

Free Fallin'? The decline in evidence-based decision-making by Canada's protected areas managers

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Abstract

The conservation of biodiversity requires various forms of evidence to ensure effective outcomes. In this study, we provide an updated assessment of the state of evidence-based decision-making in Canada's protected areas organizations by examining practitioner perceptions of: (i) the value and use of various forms of evidence, (ii) the availability of evidence to support decisions, and (iii) the extent to which various institutional and behavioural barriers influence the use of evidence. Our results compare national surveys conducted in 2019 and 2013, revealing a significant and concerning decline in the use of all forms of evidence. We found significant declines in the use of peer-reviewed literature, local knowledge, and Indigenous knowledge. Our results correspondingly demonstrate a host of systemic barriers to the effective use of evidence, including a lack of trust, how to deal with uncertainty, and limited training. These challenges persist at a time when the quantity of information is greater than ever, and recognition of the value of Indigenous knowledge is relatively high (and increasing). Leadership is required to cultivate more relevant evidence, to embed scientists and Indigenous Knowledge-Holders in conservation organizations, to (re)establishing knowledge sharing forums, and to establish accountability and reporting measures to support efforts aimed at effectively achieving Canada's biodiversity conservation goals.

Key words: evidence, knowledge, management, biodiversity, conservation, decision-making

1. Introduction

Díaz et al. (2019) recently summarized the findings of the largest assessment of the state of Earth's biodiversity ever conducted, the *Global Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES 2019), and reported that biodiversity, as well as the equitable distribution of nature's support, is in serious decline. Parks and other forms of protected areas represent both a common and critical response strategy to this unrelenting loss of

biodiversity and the availability and use of various forms of quality social-ecological data, information, and knowledge is necessary to plan, develop policy, implement management actions, and monitor and report on their effectiveness.

The importance of information and knowledge management is recognized in the original text of the United Nations *Convention on Biological Diversity* (CBD) (Article 17). More recently, the *Strategic Plan for Biodiversity 2011–2020* called on Parties to “*Enhance implementation through participatory planning, knowledge management and capacity building*” by improving, widely sharing, and applying the science base relating to biodiversity, its values, functioning, status and trends (Target 19), and by fully integrating traditional knowledge, innovations and practices of Indigenous and local communities relevant for the conservation and sustainable use of biodiversity (Target 18) (United Nations 1992; CBD 2010).

While more and better-quality information and knowledge to support sound management actions and related conservation outcomes is necessary (Geldmann et al. 2015), this can only occur through the dynamic and enduring process of learning and knowledge exchange (Roux et al. 2019). And although the extant literature widely and justifiably promotes the importance of evidence-based decision making in conservation (e.g., Pullin et al. 2004; Adams and Sandbrook 2013; Walsh et al. 2015), the acquisition and use by those responsible for implementing the wide spectrum of conservation planning and management measures, including those related to protected areas, has proven difficult. For example, Gardner et al. (2018, p. 1469) revealed that “decision makers themselves may not seek or use evidence to make their decisions, even when it is available, or test the impacts of their actions”. Several others have found that a host of (sometimes pervasive and chronic) challenges, including the selective use of literature leading to bias (Cvitanovic et al. 2014; Gossa et al. 2015), a lack of understanding how to integrate scientific information into decisions related to specific management issues like climate change (e.g., Cvitanovic et al. 2014; Hagerman and Satterfield 2014) and, more foundationally, a lack of “infrastructure” within public and private organizations that leads to the ineffective and inefficient use of evidence (Dicks et al. 2014).

Conservation-focused case studies in Canada have revealed similar results (Buxton et al. 2021; Sheikheldin et al. 2010; Young et al. 2016; Straka et al. 2018). For example, the research by Lemieux et al. (2018) (upon which this updated paper is based) revealed that while practitioners value and use many forms of evidence in their decision-making, information produced by staff and their organizations are given priority, consequently rendering Indigenous knowledge and peer-reviewed information both valued and used less. These results were similar to case studies undertaken in Australia, Brazil, and elsewhere, which have consistently found that managers rarely use research-based evidence, instead defaulting to experience or even anecdotal evidence when making important decisions (Cook et al. 2010; Cook and Hockings 2011; Giehl et al. 2017). Some have argued that this may be because the information and knowledge produced from research articles is not focussed on the needs of decision-makers, so they do not consistently supply information that is timely, relevant, and therefore useful (McNie 2007; Cook et al. 2013). Furthermore, Nguyen et al. (2019) found that the motivations of individuals and institutions appear to be an important barrier to integrating new knowledge. In their case study, examples included lack of political will, inertia, and an inability to overcome the challenge of teaching people new concepts. Consequently, some scholars have alluded to what we refer to as a “research publishing and relevance divide” taking shape, which contributes to this over-reliance on one’s own experiential knowledge to inform decisions (e.g., Cook et al. 2010; Lemieux et al. 2018).

Despite it representing a trove of insight into ecological management issues (Berkes 2017), Indigenous knowledge has similarly been excluded from many conservation decisions. The national report *We Rise Together* by the Indigenous Circle of Experts (ICE) calls for conservation leaders to work in ethical space, “a place for knowledge systems to interact with mutual respect, kindness, generosity

and other basic values and principles. All knowledge systems are equal; no single system has more weight or legitimacy than another” (ICE 2018, p. 7). Significantly, the report also identifies a need to create the capacity to make ethical space a reality.

Taken collectively, these challenges point to a host of research capacity issues in conservation agencies worldwide (Roux et al. 2019) and coalesce to result in a breakdown in the learning and knowledge exchange process. In response to these diverse and mounting challenges, we replicate and enhance a 2013 survey of Canadian conservation practitioners working within protected areas organizations (Lemieux et al. 2018) with the goal of monitoring and reporting on trends on: (i) the value and use of various forms of evidence, (ii) the availability of evidence to support decisions, and (iii) the extent to which various institutional and behavioural barriers influence the use of evidence. A secondary goal is to examine the ways in which demographic and career characteristics (such as duration of employment) influence perceived value and use of various forms of evidence and whether perceived barriers differ by these attributes. Our focus in this paper is principally around Canada’s protected areas as opposed to all conservation decision-making in the country. We do not seek to extrapolate our findings into the broader conservation space that encompasses the management of fish, forests, and wildlife.

There is a critical need to monitor the extent to which decisions are informed by evidence over space and time, and to relate these trends to the effectiveness of management and associated management outcomes. As Roux et al. (2019) and others have emphasized, evaluating and documenting the values, structures, functions, and effectiveness of knowledge uptake, use, and exchange remains poor. To our knowledge this paper represents the first attempt at addressing the need to monitor trends in evidence-based decision-making through time. This work is also important given that the goals and targets currently being negotiated as part of the UN CBD *Post-2020 Global Biodiversity Framework* have explicitly identified the need to be knowledge-dependent in terms of monitoring and reporting on the extent of implementation and associated outcomes by Parties (CBD 2020a).

2. Methods

2.1. Case study context

Our case study focuses on practitioners working within agencies and organizations responsible for the planning and management of Canada’s protected areas system. According to the most recent statistics provided by Canada’s National Focal Point for the CBD, Environment and Climate Change Canada (ECCC), Canada has over 8200 protected areas across its provinces and territories that encompass approximately 12.1% of Canada’s total terrestrial area and 13.8% of its marine area (ECCC 2020). These values exclude privately protected areas, which are currently not reported by ECCC but are a rapidly growing element of the conservation estate. Since ratifying the CBD in 1992, the terrestrial protected areas estate in Canada has doubled in size, and the marine protected areas estate increased more than 10-fold between 2017 and 2019 alone. However, among the world’s 37 Organisation for Economic Co-operation and Development (OECD) countries, Canada ranks second-last in percent total area protected (marine and terrestrial combined) (OECD 2020).

In 2010, Canada committed to achieving the Aichi Targets established under the CBD 2020 *Strategic Plan for Biodiversity* and developed the *2020 Biodiversity Goals and Targets for Canada* in 2015. Aichi Target 11 (Canada Target 1) committed Canada to the aspirational goal of protecting at least 17% of terrestrial and inland waters and 10% of coastal and marine areas by 2020. Prime Minister Justin Trudeau further made protected and other conserved areas a priority in his 2019 mandate letter to the Minister of Environment and Climate Change “to conserve 25 percent of Canada’s land and 25 percent of Canada’s oceans by 2025, working toward 30 percent of each by 2030.” Important to

the context of this research, the mandate letter qualified that “This plan should be grounded in science, Indigenous knowledge and local perspectives.” (Trudeau 2019).

Despite the progress and commitments noted above, biodiversity in Canada has not been exempted from the global biodiversity crisis. The World Wildlife Fund’s (WWF) recent *Living Planet Report Canada* revealed that, since 1970, populations of Canadian species assessed as at risk have declined by an average of 59% and species assessed as globally at risk have seen their Canadian populations fall by an average of 42% (WWF 2020). Furthermore, independent audits at both the federal and provincial levels of government and assessments by science-based nongovernmental organizations (NGOs) have detailed the ways in which various ministries responsible for protected areas and species at risk continue to fail to meet their legislated goals and responsibilities (e.g., CPAWS 2016; Office of the Auditor General of Canada 2018).

In this context, our research matters because usable information is needed to inform conservation decisions and to monitor, track, and report on Canada’s performance and progress toward its 2020 national and international biodiversity targets and whatever targets are adopted in the *Post-2020 Global Biodiversity Framework* (CBD 2020a).

2.2. Survey development and deployment

Lemieux et al. (2018) provided a detailed literature review that informed the identification of the various factors or conditions that affect evidence-based decision-making that informed the development of the 2013 survey that will not be reviewed again here. Using the 2013 survey as a foundation, we assess practitioners’ perceptions of evidence-based decision-making within their organization.

Similar to 2013, we targeted practitioners who are responsible for decisions about protected areas management, including high-level strategic decisions (e.g., guiding policy, resource allocation for management activities) and day-to-day decisions at a local level (e.g., protected areas specific management activities). This included managers of protected areas under the jurisdiction of federal, provincial, and territorial agencies, as well as privately protected areas. For the 2019 survey, we did not require respondents to identify the organization that employed them, believing that would elevate anonymity and encourage more fulsome responses regarding their agency’s knowledge mobilization capabilities and challenges.

The updated survey ([Supplementary Material 1](#)) was piloted with Alberta Parks in the summer of 2019. Feedback resulted in small adjustments in wording to the survey instrument. The survey was then distributed to other Canadian agencies and through various networks via email to maximize geographic and agency representation. These networks included the Canadian Parks Collective for Innovation and Leadership (CPCIL), the Canadian Parks Council (CPC), and the Canadian Council on Ecological Areas (CCEA). The e-mail invitation directed recipients to circulate the survey to members of their organizations engaged in decision-making ranging from front-line staff to and high-level managers.

Qualtrics XM software was used as the sole mode of survey distribution and response. Participation was voluntary, and participants were made aware that they would not be identified by name (and that their responses would remain confidential to other participants). The final survey was available in both French and English and included both closed-ended and open-ended questions. Ethics approval was provided by the Research Ethics Board at the University of Alberta (Pro00087827), which included this survey.

The survey comprised of questions that examined respondents’ perspective of value and use of evidence, access to information on conservation management issues, and barriers that affect the

access and use of knowledge in protected area management and planning. A mix of closed-ended and open-ended questions were used. Questions on participant employment experience, gender, and training were also included.

2.3. Survey results analysis

SPSS 24.0 was used to clean, recode, and analyze the data. Independent samples *t*-tests were used to compare the 2013 to 2019 responses. Identification of significant differences between the two samples was set at $p = 0.05$, and Cohen's *d* was used to calculate effect size. For this statistic the following thresholds were used to identify the magnitude of differences between responses: ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$) (Cohen 1988; Thompson 2007; Lakens 2013). Pearson's correlation coefficient was calculated to explore relationships between socio-demographic, organization type, knowledge perceptions, and use.

3. Results

In total, 181 respondents completed the 2019 survey, whereas 121 respondents completed the 2013 survey (Table 1). Among the 2019 respondents, only five respondents (2.8%) said they completed the 2013 survey; 147 respondents (82.3%) said no, and 27 were unsure (14.9%). As the invitation to participate in the survey was an open invitation, to be circulated within federal, provincial, and territorial protected areas organizations, as well as private protected areas organizations, a response rate cannot be reported.

Similar to 2013, the gender split of our sample included a slightly higher proportion of males (55%) and, on average, respondents were highly educated (>50% with a graduate degree), had been involved in protected areas management on average for nearly 13 years, and had been employed by their current organization on average for just over 9 years (minimum = <1; maximum = 39). Of the respondents who identified their educational background, most had an educational background in natural sciences (66.6%), with a correspondingly lower representation from the social sciences (31.7%). Current involvement in protected areas management was again well dispersed across all program areas, including operations and development (49.7%), strategic planning (39.8%), protected area selection and design (24.9%), management direction (39.8%), monitoring (35.9%), and education and outreach (35.4%). Although the sample size was similar across most of these management categories, proportionally there were fewer respondents engaged in management direction and more involved in operations and development in the 2019 sample compared to 2013.

All surveys are subject to error and bias. First, the membership groups we sent the survey to are not mutually exclusive, and some respondents might belong to more than one agency or initiative. To control for this, participants were instructed to only answer the survey once. Second, we were unable to remove potential biases in the types of practitioners who responded to our surveys due to the purposive design and because we relied on self-selected groups or networks of participants.

As is commonly employed in the social sciences, we used self-reported measures, whose reliability and validity are very contingent upon the respondent's ability to accurately report their perceptions and attitudes. Surveys are often completed in a "cold cognitive state" rather than in a "hot" in-the-moment circumstance where emotions influences are most salient (Metcalfe and Mishell, cited in Lawton et al. 2009). Temporal distance from events relating to knowledge use and nonuse in decision-making (Hser et al. 1992; Stone et al. 1999) and social desirability bias (Prior 2009) may also dull the accuracy of a participant's perceptions. While the statistical analyses presented in the following section are rigorous, the results should be considered with these potential limitations in mind.

Table 1. Summary of survey respondents by organization (2013 and 2019).

Organization	2013		2019	
	N	%	N	%
Provincial/territorial government				
Alberta	33	27.3	83	45.8
British Columbia	8	6.6	8	4.4
Manitoba	2	1.6	3	1.7
New Brunswick	0	0	1	0.6
Newfoundland and Labrador	1	0.8	1	0.6
Nova Scotia	0	0	4	2.2
Nunavut	5	4.1	0	0
Northwest Territories	2	1.7	3	1.7
Ontario	26	21.5	15	8.3
Prince Edward Island	1	0.8	0	0
Quebec	6	5.0	9	5.0
Saskatchewan	2	1.7	3	1.6
Yukon	4	3.3	4	2.2
Federal government				
Parks Canada	8	6.6	13	7.2
Other	10	8.3	15	8.3
Non-governmental organizations	13	10.7	2	1.1
Other ^a	0	0	5	2.8
No response	0	0	12	6.6
Total	121	100	181	100

^aOther respondents are those that did not disclose their organization nor the province or territory in which they work, but who are involved directly with protected areas planning and management.

3.1. Value and use of evidence

Similar to 2013, participants generally took the position that many forms of evidence are relevant to their protected areas management efforts (Table 2), while noting that evidence produced by both their respective staff and their organization were perceived to be more valuable than other forms of evidence (such as peer-reviewed literature). For example, over 88% of participants indicated that they perceived evidence produced by staff as “valuable” or “very valuable”, whereas far fewer participants rated evidence derived from databases or grey literature as “valuable” or “very valuable” (46% and 42%, respectively). Eighty-one percent of respondents also rated evidence drawn from professional knowledge (i.e., experience) and house-developed specific management plans (80%) as “valuable” or “very valuable” compared with evidence drawn from other forms of knowledge, including local (71%) and Indigenous knowledge (78%). Notably, both local and Indigenous forms of knowledge have increased in perceived value since the 2013 survey. That said, the standard deviation values indicate some variability, such that many respondents would have indicated a higher ranking than what is revealed by the mean response.

Table 2. Perceived value of various forms of evidence in Canada's protected areas agencies, 2013 and 2019.^{a,b}

Forms of evidence	2013			2019			Significance	Cohen's <i>d</i> ^c
	<i>N</i>	Mean	SD	<i>N</i>	Mean	SD		
1. Legislation	120	3.53	0.67	179	3.39	0.77	—	—
2. Staff assessments	120	3.81	0.44	180	3.37	0.73	0.000	0.73
3. Peer review	119	3.04	0.80	179	3.23	0.83	0.048	0.23
4. Thematic mapping	116	3.51	0.70	177	3.14	0.79	0.000	0.49
5. Professional knowledge	120	3.41	0.72	177	3.13	0.69	0.001	0.40
6. Indigenous knowledge	117	2.93	0.92	176	3.11	0.90	—	—
7. Specific management plans	117	3.09	0.77	175	3.10	0.77	—	—
8. Policy	120	3.28	0.70	179	2.99	0.84	0.002	0.37
9. Expert consultant reports	118	3.18	0.74	175	2.98	0.79	0.034	0.26
10. General management plans	119	3.13	0.80	178	2.96	0.81	—	—
11. Local knowledge	119	3.18	0.78	175	2.93	0.79	0.006	0.32
12. Strategic plans	119	2.95	0.77	176	2.71	0.81	0.011	0.30
13. International agreements	118	2.58	0.81	173	2.63	0.98	—	—
14. Consultant reports	120	3.08	0.79	178	2.62	0.81	0.000	0.57
15. Grey literature	120	2.67	0.73	180	2.49	0.75	0.043	0.24
16. Database	116	3.02	0.88	176	2.47	0.90	0.000	0.62

^aValue scale: 1 = Not at all Valuable; 2 = Moderately Valuable; 3 = Valuable; 4 = Very Valuable.

^bSignificant differences are noted in bold text.

^cCohen's *d* values = 0.2 "small" effect size; 0.5 "medium" effect size; 0.8 "large" effect size.

Similar to the value placed on different forms of knowledge, participants also reported that evidence obtained directly from their respective work environment was used most frequently in decision-making (Table 3). Evidence most often reported as "always used" or "frequently used" was drawn from staff assessments (76%), legislation (70%), and professional knowledge (65%). Evidence drawn from databases, international agreements, and Indigenous knowledge were identified as the least used, with "never used" or "occasionally used" reported in management decisions 82%, 73%, and 76% of the time, respectively.

Results based on the descriptive statistics presented in Tables 2 and 3 can be summarized as follows:

- Practitioners value all forms of evidence more than they use it, in almost all cases.
- Practitioners continue to both value and use evidence developed within their own working context the most (e.g., staff assessments, professional knowledge).
- Practitioners use evidence from databases the least, followed closely by Indigenous knowledge, grey literature, local knowledge, and peer-reviewed literature.
- While perceived value of Indigenous knowledge has increased, its declared use by practitioners has decreased.
- The largest gap between perceived value and use of various forms of evidence was Indigenous knowledge followed closely by peer-reviewed literature.

Table 3. Use of various forms of evidence in Canada's protected areas agencies, 2013 and 2019.^{a,b}

Forms of evidence	2013			2019			Significance	Cohen's <i>d</i> ^c
	<i>N</i>	Mean	SD	<i>N</i>	Mean	SD		
1. Staff assessments	117	3.32	0.68	178	3.04	0.87	0.003	0.36
2. Legislation	116	3.41	0.79	180	3.02	1.03	0.000	0.42
3. Professional knowledge	116	3.14	0.73	177	2.86	0.91	0.004	0.34
4. Policy	117	3.21	0.78	178	2.71	1.00	0.000	0.56
5. Thematic mapping	116	3.20	0.83	175	2.53	1.03	0.000	0.72
6. General management plans	118	2.92	0.86	177	2.50	0.98	0.000	0.45
7. Specific management plans	114	2.68	0.83	177	2.32	0.92	0.001	0.41
8. Strategic plans	118	2.65	0.82	177	2.20	0.92	0.000	0.52
9. Expert consultant reports	115	2.60	0.77	175	2.13	0.99	0.000	0.51
10. Consultant reports	117	2.63	0.75	178	2.10	0.91	0.000	0.63
11. Peer review	117	2.49	0.73	180	2.07	0.88	0.000	0.52
12. Local knowledge	116	2.65	0.79	174	2.07	0.85	0.000	0.71
13. Grey literature	117	2.39	0.68	179	1.92	0.87	0.000	0.60
14. Indigenous knowledge	115	2.23	0.89	175	1.85	0.86	0.000	0.43
15. International agreements	113	2.06	0.72	172	1.75	0.94	0.002	0.37
16. Database	116	2.66	0.94	179	1.70	0.86	0.000	1.06

^aUse scale: 1 = Never Used; 2 = Occasionally Used; 3 = Frequently Used; 4 = Always Used.

^bSignificant differences are noted in bold text.

^cCohen's *d* values = 0.2 "small" effect size; 0.5 "medium" effect size; 0.8 "large" effect size.

Tests of significance with respect to the value and use of various forms of evidence and between the two case study time periods revealed additional insights. Most notably, the perceived value of 11 of the 16 different forms of evidence included in our study declined significantly between 2013 and 2019 (Table 2). More concerning is the observed decline in the use of evidence. All 16 forms of evidence included in our analysis exhibited a decline in use, and all were statistically significant (Table 3). Of these, Cohen's *d* values indicate a large effect ($d \geq 0.8$) in the decline in the use of databases and a moderate effect ($d \geq 0.5$) in the decline in many other forms of evidence, most notably thematic mapping, local knowledge, and consultant reports.

We also found one significant correlation between demographic and value of information (that people with a higher level of education value Indigenous knowledge more, $r = 0.268$, $p = 0.046$) and two significant correlations between demographics and use of information, including people with a higher level of education used peer reviewed information more than people with a lower level of education ($r = 0.266$, $p = 0.043$), and older respondents used international agreements more than younger respondents ($r = 0.303$, $p = 0.029$).

3.2. Availability of information on priority conservation management issues

As with the 2013 survey (but not published in the 2018 Lemieux et al. paper), we asked practitioners about the perceived availability of information for making protected area management decisions.

Perceived availability increased in all instances (see [Table 4](#)) with the greatest gains being documented for invasive species management, visitor experience, and species-at-risk research (i.e., very high effect size >1.0). Additionally, for some management issues, information availability is still underdeveloped. For example, over-abundance of native species, socio-economic impacts, financial sustainability, and traditional way of life/lifestyle remain relatively undeveloped. These findings point to areas that may need additional research attention. However, even if evidence appropriate to a particular management is available and accessible, it does not mean that all practitioners perceive themselves to be empowered to use information due to a lack of time, staff, and financial resources. This theme is explored below in our discussion.

3.3. Barriers to implementation

As with the 2013 survey, we assessed perceived barriers to evidence-based decision-making ([Table 5](#)). The largest barriers affecting evidence-based decisions by practitioners were reported as limited

Table 4. Availability of evidence in relation to key protected areas issues.^{a,b}

Forms of evidence	2013			2019			Significance	Cohen's <i>d</i> ^c
	N	Mean	SD	N	Mean	SD		
1. Invasive species management	108	2.52	0.77	168	3.47	0.97	0.000	1.08
2. Education and interpretation	94	2.63	0.94	163	3.43	0.94	0.000	0.85
3. Species-at-risk research (such as habitat requirements)	112	2.52	0.75	172	3.42	0.87	0.000	1.11
4. Community/stakeholder engagement	N/A	N/A	N/A	165	3.35	0.91	—	—
5. Visitor experience	104	2.34	0.82	168	3.26	0.97	0.000	1.02
6. Marketing/communications	86	2.63	1.05	148	3.25	0.98	0.000	0.61
7. Governance	N/A	N/A	N/A	141	3.22	0.90	—	—
8. Landscape condition (e.g., habitat connectivity, fragmentation, conversion)	112	2.58	0.79	164	3.10	0.87	0.000	0.62
9. Climate change	103	2.48	1.03	172	3.09	1.02	0.000	0.84
10. Human resource management	N/A	N/A	N/A	129	3.04	0.98	—	—
11. Gap analysis/representation of species and ecosystems	108	2.61	0.87	150	2.97	0.94	0.002	0.40
12. Recreation and tourism impacts	116	2.31	0.78	170	2.96	0.89	0.000	0.78
13. Disturbance and succession	104	2.63	0.81	154	2.92	0.91	0.009	0.34
14. Ecosystem restoration	101	2.35	0.82	158	2.87	0.98	0.000	0.57
15. Data standards	82	2.30	0.75	127	2.87	0.93	0.000	0.66
16. Cultural heritage management	105	2.35	0.68	160	2.80	0.89	0.000	0.57
17. Integrity of ecological processes (occurring at landscape scales)	105	2.27	0.70	151	2.75	0.72	0.000	0.67
18. Management effectiveness	N/A	N/A	N/A	150	2.67	0.85	—	—
19. Traditional way of life/lifestyle	100	2.07	0.76	159	2.65	0.90	0.000	0.70
20. Socio-economic impacts	107	2.06	0.64	163	2.55	0.85	0.000	0.65
21. Financial sustainability	N/A	N/A	N/A	139	2.55	0.99	—	—
22. Over-abundance of native species	81	2.46	0.89	128	2.52	0.90	—	—

^a1 = Not Available to 5 = Very High Availability or Over Availability (too much).

^bSignificant differences are noted in bold text.

^cCohen's *d* values = 0.2 "small" effect size; 0.5 "medium" effect size; 0.8 "large" effect size.

financial resources (79% “moderately agree” or “strongly agree”), lack of staff (67%), lack of time (70%), inadequate timeframes for decision-making (66%), and a lack of commitment to long-term monitoring and assessment (66%). Limited financial resources, lack of staff, and lack of time were also identified as the top three most significant barriers in the 2013 survey.

Conversely, most practitioners trust, but may not necessarily utilize or value, a variety of different forms of evidence, with over 64% of the 2019 sample identifying trust as an insignificant barrier (or taking a neutral position on this factor) (mean = 2.81, SD = 1.06) and that conflicting results are not significant barriers to the use of evidence (mean = 2.82, SD = 0.94). While our data revealed a relatively large increase in lack of trust in empirical evidence between the two time periods, it is still a less important barrier than many other factors. However, there is an increase in the number of

Table 5. Perceived barriers that affect the access and use evidence in protected area management and planning.^{a,b}

Barrier	2013			2019			Sig.	Cohen's <i>d</i> ^c
	N	Mean	SD	N	Mean	SD		
1. Limited financial resources	119	4.11	1.01	164	4.38	0.87	0.017	0.29
2. Lack of staff	118	3.87	1.07	163	4.03	1.14	—	—
3. Lack of time	117	3.87	1.10	164	4.01	1.06	—	—
4. Lack of commitment to long term monitoring and assessment programs	118	3.79	1.20	163	3.98	1.10	—	—
5. Timeframes of empirical data incompatible with urgent problems	117	3.79	0.80	160	3.96	0.91	—	—
6. Misalignment/disconnect between research agendas, knowledge developers and users, and policy processes	117	3.76	1.07	160	3.83	0.91	—	—
7. Lack of transdisciplinary training	N/A	N/A	N/A	160	3.72	0.97	—	—
8. Management prescriptions that are not quantitatively explicit	116	3.59	0.92	159	3.71	0.90	—	—
9. Management prescriptions that do not consider unique contexts	117	3.63	1.01	161	3.67	1.06	—	—
10. Lack of policy that prioritizes/promotes use of empirical evidence	118	3.24	1.16	162	3.65	1.02	0.002	0.37
11. Lack of Indigenous knowledge training	N/A	N/A	N/A	161	3.65	1.25	—	—
12. Inadequate commitment to support external knowledge sharing	117	3.44	0.92	160	3.55	0.92	—	—
13. Empirical evidence not at relevant spatial scale	116	3.59	0.91	158	3.54	0.84	—	—
14. Limited training or experience evaluating empirical evidence	116	2.97	1.15	158	3.53	1.02	0.000	0.51
15. Lack of commitment to support internal knowledge sharing	116	3.54	0.96	162	3.47	0.97	—	—
16. Lack of relevance or applicability	118	3.17	1.07	153	3.45	0.94	0.022	0.28
17. Agency managers and leadership lack field experience	N/A	N/A	N/A	163	3.41	1.25	—	—
18. Uncertainty of empirical information	115	2.95	0.91	157	3.35	0.85	0.000	0.45
19. Availability of credible information/knowledge	117	2.97	1.07	162	3.22	1.13	—	—
20. Lack of access to credible info/knowledge	118	3.10	1.18	162	3.15	1.20	—	—
21. Conflicting scientific results	117	2.87	0.96	159	2.82	0.94	—	—
22. Lack of trust in empirical evidence	118	2.36	0.98	164	2.81	1.06	0.000	0.44

^aBarrier scale: 1 = Strongly Disagree; 2 = Moderately Disagree; 3 = Neutral; 4 = Moderately Agree; 5 = Strongly Agree.

^bSignificant differences are noted in bold text.

^cCohen's *d* values = 0.2 “small” effect size; 0.5 “medium” effect size; 0.8 “large” effect size.

respondents who indicate that limited training or experience evaluating empirical evidence was increasingly a barrier (2019 sample: mean = 3.53, SD = 1.02; size effect >0.5). Additionally, two other barriers that displayed strong significant increases in their perceptions as barriers were the impact of uncertainty of empirical information and lack of trust in empirical evidence (size effect <0.5).

For the 2019 survey, we added additional barriers related to training, including lack of Indigenous knowledge training and transdisciplinary training, and a lack of field experience and leadership by practitioners in decision-making positions. These barriers were perceived as somewhat moderate by respondents and were consistent across organizations.

It is worth noting that of the 19 barriers included in the 2013 survey, all but three were perceived to be increasing in magnitude, which suggests that barriers affecting the ability of practitioners to make evidence-based decisions are intensifying in many ways. Of the 16 barriers that were observed to increase over the past five years, six were significant, with limited training and experience evaluating empirical evidence experiencing the most significant increase according to Cohen's d values (an overall medium effect). Key perceived barriers to evidence-based decision-making were largely independent of demographic and career characteristics, suggesting some consistency of experience and opinion across Canada's protected areas managers. However, there were a few exceptions. Correlation analysis between gender and barriers did reveal some notable findings, including that males tend to be more cynical about the conflicting scientific results ($r = 0.348$, $p = 0.012$) and relevance ($r = 0.393$, $p = 0.005$) of available knowledge.

4. Discussion

Overall, our results indicate a concerning trend in the value and use of evidence by practitioners attempting to effectively conserve biodiversity in Canada. The use of virtually all forms of evidence is on a significant decline even when some forms of evidence are increasing in perceived value, and the availability of information on many management issues is greater than ever. Most barriers that affect the use of evidence are also increasing in magnitude.

As [Sutherland and Wordley \(2017, p. 1216\)](#) aptly pointed out, "evidence complacency should be as unacceptable in professional conservation work as it is in clinical medicine." We agree. Addressing these challenges will, in many cases, require a restructuring and refocusing of protected areas organizations. [Lemieux et al. \(2018\)](#) detailed several recommendations to enhance evidence-based decision-making in Canada's protected areas agencies, including increased financial investment in support of both internal and external research, monitoring, and knowledge mobilization activities; the establishment of Canada research chairs and Centres of Networks of Excellence focused on protected areas management (which still do not exist); and more effective collaboration with Canada's Indigenous Peoples and organizations to better integrate Indigenous knowledge and support reconciliation initiatives.

These recommendations remain relevant, some more important than ever, but will not be repeated here. Instead, we focus our discussion on providing several new and complementary recommendations that can work to build awareness of evidence, increase interactions between researchers and decision-makers, and enhance communication both about and access to evidence with the objective of influencing behavioural outcomes (i.e., enhancing capacity and increasing motivations and opportunities to use evidence). We link both broad and specific findings associated with the concerning decline in the use of virtually all forms of evidence in Canada's protected areas organizations to a set of specific recommendations that we feel would most effectively reverse this trend.

Specifically, we argue that transformations are needed in four fundamental areas: (i) building a more relevant evidence base, (ii) (re)establishing collaborative forums for knowledge sharing,

(iii) embedding researchers and Indigenous Knowledge-Holders within protected areas organizations, and (iv) making a commitment to accountability, transparency, and reporting with respect to knowledge management. These high-level recommendations are linked to specific findings within our extensive set of results. These strategies are unlikely to work alone but could work in various combinations to guide knowledge generation, capture, management, sharing, and ultimately utilization within Canada's protected areas organizations.

4.1. Recommendation I: Continue to build the evidence base, but work to close the relevance gap

Except for just a few management issues, our results revealed that the availability of different forms of knowledge useful for addressing key issues relating to protected areas management is not perceived by practitioners as a major barrier to evidence-based decision-making (Tables 4 and 5). And while we support the notion that “more is better” when it comes to the generation of evidence to support conservation decision-making, there is a danger of swamping decision-makers with research and monitoring findings and overwhelming their ability to synthesize them into conclusions that are timely and meaningful (Items 5, 9, and 13, Table 5).

We are concerned that Canada's evidence base for effective protected area management may be increasingly characterized by a substantial and growing relevance gap. Our findings demonstrated a clear disconnect between the production of peer-reviewed research and its consumption by protected area practitioners (Table 3). Colloquially, the likely response of a practitioner to the question “Why don't you consult the academic literature more often?” would most likely be “Why would I?” A response of this nature is likely motivated in part by challenges associated with the time and resources needed to access the literature and the technical capacity needed to effectively digest it and relate it to site and (or) program level situations. But equally, our survey results suggest that many site or program managers simply do not see the literature in this area as relevant to their needs.

In light of these findings, it is clear that we need more effective science. As Cash et al. (2003, p. 8086) noted “the ‘effectiveness’ of scientific inputs needs to be gauged in terms of impacts on how issues are defined and framed, and on which options for dealing with issues are considered, rather than only in terms of what actions are taken to address environmental problems.” Building on this approach, we define “effective” science as research and (or) monitoring work that has a specific and demonstrable effect on the management of a protected area or on a broader management activity. In our view, for research and monitoring to be effective at the protected area scale, it must demonstrate what we refer to as the “4 Rs of operational science”:

1. Rigorous—high quality in nature, ideally peer reviewed, and difficult to challenge on its merits;
2. Relevant—directly tied to a particular management need, question, or issue at the appropriate protected area management scale—site specific, regional or national network, or broader programmatic level;
3. Reliable—produced on a timetable that aligns with management decision-making needs and in forms that can be simply translated to usable decision-making support tools; and
4. Resource efficient—produced in a cost effective and affordable manner.

This attribute list does not flow directly from a body of literature or from our survey results. Rather, it is offered as a potentially helpful way of assessing the extent to which research or monitoring activities will have meaningful relevance and impact at site specific or broader programmatic scales. While further research and dialogue will aid in testing and refining this palette of attributes, intuitively, it

seems likely that any knowledge acquisition activity which fails to demonstrate one or more of these attributes is unlikely to have a strong impact on protected area management.

Our findings do point to concerns about the reliability of science for decision-making and note that results are often produced on timelines of limited utility to protected area practitioners or in forms that are difficult to digest (Item 5, [Table 5](#)). In our view, a key step in addressing this problem is to devote far greater attention to evidence syntheses (see [Ganann et al. 2010](#); [Haby et al. 2016](#); [Thomas-Walters et al. 2021](#)). [Pullin et al. \(2020, p. 115\)](#) argued that “. . . it is time to place evidence synthesis as a central pillar of evidence-informed decision-making in conservation and environmental management” and detail the role that it can play specifically in the effectiveness of conservation and other protected areas management efforts.

We support this notion because, as [Pullin et al. \(2020\)](#) pointed out, evidence syntheses are relevant to informing decisions at several critical stage points in the life cycle of a programme or initiative, including: (i) initial scoping of a new topic early on in strategic planning, (ii) identification or validation of specific intervention designs, (iii) benchmarking of institutional outcomes against other programmes, and (iv) evaluation of overall effectiveness of an intervention across multiple contexts or applications. The focus on informing the different stages of decision-making ensures the selection of a suitable method including the opportunity to engage stakeholders throughout the process and relevant communication of findings. One idea would be for the newly established (and open access) *Parks Stewardship Forum* journal (focused more on the practitioner), to have occasional special issues focused on evidence syntheses on key protected areas issues.

4.2. Recommendation 2: (Re)Establish collaborative knowledge-sharing forums to promote network and partnership development

Beyond the pervasive barriers of limited financial resources, lack of staff, and lack of time that are leading to declines in the use of various forms of evidence (Items 1–3, [Table 5](#)), our results also revealed that a disconnect between research agendas and knowledge developers and users, and policy processes currently represent significant barriers to the use of evidence (Item 6, [Table 5](#)). However, successful conservation is a team activity. Today’s conservation realities are simply too diverse, too fast moving, and too complex to allow disconnected and isolationist approaches to succeed. Our results revealed an incompatibility between the timeframes needed to collect and assess empirical data and the need to manage urgent management problems (Item 5, [Table 5](#)). Indeed, recognizing that science is not enough to successfully manage effectively, the Canadian conservation community will have to mobilize to expand existing partnerships, and forge new ones, especially with Indigenous Peoples, local communities, and new and emerging scholars, and harness innovation in communications with the goal of building “a culture of knowledge sharing”.

Extensive efforts have been made to improve communication within the protected areas and conservation sector more broadly, including between natural and social scientists ([Sandbrook et al. 2013](#)). However, this communication has been described as a “dialog of the deaf” ([Agrawal and Ostrom 2006](#)). Furthermore, [Cooke \(2019, p. 19\)](#), citing the works of [Cvitanovic et al. \(2016\)](#) and [Dunn and Laing \(2017\)](#), noted that “What a manager might consider to be important in influencing the reliability and applicability of a given piece of knowledge may differ from other stakeholders and the knowledge generator.” Our survey results point to similar challenges, including how to deal with uncertainty and issues surrounding language and interpretation of research significance (Items 13, 8, and 14).

And yet, paradoxically, the momentum that saw the establishment of Canada’s Science and the Management of Protected Areas Association (SAMPAA) and similar provincial associations has

dissipated in recent years (e.g., the Parks Research Forum of Manitoba). The result is that, despite the widespread recognition of the necessity of strong and vibrant collaborative mechanisms, there are few, if any, fora that bring together protected area practitioners, decision-makers, and academics on a regular basis. Our survey respondents consistently identify what we would term as a “sense of disconnectedness” as problematic from several vantage points (Items 6 and 12, [Table 5](#)). Left unchecked, this dynamic will worsen, not improve in the post-COVID-19 world. Accordingly, we offer two broad sets of recommendations for addressing it.

At the most general level there is a clear need for a new national forum focused on knowledge mobilization. To some degree, the recently established Canadian Parks Conference (held in 2017 and 2019) represents a positive step forward, especially in terms of Indigenous engagement. However, the first two gatherings have been more focused on uncritical “stories from the field”, cheerleading, and providing a podium for the “Old Guard” than on unbiased knowledge sharing. In fact, academics and many NGOs were nearly omitted entirely from the programs altogether.

A more effective use of the time and energies the conference marshals would be to include, *inter alia*, a full day focussed on the identification of research and monitoring needs associated with broadening the evidence base for effective protected areas management. This paper is not the venue for detailed recommendations in this regard; suffice it to note that we feel there is an important niche for this conference to play in some form of multi-workshop format to be more inclusive and representative of Canada’s diverse and growing conservation community and to collectively identify issues, needs, and explore the means for addressing them.

Similarly, more frequent provincially or regionally focussed discussions could be used to drive knowledge sharing in a spatially relevant context, bringing together a broader band of interests than are typically able to attend a national gathering. Proceedings from such events could form an extremely informative and pragmatic set of “reporting out” statements to kick off discussion at the national conference as well.

At both scales, there is a compelling need to expand the conservation collective and more effectively engage a wider audience beyond academic researchers and practitioners, such as Indigenous Peoples and organizations, journalists, NGOs, and other media representatives, artists, and other communicators, to help disseminate evidence and communicate their significance to the broader public. Local governments, other Ministries, and other sectors that deal with the drivers of biodiversity loss, including land use change, climate change, natural resource use and exploitation, and environmental impact assessment are also often overlooked and need more effective engagement in knowledge management efforts.

Forming new collaborative partnerships with research organisations and the broader community can facilitate this. For example, the Landscape Conservation Cooperatives (LCCs) introduced in the United States in 2010 offer compelling approaches for Canada to learn from. LCCs have established innovative co-governance frameworks including a network consisting of both governmental organizations and NGOs, and have been shown to facilitate shared learning, enhance regional collaboration on conservation, and build capacity for public trust to work in conservation ([Jacobson and Robertson 2012](#); [Jacobson and Haubold 2014](#)). While the Trump administration cut funding for the LCC program, the opportunities presented by these sorts of mechanisms, including the potential role of the university community within them, is worthy of further consideration and dialogue.

More specific to the production of evidence to support science-based decision-making, we propose one modest, low-cost, but key action: parks agencies must regularly identify and broadcast their research needs, highlighting to research partners the priority research questions they need answers

to. An example of this is Alberta Parks' publication of salient research questions (see [Hallstrom et al. 2019](#)). Alternatively, it could be more effective for managers to state their management issues, rather than research needs. Managers may not have the training to determine research needs, and what they most want is evidence (research) that guides decisions they need to make about important issues they are facing. This effort needs to be replicated in other jurisdictions, and this recommendation is complementary to Recommendation 1 that calls on deepening the science base and closing the relevance gap. That said, we acknowledge that simply identifying a list of research questions does not offer any guarantee they will get addressed ([Dey et al. 2020](#)). But, not identifying and sharing such a list is an almost sure guarantee that these issues will not get addressed.

4.3. Recommendation 3: Embed and empower scientists (natural and social) and Indigenous Knowledge-Holders within protected areas organizations

In both the 2013 and 2019 surveys, lack of staff and lack of time were recognized in the top 3 barriers affecting access and use evidence in protected area management and planning (Items 2 and 3, [Table 5](#)). According to [Roux et al. \(2019, p. 1272\)](#), embedding research scientists within agencies is best suited to supporting evidence-based conservation: "embedding research capacity in conservation agencies can unlock the potential of external researchers working in protected areas by promoting parks for science and science for parks." [Roux et al. \(2019, p. 1272\)](#) went on to state that "Embedded researchers are well positioned to keep their research grounded in practice and to promote management-relevant science that impacts conservation policy and practice." We firmly support this approach. We also emphasize embedding not only benefits established protected areas organizations, but also local (e.g., Biosphere Reserves) and Indigenous-led conservation organizations. An academic researcher embedded in a protected area (including Indigenous Protected and Conserved Areas) or in a government agency program brings to bear not only their personal research strengths and interests but also the large networks of professionals with whom they associate. The connection is not, therefore, just between an individual and a program but rather is much broader in scope.

Importantly, the flow of benefits from an embedded arrangement is not uni-directional. While an effective embedded researcher will link staff to the broader academic literature and community, the reverse is also true. What many academics might see as "just a park" could well take on a much broader significance if presented by a colleague as a major research opportunity, a key ecological monitoring site, or an effective and pragmatic graduate student training niche. Similarly, co-locating protected area staff in research-focused institutions such as a university for certain periods of time can trigger a range of benefit flows in both directions as well. This would again help address the relevancy gap that currently exists between research and practice (Item 16, [Table 5](#)) and help realign research agendas with policy and management needs (Items 6 and 9, [Table 5](#)).

These benefits notwithstanding, it does not appear that this approach has been viewed favourably within the Canadian protected areas community in recent years. Although Parks Canada has embedded several of its staff at the University of Waterloo in the past, and hosted academic researchers in its own facilities, no arrangements of this nature came to light as part of the recently completed work of the Independent Task Force advising the Minister of Environment and Climate Change (who is responsible for Parks Canada) on ecological integrity issues. We are unaware of any such arrangements in place in Parks Canada or the National Wildlife Area/Migratory Bird Sanctuary component of ECCC, marine protected areas programs of Fisheries and Oceans Canada, or any provinces and territories. This is a somewhat startling state of affairs given that interchanges of this nature

remain fairly commonplace in other federal science programs (such as human health or wildlife research).

Embedding of staff researchers could also kickstart and support a broader range of collaborative mechanisms that forge stronger ties between academia and protected areas agencies. Staff researcher positions have been established in park agencies before, which have swiftly been dissolved when budget cuts have occurred, highlighting the systematic undervaluing of research. As such, for this recommendation to be effective, the position needs to be placed at a (high) level where the individual can influence decisions and should be supported by some form of legislated mandate. Such a level of authority could provide the strong foundation required to initiate and support a broader range of collaborative mechanisms that forge stronger ties among academia, conservation agencies working at multiple levels of government, Indigenous Knowledge-Holders, and others.

As with our 2013 findings, it appears that some forms of evidence could be seen as a threat to those with entrenched beliefs and result in the reliance on in-house developed information. For example, our findings revealed a disconnect between the value and use of Indigenous knowledge by practitioners (Item 14, [Table 3](#)). However, as [Alexander et al. \(2019\)](#) noted, the utilization of diverse knowledge systems can improve understandings of social–ecological systems, lead to innovation, and support the identification and transition to desirable futures. And while Indigenous and science-based knowledge systems are diverse, complex, and increasingly intertwined ([Agrawal 1995](#); [Alexander et al. 2019](#)), the fusing of such evidence must be included in any knowledge management strategy if it is to be effective.

Recognizing this possibility, we propose that there is a strong need to begin the process of embedding Indigenous Knowledge-Holders in protected areas organizations. This will require greater effort to acknowledge other ways of knowing and commit to a permanent, ethically situated, inclusive space for Indigenous knowledge (as articulated in the *We Rise Together* report, [ICE \(2018\)](#)). Conservation observers suggest we may have to embrace a “unity in diversity” ([Montana 2017](#)) approach to conservation when consensus regarding conservation and biodiversity knowledge is not achievable, but shared conservation goals can result in environmental protection through collaboration ([Toomey et al. 2017](#); [Gavin et al. 2018](#)). This needs to include an acknowledgement of the political dimensions of knowledge, collective reflection of what conservation knowledge is, and the “decentering” of academia in knowledge production ([Maderson and Wynne-Jones 2016](#); [Alonso-Yanez et al. 2019](#)).

This rejection that scientists alone possess the knowledge necessary to advance biodiversity conservation effort is central to the knowledge co-production movement. Here we adopt [Norström et al.’s \(2020, p. 183\)](#) definition of co-production; it is an “iterative and collaborative process involving diverse types of expertise, knowledge and actors to produce context-specific knowledge and pathways towards a sustainable future”. To build a more relevant and accessible base of knowledge to advance biodiversity conservation, the principles of co-production need to be embraced on a consistent basis. This will not be easy as it takes time and resources to navigate pluralistic perspectives held by diverse actors in a given context. [Charnley et al.’s \(2007\)](#) case of the Pacific Northwest forest management, [Nel et al.’s \(2016\)](#) description of environmental mapping in South Africa, and [Onaindia et al.’s \(2020\)](#) review of knowledge co-production efforts in biosphere reserves are three examples of many published cases that outline both potential wins and the very real challenges of operationalizing knowledge co-production. To this end, scientific institutions should enhance incentives for co-production of knowledge through merit/tenure processes, outreach, collaboration, and more, especially considering that these efforts take significantly more time and hold much greater potential to influence decision-making.

In our view, the key first step in addressing this challenge is to ask Indigenous groups themselves how best to go about approaching it. Solutions and approaches will be highly variable across the country. In areas covered by comprehensive land claims settlements, established bodies may suffice as venues for engagement. In other areas, Indigenous organizations may be comfortable with participating in the provincial forum type format described above while in others there may be a desire to establish more specific arrangements that are reflective of the broader nature of the relationship between Indigenous governments and federal/provincial/territorial governments. The key point here is that for the authors to seek to set out a recipe or formula for this form of engagement and inclusion is to simply perpetuate many of the practices that have led us to where we collectively are today. We reject that approach.

4.4. Recommendation 4: Establish accountability, transparency, and reporting related to knowledge management

Our results revealed that a lack of commitment to long-term monitoring and assessment programs (Item 4, [Table 5](#)) and lack of policies that prioritize or promote the use of empirical evidence (Item 10, [Table 5](#)) are significant barriers affecting the access and use of evidence in protected area planning and management. However, we assert that public sharing and reporting of ecological data and information associated with protected areas has at least four major benefits.

First, it contributes to the broader scientific community by affording researchers and students alike an opportunity to deepen their understanding of ecosystems and changes in them. Second, it allows practitioners of protected areas and their partners in conservation to better understand and evaluate the outcomes of the various management treatments they apply and to alter course as need be. Third, it allows the program or agency or individual park leadership to demonstrate accountability in meeting the demands of legislation, regulations, park plans or other requirements. And fourth, fully describing and sharing this information, in conjunction with collaborative discussion and research priority setting exercises, help set an agenda for future research to researchers and practitioners.

To date, these benefits do not appear to have been compelling to the protected area management community. A review of federal/provincial/territorial website materials dealing with protected areas, coupled with the results of our literature review and the outcomes of the survey described above, has not identified any publicly available data source with respect to ecological or socio-economic parameters pertaining to protected areas. For example, the Parks Canada website presents state of the park summaries of approximately half its national parks as of approximately 2010 with no more recent updates posted. These reports portray state of the park trends using a simplistic “stoplight” system based on a small number of indicators. These reports do not share comprehensive data or metadata, links to data or data summaries of any kind. Similarly, data reports are not available for National Wildlife Areas or Marine Protected Areas in the federal system, and we are unaware of any data sharing portals or mechanisms for provincial or territorial areas. It is, therefore, essentially impossible for any outside observer to generate an informed opinion on the ecological status of protected areas in Canada.

Our findings suggest three possible reasons for this situation. First, there is no legal requirement for protected area organizations to collect, report or share any of this data. Preparing data that they do collect for sharing, even in the most rudimentary form, requires work. Managers confronted with a myriad of demands with chronically insufficient budgets typically focus on what “they have to do” and get to what “they could or should do” later which often ends up meaning never. Data sharing is firmly in category two.

Second, our results combined with our collective experience in the field suggest that sharing of data may sometimes be seen, within the leadership of many government agencies, as nothing more than handing opponents and critics a cudgel with which to beat on the agency or program. Viewed from this vantage point, the costs of data sharing are many, and the benefits are few.

And third, it is clear from our survey results that few protected area program leaders see the sites they are responsible for as part of Canada's scientific asset base or as contributors to the nation's scientific enterprise. On the contrary, it appears that protected areas programs more typically see themselves as consumers of science, not as science practitioners. Co-producing or generating and sharing data and information of potential utility to broader research issues or questions is unlikely to be enacted in this context.

The results of these drivers are well evidenced in Canada's posture with respect to the CBD. While knowledge-based processes and tools are important to evaluate performance outcomes related to national and international conservation targets, currently there is no requirement to do so in national reporting to the CBD.

The consequences of a lack of accountability within Parties to the CBD, and a lack of oversight and enforcement by the CBD itself, has led to some growing concerns over the genuine intent of national actions in relation to the goals and targets of the CBD (e.g., Lemieux et al. 2019). Similarly, engagement and accountability have been identified previously as lacking within ECCC (Canada's national liaison to the CBD) (Office of the Auditor General of Canada 2013), and there is a need for improved accountability within and between Canada's public protected areas and other conservation agencies, as well as Secretariat of the CBD. This will be critical to preventing the reoccurrence of past engagement and accountability problems within ECCC, and to ensuring that the actual spirit and intent of the (to be negotiated) *Post-2020 Global Biodiversity Framework* is met by Parties. As Lemieux et al. (2019) noted, this lack of accountability, resulting from the unilateral approach to implementation and reporting at all levels, ultimately enables ECCC to report on goal and target progress without an independent formal review process.

It is possible that this situation could be rectified at both the CBD reporting scale and domestically in protected area program design and delivery through stronger leadership by ECCC and innovative policy approaches. The CBD has been in place for nearly 30 years, and federal and provincial agencies have been rhetorizing to Canadians about their firm commitments to open government, transparency, and data sharing. Yet expansion of the shared conservation evidence base still has not happened, and we cannot see anything in our findings to suggest that a significant change will occur organically.

Change in this area could still occur as a result of stronger implementation of various government policy statements committing to evidence-based decision-making and data transparency. In our view, it is more likely to occur if it is driven by legislative imperatives. For example, at the federal level, amendments to section 12.2 of the *Canada National Parks Act* to require the Minister to collect and share ecological data sufficient to assess the ecological state of each national park would dramatically increase the likelihood that ecological monitoring programs would come to enjoy a broader scope, a deeper and more secure resource base to operate from, and a higher degree of openness and transparency than they do today. It is possible that a change of this nature would also have a salutary effect not only on the federal parks system but also on the conservation community more broadly by establishing firm federal leadership that could spur similar amendments to provincial laws.

It is evident that clear and transparent reporting measures related to progress on national and international biodiversity goals and targets is now needed, with a specific requirement to report on how the best available evidence was used to inform decisions. If implemented, the CBD will need to

regularly review progress in implementation, possibly every 2–5 years, and develop an enforceable compliance mechanism to ensure that there is a concerted effort to hold Parties accountable when a failure to use the best available evidence is evident. Third-party peer review may be an effective mechanism to facilitate compliance reviews. As [Ulloa et al. \(2018\)](#) stated, review mechanisms have potential to promote implementation of international norms by mobilising constructive criticism. Finally, careful consideration to the ethics of data collection and information sharing and protecting the rights of Indigenous Knowledge-Holders should be an essential component of this compliance mechanism.

5. Conclusions

The CBD recently asserted that “knowledge management is one of the critical means of implementation that will underpin the success of the post-2020 global biodiversity framework.” ([CBD 2020b](#)). Easy and timely access to the best available information and knowledge, including evidence from different knowledge systems, especially Indigenous knowledge, is critical for effective conservation planning, policy formulation, decision-making, and implementation.

Unfortunately, the state of evidence-based decision-making in Canada’s protected areas organizations cannot be characterized in this way. On the contrary, the results of our 2013 and 2019 surveys and our review of the literature combined with our more than a century of collective experience in the conservation field lead us to four main conclusions with respect to the prominence of evidence in conservation decision making in the protected area management field in Canada:

1. Peer-reviewed literature, scientific findings and other forms of evidence are playing a diminishing role in decision-making.
2. Indigenous knowledge and local ecological knowledge of various forms has rarely featured prominently in protected area decision-making systems outside the context of land claims-based systems and we have detected no evidence to suggest that this situation is changing.
3. There is limited evidence suggesting that protected area decision-making is becoming more open and transparent nor that it is featuring stronger progress reporting or other forms of information sharing that could strengthen ties to the evidence base.
4. We could find no evidence of the active adoption of solutions that will lead to reversals in these trends or of the strong leadership needed to drive the protected areas and conservation community more broadly toward such solutions.

These findings are cause for concern. While our study has not evaluated protected areas program effectiveness in Canada, it stands to reason that decisions based on strong, deep, timely, and comprehensive evidence are of a higher quality and greater effectiveness than ones based on weak, shallow, late or narrowly focussed information sources. Similarly, the relative absence of Indigenous knowledge and local knowledge forms in conservation decision-making makes for weaker management outcomes.

This is an unpalatable set of conclusions at the best of times. In the context of the precipitous slide toward “fact-free” decision-making in some areas of public discourse it is even more alarming. The short- and medium-term actions proposed in the four recommendations above are not offered as a set of “magic solutions” that will make these problems go away. On the contrary, the journey toward a strong evidence base for effective protected areas planning and management in Canada is a long one that faces many financial, operational, cultural, and scientific obstacles. But no journey is ever completed without taking the first steps toward its end. Our recommendations, based on the evidence we have collected and reviewed, are offered as contributions to those steps and to accelerating the Canadian protected areas community’s progress on this journey.

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Author contributions

CJL, EAH, and AJG conceived and designed the study. CJL, EAH, MH, and DCDH performed the experiments/collected the data. CJL, EAH, and MH analyzed and interpreted the data. AJG and BJ contributed resources. CJL, EAH, TS, AJG, DCDH, JB, GTH, BJ, and RR drafted or revised the manuscript.

Competing interests

Andrea Olive is a guest editor for this collection.

Data availability statement

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

Supplementary material

The following Supplementary Material is available with the article through the journal website at doi:[10.1139/facets-2020-0085](https://doi.org/10.1139/facets-2020-0085).

Supplementary Material 1

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