Indigenous knowledge and federal environmental assessments in Canada: applying past lessons to the 2019 impact assessment act

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Abstract

Policy-makers ideally pursue well-informed, socially just means to make environmental decisions. Indigenous peoples have used Indigenous knowledge (IK) to inform decisions about environmental management for millennia. In the last 50 years, many western societies have used environmental assessment (EA) processes to deliberate on industrial proposals, informed by scientific information. Recently EA processes have attempted to incorporate IK in some countries and regions, but practitioners and scholars have criticized the ability of EA to meaningfully engage IK. Here we consider these tensions in Canada, a country with economic focus on resource extraction and unresolved government-to-government relationships with Indigenous Nations. In 2019, the Canadian government passed the *Impact Assessment Act*, reinvigorating dialogue on the relationship between IK and EA. Addressing this opportunity, we examined obstacles between IK and EA via a systematic literature review, and qualitative analyses of publications and the Act itself. Our results and synthesis identify obstacles preventing the Act from meaningfully engaging IK, some of which are surmountable (e.g., failures to engage best practices, financial limitations), whereas others are substantial (e.g., knowledge incompatibilities, effects of colonization). Finally, we offer recommendations for practitioners and scholars towards ameliorating relationships between IK and EA towards improved decision-making and recognition of Indigenous rights.

Key words: Canadian policy, environmental assessment, Indigenous knowledge, traditional ecological knowledge, environmental decision-making, environmental management

Introduction

In increasingly complex social, political, and environmental landscapes, decision-making about resource management can work to either resolve or stoke tensions as divergent communities and cultures offer and process information, knowledge, and values. Environmental assessment (EA)

processes have provided a central paradigm by which many societies (predominately western societies and colonial nation states) make environmental decisions. EA is a process used by decision-makers to predict and evaluate ecological, social, health, and economic impacts of proposed development, activities, and strategic undertakings (Cashmore et al. 2004; Murray et al. 2018)—its proper application in theory supports sustainability, environmental conservation, deliberative dialogue, and biodiversity management goals in the face of proposed projects (Gibson et al. 2005). However, EA processes and outcomes are increasingly criticized for their inability to incorporate the best available environmental knowledge, or the needs and cultures of diverse communities that they ultimately impact (O'Faircheallaigh 2017).

Whereas scientific knowledge and political systems rooted in historical imperialism have dominated EA processes and related dialogue over the past several decades, other societies (e.g., Indigenous Nations) have used Indigenous knowledge (IK) or local knowledge to support decision-making about the environment outside of an EA paradigm. In the context of contemporary decision-making, IK systems offer an alternative source of knowledge, often complementary to western science (Johannes 1978; Turner et al. 2000; Drew 2005; Gilchrist et al. 2005; Berkes 2012). Over thousands of years of observation and culturally transmitted learning, Indigenous peoples of the world have established complex management and conservation strategies to steward local environments (Johannes 1998; Huntington 2000; Turner and Berkes 2006; Menzies and Butler 2007; Berkes 2012; Housty et al. 2014). Despite growing recognition of the complementary nature of IK and science (Ferguson and Messier 1997; Drew 2005; Berkes 2012; Housty et al. 2014; Service et al. 2014; Eckert et al. 2017; Ban et al. 2018) and recognition of the stand-alone value of IK (which has and continues to support environmental management and decision making by sovereign Indigenous Nations) (e.g., Agrawal 2002; McGregor 2004; Turner and Spalding 2013), theoretical and empirical gaps plague modern discussion surrounding IK as it relates to environmental management, policy, and assessments (Stevenson 1996; Paci et al. 2002; Vidler and Elhaimer 2016).

Examining the contemporary relationship between IK and EA processes is increasingly relevant in the context of expanding global environmental degradation (Scheffer et al. 2001; Bopp et al. 2013; IPBES 2019), increased attention to the rights of Indigenous peoples (e.g., *United Nations Declaration on the Rights of Indigenous Peoples*; UN General Assembly 2007), and growing conflict resulting from EA decisions that poorly align with local knowledge, values, and interests (O'Faircheallaigh 2017). Canada provides a globally relevant case study to address the relationship between IK and EA. It is a country with heavy economic focus on natural resource extraction (Rosser 2006), where exploitation occurs on lands considered sovereign by many Indigenous Nations. Relatedly, Canada has a long history of problematic government-to-government relationships with Indigenous peoples, often over resource extraction.

EA occurs across scales in Canada, but we focus in this paper on the intersection of one such scale with IK. Canada has a federal form of government, where jurisdiction and legislative authority is divided between the national and provincial or territorial governments with constitutionally protected rights afforded to Indigenous peoples. Federal, provincial, and some Indigenous governments have all developed EA processes, but we focus here on EA policy enacted at the federal level. Such attention is justified, given the passing of a new federal EA Act (*The Impact Assessment Act,* 42nd Parliament, 1st session, 2019), which presents a contemporary context in which to investigate the relationship between EA and IK in Canada. Furthermore, insights gained from assessing the contribution of IK to federal EA policy have relevance for EA processes across other scales, as federal EAs are likely to impact large-scale environmental issues (such as those that effect Canadian oceans and global climate). Notably, Indigenous peoples in Canada have expressed concerns about EA across jurisdictions for similar reasons (Booth and Skelton 2011a).

Indigenous and non-Indigenous practitioners' concerns regarding Canada's federal EA processes have been previously documented (e.g., Booth and Skelton 2011a, 2011b; Udofia et al. 2017). Such critiques are traceable to the initial Canadian Environmental Assessment Act in 1995 (Stevenson 1996; Usher 2000; Paci et al. 2002). These historical and contemporary tensions surrounding EA policy have arisen in Canada partially as a result of the functional exclusion of Indigenous Nations as decision-makers in federal EA processes (Usher 2000; Carrier Sekani Tribal Council 2007; Manuel and Derrickson 2015). Despite the reality that a myriad of proposed projects, and the federally led EAs that follow, occur on sovereign territory occupied and managed by First Nations, Inuit, and Métis peoples, the degree to which local or IK is incorporated effectively into EA processes and decisions are often not considered adequate, consistent, or comprehensively understood (Stevenson 1996; Usher 2000; Paci et al. 2002; Vidler and Elhaimer 2016). Canadian EA Acts have also been criticized for lagging behind judicial court decisions. When resolving resource management conflicts, even Canada's legal systems have increasingly recognized knowledge, Constitutional rights—and in one case, title—of Indigenous peoples (Usher 2000; Paci et al. 2002; *Tsilhqot'in Nation v. British Columbia* 2014; Manuel and Derrickson 2015). Indeed, a recent high-profile legal decision emphasized the importance of improving engagement between Indigenous peoples and their knowledge in federal EAs when the Federal Court of Appeal overturned Canada's National Energy Board's approval of the Kinder Morgan Trans Mountain Pipeline expansion project, holding that the federal government failed in its duty to meaningfully consult First Nations in the EA process (Tsleil-Waututh Nation et al. v. Attorney General of Canada et al. 2018).

Against this background, here we assess how IK might be engaged in a potentially new chapter of EA in Canada. The emergence of the new *Impact Assessment Act* (enacted by the Liberal administration in 2019 to replace the 2012 Canadian Environmental Assessment Act) provides an opportunity to analyse how the federal government intends to apply IK in assessments and regulatory reviews as well as to examine the relationship between IK and EA under previous federal EA frameworks (**Table 1**). Synthetic literature reviews that summarize the contemporary application of IK in EA processes in any area remain largely absent (Gardner 2016; Vidler and Elhaimer 2016). Whereas some have examined the relationship between IK and EA since the initiation of formal Canadian EA processes (e.g., Stevenson 1996; Usher 2000; Paci et al. 2002; Booth and Skelton 2011b), to our knowledge no recent synthetic review of this body of literature has been completed. We recognize that IK is embedded in complex worldviews, cultures, governance systems, and recognition of sovereignty of Indigenous Nations. Our analysis, however, focuses on the application of the knowledge itself in federal EA processes. Here we analysed related peer-reviewed literature (*i*) to identify key obstacles

Table 1. Past, current, and proposed Canadian federal environmental assessment policy (Government of Canada 2016, 2018).

Act title	Proposal	Year enacted
Environmental Assessment and Review Process Guidelines Order (EARPGO)	SOR/84-467, issued under the *Government Organization Act,* 1979	1984
Canadian Environmental Assessment Act (CEAA)	Bill C-78	1995
Canadian Environmental Assessment Act (CEAA)	Bill C-19	2010
Canadian Environmental Assessment Act (CEAA) and *National Energy Board Act* (NEB)	Bill C-38	2012
Canadian Impact Assessment Act and *Canadian Energy Regulator Act*	Bill C-69	2019

preventing meaningful engagement of IK in the Canadian EA process and (*ii*) to use identified obstacles as criteria to assess if and how the *Impact Assessment Act* might engage IK.

Methods

Literature review

We performed a systematic literature review, using several online databases (Google Scholar, The University of Victoria Electronic Libraries, and EBSCOhost). Search terms were: "Indigenous knowledge" or "traditional knowledge" or "traditional ecological knowledge" or "Aboriginal knowledge" or "Indigenous wisdom" or "Indigenous Law" and "Canada" and "Environmental Assessment". We included peer-reviewed publications published between 1973 (the year of the informal, but influential assessment Mackenzie Valley Pipeline Inquiry) and 2018 that focused explicitly on Canadian federal EA processes.

We approached our analysis in ways that supported reproducibility of our qualitative research. We used a qualitative content analysis approach (Krippendorff 2018). We considered papers as sampling units and corresponding sentences as units of analysis. In this systematic process, we focused on the context of relevant text, considering sentences within the greater context of paragraphs, paper sections, and within the entirety of the scope of the paper. We followed an emergent coding process; although we began our analysis with a list of key questions (**Table 2**), we identified additional themes and categories from the texts themselves, rather than establishing them prior to analysis (Charmaz 2006; Charmaz and Belgrave 2012). We created a code book (**Supplementary Material 1**) to describe in detail our analyses.

Papers we analysed spanned a range of geographical locations and project types. While some papers broadly analysed the federal EA process across geographies, several examined case studies. Papers included in the review covered federal EA study cases across Canada; five papers (26%) commented on projects undertaken in the Northwest Territories, two (11%) occurred in Saskatchewan, three (16%) discussed processes that occurred in Ontario, three (16%) papers focused on processes in British Columbia, one (5%) in Alberta, and five (26%) were not geographically specified beyond Canada.

All qualitative analyses were performed through NVivo-QSR software (NVivo qualitative data analysis Software 2012). One person (LEE) read selected papers, coded answers to questions established prior to reading the papers (**Supplementary Material 1**), and identified emergent themes. We conducted an iterative coding process; novel themes were coded into broad categories, and then

Table 2. Key questions utilized in qualitative analysis process and code book.

Key questions
Does the paper indicate that the author(s) find the relationship between Indigenous knowledge and federal environmental assessment adequate and positive, either implicitly or explicitly?
Does the paper indicate that the relationship between Indigenous knowledge and federal environmental assessment in Canada is in some way flawed or inadequate, either implicitly or explicitly?
Does the author explicitly indicate obstacles that prevent a positive and effective relationship between Indigenous knowledge and federal environmental assessment in Canada? If so, what are these obstacles?
Does the paper identify ways forward in repairing or improving the relationship between Indigenous knowledge and federal environmental assessment either explicitly or implicitly? If so, what are these suggestions?

further into sub-categories. As new categories and sub-categories emerged, all papers underwent a second round of analyses.

Relating themes to the impact assessment act

We used the identified obstacles from our literature review as criteria to assess the *Impact Assessment Act*. We coded all identified obstacles from the literature search (**Supplementary Material 1**: Question B1), and then sub-coded obstacles into finer categories (Historical Obstacles, Procedural Obstacles, Legal Obstacles, Epistemological Obstacles, Political Obstacles, and Resource Limitations), and finally into obstacle components (e.g., Unresolved Treaty and Title Rights, Historical Colonization, Financial Limitations, etc.). Then, we qualitatively analysed the *Impact Assessment Act* using key search terms and with identified obstacles in mind (see **Supplementary Material 2**). While analyzing the Act, we focused on the Act's language relating to addressing these obstacles within the broader context of the legislation itself. Similar to our literature analysis, we used a code book to guide, inform, and appropriately constrain our analysis of the Act and our interpretation (**Supplementary Material 2**). This code book used the key search terms we relied upon in our literature review (excluding "Canada" and "Environmental Assessment"), as well as new search terms (See **Supplementary Material 2** for additional information).

Finally, we evaluated whether identified obstacles were surmountable or addressed by the *Impact Assessment Act* based on this guided qualitative review and information that emerged in the literature review. In this context, we defined surmountable as reasonably able to be overcome within the confines of current Canadian federal governance norms. We defined addressed as a directed, actionable written statement acknowledging an obstacle to engaging IK in the EA process, which will likely contribute to that obstacle's remediation. Using these definitions and the text of the *Impact Assessment Act*, we evaluated whether the Act identified or addressed obstacles (see **Supplementary Material 2** for more details and methodological examples). To identify whether or not obstacles were surmountable, we consider how embedded they were within systems typically resistant to change (e.g., colonial systems, worldviews, etc.).

Personal experience

We complemented the literature search with authors' personal experiences, especially in our interpretation of analysis in the Discussion and Conclusion. Our team's experiences with federal EA processes were diverse and contributed to understanding the potential practical applications of recently passed EA legislation, given that analyzing a recently passed *Impact Assessment Act* (rather than an established Act) generates limitations in understanding how the proposed Act will be applied. Two authors (LEE, NCB) are engaged as ethnoecological researchers hired to investigate environmental and cultural impacts after an industrial contamination in Indigenous territory. One author (NXC) has testified in the context of federal EA hearings representing the Tsawout Nation's concerns and positions on proposed industrial projects, in recognition of shared Tsawout responsibility to manage their traditional territories. One author (CTD) has been engaged in a federal EA process as an official Intervenor. One author (AJ, a lawyer) has represented Indigenous clients in federal EAs, served on a multi-interest advisory committee appointed by the government to advise on the *Impact Assessment Act*, and has appeared before the House of Commons and Senate committees reviewing the bill.

Here we also address our positionality as authors. We recognize the inherent biases and limitations that influence our analyses and results. We attempt to reflect critically on our positionality as scholars, practitioners, and non-Indigenous and Indigenous authors. The Euro-Canadian scholars among us recognize that, as individuals who have benefitted directly and indirectly from forces of colonization and who are embedded within the cultural milieu of western society, there are as aspects of IK and

culture that we will never comprehend. The same limitation may be applicable to many of the authors whose publications were reviewed in this paper, most of whom were non-Indigenous.

Results and discussion

Literature review

Nineteen papers (**Supplementary Materials 3** and **4**) matched our search criteria for review. None identified the relationship between IK and Canadian federal EA as adequate and positive. All papers explicitly identified obstacles in engaging IK in Canadian federal EAs, and nearly 90% (16 papers) suggested ways, either explicitly or implicitly, by which these obstacles could be confronted.

Obstacles identified

We identified six categories of obstacles to engaging or incorporating IK appropriately in Canadian federal EA. We divided each obstacle into three components (**Fig. 1**).

Historical obstacles

Fifteen papers cited historical obstacles as barriers to including IK meaningfully into the federal EA process (**Supplementary Material 3**). Eleven papers (58%) acknowledged historical colonization of Indigenous peoples (**Fig. 1**) and associated harms by the Canadian government. Baker and Westman (2018), for example, posited that the Chipewyan Lake EA health survey failed to capture the potential impacts of a proposed mining operation for Bigstone Cree Nation members living in the community of Chipewyan Lake, and appropriately engage their knowledge, "…because they [Indigenous peoples] did not trust the researchers (potential government co-conspirators) and feared
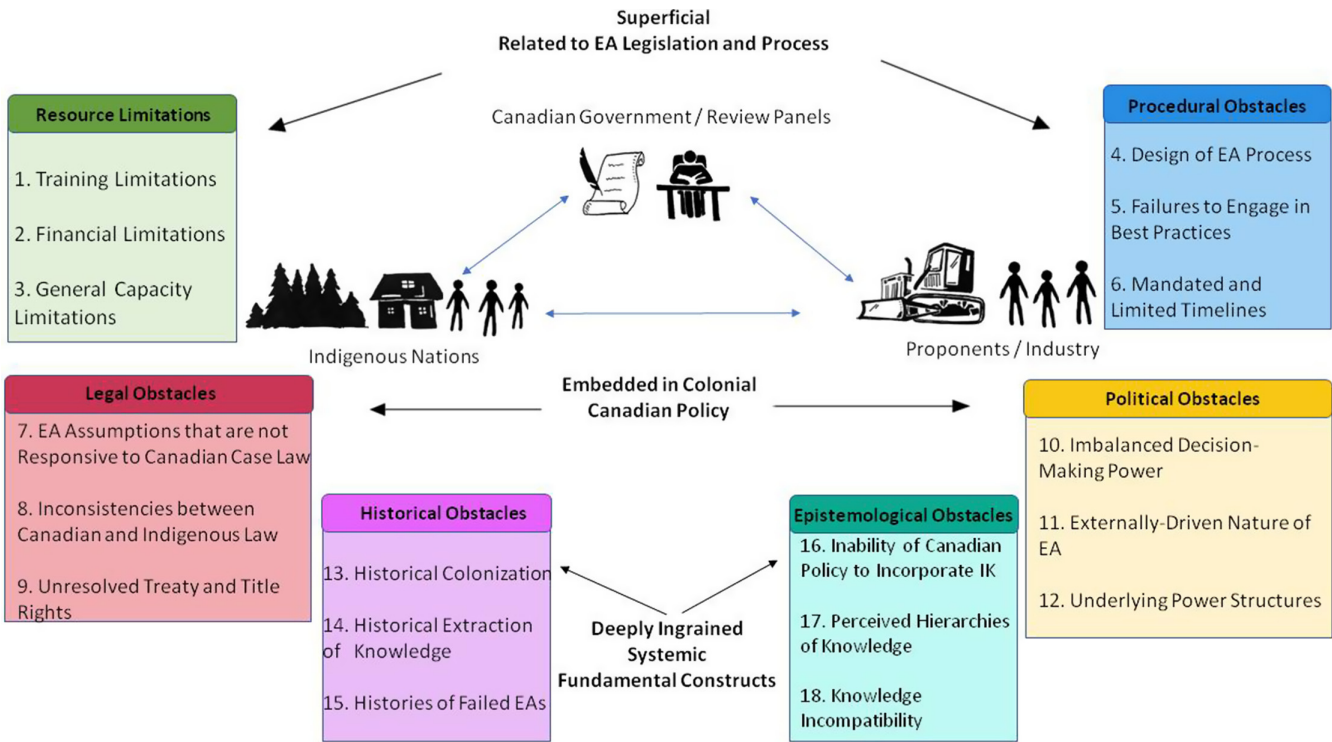

Fig. 1. Obstacles and their components positioned within the context of parties involved in a typical federal environmental assessment process.

loss of hunting and harvesting rights, considering the past and current government activities in limiting rights and movements of Aboriginal peoples in Canada" (Baker and Westman 2018, p. 148).

The historical and continuing impacts of colonization in Canada are increasingly discussed beyond the context of federal EA and have serious implications for the use of IK in the context of assessments. The significant and continuing impacts of colonization are well-documented (Environics Research Group 2008). Engaging in reparative, reconciliatory nation-to-nation relationships with Indigenous peoples is a voiced and oft emphasized goal of the modern Canadian federal government (e.g., Canada's Truth and Reconciliation Commission (Environics Research Group 2008)). Despite the Canadian government's attention to reconciliation, many considered that Canadian EA policy fails to recognize the historical and ongoing impacts of colonization explicitly or meaningfully (e.g., Usher 2000; Paci et al. 2002; Ellis 2005).

Eight papers (42%) cited the historical extraction of IK (Fig. 1) by state governments or scientific researchers for its role in Indigenous hesitation to offer their knowledge in the context of EA processes. Supporting this concern, Usher (2000) noted, "[t]here is a risk that any knowledge, taken out of the context in which it was generated, can be misinterpreted or even deliberately misused" (Usher 2000, p. 192). Several other authors and practitioners recognized that "there is resistance by indigenous people to [IK's] integration, seen by some as continued colonization and exploitation" (Paci et al. 2002, p. 117).

The risk of extraction of knowledge is recognized as a barrier across research and practice that spans IK and western science. Indeed, such hesitation on the part of Indigenous peoples to engage in externally led scientific research is echoed across the practitioner (Booth and Skelton 2011a) and Indigenous experience (Nadasdy 1999; Menzies and Butler 2007) and beyond the peer-reviewed literature analysed in this paper. The exercise of "integrating" IK is seen by some as a form of neo-colonization, which assumes that the complexities of IK construe simply a new source of "data" to be subsumed within the cultural assumptions of westernism and science and the management structures that support these systems (Nadasdy 1999). Under this framework, knowledge is extracted from its cultural and spiritual context, and knowledge holders are expected to conform to the institutional, cultural, and political norms of the western world. Once knowledge is extracted, the power to control said knowledge is removed from the knowledge holder and nation (Nadasdy 1999; Paci et al. 2002; Ellis 2005; Butler and Menzies 2007; O'Faircheallaigh 2007). Many examples of this extraction of knowledge exist (e.g., Nadasdy 1999; Agrawal 2002; Berkes 2012), and no legislated safeguards assure participants that knowledge contributed to the EA process will not be de-contextualized or misused in the hands of western scientists or decision-makers.

Eight papers (42%) noted that histories of failed EAs (Fig. 1) continue to prevent Indigenous involvement and willingness to share knowledge in the EA process. These EA process failures most often take the form of inadequacy of decision-making structures to respond to Indigenous concerns. These process failures may culminate in several ways: Indigenous resistance to engage (Udofia et al. 2017), participant exhaustion (Baker and Westman 2018), perceptions of wasted resources and time by Indigenous Nations, and the perpetuation of poor relationships between governments and proponents (Booth and Skelton 2011b; Baker and Westman 2018). Baker and Westman (2018) studied the exhaustion and disappointment perpetuated by historical impacts of EAs that have failed to engage IK, stating:

> "The cumulative effect of this disappointment (with consultations and impact assessment) is a psychological and spiritual fatigue... They [Indigenous participants] are tired of expressing the same concerns and telling the same stories, which seem to have no effect on the course of development..." (Baker and Westman 2018, p. 145).

Together, these identified historical obstacles are inherently interrelated, and deeply ingrained in Euro-Canadian cultural and political systems (**Fig. 1**). These historical barriers inform behavior, attitude, and practice of Indigenous and Canadian governments as well as project proponents, informing worldviews, and bureaucratic processes explicitly and implicitly. We consider this obstacle as profoundly embedded within the experiences of the federal Canadian government, EA practitioners, and First Nations (**Fig. 1**), recognizing that historical obstacles allow for and are inherently interrelated with more superficial, though still problematic, obstacles identified below.

Epistemological obstacles

Eighteen papers (**Supplementary Material 3**) cited epistemological obstacles to appropriately engaging IK in the EA process. Sixteen (∼85%) identified existing EA framework deficiencies (i.e., the inability of Canadian policy to incorporate IK; **Fig. 1**) as preventing a positive and collaborative relationship between IK and Canadian EA. Poorly understood or defined nature of IK in EA processes comprises a frequently cited deficiency in legislation framework. Stevenson (1996) emphasized this obstacle:

> "...the role of traditional knowledge in [Environmental Impact Assessment] EIA in the North is often not adequately understood or appreciated by government and industry, partly because this requirement is relatively new, and few examples exist to serve as models... Thus, there appears to be a general misunderstanding of what traditional [Indigenous] knowledge is, how it is constructed and what role it has in EIA" (Stevenson 1996, p. 279).

Whereas nonexistent or inadequate definitions of IK are an oft-cited EA framework deficiency, a variety of additional framework challenges arose in our literature review. Beyond failures to define IK explicitly or accurately (a common challenge at the intersection of IK and ecological research; Nadasdy 1999; Agrawal 2002; Berkes 2012), authors also recognized overwhelmingly that past and modern EA legislation is simply neither constructed to allow equitable, respectful, and appropriate knowledge sharing (Paci et al. 2002; Roue and Nakashima 2002; McCreary and Milligan 2013; Vanclieaf 2014; Hoogeveen 2016; Sandlos and Keeling 2016), nor have past EA Acts explicitly required the incorporation of IK into EAs. These failures are arguably rooted in the colonial nature of Canadian legislation itself and the implicit values that reflect cultural assumptions and uphold the asymmetrical prominence of scientific knowledge and project approval (Paci et al. 2002; Ellis 2005; Butler and Menzies 2007; Berkes 2012).

Thirteen papers (∼70%) acknowledged perceived hierarchies of knowledge (**Fig. 1**)—namely, the problematic perception that scientific knowledge is superior to IK, as a barrier to engaging IK in federal EAs equitably. Scholars acknowledged that implicit assumptions throughout the EA process, and in other processes and sciences in which IK is invoked, can unintentionally position IK as the supplementary "handmaiden" of science (Stevenson 1996). Similarly, EA processes value IK only after its problematic "scientization" (Ellis 2005, p. 72) into a form palatable to western managers, scientists, and policy-makers (Roue and Nakashima 2002; Ellis 2005; O'Faircheallaigh 2007; Sandlos and Keeling 2016). Despite growing recognition that Indigenous and local knowledge have functioned as independent approaches in environmental management for millennia (Turner et al. 2000; Trosper 2003; Houde 2007; Berkes 2012; Housty et al. 2014) and increasing scrutiny of the dominance of western scientific knowledge (Latour 1998, 1999; Menzies and Butler 2007) this perception of knowledge hierarchy limits the efficacy of the application of IK to federal policy processes.

Fifteen papers (∼80%) cited fundamental knowledge incompatibilities (**Fig. 1**) as a core component of this obstacle. Hoogeveen (2016) discussed these epistemological clashes as they relate to impacts on culturally important fish species defended by the Tsilhqot'in Nation during the Prosperity Mine proposal and following federal EA:

"The distance between Indigenous epistemologies of fish and the quantification of trout matters here greatly. For the Tsilhqot'in... fish represent much more than 'a limbless cold-blooded vertebrate animal with gills and fins living wholly in water' as defined by the Oxford English Dictionary... It would seem this definition, however, fits within the biological renderings supposed in mining feasibility studies" (Hoogeveen 2016, p. 363).

This excerpt represents a frequently arising problem in federal EAs; values that inform Indigenous and western knowledge systems are oftentimes at odds with each other (Houde 2007; Berkes 2012). In seeking the inclusion of IK in a Canadian bureaucratic and political process, proponents and practitioners seek to represent the complexities of IK in quantitative, economic, and often incompatible western terms (Baker and Westman 2018). This fundamental disconnect, shaped by divergent worldviews and cultures in which western and IK systems are embedded, comprises a fundamental hurdle in the exercise of invoking IK in federal EAs (Tsuji et al. 2011; Vanclieaf 2014; Hoogeveen 2016; Sandlos and Keeling 2016).

Epistemological obstacles were the most frequently cited throughout our literature review. We perceived these barriers as deeply embedded within the assumptions and values that constitute Indigenous and Canadian worldviews, cultures, and inform governance, thus positioned similarly to historical obstacles. Therefore, epistemological obstacles comprise a platform on which forthcoming obstacles emerge and are interwoven throughout identified obstacles and components.

Legal obstacles

Seven papers (Supplementary Material 3) cited legal obstacles as obstructions to engaging IK appropriately in Canadian federal EA processes. Five (~25%) cited EA policy assumptions that have not responded to modern and unfolding Canadian case law decisions (Fig. 1) as problematic when attempting to engage IK in EAs. Paci et al. (2002) reflected that the "current federal legislation [CEAA 1995] ignores the federal fiduciary responsibilities to Aboriginal people and hampers community-based planning efforts" (Paci et al. 2002, p. 120).

Disconnects between Canadian legal precedents and policy are evident throughout scholarly examination of relationships between IK and EA. Indeed, modern Canadian case law reflects a growing recognition of the treaty and unceded title rights of Indigenous Nations (e.g., Delgamuukw v British Columbia 1997; Gladstone v. Attorney General of Canada 2005; Tsleil-Waututh Nation et al. v. Attorney General of Canada et al. 2018). However, these judicial decisions and legal realities are at odds with legislation and top-down decision-making powers exercised in historical, modern, and newly passed federal EA. Crawford (2018) contended that Canada's former and new EA policies categorically fail to fulfill Canada's Crown duty to consult with Indigenous Nations during these processes.

Three papers (~15%) identified inconsistencies between Canadian and Indigenous law (Fig. 1) as a hurdle in interweaving IK with the federal EA process. These papers asserted that living and historical Indigenous legal systems are neither considered in, nor are congruent with, western laws as applied through the federal EA process (O'Faircheallaigh 2007; Booth and Skelton 2011b; McCreary and Milligan 2013). While Indigenous rights and title are constitutionally recognized in Canada, Indigenous legal systems are not currently recognized explicitly under Section 35 of the Canadian Constitution Act (Canadian Charter of Rights and Freedoms 1982). Although their application may not extend widely in the eyes of the Crown, these laws hold great impact and authority for the Indigenous Nations and peoples that created and enforce them (Borrows 2005). Modern Canadian EA laws and policies do not recognize, and often result in decisions that are contradictory to, local legal systems (McCreary and Milligan 2013).

Finally, five papers (∼25%) acknowledged that unresolved legal treaty and title rights of many Indigenous Nations within the country currently known as Canada (Fig. 1) hamper the use of IK in the context of EAs. These authors noted that, while Indigenous Nations frequently make their interpretation of unresolved title or treaty rights clear, the federal EA process fails repeatedly to do so explicitly (Booth and Skelton 2011b). This failure, combined with the unsettled answer of legal land rights in locations where developments are proposed, is recognized as a core obstacle preventing the meaningful incorporation of IK in EA processes (Wiles et al. 1999; O'Faircheallaigh 2007; Booth and Skelton 2011b; Udofia et al. 2017). A pervasive challenge for Indigenous participants in EA processes is that Canadian EA as legislated does not provide the appropriate process to settle these lingering, unresolved, and consequential legal queries (Wiles et al. 1999).

The legal obstacles synthesized in this review are related to, and impact, Canadian policy and legislation far beyond the federal EA process and its relationship to IK and knowledge-holders (Fig. 1). Nonetheless, these legal inconsistencies and barriers directly affect individual EA processes, despite being embedded in a larger construct of Canadian political assumptions.

Political obstacles

Thirteen papers (Supplementary Material 3) identified political obstacles towards meaningfully engaging IK in the federal EA process. Eight (42%) identified imbalances in decision-making powers (Fig. 1) as substantially hindering a positive relationship between IK and EA. Current top-down federal EA processes may engage IK in the process of assessment but do not place Indigenous Nations or Knowledge Holders in a position to mobilize their expertise towards impacting decision-making (Sallenave 1994; Stevenson 1996; O'Faircheallaigh 2007; Kirchhoff et al. 2013), let alone recognize Indigenous decision-making authority under their own laws and United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). Scholars asserted that this barrier is consequential, and inherently challenging to surmount:

> "The … perhaps most overwhelming barrier to the inclusion of traditional knowledge is the political obstacle. The decision-making process for EIAs would have to be altered significantly to accommodate the use of [traditional ecological knowledge] TEK and such alteration may not be politically palatable to policy makers" (Sallenave 1994, p. 6).

Nine papers (47%) suggested that the externally driven nature of the EA process (Fig. 1), with its focus on project approval, forms a barrier to appropriately engaging IK in EAs. Baker and Westman (2018) recognized that the approval-focused nature of the current federal EA process often obfuscates important information and diminishes opportunities for authentic consultation, leading to the exclusion of important information regarding public safety and environmental impacts in exchange for reassurances about the project's safety and legitimacy (Baker and Westman 2018, p. 247).

The suggested approval-oriented nature of the process is supported outside of the peer-reviewed literature. Compelling evidence to support the approval-oriented function of modern Canadian federal EA processes exists in contemporary responses to the *Impact Assessment Act*, condemned by some due to its "… potential effect on our [Canada's] ability to harness our natural resources and potential negative affect on our economy [and creation of] enormous uncertainty, more red tape and increased court challenges" (Findlay 2018). The assumption underlying this public pushback to EA reform may be embedded in an understanding that EA in Canada should primarily serve to increase efficiency of bureaucratic processes (e.g., Udofia et al. 2017) and decrease hurdles in the way of industrial project approvals.

Ten papers (∼50%) identified underlying political power structures (Fig. 1) (e.g., suppression of IK in policy-making, socioeconomic structures, colonial practices in current Canadian political systems, etc.) as barriers between IK and the EA process. Ellis (2005) identified this "underlying political

reason" as a core cause of failure for strategies to incorporate IK in federal in EA in the Northwest Territories (Ellis 2005). He reflected that overcoming this barrier challenges systemically embedded power structures:

> "Simply stated, advocacy of traditional knowledge threatens the stability of conventional power structures rooted in the Western industrial complex. The driving force behind this complex is growth and, consequently, industrial development... To empower traditional knowledge and its aboriginal holders on their own terms necessarily means to give voice to a system of understanding that may oppose the objectives and practices of Euro-Canadian institutions..." (Ellis 2005, p. 74).

These elicited power structures play a foundational role in relating IK and EA. Underlying political power structures, embedded in federal decision-making and EA processes, are evidently at odds with government mandates to engage in reconciliatory ways with Indigenous Nations and with an improved relationship between IK and EA (Sallenave 1994; Paci et al. 2002; Ellis 2005; Vanclieaf 2014). As Ellis (2005) contended, overcoming this obstacle would require a fundamental shift in sociopolitical systems towards power sharing.

The political barriers we synthesize are influenced by historical and epistemological barriers and in turn influence other identified obstacles (Fig. 1). Authors suggested that overcoming these barriers will challenge the status quo of Euro-Canadian governance systems and the western cultural assumptions that inform them (Paci et al. 2002; Ellis 2005; Vanclieaf 2014), making political obstacles inherently challenging to surmount.

Procedural obstacles

Fifteen papers (Supplementary Material 3) acknowledged procedural obstacles at the interface of IK and federal EA in Canada. Twelve (~66%) identified the fundamental design of the EA process (Fig. 1) (based on colonial and neoliberal presumptions) as poorly modeled to understand or incorporate IK in decision-making adequately. Indeed, EA procedure in Canada has evolved to match the colonial and capitalistic values that underlie Canadian federal policy. These values are frequently at odds with IK and the practical processes its appropriate inclusion in EA would require (O'Faircheallaigh 2007; Kirchhoff et al. 2013; Udofia et al. 2015; Sandlos and Keeling 2016). Udofia et al. (2015) examined how the demand for increased efficiency in the Canadian EA process prevented meaningful engagement and the associated inclusion of IK and Indigenous Nations:

> "A... challenge to ensuring effective engagement in EA concerns recent streamlining efforts to achieve greater efficiencies. The main efficiency concerns in any EA process are the time and cost involved ... Industry proponents are expressing concerns about needless delays, often caused by consultation requirements, echoing the need to ensure efficiency in EA processes ..." (Udofia et al. 2015, p. 103).

Twelve papers (~66%) cited a lack of articulated or implemented best practices (Fig. 1) that restrict the relationship between IK and EA. Some of these failures in best practices included failures: by proponents to engage in early consultations with Indigenous Nations (e.g., Udofia et al. 2015), to address language barriers (e.g., Baker and Westman 2018), to include socio-cultural or historical concerns in EA processes (e.g., Udofia et al. 2015), to consider scoping practices that include all relevant Nations in assessments (e.g., Tsuji et al. 2011), to appropriately or adequately define IK (e.g., Stevenson 1996), to engage appropriate experts (e.g., Gardner et al. 2015), and to give enough notification of hearings or consultations to involved Nations (e.g., Gardner et al. 2015).

While best practice failures were diverse and frequently cited by scholars, they represent obstacles that could likely be overcome via additional legislated requirements within Euro-Canadian systems.

However, without explicit requirements for these practices, proponents and government authorities often establish research and assessment agendas without best practices in mind, missing opportunities to engage IK and improve relationships with involved Indigenous Nations (Sallenave 1994; Wiles et al. 1999; O'Faircheallaigh 2007; Tsuji et al. 2011; Gardner et al. 2015; Sandlos and Keeling 2016).

Seven papers (~37%) cited limited and mandated timelines (Fig. 1) as a core procedural obstacle in relating IK and EA appropriately. Scholars contended that limitations on EA process timelines (e.g., 365 days for the Canadian Environmental Assessment Act 2012) made it difficult for Indigenous Nations to participate fully, and share their knowledge, in federal EAs. Resource limitations, logistical challenges for remote or isolated Nations, relationship building, and conflicts with timelines of Indigenous decision-making protocols require extensive, flexible, and perhaps even case-by-case timelines (O'Faircheallaigh 2007; Udofia et al. 2017). However, tailoring timelines to match Indigenous needs is at odds with persistent demands from industry proponents and government officials to streamline EA processes and avoid delays they may consider "needless" (O'Faircheallaigh 2007; Kirchhoff et al. 2013; Udofia et al. 2017).

The procedural obstacles we synthesized and described emerge as superficial barriers to improving the relationship between IK and EA (Fig. 1). We identify these obstacles as superficial because they are directly related to the EA process and legislation itself, and while inherently intertwined with more fundamental obstacles (e.g., historical and epistemological obstacles), there is a greater opportunity to overcome them through law and policy changes. We note, however, that despite their superficial nature, their impacts throughout the EA process can be nonetheless profound.

Resource limitations

Twelve papers (Supplementary Material 3) cited resource limitations (Fig. 1) as perpetuating obstacles between IK and EA. Five (26%) recognized training limitations (e.g., lack of technical training available to Indigenous participants, lack of cultural training or formal training to understand IK for technical practitioners, etc.) as barriers to improved relationships (Stevenson 1996; Booth and Skelton 2011b; Vanclieaf 2014; Gardner et al. 2015; Udofia et al. 2015). While mandated training opportunities could assist in overcoming these cross-cultural barriers, they are not legislated in modern EA processes. Booth and Skelton (2011b) reflected on the impacts of this limitation:

> "...[O]ne key complaint that we heard from industry participants, and some government officials, was that they themselves lacked an understanding about what would work to facilitate First Nations' engagement during an EA.
>
> If we knew what it was we were aiming at. Then we would do our darndest to meet it... but if the standard, the scale and the expectations are not thoroughly defined up front; are subject to interpretation and criticism, before, during and after, the lack of certainty makes things very, very difficult. (Industry Proponent 1)" (Booth and Skelton 2011b, p. 50).

Eleven papers (~60%) cited financial limitations (Fig. 1) as a key obstacle to improving relationships between IK and EA. Engaging in federal EA processes, and sharing knowledge in these contexts, requires substantial financial resources. Nations must often hire experts and lawyers to carry out studies, fund travel to facilitate expert and leadership involvement in EA hearings, pay for internal technical training, and fund monitoring projects after industrial proposals are approved (Sallenave 1994; O'Faircheallaigh 2007; Booth and Skelton 2011b; Kirchhoff et al. 2013; Vanclieaf 2014; Udofia et al. 2015). Without adequate funds to support these costs, meaningful inclusion of IK in EAs is difficult. Where funding does exist, its distribution on an ad hoc basis limits the efficacy of research or locally specific studies; such studies are often responsive to industrial proposals, and funding is not available to engage in long-term baseline, cumulative effects or monitoring programs.

Finally, six papers (~33%) noted that general capacity limitations (Fig. 1) (e.g., lack of available staff, community capacity, technical expertise, or understanding of IK, etc.) prevented a meaningful role for IK in federal EAs (Kirchhoff et al. 2013; Udofia et al. 2015, 2017). These procedural barriers affect the ability of Nations to engage their knowledge meaningfully, or at all, in federal EA processes (O'Faircheallaigh 2007; Booth and Skelton 2011b; Udofia et al. 2017).

We interpret resource limitation obstacles as superficial barriers in the context of federal EA (Fig. 1). While these barriers are intertwined with others, we suggest that they could be overcome by provisions that account for them in EA legislation. Scholars contended that abating resource limitations for Indigenous Nations and practitioners may also assist in improving nation-to-nation relationships, and strengthening data collection and monitoring surrounding industrial proposals (O'Faircheallaigh 2007; Udofia et al. 2015).

Emergent suggestions towards improvement

Higher-order themes emerged across papers to move beyond identified obstacles, preventing an appropriate relationship between IK and federal EA (Supplementary Material 4). Suggestions towards improving this relationship did not necessarily correspond with identified obstacle categories or components, although some consistencies did emerge.

Epistemological changes

Nine papers identified a need for political and cultural shifts in epistemological understanding as foundational to improving relationships between IK and Canadian EA. Namely, scholars contended that incorporating IK equitably into federal EA processes will require reflection on the assumptions inherent to western science and value systems, and more equitable means towards approaching different knowledge types. Paci et al. (2002), for example, suggested, "[i]t is important to recognize the Western constructs utilized as value free in managing natural resources. TEK requires changing the way things are done, envisioning knowledge as a quilt made up of many smaller cognitive maps, possibly representing more closely ecosystems thinking" (Paci et al. 2002, p. 119).

We interpret this suggestion as inherently challenging to enact, given the resistance of bureaucratic systems to change (Rickson et al. 1990), particularly change that requires large-scale value shifts (Kluckhohn and Strodtbeck 1961). However, many authors (e.g., Stevenson 1996; Paci et al. 2002; Roue and Nakashima 2002; Sandlos and Keeling 2016) framed this suggestion as fundamental to discussions surrounding the inclusion of IK in EA. Without extensive consideration of the assumptions, cultural biases, and power structures that shape western EA—and an increased acceptance of the essential ways in which IK and associated worldviews differ—western EA practices and IK cannot be appropriately or equitably intertwined.

Power shifts

Eight papers explicitly called for fundamental power shifts to overcome obstacles towards an improved relationship between IK and EA. These power shifts included "[p]utting more control in the hands of communities, who would help direct the assessment and determine its findings..." (Baker and Westman 2018, p. 152), and there was a frequent assertion across papers that, to ameliorate current obstacles, Canadian EA "must confer on [I]ndigenous participants a real and substantial role in decision making, rather than merely affording them an advisory or titular role" (O'Faircheallaigh 2007, p. 325).

Other authors cited a broad socio-political need for power shifts in political, social, economic, and institutional realms in Canada. This call for fundamental power shifts is well summarized by Ellis (2005):

"There must be a shift in the balance of power, a reformulation of the values, practices, and knowledge that underlie environmental decision-making processes. Power over land-based knowledge and the consequent power over land must be asserted by aboriginal peoples, taken out of the exclusive realm of science and Euro-Canadian institutions, and taken into a realm where traditional ways of knowing and doing share equal influence" (Ellis 2005, p. 75).

Similar to author suggestions for epistemological shifts, creating power shifts is difficult to enact because it challenges the assumed authority of the Canadian government. However, authors emphasized that, until real decision-making and political power is conferred upon Indigenous participants in EA, it is not feasible to harmonize the two knowledge types towards informed decision-making (Sallenave 1994; O'Faircheallaigh 2007; Booth and Skelton 2011b; Udofia et al. 2015).

Procedural changes

To overcome obstacles at the intersection of IK and EA, twelve papers (Supplementary Material 4) in our review suggested procedural changes to modern Canadian EA processes. Namely, these suggestions included, "…new institutions or bodies created by EAs [that] should have EIA follow-up and promotion of [I]ndigenous participation as explicit and central components of their mandates" (O'Faircheallaigh 2007, p. 322) as well as formalization of the consultation process (Baker and Westman 2018), the creation of professional designations and standards for researchers and industry engaging with IK and peoples during EA processes (Baker and Westman 2018), the creation of formal laws and regulations that govern the inclusion of IK (Vanclieaf 2014), and the formation of agreed-upon and inclusive definitions of IK (Stevenson 1996).

Suggestions for procedural changes emerge as practical and concrete responses to identified obstacles between interweaving IK and federal EA. These suggested changes (e.g., O'Faircheallaigh 2007; Tsuji et al. 2011; Kirchhoff et al. 2013; Baker and Westman 2018, etc.) present practical ways that EA (and the proposed new EA Act) could procedurally shift towards more equitable standards for incorporating IK.

Best practices defined

Finally, 14 papers (Supplementary Material 4) suggested the identification and formalization of best practices in the EA process as a means of better engaging IK in current EA policy frameworks. Suggestions for best practices included: early and formal consultation and engagement with involved Indigenous Nations (e.g., Booth and Skelton 2011b; Baker and Westman 2018); inclusion of socioeconomic, health, and cultural considerations and research in federal EAs (e.g., Sandlos and Keeling 2016); the creation and implementation of on-going monitoring programs after an EA has been approved (e.g., O'Faircheallaigh 2007); adherence of proponents and Canadian federal policy to UNDRIP (e.g., Baker and Westman 2018); and appropriate funding provisions for Indigenous engagement and knowledge engagement (e.g., Gardner et al. 2015) among others. Authors recognized that these best practices could improve the relationship between IK and EA within the confines of current top-down federal EA practices (Stevenson 1996; Ellis 2005; Whitelaw et al. 2009; Gardner et al. 2015) and could be implemented within Act language or requirements.

Assessing the newly passed impact assessment act

We used the obstacles we summarized as criteria to assess the *Impact Assessment Act*. We examined how and if the Act addresses the obstacles that authors asserted have plagued former versions of Canadian federal EA policy in its capacity to meaningfully engage IK. We also considered and described whether each identified obstacle is likely surmountable within current EA processes (Fig. 2).
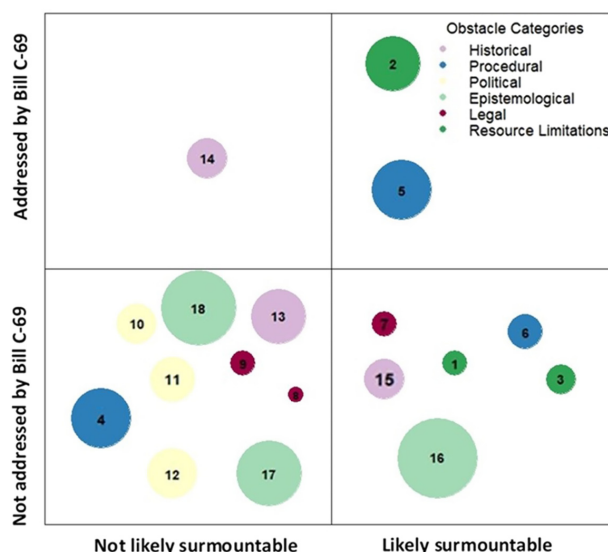
Fig. 2. We examined whether obstacles preventing integration of Indigenous knowledge are likely surmountable (*x*-axis) and addressed by *Impact Assessment Act* (*y*-axis). Numbers correspond to obstacle components (as labeled in **Fig. 1**), colors represent obstacle category, and the size of each bubble corresponds to the number of reviewed papers that cited the obstacle component. The specific location of each circle within each quadrant, however, is arbitrary, and designed for optimal visualization.

Our results suggested that *Impact Assessment Act* responds to some of the identified obstacles in ways that improve upon past federal EA Acts, but it falls short of guaranteeing a measurable improvement. While the Act legislates some best practices (e.g., *Impact Assessment Act* 2018, s 64 (1)), provides financial opportunities for involved First Nations (e.g., *Impact Assessment Act* 2018, s.75 (1)), and aims to overcome historical impacts of wrongful extraction of IK (*Impact Assessment Act*, s.119) by legislating provisions respecting the confidentiality and use of IK, it either fails to address entirely, or fails to ensure that EAs under the legislation are mandated to fully address, 15 of 18 obstacle components we identified in this literature review. Our criticisms of the *Impact Assessment Act* are also situated among other scholarly and public criticisms of the Act and preceding bill, including its failure to effectively legislate use of scientific knowledge as evidence (Westwood et al. 2019), the broad discretion it confers on decision-makers (Assembly of First Nations Quebec-Labrador 2019), and its incapacity to fulfill the Canadian Crown's duty to consult Indigenous Nations in the broader consultation process (Crawford 2018).

There are several key improvements in the Act that, while they do not adequately overcome obstacles defined, do acknowledge them. We recognize that the requirement to include and explain the use of IK in EA reports (*Impact Assessment Act*, s. 22) is a critically important step to ammeliorating the current relationship between IK and EA (*Impact Assessment Act*, ss. 28(3.1), 33(2.1) and 51(1)(d)(ii.1)). The third-reading amendment that explicitly requires information on how IK has been collected and incorporated into decision-making and assessment reports, requested by Indigenous stakeholders, is critical to improving the interweaving of IK and federal EA. We interpret this requirement as an opportunity that will allow the exploration of what strategies work—and fail—in including IK in EA. Furthermore, the Act includes language that makes the integration of IK, upholding the rights of Indigenous peoples, and the implementation of the United Nations Declaration of the Rights of Indigenous Peoples explicit purposes (*Impact Assessment Act*, Part 1, Preamble). While this

language does not overcome histories of colonization or underlying political powers by intention alone, it does signal intent to advance reconciliation.

Several limitations were inherent in our analyses, and in the categorizations described in Fig. 2. First, the coarse categories we used (e.g., "Addressed", "Not Addressed", "Surmountable", "Not Surmountable") do not address the complexity and variation inherent in the surmountability of, or ability of the *Impact Assessment Act* to address in practice a given obstacle component. However, we believe that this coarse categorization is appropriate given the qualitative nature of our data and analyses. We were limited to legal and theoretical interpretation when seeking to understand if the Act addresses emergent obstacles, as materials that emerge to supplement the Act and on-the-ground interpretation of policies cannot be analysed at this time. Nonetheless, our shared and diverse perspective as scholars (LEE, CTD, NCB, CO, NC, FM), EA participants (NXC, CTD, FM), and legal experts (AJ) provide us insight to engage in this interpretation and emerge with new understanding of the Act's capacity to engage with IK and knowledge holders. Furthermore, while we cannot predict with any certainty how the Act will be implemented, our analysis of the legislative language does illuminate possible directions in implementation, as well as the spirit of the Act—its intentions, constraints, and parameters in the context of historically pervasive obstacles.

Our results suggest that many obstacles are potentially surmountable within the constraints of top-down Canadian federal EA processes, yet are not addressed by the *Impact Assessment Act* (bottom right quadrant in Fig. 2). Thus, one suggestion that emerged from our research is that policy-makers focus their energy and resources on these surmountable obstacles (e.g., framework deficiences, resource limitations, congruency of Canadian law and EA policy, etc.) as steps towards aligning the *Impact Assessment Act* with improved capacity to engage IK.

Surmountable obstacles not addressed by the Act (e.g., mandated and limited timelines, training limitations, etc.) may yet to be overcome by regulations, policy guidance, and on-the-ground implementation of the Act. For example, our literature review revealed that a dearth of technical and cross-cultural training opportunities for Indigenous and non-Indigenous EA participants imposes a barrier to improving the relationship between IK and EA in Canada. Establishing regulations that require the Impact Assessment Agency of Canada to establish a training program, along with funding to support that training, would provide a means to overcome this barrier in future iterations of EA legislation in Canada. Longer-term capacity funding for Indigenous groups could assist Nations in proactive engagement in federal decision-making. The *Information and Management of Time Regulations* could be amended to allow for timelines to be suspended when requested by an Indigenous authority or rights-holder, when required to gather or consider IK, and for meaningful consultation and Crown-Indigenous cooperation. Similarly, the *Information and Management of Time Regulations* should be amended to provide principles and requirements respecting the weaving of IK and western science, to prevent any "knowledge hierarchy" from prevailing in EAs under the new legislation.

While we encourage reevaulation of Canada's federal EA legislation in the context of identified obstacles, we recognize that many are not easily surmountable via modifications to modern Canadian EA legislation. Indeed, our results show that most obstacles identified in this review are neither addressed by the Act, nor likely readily surmountable within the context of top-down Euro-Canadian politcal systems (Fig. 2). The embedded, fundamental nature of many obstacles (e.g., histories of colonization, underlying political power structures) and their inherent inflexibility to change, casts doubt on whether Canadian federal EA can ever appropriately and equitably engage IK while informed solely by western cultural assumptions and values, or when the decision-making power conferred upon Indigenous Nations is left to the discretion of the Minister. Simply stated,

our results suggest that top-down colonial EA processes, as currently envisioned and enacted, are inherently at odds with equitable knowledge sharing.

Conclusion

Our research draws upon scholarly interpretation of the relationship between IK and federal EA in Canada over the last three decades to understand obstacles and ways forward at the interface of these two systems. Moreover, we examined whether the Canadian government's *Impact Assessment Act* addresses these obstacles. Our results suggest that, while the *Impact Assessment Act* makes some measurable improvements to appropriately engaging IK in EA processes, it ultimately fails to wholly ensure that most obstacles identified in our literature review will be addressed—namely by leaving actions that may address them to the discretion of the Minister, rather than legislating an outright solution. While some of these obstacles may yet be overcome with future revisions to Canada's federal EA legislation, through the development of its regulatory and policy framework or in implementation with the assistance of the Indigenous Advisory Committee provided for under the *Impact Assessment Act* (s 158), overcoming most of them would require actions and changes that are likely inherently at odds with existing Euro-Canadian policy and legal systems and the power imbalance that supports them.

Our results are nested within expert and practitioner dialogue that considers relationships between Canadian EA and Indigenous peoples. Despite the practically defined and narrow scope of our search criteria, the obstacles and suggestions that emerged from our review align well with the publications and recommendations of Indigenous peoples and expert panels involved in Canadian EA review. These review processes described similar barriers to engaging IK and peoples in the EA process (e.g., failures to recognize Indigenous rights or legal traditions, mischaracterization and misuse of IK, Indigenous hesitancy to engage in EA processes due to framework deficiencies and histories of colonization, capacity limitations, etc.) (Canadian Environmental Assessment Agency 2017). Recommendations from these panels were similar to the suggestions that emerged from our literature review and called for: Indigenous power in the decision-making process, explicit recognition of land and treaty rights, legally binding adherence to UNDRIP, increased funding programs and opportunities, oversight of IK by Indigenous peoples, and recognition of fundamental differences in western and IK, culture, and worldview (Canadian Environmental Assessment Agency 2017). While the *Impact Assessment Act* does provide provisions for the protection of IK, and owing to amendments made by the House of Commons does invoke UNDRIP, many of the panels' additional recommendations remain unaddressed.

That the new Canadian EA legislation fails to adequately address obstacles that emerge from both expert panel reports and decades of relevant scholarly literature is problematic for Indigenous Nations and the efficacy of the EA process itself. Around the world and across landscapes in the region now known as Canada, complex values, worldviews, cultures, and knowledge systems inform diverse societal approaches to environmental decision-making. In this review, we examined Canada as a case study towards better understanding the relationship between IK and western EA processes. Despite substantive scholarly discussion surrounding the relationship between IK and peoples and modern Euro-Canadian EA processes, even the most contemporary federal EA framework in Canada ultimately fails to ensure the engagement of the critically important knowledge of Indigenous peoples in environmental decision-making. Furthermore, while we identify that *Impact Assessment Act* fails to substantially improve the relationship between IK and EA, it has faced severe and continuing backlash (e.g., Findlay 2018; Elliott 2019; Friedman 2019; JWN Staff 2019) from industry proponents and many non-Indigenous Canadians for the few improvements it does make. Canadian EA thus misses opportunities to inform environmental decisions with the best available knowledge and to support Indigenous rights, sovereignty, and well-being. This failure is supported by a fundamental assumption

of Canadian federal power, authority, and ownership of land that is increasingly challenged in modern legal landscapes. Given Canada's mandate to engage in reparation and reconciliation with Indigenous peoples, unresolved nation-to-nation conflicts, and the reality that Canadian social, economic, and environmental well-being are dependent upon well-informed, inclusive, and sustainable environmental decision-making practices, harmonizing IK and Canadian federal environmental decision-making remains singularly important.

The Canadian government has opportunities to fulfill their reconciliation agenda while likewise upholding well-informed, regionally specific, comprehensive EAs. Given that many identified fundamental obstacles are unlikely to be surmountable without direct inclusion of Indigenous peoples in EA decision-making processes, we suggest widespread recognition of Indigenous-led EA (e.g., Bruce and Hume 2015; O'Faircheallaigh 2017; Gibson et al. 2018) as a way forward, alongside cooperative assessments designed by Crown and Indigenous authorities. Indigenous-led EA, which is fortified by millennia of experience in natural resource management and environmental decision-making practices (Turner et al. 2000; Trosper 2003; Butler and Menzies 2007; Berkes 2012; Housty et al. 2014; O'Faircheallaigh 2017; Artelle et al. 2018), is on-going in Canada and represents a reassertion of Indigenous management rights that may respond comprehensively to legal, historical, epistemological, and political obstacles. This process, developed specifically by and for Indigenous Nations, has the potential to improve relationships between governments, project proponents, and practitioners while upholding human rights (Paci et al. 2002). The *Impact Assessment Act* does legally allow for Indigenous-led EA through substitution and delegation powers (*Impact Assessment Act*, ss. 29 and 31), as did its predecessors. Furthermore, Indigenous-led EA is already blazing a trail for new decision-making processes palatable to industry proponents and informed by local cultural values and legal traditions. For example, in 2018 the Squamish Nation approved the development of the Wood Fibre LNG with specific and community-driven mandatory regulations (Bruce and Hume 2015). While we recognize that this example—an independently led Indigenous EA—is not broadly generalizable across Canada, we note that other structures of Indigenous-led EA exist (e.g., co-management or co-creation structures, see Gibson et al. 2018) alongside other power-sharing opportunities between Indigenous and Canadian federal governments. Continued implementation of Indigenous-led EA and recognition of the validity of these processes by Canada's federal government provides an opportunity to improve government-to-government relationships, promote environmental decisions that respond to local social and ecological heterogeneity, and overcome fundamental and superficial barriers in relating IK and Canadian EA.

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Author contributions

LEE and CTD conceived and designed the study. LEE performed the experiments/collected the data. LEE, NXC, CO, AJ, NCB, FM, and CTD analyzed and interpreted the data. LEE, NXC, CO, AJ, NCB, FM, and CTD contributed resources. LEE, NXC, CO, AJ, NCB, FM, and CTD 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 Supplementary Material.

Supplementary material

The following Supplementary Material is available with the article through the journal website at doi:10.1139/facets-2019-0039.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

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