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A mixed methodology for evaluating use of evidence in conservation planning

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Article impact statement: A new mixed methodology assesses the use of multiple types of evidence in conservation plans to improve reliability and rigor in planning.

Abstract

Conservation practitioners widely recognize the importance of making decisions based on the best available evidence. However, the effectiveness of evidence use in conservation planning is rarely assessed, which limits opportunities to improve evidence-based practice. We devised a mixed methodology for empirically evaluating use of evidence that applies social science tools to systematically appraise what kinds of evidence are used in conservation planning, to what effect, and under what limitations. We applied our approach in a case study of the Nature Conservancy of Canada (NCC), a leading land conservation organization. We conducted qualitative and quantitative analyses of 65 NCC planning documents ($n = 13$ in-depth) to identify patterns in evidence use, and surveyed 35 conservation planners to examine experiences of and barriers to using evidence. Although claims in plans contained a wide range of evidence types, 26% of claims were not referenced or associated with an identifiable source. Lack of evidence use was particularly apparent in claims associated with direct threats, particularly those identified as low (71% coded as insufficient or lacking evidence) or medium (45%) threats. Survey participants described relying heavily on practitioner experience and highlighted capacity limitations and disciplinary gaps in expertise among planning teams as barriers to using evidence effectively. We found that although time-intensive, this approach yielded actionable recommendations for improving evidence use in NCC conservation plans. Similar mixed-method assessments may streamline the process by including interviews and refining the document analysis frames to target issues or sections of concern. We suggest our method provides an accessible and robust point of departure for conservation practitioners to evaluate whether the use of conservation planning reflects in-house standards and more broadly recognized best practices.

KEYWORDS
document analysis, ecosystem management, evidence-based conservation, knowledge synthesis, monitoring and evaluation, North America, science–practice divide, traditional ecological knowledge

Resumen: Los practicantes de la conservación reconocen ampliamente la importancia de tomar decisiones con base en la mejor evidencia disponible. Sin embargo, pocas veces se evalúa la efectividad del uso de evidencias en la planeación de la conservación, lo que limita las oportunidades para mejorar la práctica basada en evidencias. Diseñamos una metodología mixta para evaluar empíricamente el uso de evidencias que aplica herramientas de las ciencias sociales para estimar cuáles son los tipos de evidencia que se usan en la planeación de la conservación, con cuál efecto y con cuáles limitaciones. Aplicamos nuestra estrategia a un estudio de caso de la Nature Conservancy of Canada (NCC), una organización puntera en la conservación del suelo. Realizamos el análisis cualitativo y cuantitativo de 65 documentos de planeación de NCC ($n = 13$ a fondo) para identificar patrones en el uso de evidencias y encuestamos a 35 planeadores de la conservación para examinar las barreras y las experiencias del uso de evidencias. Aunque las afirmaciones en los planes contenían una amplia gama de tipos de evidencia, el 26% de éstas no estuvo referenciado o asociado con una fuente identificable. La falta del uso de evidencias fue particularmente

evidente en las afirmaciones asociadas con amenazas directas, particularmente aquellas identificadas como amenaza menor (71% codificado como insuficiente o falto de evidencias) o media (45%). Los participantes de la encuesta describieron una fuerte dependencia de la experiencia de los practicantes y resaltaron las limitaciones de capacidades y brechas disciplinarias en la experiencia entre los equipos de planeación como barreras para el uso efectivo de las evidencias. Descubrimos que, aunque lleva tiempo, esta estrategia produjo recomendaciones viables para mejorar el uso de evidencias en los planes de conservación de la NCC. Las evaluaciones similares de métodos mixtos pueden simplificar el proceso al incluir entrevistas y refinar los marcos de análisis documental para enfocarse en temas o secciones de interés. Sugerimos que nuestro método proporciona un punto de partida accesible y sólido para que los practicantes de la conservación evalúen si el uso de la planeación de la conservación refleja los estándares internos y las mejores prácticas reconocidas más ampliamente.

Una Metodología Mixta para la Evaluación del Uso de Evidencias en la Planeación de la Conservación

PALABRAS CLAVE:
América del Norte, análisis de documentos, conocimiento ecológico tradicional, conservación basada en evidencias, división ciencia-práctica, gestión ambiental, monitoreo y evaluación, síntesis del conocimiento

【摘要】保护工作者普遍认同基于现有最佳证据做出决策的重要性。然而, 保护规划中证据使用的有效性很少得到评估, 这限制了进一步改进循证实践的机会。我们设计了一种混合方法来实证评估证据的使用, 该方法运用社会科学工具, 系统地评估了保护规划中使用了哪些类型的证据, 有什么效果, 以及有什么限制。我们将该方法应用于加拿大自然保护协会这一重要土地保护组织的案例研究之中, 对其65份规划文件进行了定性和定量分析, 并对13份文件进行了深入分析, 以确定证据使用的模式;我们还调查了35位保护规划者, 以分析其使用证据的经验和面临的障碍。结果表明, 尽管规划中声称囊括了多种类型的证据, 但其中26%没有参考或明确的来源。与直接威胁相关的内容明显缺乏证据支持, 特别是那些较低威胁(71%被认定为证据不充分或缺乏证据)和中度威胁(45%)的结论。受访者表示其高度依赖保护工作者的经验, 并强调规划团队的能力限制和专业知识的学科差距阻碍了证据的有效使用。我们发现, 尽管这种方法比较费时, 但它能得到改进加拿大自然保护协会保护规划中的证据使用的可操作性建议。类似的混合方法评估可通过加入访谈和完善文件分析框架来简化流程, 从而聚焦于关注的问题或组成部分。我们认为我们的方法为保护实践者提供了便捷、稳健的出发点, 以评估保护规划的使用是否能反映内部标准和更广泛认可的最佳实践。**【翻译: 胡怡思; 审校: 聂永刚】**

关键词: 生态系统管理, 北美洲, 传统生态知识, 文件分析, 基于证据的保护, 知识综述, 监测和评估, 科学与实践的差距

INTRODUCTION

With biodiversity loss accelerating globally, the need to act quickly, efficiently, and effectively has prompted calls to critically examine and improve the information guiding conservation decisions. In the early 2000s, informed by standards for evidence-based practice developed in the field of medicine, Sutherland et al. (2004) proposed that current practice is based largely on "anecdote and myth, rather than upon the systematic appraisal of the evidence" and argued instead for mainstreaming an evidence-based approach to conservation (EBC). This has since been widely espoused and adopted into the mission statements of many leading conservation organizations and government agencies.

Although an EBC has been advocated, conservation practitioners operate in the "messy real world" (Adams & Sandbrook, 2013) in which practical limitations constrain how information is gathered, synthesized, and applied in the context of conservation interventions (Christie et al., 2020; Rose et al., 2018; Walsh et al., 2019). Appropriate evidence to support conservation decisions is often lacking, and where it exists, it may be inaccessible to practitioners (Gutzat & Dormann, 2020). Moreover, factors related to institutional culture and planning processes present further obstacles to operationalizing evidence (Walsh et al., 2019). A considerable body of literature at the science–practice interface discusses the barriers to evidence use (Table 1) and posits strategies for overcoming them, including improving the applicability of research questions (Fabian et al., 2019) and

TABLE 1 Barriers to effective use of evidence in conservation identified through the literature*

Type of barrier	Specific barrier	Description	References
Appropriateness of evidence	Knowledge gaps	Appropriate evidence to support decisions nonexistent	Walsh et al., 2019; Junker et al., 2020; Hunter et al., 2021
	Lack of relevance to context	Existing evidence not applicable to area or region or issue; existing evidence narrow and systematic reviews lacking, inhibiting generalizability	Cvitanovic et al, 2016; Christie et al., 2020; Gutzat & Dormann, 2020; Hunter et al., 2021
	Complexity and uncertainty	Causal relationships complex and uncertain; information inconclusive, contradictory, or misaligned with conservation priorities	Karam-Gemael et al., 2018; Rose et al., 2018; Gutzat & Dormann, 2020
	Poor research quality	Quality of evidence unreliable due to poor research and data collection practices	Fidler et al., 2017; Fraser et al., 2018; Walsh et al., 2019; Christie et al., 2021
	Outdated evidence	Available evidence outdated and not applicable due to, for example, delay between research and publication	Rose et al., 2018
Accessing evidence	Capacity limitations	Time, funding, and resources insufficient to support planners in robust evidence gathering	Fabian et al., 2019; Walsh et al., 2019; Sutherland et al., 2021
	Paywalls	Paywalls and lack of credentials prevent planners from accessing relevant evidence (particularly peer-reviewed literature)	Farwig et al., 2017; Walsh et al., 2019
	Language barriers	Relevant evidence published in languages unfamiliar to planners; jargon may present challenges to understanding	Fabian et al., 2019
	Relationships	Planners do not have established relationships necessary to appropriately access and learn from relevant sources of evidence (e.g., Indigenous and local knowledge).	Bohensky & Maru, 2011; Watson, 2013; Reo et al., 2017
	Expertise	In-house expertise in some disciplines and subject areas limited, causing difficulty identifying and evaluating some evidence; newer professionals lack expertise to engage with evidence effectively	Adams & Sandbrook, 2013; Fabian et al., 2019
Operationalizing evidence	Institutional and practitioner culture	Organizational leadership not perceived to value evidence use in decision-making, undervalues certain sources of information as evidence (e.g., practitioner knowledge), or prioritizes reputational considerations over evidence use	Pullin & Knight, 2005; Persson et al., 2018; Walsh et al., 2019; Gutzat & Dormann, 2020
	Incompatible planning processes	Planning processes do not adequately support evidence use (e.g., inadequate planning templates that do not enable evidence to be cited transparently; poor intraorganizational communication)	Walsh et al., 2019; Gutzat & Dormann, 2020
	Practitioner–stakeholder relationships	Fraught or nonexistent practitioner–stakeholder relationships limit access to information and constrain how evidence can inform decisions and actions	Seavy & Howell, 2010; Rose et al., 2018; Walsh et al., 2019
	Balancing evidence use trade-offs	Quick decisions to stave off potential consequences of not acting inadvertently yield ineffective or harmful outcomes due to insufficient evidence	Cook, Pullin, et al., 2017; Cooke et al., 2016; Iacona et al., 2018; Sutherland et al., 2021

*Details of the thematic literature review procedures are described in the Appendix S1.

the quality of research practices (Fidler et al., 2017; Fraser et al., 2018), accelerating the peer review process time (Cooke et al., 2016), and engaging government decision makers to narrow the science–policy gap (e.g., Haddaway & Pullin, 2013). However, many substantive challenges persist.

In this study, we addressed concerns regarding the use of evidence in the conservation planning stage. Specifically, we asked how does a conservation organization know it is using evidence effectively? To address this question, we developed and piloted a mixed-methods approach to evaluate evidence use in the Nature Conservancy of Canada (NCC), a nongovernmental conservation organization. Based on what we learned, we devised a methodology (Figure 4) for conservation organizations to evaluate evidence use internally through document analysis of conservation plans, interviews, and surveys of conservation planners.

Defining evidence

Salafsky et al (2019) defined evidence as "relevant information used to assess one or more hypotheses related to a question of interest." Yet, this definition does not clarify what forms of evidence constitute information. Several authors (e.g., Haddaway & Pullin, 2013; Salafsky et al., 2019) have proposed a hierarchy of evidence based on reliability, bias minimization, or

confidence in data quality; these typically elevate quantitative, experimental, controlled studies (Salafsky et al., 2019). Other forms of experiential evidence—practitioner and local knowledges, gray literature, and so forth—are posited as useful complementary or contextual information, but alone considered an insufficient evidentiary base (Fazey et al., 2006). Relying on scholarly literature alone could result in conservation planners undervaluing other sources of information or overlooking the influence of context, values, and relationships (Adams & Sandbrook, 2013; Rose et al., 2019; Toomey et al., 2017). Proponents of this evidence-informed approach seek to dismantle the hierarchy of evidence—concerned that this unduly prioritizes quantitative over qualitative data and academic sources over other knowledge systems (Adams & Sandbrook, 2013; Rose et al., 2018; Rose et al., 2019).

Alternative typologies categorize forms of information nonhierarchically (e.g., Adams & Sandbrook, 2013). This is justified by practical and ontological imperatives: experimental studies with controlled variables are rarely appropriate in conservation contexts. Broadening what counts as evidence can open the door to evidence that is better fit for purpose for certain questions (Haddaway & Pullin, 2013). For example, social science is making inroads in conservation decision-making by applying insights from, among others, literature in human perceptions (Bennett, 2016), expert assessment (Dicks et al., 2016; Martin et al., 2012), and qualitative forms of inquiry (Drury et al., 2011). Indigenous and local knowledges are increasingly recognized as robust and relevant systems of evidence synthesis on their own terms (Latulippe, 2015; Persson et al., 2018; Watson, 2013). Far from representing a compromise in rigor, these types of knowledge provide insights into new and important domains of information for conservation practice (Drury et al., 2011).

The treatment of Indigenous and local knowledge in conservation planning warrants closer scrutiny. Like all knowledge systems, Indigenous knowledges are embedded in specific worldviews and have their own epistemological and ontological assumptions. Indigenous Peoples and social scientists have widely critiqued the notion of integration for entrenching the dominance of Western management models and sciences in environmental decision-making and risking intellectual property infringement (e.g., Ahenakew, 2016; Bohensky & Maru, 2011; Nadasdy, 1999). As a result, Indigenous knowledge systems frequently remain marginalized in environmental decision-making even when Indigenous Peoples have a seat at the table (Latulippe, 2015; Watson, 2013). Multiple evidence-based approaches (Tengö et al., 2014) and knowledge braiding or weaving (Kimmerer, 2020) offer pathways toward more ethical and equitable knowledge sharing across knowledge systems, with distinct potential to enhance conservation efforts and advance the goals of reconciliation (Wong et al., 2020).

Application of evidence

We sought to delineate best practices for how to use evidence in conservation by conducting a thematic literature review. We then devised a conceptual model (Figure 1) for understanding an EBC process based on these best practices, identified common barriers in the use of evidence (elaborated in Table 1), and provided examples of strategies for mitigating these challenges at different phases. Figure 1 illustrates that in early project phases, planners rely on the existing body of evidence, whereas in ongoing stages of the project additional evidence should be gathered and applied through monitoring processes. Such evidence may then be incorporated in further planning efforts.

Adaptive management requires that the outcomes of conservation actions be monitored and evaluated against other potential sources of change, that relationships of causality be well-understood, and that results of monitoring be used to inform the next generation of planning (Lapointe et al., 2015; Salafsky et al., 2019). The need for evidence gathering should be weighed carefully against its costs—when resources are scarce, evidence use should be prioritized for higher risk actions (Sutherland et al., 2021). Broadening the knowledge base of conservation planning teams can help planners draw more efficiently on a broad range of expertise (Persson et al., 2018). Use of systematic reviews, evidence synthesis tools, and standardized planning processes can streamline evidence gathering, improve reliability, and mitigate the resource burden associated with conducting rigorous reviews (Cook, Nichols, et al., 2017; OLeary et al., 2017; Sutherland et al., 2019). However, the quality of reviews varies and reliability can be difficult for practitioners to assess (OLeary et al., 2017; Woodcock et al., 2014). Finally, evidence use is most effective if all actors can share in the lessons of success and failure (Adams, 2011). Recently, there have been concerted efforts to increase transparency between and among scientists and practitioners in terms of the cost of implementing conservation interventions (Iacona et al., 2018) and decision-making processes (Cvitanovic et al., 2016). This includes identifying data-quality limitations (Christie et al., 2021; Fidler et al., 2017; Fraser et al., 2018) and knowledge gaps (Junker et al., 2020).

Barriers to applying evidence in these ways include limited capacity and resources, inertia in management (a tendency to default to status quo), and fraught practitioner–stakeholder relationships (Table 1). Scholars and practitioners have generated a range of planning and decision support tools and frameworks to improve processes for evidence use, including systematic conservation planning (McIntosh et al, 2018), expert assessments (e.g., Dicks et al, 2016; Martin et al., 2012), decision triggers (Addison et al, 2016), and impact evaluation (McKinnon et al, 2015). Open-source resources such as the Collaboration for Environmental Evidence Synthesis Assessment Tool (Woodcock et al., 2014) and the Conservation Evidence Database (Sutherland et al., 2019) and the Evidence-to-Decision tool (Christie et al., 2022) can help practitioners use evidence effectively.

Assessing evidence use in conservation planning

Equipped with key principles for what constitutes best practice, we then searched for methods to appraise how effectively a

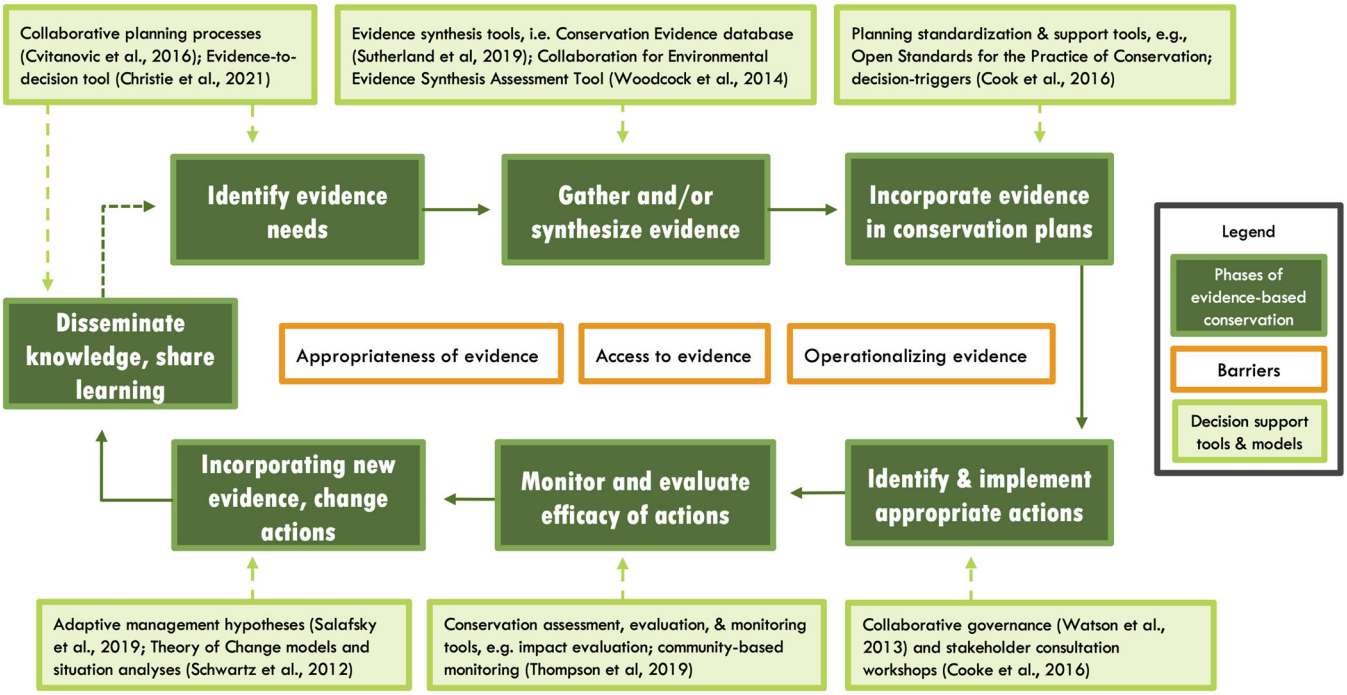

FIGURE 1 Conceptual model for evidence use in conservation, including examples of barriers and decision-support tools and models to overcome barriers

conservation organization uses evidence in planning. Remarkably, few studies address this aspect of the science–practice interface (Fabian et al., 2019). Most of these rely only on interviews (Gutzat & Dormann, 2020) or surveys of conservation planners or practitioners (e.g., Cook et al., 2010; Fabian et al., 2019; Pullin & Knight, 2005); evaluate only the use of scientific evidence in the peer-reviewed literature (Cvitanovic et al., 2016; Hunter et al., 2021); and focus on information used without further investigating the processes by which evidence is applied. We found only 1 study incorporating both formal document analysis and survey methods (Pullin et al., 2004); it examined management plans of major United Kingdom conservation organizations. Although this study was highly informative in shaping our approach, the authors conducted a coarse document analysis (plans as units of analysis) and offered limited details of their methodological choices (Pullin et al., 2004).

Our study emerged from an interest among ourselves and planners at the Nature Conservancy of Canada (NCC) to try to determine whether the organization's use of evidence is effective and consistent with its goals and broader standards. Confronted with a lack of tested and replicable methods for assessing evidence use, we developed and piloted an approach combining survey and document analysis methods (Figure 2). Reflecting on the strengths and limitations of this case study, we then revised the methodology proposed in Figure 4.

Evidence use in conservation planning at the NCC

As a leading conservation organization in Canada, NCC has helped protect over 14 million ha across the country in pursuit of its mission to conserve Canada's important natural areas and biodiversity. Evidence-based decision-making is central to NCC's stated vision and goals: "We are guided by the best available conservation science…[and] committed to continuous learning, and finding practical resourceful and innovative solutions to conservation challenges" (Lapointe et al., 2015). To facilitate evidence-based planning, NCC uses the Open Standards for the Practice of Conservation and its associated planning software, Miradi (Schwartz et al., 2012).

The NCC conducts planning on 3 scales: largely conceptual and vision-oriented Conservation Blueprints at the largest ecoregion scale, detailed Natural Area Conservation Plans (NACPs) for natural areas at the intermediate scale, and Property Management Plans (PMPs) for individual stewardship projects and NCC-owned or NCC-managed properties (Appendix S3). Periodically updated internal planning documents for each scale provide guidance on the process and standards. The NCC has stated its commitment to fostering more collaborative land management, particularly through partnerships with First Nations, and outlines aspirational principles in its 2019 Indigenous Engagement Framework (NCC, 2019).

METHODS

Document analyses

To develop conceptual models (Figure 1) and identify best practices for evaluating NCC's use of evidence, we first conducted a thematic review of scholarly literature on evidence in conservation (Appendix S1 https://doi.org/10.6084/m9.figshare.16451871). Second, we conducted a document analy-

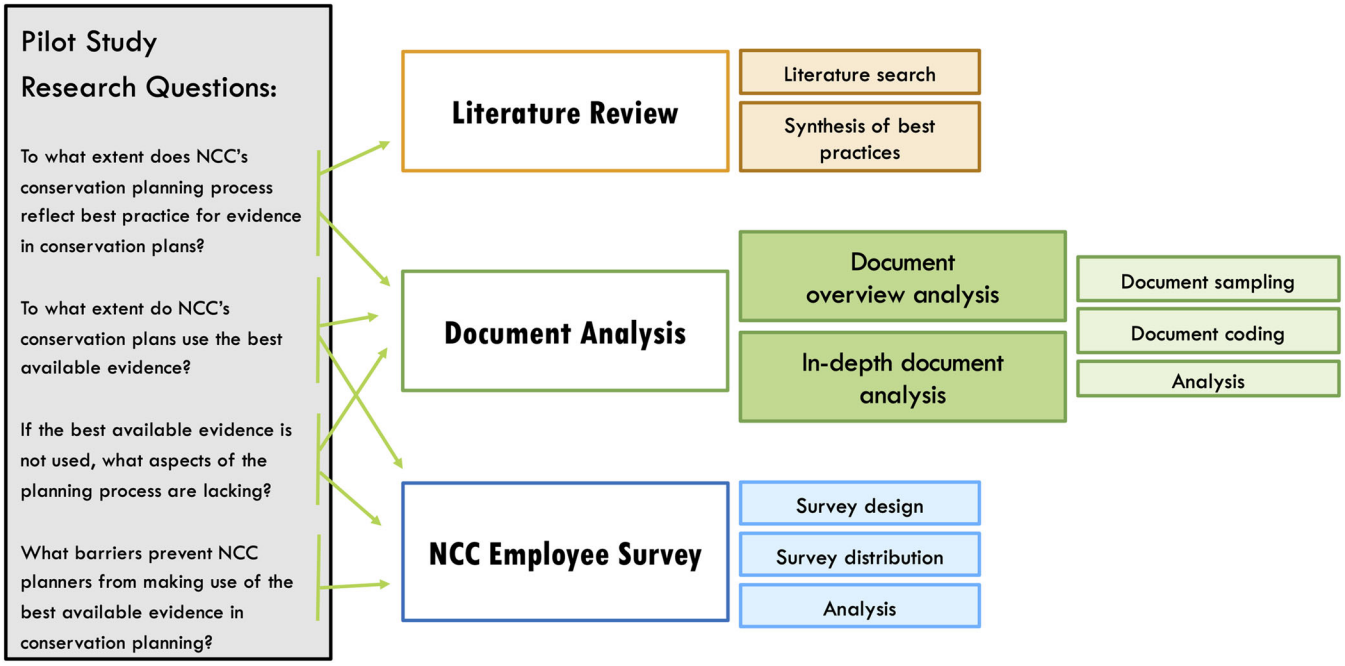

FIGURE 2 Research questions and methods for the case study of evidence use in conservation planning at the Nature Conservancy of Canada (NCC)

sis of NCC's NACPs and PMPs to analyze the effectiveness of NCC's use of evidence in conservation planning. We selected a regionally representative sample of conservation plans ($n = 13$) for coding from a dataset of 35 NACPs and 30 PMPs developed from 2016 to 2019. Where possible, we selected PMPs from within the natural areas we evaluated for better analysis of the nested structure of the planning process. We were also provided with 5 NCC planning guide documents. These were coded and analyzed thematically to inform the planning document coding frames. Due to confidentiality considerations, these documents are not publicly available (discussion of data availability in Appendix S2).

We used QSR International's NVivo software (Version 1.3.2, 2020) (Hall & Steiner, 2020; Jackson & Bazeley, 2019) to perform coding at 2 scales: a document overview analysis and an in-depth document analysis. For the overview analysis, we focused on overall characteristics of the plans (e.g., planners' disciplinary backgrounds, types of references) and targeted sections (direct threats, lessons learned, and biodiversity targets [Appendix S3]). The in-depth analysis entailed a close reading of the full documents, wherein we coded each sentence to themes pertaining to evidence use, the overall planning process, best practices and standards, and section-specific indicators. To enable more precise assessment, we treated discrete claims (statements requiring evidentiary basis [Appendix S4]) as the unit of analysis.

We developed the coding frames—the set of codes used to analyze the documents—with a grounded-theory approach, wherein themes emerged through the process of coding (Charmaz, 2006; Cresswell, 2013). This process was informed by the literature review and initial coding of the planning guides. Coding frames were developed separately for in-depth and overview analyses and then compared for consistency (Flick, 2014; Maxwell, 2013). Coding frames, coding criteria, and associated explanatory notes are available in Appendix S4. Throughout the process of coding, a subset of specific claims and stated knowledge gaps ($n = 203$) were fact checked for consistency with available literature (an approximately 15-min literature search per claim in Google Scholar). We performed an analysis of the strength of evidence use supporting these claims (coded as *effective*, *partial*, or *insufficient*) (Table 2 & Appendix S4), focusing on whether the evidence was well fit for purpose. Plans were selectively double-coded to check for accuracy and consistency of coding (details in Appendix S4).

Our document analysis approach was both qualitative and quantitative. Qualitative analysis began during the coding process, in which we used annotations to generate key insights and made note of questions that emerged from coders' close reading of the texts. Following the coding, we evaluated themes and annotations to identify clear examples of effective and ineffective evidence use (based on the strength of claim criteria in Table 2) and compared plans and codes. Although not generalizable, these results offered NCC illustrative examples, presented in the pilot study report, of effective use of a range of different evidence types and qualitatively identified patterns among claims that were insufficiently substantiated. To support the qualitative findings, we conducted crosstab queries to develop simple descriptive statistics on coding frequency compared between plans, presented internally in graphs and tables. These quantitative data were used to characterize the years of references used across different plans and to identify the most used evidence types by plan section and topic.

Survey of NCC conservation planners

To complement the document analysis, we designed and distributed a questionnaire survey (Appendix S5) to NCC

conservation planners (n = 35). The goal of this survey was to better understand underlying barriers and patterns of evidence use in NCC conservation planning. Participants were considered eligible for inclusion if they had been involved in planning processes at any of the 3 NCC planning scales. We distributed surveys to regional department heads who then shared the survey with their staff members. The questionnaire was voluntary and approved by UBC's Behavioural Research Ethics Board (ethics identification number H20-00508), consistent with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2 (2018). All participants were guaranteed confidentiality and no personal data were collected (Appendix S2). Conducted via the Qualtrics online platform (Qualtrics XM, 2005), the survey included questions regarding access to evidence, barriers and enablers of evidence use, and incorporation of different sources of evidence in conservation planning and decision-making. The survey instrument (Appendix S5) included a mix of matrix, multiple choice, open-ended, and ranking questions. Using R (R Core Team, 2020), we ran descriptive statistics to summarize and highlight the key findings of the survey.

RESULTS

Evidence use by type and claim

The NCC plans (in which we coded 1994 references across 1331 claims) incorporated a wide range of evidence types, but relied the most on government data sources (23%), peer-reviewed literature (18%), and gray literature (17%; Figure 3). Systematic reviews of scientific literature were cited in 2% of claims. Though infrequently referenced, in-house practitioner experience (7%) and expert opinions outside NCC (4%) were identified as important sources of evidence by survey participants. Attribution of data to multiple sources (bi- or triangulation) was rare (3% of claims). In total, 26% of claims were made without a reference or clearly identifiable source. The proportion of unreferenced claims ranged from 6% to 63% in sampled plans and revealed discrepancies in use of evidence at different planning scales. On average, a given NACP provided evidence for a mean of (SD) 79% (7.61) of total claims in a sampled document, whereas PMPs provided evidence for 66% (18.9) of total claims.

Survey results supported this finding. According to one participant, "for PMPs in particular, I find that firsthand observations/field data, and opinions of NCC staff (generally via old PMPs and other NCC documents) form the basis of most PMPs. Any information that can be obtained by literature or other reports is most useful for adding weight/importance/credibility to a decision I wanted to make anyway." Survey participants largely agreed (59%) that there was valuable evidence outside the published literature that is not cited explicitly and indicated significant reliance on existing in-house materials (most of the time and always = 83%), firsthand observations (82%), and expert consultations (53%) when compiling plans. A survey respondent noted, "Local [practitioner] experience is sometimes the most influential for conservation planning. Often, peer reviewed evidence does not pertain to the area you're working in with your unique threats/targets and the useful outcomes of conservation planning research are often very long-term." By coding the disciplinary backgrounds of each member of the planning teams, we assessed where NCC showed disciplinary gaps that may have hampered its use of practitioner experience. Planning teams were highly interdisciplinary within the natural and applied sciences, but rarely included social scientists (8%). A survey participant noted that "the largest challenge is a lack of in house capacity across NCC in certain subject areas, to even explain how to understand the literature, and lack of access to these experts."

Throughout the coding process, a subset of specific claims (n = 203) were checked for accuracy against a literature search. For example, an NCC plan from 2019 included the following claim about polar bear (*Ursus maritimus*) abundance: "Across Canada [the polar bear] is listed as Special Concern, but the Lancaster Sound subpopulation is likely stable or increasing (COSEWIC, 2008), due to the high productivity of the ecosystem and availability of ringed seals (Welch et al., 1992)." According to the IUCN Polar Bear Specialist Group (PBSG), this population is currently listed as data deficient, but "thought to be declining, because of highly selective harvest of male polar bears." However, on this point there has been high-profile

TABLE 2 Coding criteria* for evaluating strength of claims in the Nature Conservancy of Canada's conservation plans

Coding question	Effective justification of claims	Insufficient justification of claims
Is the claim explicitly referenced to sources of evidence?	Sources of evidence clearly referenced	Without references or sources unclear
Is the claim supported by multiple sources and types of evidence?	Data triangulated across multiple sources and evidence types	Reliance on 1 source or type of evidence
Is the appropriate type of evidence used to support a given claim?	Evidence fit for purpose	Evidence not fit for purpose
Is the claim specific to context?	Context-specific and relevant	Lacking reference to specific context
Are uncertainties acknowledged and accounted for?	Knowledge gaps and data limitations identified	Potential knowledge gaps overlooked
Is the claim consistent with available evidence?	Consistent with theory & broader literature	Claims not supported by literature; contradictory claims in plan
Is the evidence used to substantiate a claim still relevant?	Up-to-date evidence	Outdated evidence

*Complete details of coding criteria are available in Appendix S4.

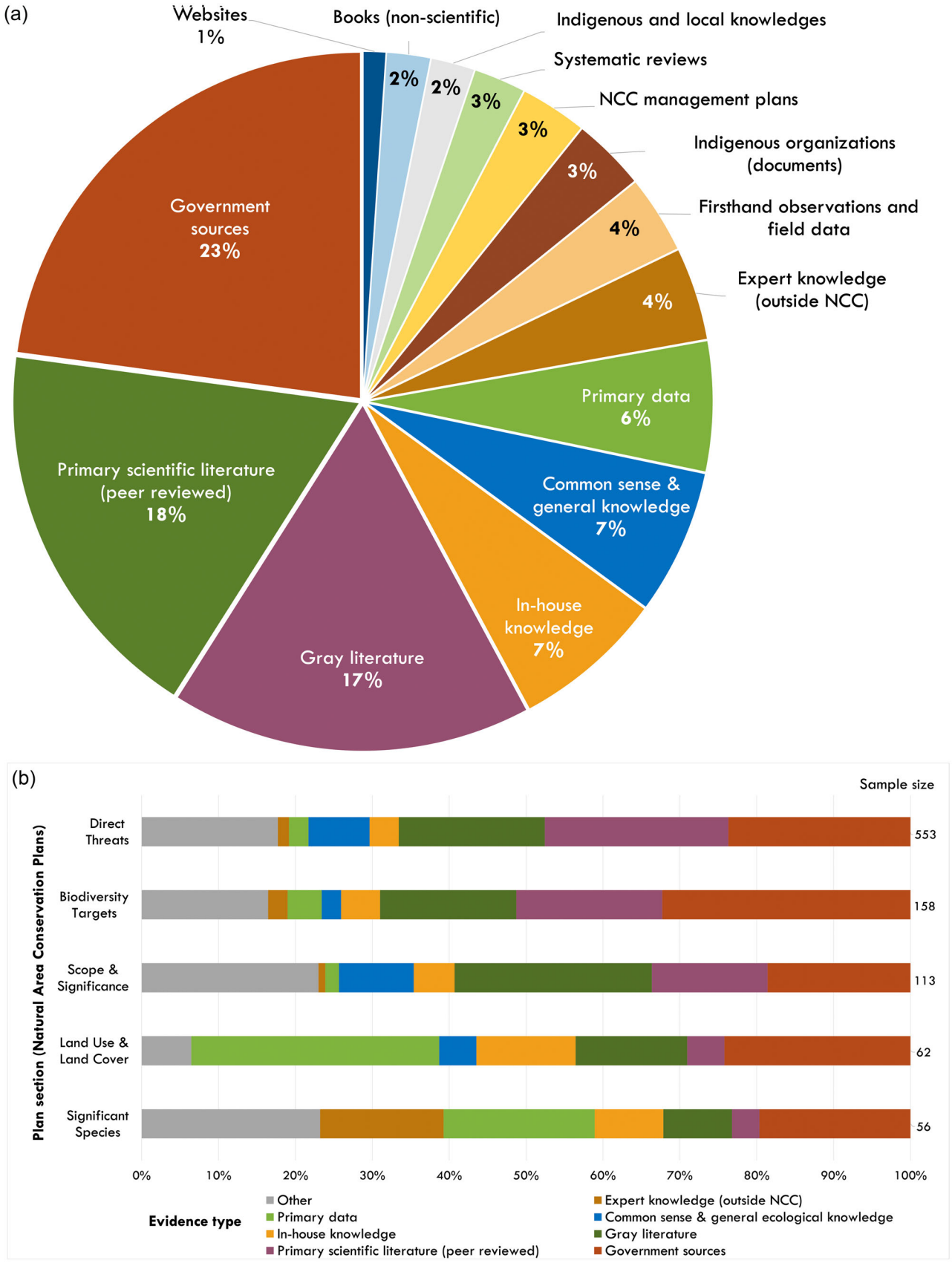

FIGURE 3 Type of evidence use in Natural Area Conservation Plans at the Nature Conservancy of Canada (a) coded by total claims ($n = 1331$) and excluding claims without references and (b) coded by claims in the 5 sections of Natural Area Conservation Plan (NACP) documents with the highest number of references, excluding claims without references. The 7 most used evidence types are listed; the rest are classified as other

TABLE 3 Examples of claims in the Nature Conservancy of Canada's Natural Area Conservation Plans (NACPs) coded by strength of claim

Example of Claim	Coded as*	Explanation
Claim: The threat of marine traffic is medium in the Natural Area for whales, Atlantic walrus, and seals. Supporting evidence: "Ship collisions with whales, especially Bowhead (COSEWIC, 2009), and to an unknown extent with Walrus (COSEWIC, 2017), are a recurrent result of marine traffic. Narwhals are at risk because they are generally skittish while sometimes exhibiting a freeze response to approaching ships (COSEWIC, 2004). Narwhals in the Milne Inlet and Eclipse Sound area (in the NMCA adjacent to the community of Pond Inlet and along the shipping route for the Mary River Mine) are thought to be particularly at risk of vessel strikes because of vessel traffic volumes (Hauser et al, 2018). Displacement of this population would have unknown consequences for the Narwhal, and be devastating for the community of Pond Inlet from the perspective of food security and cultural practices. And elders have already reported displacement of Seals in the area since mining operations began (Andrew Dumbrille, personal communications). Proactive navigation practices (Coastal Ocean Research Institute, 2018; WWF- Canada, 2018) can help mitigate this risk. Similarly, threats to birds can be managed with supporting information, such as estimating colony foraging range to predict overlap with shipping and other industrial activity (Gaston et al, 2013). Given that the science doesn't speak directly to the likelihood and severity of impacts, a precautionary approach is in order."	Effectively justified claim	This claim explicitly references a diverse array of recent evidence sources, including scientific literature, gray literature, government sources, and Indigenous knowledge. Sources are context specific and largely up-to-date, reflecting recent changes. Knowledge gaps and uncertainties are identified, and importantly, a precautionary approach is accordingly advocated. Areas for future research and evidence gathering are also indicated.
Claim: "Ecological connectivity within the Natural Area is good." Supporting evidence: "Large matrix forest blocks suggest an adequate level of ecological connectivity across the landscape for forest viability (e.g., Anderson & Bernstein, 2003; Fahrig, 2003). Ecological disturbance, such as insects and wind, is within the natural range of variation, with the exception of fire events, because fire has been suppressed in the NA (Canadian Forestry Service, 2000)."	Insufficiently justified claim	The statement that ecological disturbance is within the natural range of variation is not referenced, nor are the implications of fire suppression explained. Cited literature is relatively outdated and not specific to the context. Additionally, landscape connectivity is species specific; claims of connectivity are not linked to specific targets.
Claim: The threat of unsustainable forestry to biodiversity targets in the Natural Area is low. Supporting evidence: "Unsustainable forestry can create different temporal and spatial patterns than natural disturbances such as wind throw and fire. Harvesting within mature forests creates early-successional habitats which can degrade forest habitat and wildlife movement corridors. Harvesting has direct impacts on wetland and river targets through harvesting within riparian areas and indirect impacts through alteration to quality, quantity and timing of water flows. Depending on the nature of the unsustainable forestry, the threat may slightly to seriously degrade or reduce the target. Logging and wood harvesting is ranked as the only very high threat to priority bird species within the Pacific and Yukon Region (Environment Canada, 2013)."	Insufficiently justified claim	This claim includes minimal citation, and the reference is not specific to the context (an Environment Canada report on bird conservation strategies in the Northern Pacific Rainforest). No other types of evidence are referenced. Unsustainable forestry practices are not defined, nor are the specific projected impacts assessed. Potential uncertainties are not identified, and the link between the threat description and a low threat status is not described.

*Strength of claim coded based on the criteria described in Table 2.

disagreement between Indigenous knowledge holders and government biologists (York et al., 2016). The PBSG acknowledged that "the population is thought to be stable based on local traditional information" (IUCN SSC PBSG, 2021). Despite these uncertainties and the reliance on outdated literature, the status of this biodiversity target was assessed as good. Note that the quantitative results of the overall accuracy of claims are not presented here because the sample was not representative.

Gaps in evidence use

The process of analyzing claims also revealed consistent gaps in evidence use in specific sections of the plans (action and monitoring plans, direct threats, and situation analyses) and topic areas (human–wildlife conflict, impacts of tourism and recreation, invasive species control measures, aquaculture, and communication strategies). Direct threat sections demonstrated the most use of evidence (Figure 3b), but also left a large proportion of claims unsubstantiated (22%). This was particularly prevalent in summaries of threats assessed as low (71% coded as *insufficient* or *lacking evidence for threat assessment*) versus those determined to be medium (45%) or high (18%). This was notable in certain topic areas: for instance, claims regarding human–wildlife conflict were frequently underdocumented in NCC conservation plans. In one illustrative example, the Milk River Ridge (MRR) NACP III (2018) claims: "Grizzly Bear are currently expanding their range into the MRR Natural Area after decades of absence; however, range expansion may be limited by conflict with humans and the threat of reprisal killings. Predator control is an issue for more than just Grizzly Bear, as Coyote, Wolf, and Cougar are also targeted. Predator control is always an issue on

agricultural land in Alberta." This claim does not explicitly reference evidence, including practitioner knowledge, or address underlying behavioral motivations. In verifying this claim, we found a significant body of peer-reviewed literature that identifies drivers for human–wildlife conflict and highlights attitudes, perceptions, and ecological impacts of conflict on these species (Treves et al., 2011; Milligan et al., 2018; Appendix S6).

Action and monitoring planning demonstrated the least direct use of evidence, with <1% of all claims referenced. All action plans analyzed included communication and outreach strategies, but none cited relevant evidence or measured the outcomes of chosen approaches. Survey responses echoed the need to improve linkages between planning and implementation: "Many of our plans are rarely used to help inform day-to-day decisions (although we're trying to make changes to improve this) and they are very heavily focused on conservation only. Most day-to-day decisions include nonconservation perspectives, and there is a disjunct between our conservation plans and the reality in which we work."

Actions were also coded based on whether they were consistent with, or departed from, conventional actions and strategies: 38% were coded as status quo (continuations of existing or conventional management strategies), 31% were coded as modifications to existing strategies, and 31% were coded as novel or alternative strategies (Appendix S4). The NCC action plans remain heavily focused on land acquisition, whether through conservation easement or fee simple land purchase. This corresponds to budgeted weight. In each of the NACPs sampled, the portion of budget allocated to private land securement was over 33% and up to 97%, dwarfing any other single allocation of resources in every plan.

Indigenous and local knowledges

Among the plans sampled, Indigenous knowledges were infrequently referenced or availed as an evidence source for social and ecological claims (2%). Indigenous values related to traditional territories—which underlie natural areas—were also rarely acknowledged, particularly at the Property Management Plan level. Most sampled plans contained general statements on engagement with First Nations and Indigenous communities, yet few elaborated to identify specific, actionable strategies to align their practices and outreach efforts with the goals and interests of Indigenous partners and rightsholders. Survey results also indicated that 11% of respondents considered Indigenous or local knowledges as evidence in planning always or most of the time, and 34.5% of participants suggested that they experienced difficulty engaging with these knowledges. In open-ended responses, participants further elaborated that efforts to engage seriously with Indigenous communities are recent, vary by planning region, and are currently limited due to resource constraints and a lack of established relationships (example responses in Appendix S7).

However, qualitative analyses revealed several notable examples of collaborative, multiple evidence-based conservation planning. The Gamdis Tlagee PMP I (2018) engaged consistently in collaborative conservation planning and comanagement; the Tallurutiup Imanga NACP I (2018) showed NCC supporting Indigenous conservation by acting in a technical capacity; the Bay of Fundy NACP I demonstrated support for Indigenous-held protected areas as an alternative to fee-simple purchase for protecting land in its action and monitoring plan; and the Lower Q'Apelle and Quill Lakes NACP II (2019) illustrated a respectful and practical action plan for developing partnerships with First Nations and learning from Indigenous knowledges. In 2019, NCC published a guidance document for planners outlining principles for engagement with Indigenous Peoples (NCC, 2019). Several NCC planners suggested that these ideals are informing a broader organizational effort to better align the planning paradigm with Indigenous partners' goals, rights, and knowledges.

Organizational deliverables

We compiled our results into a detailed report on evidence use for internal distribution at NCC (for details, see Appendix S2). This report included a thorough literature review and discussion of methods, document analysis, and survey results, including summary tables with explanation of the coding criteria and examples from specific plans, organized by section and plan type, discussion of overarching findings on patterns in evidence use, including regional strengths and weaknesses, and specific recommendations for improved use of evidence in planning, referencing updated literature where appropriate.

DISCUSSION

Our document analysis showed specific opportunities for improving NCC's planning processes. The gap in evidence use associated with action and monitoring plans suggests missing links between planning and implementation. The EBC literature indicates persistent management inertia, characterized by continued reliance on conventional management options despite new data on the effectiveness of certain interventions (Pullin et al, 2004). Although NCC appears to modify actions and incorporate novel strategies, these rarely met the criteria we identified for effective use of evidence (Table 2). Notably, action items associated with communication, stakeholder engagement, and outreach rarely avail evidence from academic research on environmental communications to identify appropriate and effective outreach approaches (e.g., Sterling et al., 2017; Stern et al., 2017) (Appendix S6). Where the evidence used to support claims and decisions in conservation plans is not clearly described or cited (Table 3), future planners will be unable to count on these existing in-house plans as reliable sources of evidence. Explicit references to the information underpinning claims can bolster planners' confidence in a critical source of efficient, context-specific, and accessible information to support decisions.

We paid particular attention to the engagement with Indigenous and local knowledges, evaluated against both NCC's internal documents and practices recommended by Indigenous academics in the peer-reviewed literature (Ahenakew, 2016;

Reo et al., 2017). Our results suggest that, despite significant interest among planners in engaging more effectively with Indigenous Nations, barriers persist. Many planners surveyed expressed interest in doing so, but were uncertain about how to appropriately engage with Indigenous Peoples and their knowledges—this discomfort reflects the persistent challenges of building relationships sufficiently trusting and equitable to support respectful knowledge sharing across knowledge systems. There is difficult work ahead to meet evolving expectations for Indigenous and nongovernmental organization partnerships in conservation and to align conservation work with goals of reconciliation. Although these changes do not occur overnight, some recent plans showed encouraging signs of shifting priorities. These examples—coupled with the responses of NCC planners and NCC's recent efforts to formally reframe principles of Indigenous engagement (NCC, 2019)—indicate a willingness and interest in engaging effectively with Indigenous Peoples in conservation planning and enabling Indigenous-led conservation.

Strengths and limitations

We demonstrated a systematic and detailed approach for evaluating patterns in evidence use within and across conservation plans. By treating claims as units of analysis, we were able to conduct a rigorous quantitative analysis of the types and amount of evidence used, whereas the qualitative analysis added depth and nuance to these insights (in addition to improving their utility for NCC planners). Survey results further allowed us to identify barriers and compare perceptions of evidence use with references documented in the conservation plans. This mixed-methods approach enabled targeted recommendations, which can assist in developing more robust, multiple evidence-based planning as NCC moves to redefine its planning standards under a new strategic plan. However, because our pilot case study explored evidence use only at 1 organization, specific results and recommendations are not broadly generalizable beyond NCC. Nonetheless, we anticipate that the proposed methodology could offer a useful evaluation template for conservation organizations that compile area-based plans and rely on dispersed networks of planners to undertake standardized planning processes.

The criteria used for assessing the strength of claims (Table 2; details in Appendix S4) aimed to reflect standards for both quality and quantity of evidence, including importantly whether the evidence provided is fit for purpose. For example, a claim regarding the system dynamics of a specific local context, attributed explicitly to a seasoned planners' observations, would be categorized as a well-justified claim. This design disrupts a conceptual framework that places peer-reviewed scientific literature unambiguously at the apex of an evidence hierarchy, allowing for broader consideration of the evidence informing decisions. However, the strength of claim analysis had several shortcomings. First, because the appropriate quantity and type of evidence differed among claims, strength was difficult to assess systematically. To address this, claims were selectively double coded for consistency, but were not verified by a full duplicate round of coding. Second, because the subset of claims coded by strength of claim in our pilot study were not sampled representatively, a formal statistical analysis of the proportion of claims that were effectively justified fell outside the scope of this study. Finally, although we identified many studies considered relevant or potentially relevant by coders (Appendix S6), these searches to test the accuracy of claims were not exhaustive and likely missed relevant evidence.

Another potential limitation of our approach is that assessment methods are susceptible to a Catch-22 (Pullin et al., 2004; Walsh et al., 2019): If planners do not have the capacity to conduct literature reviews, how likely are they to have the spare time to evaluate their own use of evidence? The proposed mixed methodology, particularly the in-depth document analysis component, is undeniably resource intensive. During our own analysis, more than 50 coding hours were spent on the subset of claims checked for accuracy. Completing surveys requires planners to take time away from other pressing tasks. Trade-offs notwithstanding, identifying specific gaps in evidence use—particularly those with high consequences in terms of outcomes—may yield benefits in efficacy and efficiency down the line.

Proposed changes to the methodology

Figure 4 illustrates a step-wise summary of our proposed methodology, which entails a few key departures from the pilot study. First, we suggest that beginning the assessment process by conducting expert interviews with conservation planners (Figure 4, step 2) may streamline the process by addressing specific needs or gaps, informed by planners' understanding of the organizational context. Inclusion of interviews prior to conducting a survey could enhance buy-in and collaboration among organizational staff, in addition to informing the questionnaire. This step can help evaluators hone the document analysis process and reveal context-specific barriers to evidence use to inform more feasible recommendations.

Second, tailor the methodology to fit organizational needs and capacity limitations. The proposed approach is more comprehensive than is practical for most in-house teams to adopt. The interview and survey portions of the study design could be augmented or omitted depending on organizational capacity and interest. Portions of the document analysis coding frames could be selected to target the analysis toward specific topics or aspects of the planning process (e.g., threat assessments, gaps in planners' expertise, high risk actions). Using a more efficient and better-contextualized coding strategy, the project coordinators could then analyze a larger sample size of plans, allowing for improved comparison between planning regions and scales (coding frame [Appendix S4] has been streamlined since the pilot study). Alternately, a robust randomized sampling approach (of plans and of claims in plans) could allow evaluators to apply the full method to a smaller volume of data and yet draw significant conclusions. This would usefully be

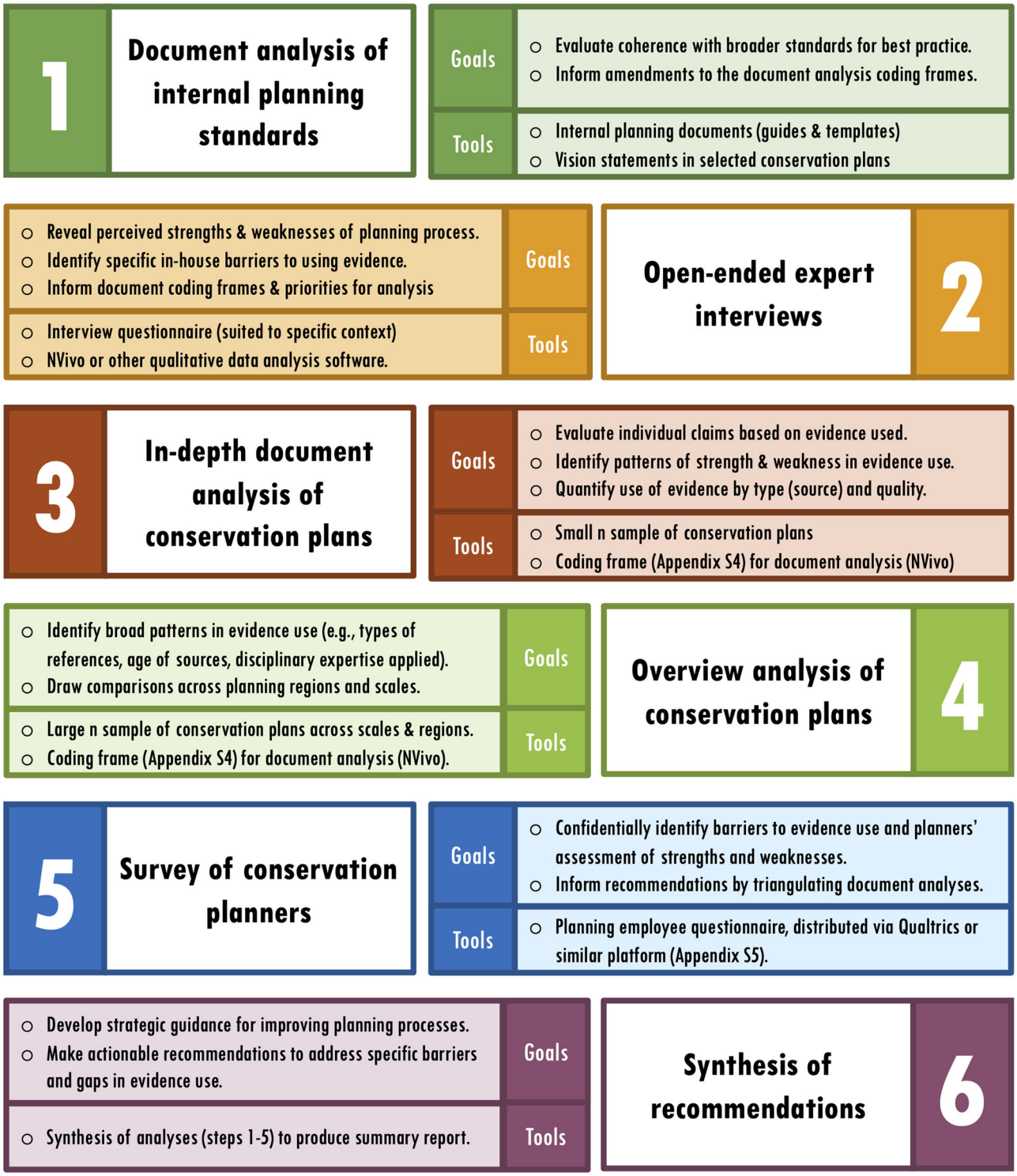

FIGURE 4 Based on this study, a proposed step-wise methodology for evaluating evidence use in conservation planning

coupled with an overview analysis—perhaps employing automated coding for tasks such as checking references—to rapidly appraise evidence use across the organization (Figure 4, step 5). Ideally, future applications of this method would also include duplicate coding of the document analysis to triangulate results to improve the accuracy and consistency of the findings. These changes could improve the method's efficiency and procedural soundness.

Finally, if applied consistently and transparently, this methodology could also allow for comparison of evidence use between organizations, critical for collective learning among the conservation community of practice. Sharing evaluation strategies and

associated results would greatly add to the value of carrying out such assessments. As a survey respondent noted, "More stringent process for reporting on successes and failures of previous plans [are necessary]. By identifying successes, we can ensure that evidence is used to develop future iterations of plans. By identifying failures, we can better understand why approaches failed and adjust our approach." We argue that this methodology fills an important practical gap in the assessment literature—to our knowledge, there is no widely adopted method in the conservation social science literature for evaluating evidence use. Because it provides insights not only into the types of evidence used, but also into the underlying processes that structure decision-making in planning, this methodology could support transitions to more effective conservation planning by highlighting procedural insufficiencies.

Among the conservation community, there is broad agreement on the need to make management decisions based on the best-available evidence. Yet assessment of progress toward this goal remains limited. Tools for evaluating the use of evidence in conservation planning documents can support practitioners in improving their planning processes to better incorporate the diversity of relevant information available. The mixed assessment methodology we propose combines a rigorous analysis of planning documents with a focus on the perspectives and experiences of planners themselves to inform targeted recommendations for improvement.

In a crisis discipline such as conservation, it is imperative to make strategic use of scarce resources and to ensure that lessons learned are disseminated with the wider community of practice. Sharing results of in-house assessments can serve other conservation organizations by drawing attention to key knowledge gaps, revealing procedural barriers that inhibit evidence use and allowing comparison of strategies. By paying attention to the underlying planning structures, this process can also yield insights about organizations' evidentiary biases and the relationships with outside stakeholders and rightsholders. All of these lessons can inform actionable recommendations for improved practices of evidence use in planning. Accordingly, we emphasize the potential utility of adopting a transparent, inclusive, and accessible assessment methodology for ensuring that conservation planning and decision-making is actually making the best possible use of the best possible evidence.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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