

# Hidden participants and unheard voices? A systematic review of gender, age, and other influences on local and traditional knowledge research in the North

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## Abstract

Local, lay, and traditional ecological knowledge (LTK) is widely discussed in academic studies of climatic and environmental change. Here, we report on a systematic literature review that examines the role of such factors as gender, age, and scholarly networks in shaping LTK research. We focused on research in the circumpolar North, where LTK research has been ongoing for at least four decades. We explored how recruitment approaches and research methods can circumscribe local expertise and found that much of the literature fails to adequately report sampling and participant demographics. There is an apparent bias towards male knowledge-holders, usually hunters and Elders, over women and youth. Studies were largely led by male authors, and male authors outnumbered female authors 2:1. We also identified two potential “invisible colleges” in the literature—communities of practice linked by one or a few authors. We discuss our findings through the lens of “intersectionality”, which captures how power differences at play within communities, whether around age or gender or some other social categorization, contribute to the creation of multiple kinds of knowledge. We conclude with a discussion of how we can improve this area of research by challenging assumptions and collaborating with a wider range of individuals.

**Key words:** climate change, gender, Indigenous knowledge, invisible colleges, local knowledge, traditional ecological knowledge



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## Introduction

Local, lay, and traditional ecological knowledge (LTK) is widely discussed in academic research as being an important locus of insight for understanding and responding to environmental problems such as climate change (Hall et al. 2000; Huntington 2000; Nakashima et al. 2012; IPCC 2014). LTK is a multifaceted concept that has been defined and named in multiple different ways (Usher 2000; Berkes 2008; Davis and Ruddle 2010). In general, LTK encompasses a body of knowledge, beliefs, traditions, practices, institutions, and worldviews, developed and sustained over time by Indigenous, peasant, and other local communities (Nabhan 2003; McGregor 2004; Barnhardt and Kawagley 2005). Research on environmental change that engages with LTK varies significantly in aims and scope, ranging from work that primarily seeks to collect local observations for integration with

existing scientific datasets, to more ambitious programs of research that seek to empower local people and re-make environmental governance via the collaborative production of knowledge (Davidson-Hunt and O'Flaherty 2007; Hind 2015).

Although there is widespread agreement that LTK is critical to observing, understanding, and responding to change, some scholars have noted that LTK, especially when brought into discussions of environmental planning and management, takes on a distinctly political character (Brush 1993; Nadasdy 1999; Cameron 2012). That is, LTK in science and policy can either be disruptive to, or exploited by, existing sociopolitical regimes. For example, LTK has long been attractive from the perspective of profit-minded bioprospectors (Brush 1993). Likewise, although LTK is seen as a promising way to elevate local people in governance, as Davidson-Hunt and O'Flaherty (2007) discussed, increased attention paid to LTK by scientists and managers may not be sufficient for changing the unequal conditions that marginalized groups face in environmental decision-making. Rather, it may be that political change, whether through activism, legislation, or court action, must precede engagement by scientists, at least if local knowledge is to be fully accepted into the decision-making sphere (e.g., Jones et al. 2016). Because of these and other political dimensions of how scientists and policy-makers engage with local people, it is essential to explore whose voices are being privileged or marginalized in LTK research (Furgal and Laing 2012; Breton-Honeyman et al. 2016), and whether academic and policy discourses are shaping the presentation of these studies and the collective knowledge that they purport to represent (Davis and Ruddle 2010; Yeh 2016).

We performed a systematic literature review to explore the role of such factors as gender, age, and scholarly networks in LTK research. We focused on LTK research on climate change in the circumpolar North, a research area where LTK research is arguably mature, given its development over at least four decades (Breton-Honeyman et al. 2016). Specifically, we were interested in how researchers define experts and expertise, which we evaluated based on reported methods for participant recruitment and reported demographic details regarding research participants. How experts and expertise should best be defined, and by whom, is a recurring discussion in LTK research (Bielawski 1996; Davis and Wagner 2003). It is important that local people being recruited to participate in these studies have experience observing and interacting with the environments in question (Ainsworth et al. 2008; Beaudreau and Levin 2013); however, how experts and expertise are defined can reflect deeply-seated assumptions about the nature and validity of specific forms of knowledge and ways of knowing (Nader 1996; Yeh 2016). "Expert" is, in any cultural context, a nuanced social position with its own set of locally-defined rules and customs; in Indigenous communities, for example, "Elder" is a received social status of great import. As such, researchers often put the matter of identifying experts to community leaders, who as a matter of self-determination, may put forward individuals for multiple reasons, including political ones (Howard and Widdowson 1997). If and how the literature on LTK handles these nuances, and whether, as a result, important voices are being marginalized, is an important question (Cameron 2012). Below, we discuss our findings regarding this body of literature, and conclude with some suggestions for moving forward.

## Background

Increasingly, LTK is recognized as having much to offer in studies of environmental and social challenges, within such diverse research areas as ethnobiology, natural resource management, and global environmental change (Davis 1985; Brush 1993; Nabhan 2009; Alessa et al. 2015). In many circumstances, local expertise is founded on hundreds, if not thousands, of years' worth of acquired experience (Basso 1996; Berkes 2008), and this time-depth is one of many cited reasons for its importance to scientific research and ecological understanding (Orlove et al. 2010). LTK is also often attributed a holistic and (or) synoptic quality, and, as such, many policymakers look to local experts to guide the development of more effective and equitable resource management strategies (Dongoske et al. 2010).

There are many ways that LTK is already being integrated into research and management, including for environmental monitoring (Danielson et al. 2005), assessment of species distribution and abundance (Anadón et al. 2010; Beaudreau and Levin 2013), interpretation of emerging environmental trends and feedbacks (Berkes et al. 2000; Alessa et al. 2015), and to understand changing human behaviors in response to environmental and socioeconomic change (López-Hoffman et al. 2006; Chan et al. 2017). LTK, and multiple ways of knowing more generally, are also increasingly discussed as being a basis for de-colonizing the very social institutions that underpin natural resource science and management (Huntington 2000; Davidson-Hunt and O’Flaherty 2007; Barrett 2013).

Scholars have offered multiple definitions and frameworks for local knowledge, and a variety of descriptors and acronyms can be found in the academic literature: Indigenous knowledge (IK), traditional knowledge (TK), traditional ecological knowledge (TEK), local ecological knowledge (LEK), and local, lay, and traditional knowledge (LTK), are among the most common. All of these terms have been extensively disassembled and critiqued (Morrow and Hensel 1992; Agrawal 2005; Nadasdy 2005, 1999; Dove 2006), and it is not our intent to revisit these critiques here. Suffice to say that terms such as “Indigenous”, “traditional”, “ecological”, and “local” are each heavily contested, often politically and (or) ideologically fraught, and should be applied with care. Following Ingold and Kurttila (2000), we opted for LTK because it does not inherently privilege or marginalize particular communities of knowledge-holders, domains of knowledge, or ways of knowing, and simply recognizes the situated nature of knowledge about the environment gained through any number of different experiences, including the scientific method.

As noted above, questions of validity and expertise often emerge in research about how best to bring LTK and “western science” together (Davis and Wagner 2003; Davis and Ruddle 2010; Harrison et al. 2018). One challenge involves how to best define expertise in a way that provides clarity regarding who is sharing their knowledge and what kind of knowledge they are sharing (Davis and Wagner 2003; Davis and Ruddle 2010). Fazey et al. (2006), for example, defined expertise as something that develops when people experience direct feedback from their actions in their environment; this fits within the broad area of information theory and a positivist theory of knowledge, suggesting that different people will have different opportunities to observe their local land and seascapes, and that the details of these interactions circumscribe the subjects on which people may be knowledgeable (Davis and Ruddle 2010; Loring et al. 2014). Gender and age can play important roles here (Rocheleau et al. 1994; Setalaphruk and Price 2007; Beaudreau and Levin 2013): Indigenous hunters, for example, may observe the animals in situ, gaining a nuanced understanding of their behavior and geographic ranges, whereas women who butcher and process fish and game may have different, but no less extensive, opportunities to observe animal condition, including evidence of malnutrition or the presence of parasites (e.g., Fleener and Thomas 2003).

Beyond these positivist dimensions of ecological expertise, there are additional, epistemologically diverse and nuanced forms of LTK: some knowledge is empirical and experiential, but some is received (e.g., through story), or revealed through dreams, visions, and intuition (Castellano 2000). With western science and resource management being anchored in positivism and “evidence-based” approaches (Sutherland et al. 2004), these aspects of LTK are an area in which local ways of knowing can be either marginalized by, or disruptive to, systematic biases and hegemonic understandings of knowledge (Nader 1996; Smith 1999; Hall et al. 2000). That is, it is possible, and perhaps essential, to bring all of these forms of knowledge into cross-cultural engagements, even if they are based on apparently contradictory epistemological foundations (e.g., what constitutes “truth”), to achieve truly transformative action toward sustainability (Barrett 2013).

It is also important to recognize that the power differences at play within any community, whether around age, gender, or some other social categorization, also influence the development of different

kinds of knowledge. That is, individuals necessarily relate differently to climatic and environmental change because of how their lives, practices, and identities are situated, whether in different positions in local power or family and community roles and categorizations (e.g., Elders, hunters, and head of household). Likewise, these same features can contribute to whether others trust the knowledge that specific groups of people offer (Harrison et al. 2018). Because the effects of environmental change will be experienced by different people in different ways, it is important that we apply a critical lens to how we, as academics, engage with local people in developing knowledge and prescriptions for action (Kaijser and Kronsell 2014). Feminist theory, specifically the concept of intersectionality, is informative here: as Kaijser and Kronsell (2014, p. 419) explained, “intersections of power can be found on all levels from institutional practices to individual actions . . . Social categorizations, often in combination (e.g., working class man, Indigenous woman), serve as ground for inclusion and exclusion”. Discussions of LTK and expertise regarding climatic and environmental change are arguably not exempt.

Following Kaijser and Kronsell (2014), it is essential that LTK research on climatic and environmental change be both reflexive and transparent regarding the types of knowledge that are being privileged: are academic and other framings of expertise being inadvertently drawn from, and possibly reproducing, existing social inequities and prejudices? Specifically, the research we present below responds to the following questions set out by Kaijser and Kronsell (2014, pp. 429–430): Which social categories, if any, are represented in the literature, and which are absent? Are there explicit or implicit assumptions about social categories? Which identities are promoted and considered to serve as grounds for political action? And finally, are any other aspects of identity neglected or deemed insignificant?

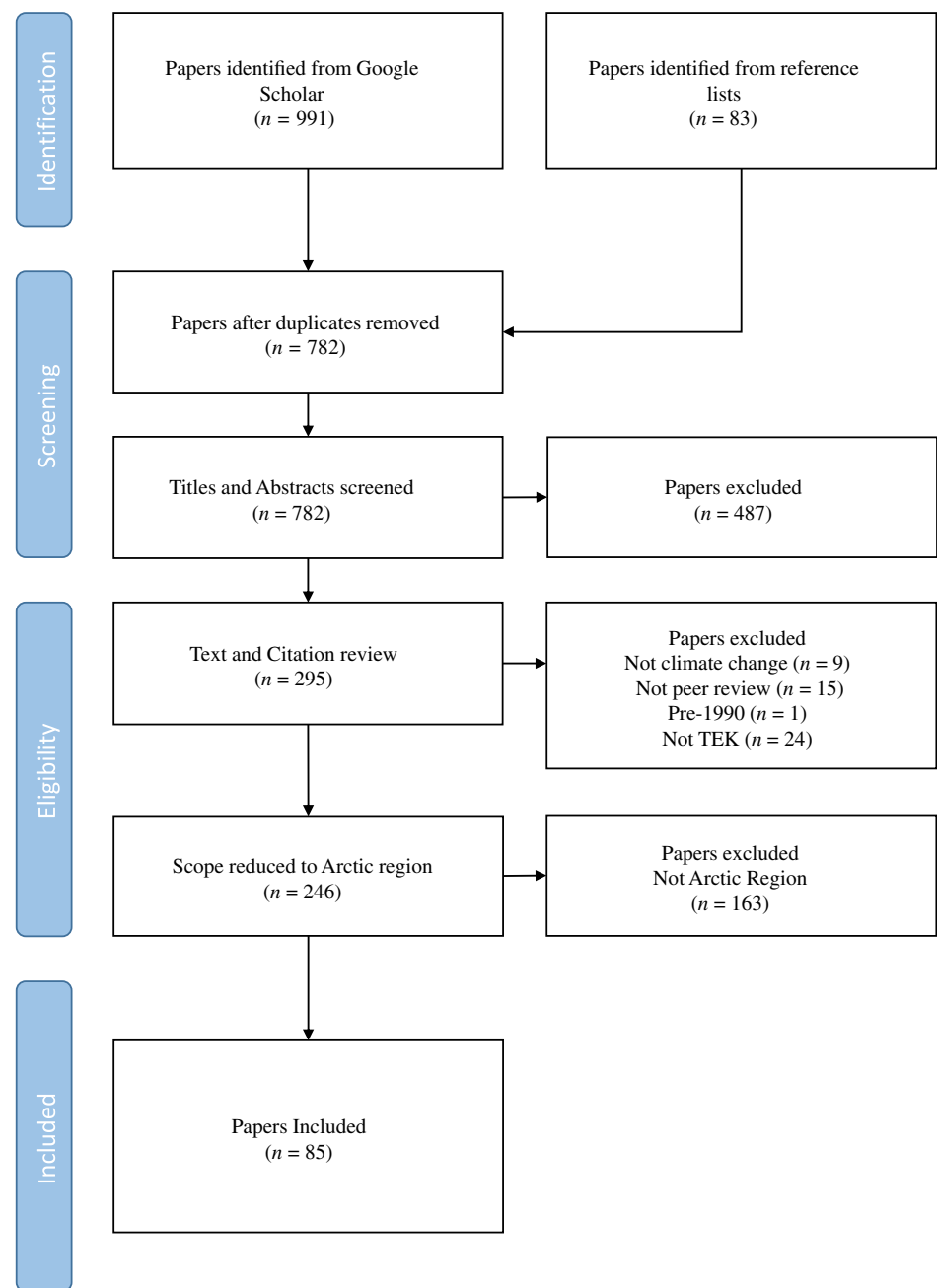
## Methods

To address these questions, we reviewed peer-reviewed literature documenting LTK in the circumpolar Arctic, with a specific focus on research addressing environmental and climatic change. Grey literature in this area, which is extensive, was not included, for several reasons. First, our goal was to evaluate the uptake of LTK in academic research, as this is a frequently-stated goal among LTK researchers and proponents of social movements to decolonize academia. Likewise, grey literature that engages with LTK, such as reports on fish and wildlife, is often stored in specific community or regional Arctic archives that are not widely known or accessible to university researchers and students. Additionally, policy decisions regarding environmental and climate change commonly rest on the strength of the peer-reviewed literature (e.g., Melillo 2014).

As described in more detail below, our review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al. 2009), the details of which are provided in Fig. 1 and Table S1.

## Article identification and eligibility

Using Google Scholar, we identified articles using all combinations of one knowledge keyword (“traditional ecological knowledge”, “traditional knowledge”, “Indigenous knowledge”, or “local knowledge”) and one climate change keyword (“climate change”, or “environmental change”). Only Google Scholar was used for the initial search, given that it has been shown to be effective for identifying both highly cited and lesser known articles (Beel and Gipp 2009; Martin-Martin et al. 2017). However, as we describe below, we also used the references cited lists from grey literature included in the search results, to ensure that important articles were not missed. Our criteria for search saturation were met when three consecutive pages of results (30 results in total) resulted in no new articles that met our inclusion criteria. However, in all cases, the first 10 pages of results (100 results in total) were always reviewed for inclusion.



**Fig. 1.** A PRISMA flow chart of literature reviewed for this systematic review of English literature presenting traditional ecological knowledge of climate change in the circumpolar Arctic, collected after 1 January 1990.

We deemed identified articles to be eligible for inclusion if they were (1) peer-reviewed, (2) published prior to 1 September 2017 (the date when the study began), (3) written in English, and (4) presented LTK regarding climate change or environmental change. Articles were excluded if they did not clearly present environmental knowledge from the perspective of local knowledge holders. That is, the knowledge had to be specifically attributed to local community experts to be included. Additionally,

we only included articles with aspects of LTK explicitly linked to climatic and environmental change by participants, or when the author presented the knowledge in this manner. For example, a number of articles regarding Saami terminologies for snow were identified in the first pass of the search; these articles were only included if the authors also presented Saami understandings of how snow has *changed* over time. Likewise, papers focusing on LTK for resource management and co-management, but without any explicit focus on change, were excluded.

We focused on environmental change research because of the relevance to policy implicit in this body of literature. That is, Arctic peoples are widely known to be on the front lines of climate change, and how governments and non-governmental organizations (NGOs) might best support these people in effectively adapting to these changes is a critical policy area (Ford 2008). Given the importance of developing policies for sustainable development that are reflective of local culture and context (Kottak 1990), we argue that this specific body of literature bears an added responsibility to fully represent the plurality of local voices and experiences in northern locales.

Initially, any article meeting our four criteria outlined above were included. However, we chose to limit the scope of our analysis by time and location, and to papers published between January 1990 and September 2017 that present data for the Arctic region. As definitions of the Arctic are contested, we relied on the region as described by the author(s) of the respective paper. Where the author(s) did not clearly indicate the region of their study, the study was included if its setting was north of 66°30'N, which is the southernmost point of the circle in North America (specifically, Baffin Island, Nunavut) per Wikipedia (Arctic Circle 2018). Our intent with limiting our scope in this way was primarily to achieve a manageable sample size.

Each of the identified articles was screened three times. In the initial pass, we screened the title of each article for possible eligibility. We reviewed the abstract of those we deemed eligible at this stage. If articles were still deemed eligible after abstract screening, we accessed the full article and screened the full text for eligibility. Where the abstracts were deemed eligible, we also examined the references for previously unidentified articles, which were then screened as above. In this process, we also examined the references of grey literature publications identified by the search. Two reports, in particular (Galloway McLean et al. 2009; Nakashima et al. 2012), each of which is frequently cited and that collectively offered hundreds of possibly-eligible articles, informed our decision to take this approach. After encountering these two articles, we opted to examine the reference lists of all grey literature reports identified by the keyword search for cases where the summary or abstract was deemed eligible for inclusion (as above). Topical textbooks, anthologies, and non-fiction books encountered were rarely available in full online, so it was not possible to review their references for additional peer-reviewed studies.

## Data collection

All of the screened articles were downloaded and stored locally to facilitate future accessibility. Upon full-text screening, we recorded publication information (author(s), year, journal, and digital object identifier (DOI)), methodological information (sampling technique, data collection, location, and region) and information relevant to the research questions (participant ages, genders, and number) in a Microsoft Excel (Microsoft, Redmond, Washington, USA) spreadsheet for easy reference. This information was gathered from the publication itself. We also recorded the genders of the publication's authors. For this latter information, we searched Google using the authors' names, sometimes in conjunction with their University affiliation. Where possible, we relied upon biographical information on University or research lab websites to make a gender determination (e.g., gendered personal pronouns). Photos connected to Academia.edu or ResearchGate accounts were also sometimes used. If these sources were unavailable, or if these sources conflicted or were unclear, the gender of the author was recorded as unknown.



Social network analysis

Additionally, we performed a social network analysis of co-authorship within the final sample of included papers using UCInet for Windows (Borgatti et al. 2014). We added this analysis following the first full round of article reviews, based on our qualitative observation that there may be one or more “invisible colleges” present in this body of literature. An invisible college describes a set of researchers publishing in a specific research area that interact and collaborate amongst themselves and cite and support other college members in a disproportionate manner (de Solla Price 1963; de Solla Price and Beaver 1966; Zuccala 2006). Invisible colleges can be problematic if they serve to unequally favor specific academic discourses or specific authors’ reputations within the college (through mutual citations and collaborations). Invisible colleges can also reinforce the colonial underpinnings of academia that marginalize the voices of Indigenous peoples, women, people of color, and intersections therein (Todd 2016).

Here, we recorded the number of papers authored by each individual, used the number of co-authored manuscripts as an indicator for tie strength, and calculated “betweenness centrality”, which is a measure of how important specific individuals are for connecting others in the network (Borgatti 2006). We note that our goal with this part of the analysis is exploratory and descriptive: we do not purport to quantitatively compare author networks nor identify the full extent of the communities of practice that exist among these researchers in general; rather, our goal is to view whether there is evidence that existing communities of practice may be creating the structures of exclusion that make invisible colleges problematic.

Results

Eighty-five papers met all inclusion criteria (Supplementary File S2). Most of these papers were published since 2005, with publication rates increasing over the early 2000s, but apparently decreasing in recent years (Fig. 2). In the 85 papers, male authors outnumbered female authors roughly 2:1 (230 men, 120 women, 23 unknown). Roughly 20% of papers were literature reviews ( $n = 18$ ), whereas

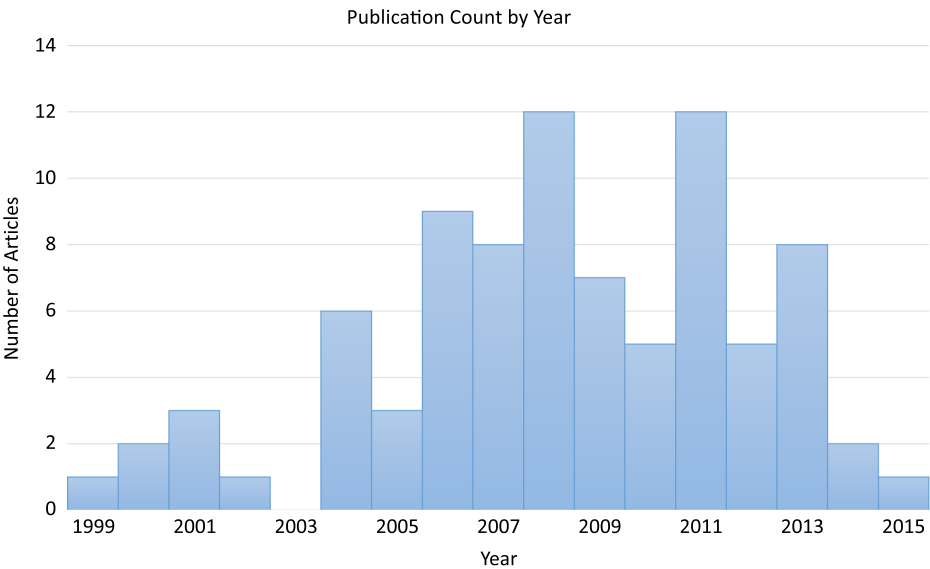


Fig. 2. Publication count by year.

the remainder reported new data collection. Geographically, most of the studies focused on the North American Arctic ( $n = 68$ ), followed by Scandinavia ( $n = 6$ ) and Russia ( $n = 7$ ), although this may, in part, be influenced by our focus on English-language publications.

With respect to recruitment, purposive sampling is the most commonly reported sampling method ( $n = 31$ ). This describes where the researcher(s) begin with key informants identified by community partners and then following a snowball sampling approach, adding new participants through recommendations. However, half of the papers that presented new data collection did not describe their sampling methods at all ( $n = 33$ ). Likewise, the majority of papers ( $n = 69$ ) did not provide demographic breakdowns of their participants by age or gender. Thirteen provided some information, and only three provided both gender and age data for participants. Indeed, only 23 of the 85 papers provided precise counts of participants; in some cases, this appears to be a result of the researchers using multiple methods and simplifying the complex demographics of participant groups into a couple of sentences. For example, [Laidler and Elee \(2008, p. 52\)](#) described their participants as follows: “In total (over the four research trips), 30 semi-directed interviews were conducted with 21 different people, 17 male, 4 female (out of a recommended list of 30 people) . . . Two focus groups were conducted in one in each of the third and fourth research trips”.

For the papers that provided additional details regarding participants, recruitment emphasized men (166 women to 317 men), elders, and the people responsible for directly harvesting the fish and game (i.e., hunters, fishers, herders, etc.). Only one study explicitly sought out the traditional knowledge of elder women and knowledge holders of women’s roles ([Dowsley et al. 2010](#)). Likewise, only one study explicitly included youth ([Sakakibara 2008](#)).

With respect to research methods, one-on-one interviews were most common ( $n = 38$ ), followed by focus groups ( $n = 18$ ) and participant observation ( $n = 14$ ). A small number of studies ( $n = 8$ ) reported “case studies” from the North American Arctic but didn’t include any information about how this information was collected, who it was collected from, or the context in which it was collected. Likewise, we encountered some cases where literature reviews included elements of LTK without identifying the primary source of the knowledge. For example, almost all the studies from this region mentioned that hunters have reported ice becoming less predictable and that this leads to danger; however, many of these papers did not cite a source for this claim, and those that did often cited another article or review that likewise reported but did not attribute the claim. Very few ( $n = 7$ ) of the researchers who cited this widely-reported observation cited a primary source.

Papers primarily reported observations of climate change; for example, how some environmental feature is changing, or discussion of people’s vulnerability to ongoing changes. Generally, we found that these observations primarily focused on the largest harvested animals (e.g., whale, caribou, seal, moose, etc.), whereas botanical resources, small mammals, and fish were rarely discussed.

Multiple publications apparently stemming from the same study were common ( $n = 26$ ). This number is an estimate; an exact number is difficult to report because not all papers explicitly connected their results to the methods/results presented in other publications. Because individual papers do not always explicitly identify their connection with other studies/papers it is not always fully clear what represents a discrete set of collected data.

With respect to differences in authorship, we found that women authors were relatively underrepresented in this literature by a ratio of 1:2 (94 women: 187 men). Women-led manuscripts (i.e., as lead author) were not more likely to recruit female participants or report the gender breakdown of the participants.

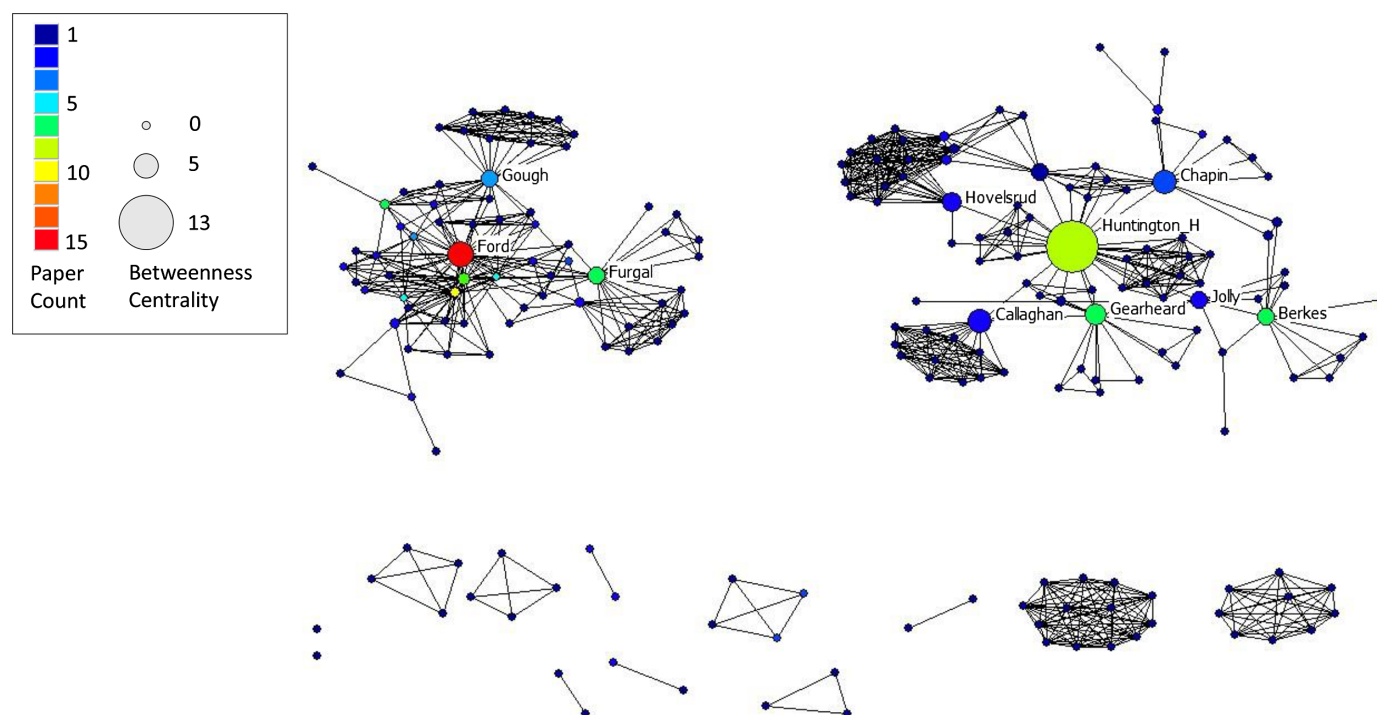


## Social network analysis

Although performing the review, we observed, qualitatively, that there were two communities of authorship in this body of literature. This was confirmed via network analysis, by which we identified two fully isolated sub-regions that accounted for 76% of the overall network (Fig. 3): one centered on Henry Huntington (Huntington Consulting), and the other around James Ford (McGill University). All but 10 of the 85 articles were a part of one of these two co-authorship networks. Overall, the network is very disconnected, with a total network density (proportion of existing ties to all possible ties) of 0.04. We discuss the possible implications of these various findings below.

## Limitations

Our search criteria intentionally limited this review to literature on climatic and environmental change in the North. It is possible that similar literature in other parts of the world do not share similar patterns regarding recruitment and the reporting of methods. Given that this research has been ongoing for four decades, and that the changing Arctic is considered a frontline for climate-driven environmental change in lower latitudes, our hypothesis is that patterns observed in this literature will be found elsewhere. A second limitation is our use of a binary (male–female) category for the gender of the author, as well as our method for determining gender, which captures gender expression as opposed to self-reported gender identity. A third limitation is our focus on only English-language literature, which necessarily excludes papers written in Russian and French, and, as such, may contribute to the geographic distribution of studies noted above. We note that language barriers have been a challenge for collaboration in Arctic studies, and this can reinforce the issue of invisible



**Fig. 3.** Social network map of co-authorship within the reviewed body of literature. The size of the nodes illustrates betweenness centrality, which indicates how important an author is for connecting other authors to each other. The colors indicate the number of articles authored.

colleges discussed below (Dobermann and Hamilton 2017). Cross-cultural collaboration in Arctic research that addresses the language barrier would be extremely valuable.

Finally, it is critical to impart the dangers of taking the studies identified through our methods out of context and looking at them in an individual manner. Each study offers only a small glimpse into a larger project and larger phenomenon. We hope that by aggregating the data from all the identified studies that the political and scientific biases of individual studies balance out. Put simply, this may not be the case, especially within larger colleges of practice such as the possible invisible colleges identified here. This potential for unintentional, unseen bias should be considered in the context of the results presented here and the wider implications discussed below.

## Discussion

Many of the above findings are not surprising; in their review of LTK for narwhal Furgal and Laing (2012) found similar shortcomings regarding how methods and recruitment are reported. Likewise, gender inequities in science publishing are widely recognized (Del Boca 2016; Lerback and Hanson 2017). With respect to our research, it is also not surprising that research on LTK in the North has generally focused on large species that are highly valued for local food security, and local participants in this research, generally, are the hunters that have opportunities to interact with and observe these species. From a perspective of assessing vulnerability, focusing on these species is valid and appreciable; however, if the goal is to monitor and examine ongoing changes to ecosystem structure and function, the focus on larger species may obscure information that is both important to local food security (berries, small fish) as well as information that might better signal ecosystem-wide trends and trajectories.

The disproportionate emphasis on older male participants that we observed is arguably problematic, given that both women and youth have a basis for developing their own unique and valuable bodies of knowledge about local environments. Indigenous women, in particular, are often overlooked in terms of their importance to subsistence practices and economies (Kafarowski 2009; Kuokkanen 2011). As noted above, women in northern communities are often in charge of processing fish and game as well as working with non-food products (skins, medicines, etc.) (Ohmagari and Berkes 1997; Frink et al. 2003; Kafarowski 2009). They likewise participate in social networks that contribute to household security and likely shape individual and shared learning about change (BurnSilver et al. 2016; Ready 2018). Similarly, youth experience local land and seascapes through their own unique social context (Wexler et al. 2014). How youth learn and transform these experiences into knowledge is an important aspect of how LTK evolves as a living phenomenon (Simpson 2004). It has become common in the academic literature on the North to acknowledge only the risks facing northern youth, such as the apparent disconnect between youth and elders (often specifically with regards to learning ecological knowledge, hunting, and fishing practices). Although this is an appreciable subject for research, it should not be a reason for excluding youth or considering their knowledge and experiences to be somehow less than authentic (Cameron 2012; Wexler et al. 2014).

In sum, the peer-reviewed literature on LTK in the North does not adequately situate LTK in the lives, roles, social settings, and ways of knowing of the research participants. To be clear, we are not questioning the legitimacy and importance of the knowledge that the participants in these studies have so generously contributed; rather, our observation is that too much of it is presented by the authors in a way that is disembodied from the people who shared it, and reported without the contextual information that is necessary to fully understand what is being shared. The scientific community has long wanted to believe that observation and experimentation can be performed in an apolitical manner, but increasingly, science studies are revealing the numerous fallacies of this assumption (Latour and Woolgar 1986; Nader 1996). Knowledge is inherently political, and the act of sharing it

is inherently intertwined with power and policy at multiple scales; whether the goal is to draw from LTK to produce a better understanding of ecological conditions or to develop better policy responses to change, research needs to more fully situate LTK in people's lives and lived circumstances.

A partial solution would be for journals to require better reporting of recruitment, methods, and participation, and indeed, some journals do now actively require this level of detail (e.g., PLoS ONE). However, we argue that there is a more fundamental opportunity to elevate LTK research by building it on the theoretical frames of intersectionality and feminist theory more generally. This would mean designing LTK research in a way that doesn't only acknowledge the intersectionality of knowledge, but actively engages with it. That is, rather than seeking out "experts" on a particular topic (e.g., asking "Which people in your community know about sea ice?"), researchers should work with their community partners to identify which different people or groups of people might have different kinds of knowledge or experiences to contribute to this discussion, especially groups that do not immediately come up, such as women and youth. The goal of reframing the research in this way is to actively address any hidden assumptions or power structures that might create and reproduce marginalization of women, youth, or others. Indeed, the very notion of the "expert" could unintentionally serve as an instrument of power and exclusion. To keep this from happening, we need to actively seek out unexpected knowledge and bring all of these elements to bear, as collective local expertise, on the questions at hand.

One complication is the importance, as guests in the places where we do this research, of respecting a community's right to identify their experts and spokespersons. As discussed above, there are important political and intellectual property considerations regarding LTK that may influence how local leaders decide with whom outside researchers should speak and what ought to be shared (Riley 2004). Generally, these issues are negotiated through proper consultation and institutional review of research protocols. Still, it is possible that some of the suggestions we note here, at least with respect to proactively seeking the inclusion of women and youth in these studies, will touch on tensions between individual and collective rights, or between interference and self-determination (Speed 2008; Kuokkanen 2012). It is entirely reasonable that a community or tribal council may want to nominate or exclude specific knowledge-holders as the representatives of their community's collective knowledge and best interests. As such, the intentionally disruptive and emancipatory aims of feminist approaches could be critiqued as being somewhat colonial—as advancing "universal" individual rights over local community sovereignty (Kuokkanen 2012).

However, as Kuokkanen (2012) explained, this is likely more of a problem in principle than in practice—Indigenous peoples widely consider individual and community rights to be complementary, and would arguably appreciate researchers' efforts to be more inclusive with our work. Given that Indigenous women and two-spirit people around the world continue to endure widespread violence and marginalization at the hands of men, we argue that it is possible, and essential, to respect community-level rights while also raising with our partners, in an earnest and transparent dialogue, the importance of seeking out unheard voices (Speed 2008; Kuokkanen 2012). Ideally, research engagements should start with this as one of many matters to be addressed in the co-development of project goals.

A final point of interest in this review is our identification of two apparent communities of practice. These sub-networks align with the two streams of LTK research identified previously by Cameron (2012, p. 104): one that seeks to document and integrate LTK into discussions of climatic and environmental change to "deepen or alter understandings" of how these will impact northern places and peoples; and, another that seeks to engage northern peoples "in the identification of exposure, vulnerability, and potential adaptations to climate change". The works that center around Huntington and colleagues generally represent the former, and those that center around Ford and colleagues represent the latter (although there certainly is some thematic overlap). Although this, on its own, is interesting,

these structural aspects of the network may indicate the existence of one or more invisible colleges in this body of literature.

The structure of the two sub-networks bears note: in the network centered around Ford, we see a single author with a relatively high paper count but modest betweenness centrality; in contrast, in the Huntington network, we see a central scholar with a comparatively lower paper count but higher betweenness centrality. In plain language, this suggests two styles of collaboration: one where a core group of researchers participates in most papers, bringing in others as they deem necessary, and a second where one author connects multiple groups but does not necessarily always participate in their collaborations. Supervisor–student dynamics may play a role in the structure of the Ford network. Dr. Huntington, by comparison, works as an independent consultant and, as such, would necessarily be collaborating with co-authors in different ways. Our observations here are strictly qualitative, and the structure seen in the Ford network may also be related to our earlier observation that several studies in this group appear to derive from the same project and data collection activities. More research would need to be done to identify whether either of these apparently distinct structures of collaboration are more or less friendly to the development of invisible colleges.

It is also likely that trends in funded research influence the structure of the network observed, as well as the increase in publications seen in the late 2000s. The fourth annual International Polar Year ran from 2007–2008, which, no doubt, provided an injection of support to research in this area (e.g., [Lovecraft and Eicken 2011](#)). Similarly, ArcticNet in Canada was founded as a research collaboration network in 2003 ([arcticnet.ulaval.ca/](http://arcticnet.ulaval.ca/)). Unfortunately, funding and project affiliation was inconsistently reported in these manuscripts, so it is not possible to determine the role of these events and networks in the shape of this body of literature.

It is essential that researchers be self-aware of the possible influence that these networks, regardless of how they form, can have on how knowledge is generated: invisible colleges can have a sizable impact on accepted methodology and scholastic achievements in an area of research, as they inflate citations of college members relative to non-college members, and in so doing influence research patterns, for example, acceptable methodologies and analytical frameworks. In psychological research, for example, invisible colleges have been shown to keep new researchers out of established fields of specialization, because of “in-group favoritism” and by amplifying linguistic and cultural barriers ([Dobermann and Hamilton 2017](#)). We likewise know from Indigenous scholarship that invisible colleges can create a “politics of citation” that perpetuate structural inequities in academia that limit the inclusion of marginalized voices ([Todd 2016](#)). There is a danger, in other words, that invisible colleges will unintentionally circumscribe who and what are “legible” in LTK research, validating only specific aspects of lifeways rooted in privileged species, activities, and perspectives. Future research on the possible impacts of invisible colleges on this and other bodies of research might move beyond authorship networks to look at citation networks as well (e.g., [Janssen et al. 2006](#)).

To be clear, just as our analysis should not be taken as a basis to delegitimize the contributions of northern people to this research, we also do not wish to cast any aspersions on the researchers whose work is represented in this review, by perhaps implying any negligence on their part. LTK research is a work in progress, and we are confident in saying that this body of research exhibits an earnest desire on the part of the authors to use research to empower local communities facing climate change. Rather, the key people in these networks are uniquely situated to make this area of scholarship more inclusive and create positive change on the various issues noted above ([Dobermann and Hamilton 2017](#)). To continue to move the field forward, leaders in this research should continually seek out new colleagues with new perspectives and approaches, the isolates in [Fig. 3](#), perhaps, to actively work against the emergence of structures of exclusion in this work.

## Conclusions

The body of literature we reviewed here is a tremendous resource for exploring local and traditional knowledge about climate change in the North. Our goal with this review was simply to point out ways that this important field can take another step to deepen, broaden, and strengthen local knowledge research. As Cameron (2012, p. 111) admitted, “all studies involve choices around subjects, methods, and scholarly audience, and no study can address all dimensions of an issue”. However, if these choices are not explicit, it is impossible to attend to the many assumptions, exclusions, and orientations in academic research that may serve to reproduce the marginalization and dispossession of colonialism, despite the fact so many scholars are working actively *de-colonize* their research. It is essential that researchers take better steps to report study methods, including any predeterminations or assumptions regarding experts and expertise. If methods are not reported and participants are hidden, not only does this do a disservice to the people themselves, it also works against the broader societal agenda implicit in much of this work—to advance the equal engagement of local people and local ways of knowing in environmental decision-making.

Specific changes that journals might make to encourage more effective reporting of this research include structured requirements for methods reporting such as the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist, and adjusted length limits to allow authors to be more generous in their direct quoting of local voices. Supplemental files may also be a way to attach this information to articles where page limits are a challenge. For researchers, it is important to pay attention to ways that we unintentionally circumscribe whose knowledge counts, and how our own study methods, including decisions about whom to interview and how to ask within a community about whom to interview, might open or limit the voices that we encounter.

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## Author contributions

MKH and PAL conceived and designed the study. MKH and PAL performed the experiments/collected the data. MKH and PAL analyzed and interpreted the data. PAL contributed resources. MKH and PAL drafted or revised the manuscript.

## Competing interests

The authors have declared that no competing interests exist.

## Data availability statement

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

## Supplementary Materials

The following Supplementary Material is available with the article through the journal website at doi:[10.1139/facets-2018-0010](https://doi.org/10.1139/facets-2018-0010).

Supplementary Material 1

Supplementary Material 2

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