathering Indigenous scientific knowledges (e.g., interviews, questionnaires, focus groups) and methods for collecting natural sciences data (e.g., wildlife monitoring, biological tissue analysis, mapping). In the case studies reviewed, Indigenous and Western sciences were applied in at least five *method sequences*. We emphasize that these research pathways are only a

Example 1. **Brewster et al. (2016)**

Traditional Ecological Knowledge (TEK) at Shingle Point, YT: Observations on Changes in the Environment and Fish Populations



A. The objective (Category 1 – *Species ecology*; Figure 3) was to understand environmental changes and determine baseline information for Beaufort Sea fishes (specifically their distribution range), in order to sustain fish populations and habitats within a changing Arctic. The authors specified that the study was requested by the Aklavik (Akłarvik) Hunters and Trappers Committee and the Fisheries Joint Management Committee.

B. The method bundle consisted of one method for collecting natural sciences data (*biotic field work*) and two methods for gathering Indigenous scientific knowledges (*written knowledge sharing, verbal knowledge sharing*). The *biotic field work* consisted of a Fisheries and Oceans Canada fish monitoring program in which fishes were collected and inventoried by researchers and local harvesters. Questionnaires and interviews (*written and verbal knowledge sharing*) gathering knowledge on fish population changes, environmental changes, and concerns were created with the Aklavik (Akłarvik) Hunters and Trappers Committee and conducted with Shingle Point harvesters.

C. This case study used Sequence 3 (Table 7). The fish monitoring program informed the questionnaires and interviews. Monitoring had been occurring at Shingle Point since 2010, and the sixteen most commonly captured fish species were the focus of the questionnaires and interviews conducted in 2015.

FIGURE 4 Example pathway highlighting the application of decision points in Brewster et al. (2016).

subset of those found within research and monitoring literature and that they serve specific roles in their respective case studies. In this paper, we did not seek to link the decision points together to offer method advice, as there are as many unique pathways as there are case studies. Instead, we encourage researchers and community partners to collaboratively explore research pathways, and we maintain that bridging can, but need not be, a complex endeavour (i.e., there are many smaller and simpler method bundles). We highlight five takeaways for reflection that emerged directly or indirectly from the decision points, discuss their respective contexts, and in doing so, offer suggestions for researchers.

4.1 | Takeaway 1: While the composition and complexity of method bundles are highly variable, some methods appear more frequently than others.

The composition and complexity of method bundles are highly variable, with most case studies characterized by a different method bundle. There are; however, many instances where methods are used repeatedly and in complementary ways to enhance the breadth, depth, and local relevancy of knowledge generated (see Table 6). Such synergisms can enable insight into multiple dimensions of complex problems, such as community implications of environmental change (Rathwell et al., 2015; Shackleton et al., 2021). In the case studies reviewed, the prevalence of *verbal knowledge sharing* in bundles may be attributed to parallels between this method and the transmission of Indigenous teachings and cultures through oral tradition. The inherent flexibility of this method also creates the potential to gather detailed knowledge on a variety of topics. Similarly, the versatility of *guided group interactions, spatial mapping*, *written knowledge sharing*, and *document review* positions these methods to complement knowledge gained through verbal means as they can enhance specificity when discussing locations and phenomena. Yet, the regular use of these methods may be at the expense of others, such as *participant observations*, which require spending a significant amount of time in a community.

For natural sciences data collection methods, *document reviews* appeared frequently as important

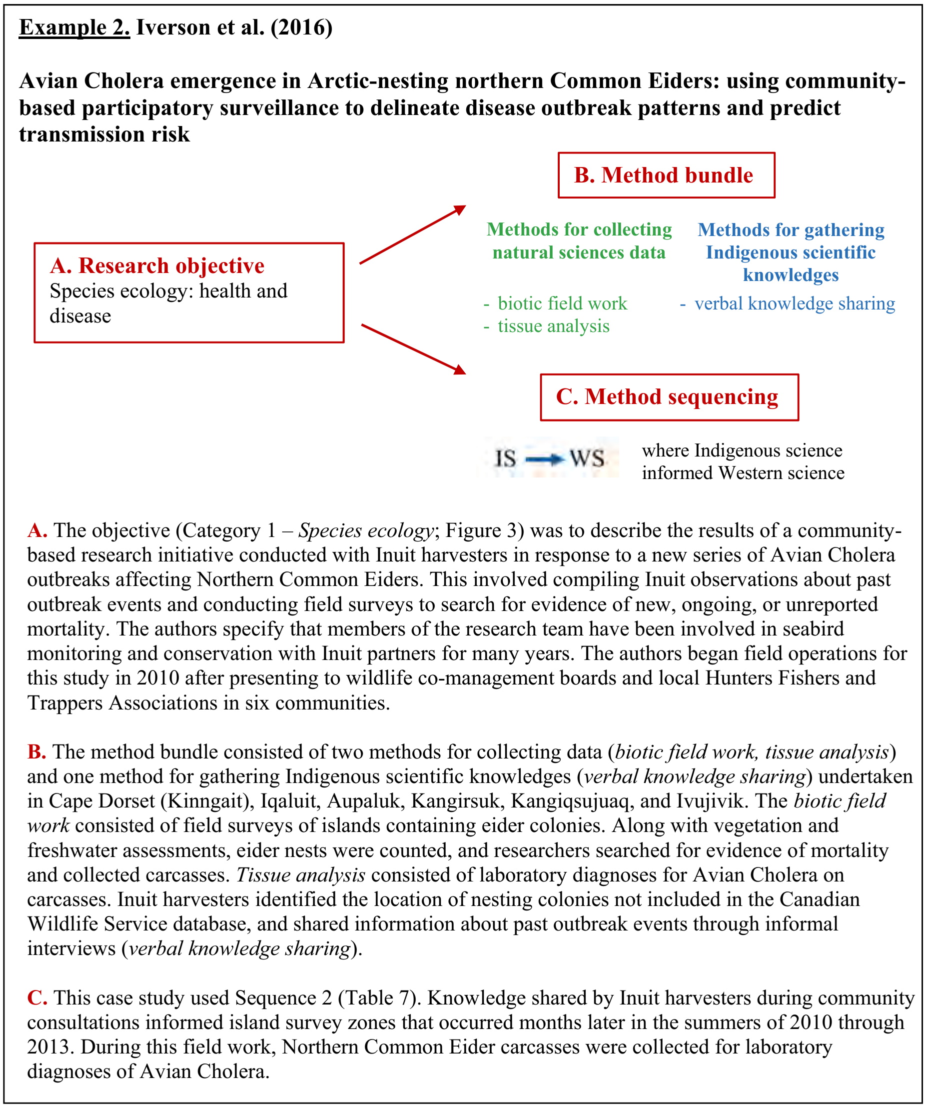


FIGURE 5 Example pathway highlighting the application of decision points in Iverson et al. (2016).

components of larger bundles and complemented field and laboratory data. While this method is useful due to the vast amount of data readily accessible in secondary sources, document reviews often involve minimal levels of community collaboration. The use of *biotic field work*, *tissue analysis*, and *observational methods* (e.g., aerial surveys, photographs) in many bundles reflect efforts to fill significant Arctic ecological knowledge gaps, and the importance of various species (e.g., marine mammals, fishes) to Inuit research partners. These methods, which can require more intensive levels of community participation, can strengthen bridging through knowledge exchange within and between researcher and community groups. Researchers should remain aware of their reasoning for employing method bundles with a specific composition and complexity, and ensure that their use of methods is in full alignment with community values and wishes.

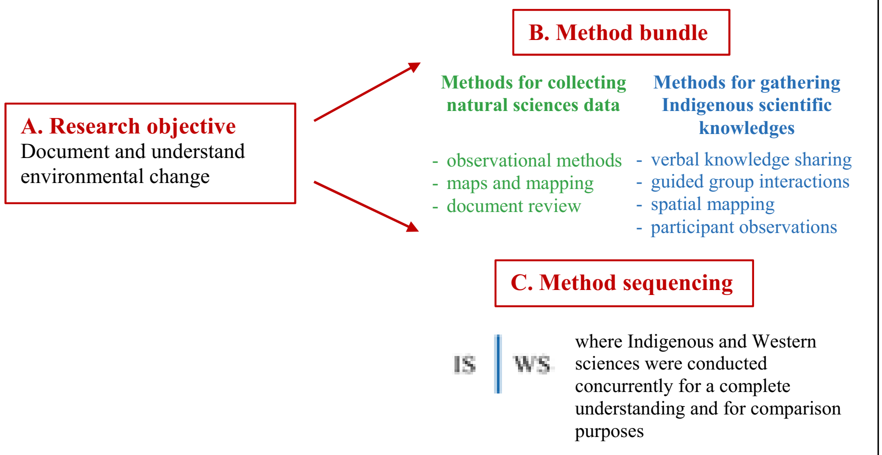
4.2 | Takeaway 2: There is an imbalance in the roles of Indigenous and Western sciences within method sequences.

Indigenous and Western sciences were used sequentially with the purpose of informing the other science, and used concurrently to broaden knowledges/data (see Table 7). However, there was a clear gap when comparing Sequence 2 (i.e., Indigenous sciences applied prior to Western sciences) and Sequence 3 (i.e., Western sciences applied prior to Indigenous sciences). For these sequences, case studies showed that Indigenous sciences were used to support or verify Western sciences. Yet, the opposite, where Western sciences were used to support Indigenous sciences, was not found. The imbalanced roles of Indigenous and Western sciences are not surprising, as Indigenous sciences are often only accepted and reported when concurring with Western (natural sciences) data (e.g., Kadykalo et al., 2021; Kimmerer, 2013; Reid et al., 2021; Wheeler et al., 2020;

FIGURE 6 Example pathway highlighting the application of decision points in Fox (2004).

Example 3. **Fox (2004)**

When the Weather is *Uggianaqtuq:* Linking Inuit and Scientific Observations of Recent Environmental Change in Nunavut, Canada



A. The objective (Category 2 – *Document and understand environmental change*; Figure 3) was to document Inuit observations and knowledge of climate and environmental processes and changes, and to examine how these observations intersect (or do not intersect) with scientific observations. This author shared that several community visits and discussions with community governments, Hunters and Trappers Organizations, Elder groups, and individuals were important components of project initiation.

B. The method bundle consisted of three methods for collecting data (*observational methods*, *maps and mapping, document review*), with four methods for gathering Indigenous scientific knowledges (*verbal knowledge sharing*, *guided group interactions*, *spatial mapping*, *participant observations*) undertaken in Baker Lake (Qamani'tuaq) and Clyde River (Kangiktugaapik). The methods for collecting data included air photos and photographs (*observational methods*), maps (*maps and mapping*), and the consultation of secondary sources and scientific literature, as well as raw weather station data (*document review*). Semi-directed and unstructured interviews (*verbal knowledge sharing*) were conducted with Inuit hunters and elders, and focus groups (*guided group interactions*) were held in each community. Participatory mapping (*spatial mapping*) was undertaken during interviews and focus groups. *Participant observations* encompassed the author's role as an active member of community life, including participating in travel and harvesting.

C. This case study used Sequence 4 (Table 7). The interviews were conducted in 2000 and 2001, and focus groups were held in 2001. Participatory mapping took place during interviews and focus groups in 2001, with secondary topographic maps providing a base layer, and sources such as air photos and photographs being used to facilitate discussions. Weather station data from 1960 to 2000 were collected and analyzed to link Inuit observations of environmental change to scientific data. While Indigenous and Western sciences were not inter-reliant, they together allowed for greater overall detail.

Wheeler & Root-Bernstein, 2020). In bridging endeavours, efforts must be enhanced to apply Western sciences as a means of supporting Indigenous sciences (rather than the contrary) to ensure that Indigenous sciences occupies the full extent of possible roles in research or monitoring (e.g., informing, supporting, allowing for research comparisons).

4.3 | Takeaway 3: Bridging research limited to particular research objectives, as well as the common use of a few methods and sequences, can lead to path dependency and research fatigue.

The prevalence of species ecology case studies, and the paucity of studies related to other topics (e.g., environmental change, harvest patterns, pollutants) suggests that there is room to broaden the spectrum of research topics in which bridging is undertaken. Additionally, the intensive use of a few key methods in method bundles (e.g., *verbal knowledge sharing*, such as interviews) and the use of a few method sequences points to the occurrence of path dependency among the case studies. Path dependency is a phenomenon where previous actions affect decisions, which shape a path that is then stabilized through positive feedback (Röhring & Gailing, 2010). Resulting dependencies render it difficult to depart from this path, and potentially sub-optimal options establish themselves permanently (Röhring & Gailing, 2010). This phenomenon is often discussed in science policy and climate change action and adaptation research (e.g., Aghion et al., 2014; Barnett et al., 2015), and occurs through the repeated use and application of methods in projects or programs with communities. The use of the same methods in a community over time, especially among similar demographic groups (e.g., male Elders and hunters, see Hitomi & Loring, 2018), can place a disproportionate burden on community members, and potentially amplify limitations and biases associated with these methods (David-Chavez & Gavin, 2018). Moreover, any duplicative efforts can evoke or worsen existing research and engagement fatigue in Arctic regions that are heavily researched for climate change impacts (Ford et al., 2016; ICC, 2021). It is our intention to help researchers curb these effects by drawing attention to these problems and presenting a variety of alternate research approaches.

4.4 | Takeaway 4: All details related to project initiation and methods must be included in case studies.

This takeaway has been echoed in previous research (e.g., Drake et al., 2022; Mosurska & Ford, 2020), as missing details pose a challenge to understanding research context and decision-making regarding methods. The degree and nature of early communication between researchers and communities can influence how research objectives are derived, and how and why method bundles and sequences are chosen. Examples of important details include Carmack and MacDonald (2008) sharing that a meeting over coffee with an Elder and his grandson led to the refocusing of their research plan, or other researchers describing previous community partnerships and long-standing relationships with local families that guided their bridging endeavours (e.g., Fox, 2004; Huntington et al., 2011). These details were insightful when included, and when not present, limited our understanding of decision points as well as community participation in case studies. Furthermore, we noticed fragmented reporting of ethical and relational components, including licensing, permitting, consent, confidentiality, and verification and dissemination of findings with community members. Limited transparency surrounding these practices will continue to challenge bridging.

4.5 | Takeaway 5: Bridging sciences is fundamentally relational, and not solely technical.

Last, we emphasize that bridging Indigenous and Western sciences is relational, and not solely technical (Goodchild, 2021; Held, 2019; McGregor et al., 2018). Upholding ethical standards and conducting research 'in a good way' should be at the heart of these forms of research. This means that the process is as or more important than results, and that relationship-building and accountability are central (AHA Center, 2018; Ball & Janyst, 2008; Wilson, 2008). Although two Inuit-specific research models are available, with the *Qaggiq* Model serving as a metaphor for renewing relationships (McGrath, 2012, 2018; see Section 1), and *aajiiqatigiingniq* encompassing a consensus decision-making approach (Ferrazzi et al., 2019; see Section 1), there is a lack of representation in the literature that was included. This gap suggests that there are opportunities to seek guidance from relevant models offered by and for Inuit and Western science-based researchers.

Many are now familiar with good practices in community engagement in research and monitoring that have been shared by the Inuit Tapiriit Kanatami *National Inuit Strategy on Research* (ITK, 2018) and the Inuit Circumpolar Council *Ethical and Equitable Engagement Synthesis Report* (ICC, 2021). Underpinning these is Indigenous data sovereignty and governance, which align closely with First Nations OCAP® principles of ownership, control, access, and possession (FNIGC, 2019). We encourage researchers to engage in practices that centre relationality and respect, and to undertake and report methods with transparency for continued mutual learning.

5 | CONCLUSION

Bridging Indigenous and Western sciences can strengthen aquatic research and monitoring by enabling holistic insights into ecological processes, and at the same time, help redefine relationships between settlers and Indigenous Peoples in Canada. The lack of clarity into the operationalization of bridging sciences poses a significant challenge in this context. In this systematic realist review of coastal and marine case studies from Inuit Nunangat, we identified three decision points (research objectives, method bundles, method sequencing) that shape research and monitoring projects, and explored the applications of these decision points in 25 case studies reviewed. We drew attention to the rich diversity of research pathways available, and presented decision point examples to help equip researchers and communities with an array of possible research practices. We maintain that each research pathway serves a specific role in a case study, and that none is more valuable than another. Rather, it is paramount that research is driven by communication between researchers and community members. Finally, we discussed five takeaways for further reflection regarding method bundle composition, missing method sequences, path dependency and research fatigue, the importance of contextualizing research with details, and bridging as a relational rather than technical endeavour.

It is clear that bridging Indigenous and Western sciences necessitates researcher reflection and guidance by community leadership throughout research projects. In the future, it will be important to look in depth into how research objectives are derived, how methods are decided upon (and why they are appropriate in a given context), and how (and why) particular sequences were chosen. It is our hope that these insights contribute to ongoing cross-cultural and intersectional processes and partnerships.

AUTHOR CONTRIBUTIONS

Conceptualization: A.K. Drake, J.F. Provencher, D.A. Henri, S.M. Alexander. Data analysis: A.K. Drake, K.M. Dunmall, V.M. Nguyen, S.M. Alexander. Writing – original draft: A.K. Drake. Writing – review and editing: A.K. Drake, K.M. Dunmall, V.M. Nguyen, J.F. Provencher, D.A. Henri, S.M. Alexander.

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DATA AVAILABILITY STATEMENT

All relevant data are available in the Tables S1, S2, and S3 within this manuscript.

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ENDNOTES

[1] 'Bridging' has been used by several authors in recent years (e.g., Abu et al., 2020; Chapman & Schott, 2020; Mistry & Berardi, 2016; Rathwell et al., 2015).

[2] We recognize that Indigenous erasure has been a cornerstone of conservation (e.g., Brockington & Igoe, 2006; Loring & Moola, 2020), and that current efforts must centre Indigenous priorities and values, lifeways and livelihoods (e.g., Buschman, 2022; Mistry & Berardi, 2016).

[3] Janet Tamalik McGrath grew up in Taloyoak, near Uqšuqtuuq. The late Mariano Aupilarjuk was a respected Inuk Elder and philosopher from Rankin Inlet (Kangiqliniq). The *Qaggiq* Model is initially developed through McGrath's work with Aupilarjuk for her doctoral dissertation (McGrath, 2012).

[4] Qablunaat or qallunaat are used to refer to non-Inuit across Inuit Nunangat. Varied spellings are used depending on the local or regional dialect (Tester & Irniq, 2008).

[5] See Ljubicic et al. (2021) for a recent application of this model in a caribou and land camp project with the community of Uqšuqtuuq (Gjoa Haven, Nunavut).

[6] Inuit Nunangat (ᐃᓄᐃᑦ ᓄᓇᖓᑦ; includes lands, waters, and ice) is a distinct geographic, cultural, and political region encompassing the Inuvialuit Settlement Region (Northwest Territories and Yukon Territory), Territory of Nunavut, Nunavik (Northern Québec), and Nunatsiavut (Northern Labrador).

[7] We have chosen to differentiate knowledge documentation and data collection processes associated with Indigenous sciences and Western sciences, respectively, as we consider Indigenous scientific knowledges to be much richer than 'data' or 'information' suggests.

[8] Individuals including Unangax̂ scholar Dr. Eve Tuck and Dr. K. Wayne Yang (see Tuck & Yang, 2012) and Red River Métis/Michif scholar Dr. Max Liboiron (see Liboiron, 2021) use a definition of decolonization that refers to the repatriation of Indigenous lands to Indigenous Peoples and communities.

[9] Note that this table could also be presented and organized by the complexity of methods for gathering Indigenous scientific knowledges. We chose to present the method bundles by complexity of methods for collecting natural sciences data as the maximum number of methods used for either science in any case study was five methods for collecting natural sciences data. This order is not intended to imply importance.

[10] It is important to recognize the variation in the use and applications of methods comprising method bundles beyond what is shown here. For example, see Table 3 and Table 4 for variation present within each method for gathering Indigenous scientific knowledges and method for collecting natural sciences data.

[11] Characteristics of 'shaping the other science' are similar to Sequences 2 and 3, but this case study (Mallory et al., 2006) was classified in this category as the methods were not conducted sequentially.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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