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Bridging the research-implementation gap requires engagement from practitioners

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Abstract

A widely recognized challenge in natural resource management and conservation is the gap between the knowledge generated by researchers and the information being used to inform policy and practice. This research-implementation gap can limit the effectiveness of conservation practice when it results in delayed adoption of approaches that produce better outcomes or a failure to discontinue the use of ineffective practices. To date, much of the discussion about bridging the research-implementation gap has focused on changes to the supply side, that is, the flow of information from scientists to practitioners. However, changes to the practice of conservation, the demand side, are an important, and often overlooked, component of efforts to increase conservation gains in the face of unprecedented rates of extinction. We use a decision-theory perspective to explore how program managers and implementers can use existing tools from evidence-based conservation and adaptive management to more efficiently allocate investments to the use and generation of evidence. Use of these frameworks to achieve broad-scale change in conservation practice will require building additional capacities into conservation programs across scales. We recommend five actions that conservation practitioners and their institutions can take to bridge the research-implementation gap in conservation.

KEYWORDS
adaptive management, decision making, effectiveness, evidence-based practice, knowing-doing gap, knowledge mobilization, research utilization

1 | INTRODUCTION

For more than a decade, conservation scientists have recognized the challenge of closing the gap between the knowledge generated by researchers and the information being used to inform policy and practice (Knight et al., 2008; Sunderland, Sunderland-Groves, Shanley, & Campbell, 2009). The traditional separation between the work of academics and that of practitioners can lead to a mismatch between the topics being researched and the information needs of those engaged in conservation practice.[1] This mismatch can diminish the relevance of biodiversity and environmental science to policy and

Tweetable Abstract Practitioners can expand the use of existing decision support tools to help close the gap between conservation science and implementation. Target audience: Practitioners interested in building the evidence base.

implementation decisions (McNie, 2007; see also Bayliss, Stewart, Wilcox, & Randall, 2013). Among practitioners, a culture of "evidence complacency" (Sutherland & Wordley, 2017), in which evidence is not sought or used to inform decisions, can sustain the gap between research and implementation even in the presence of growing efforts to build a more relevant and useful evidence base. A consequence of the research-implementation gap is that conservation practitioners make decisions with incomplete information, which can lead to missed opportunities for action, diminished efficacy, and failures in implementation. As we face unprecedented loss of the earth's biodiversity (Ripple et al., 2017), availing ourselves of all viable options to increase the efficacy of our conservation investments is particularly urgent.

Calls for better science communication, stronger engagement in conservation decision-making processes, and expanded use of participatory modes of research are some of the many strategies proposed for and used by researchers to increase the uptake of science into practice (e.g., Born, Boreux, & Lawes, 2009; Gibbons et al., 2008; Wall, McNie, & Garfin, 2017). A large body of literature on improving the value of research to practice has led to a rich discussion—and many successful examples—about this topic. Our purpose in this article is not to diminish the importance of efforts on the research side of the gap, but to expand the dialogue to more explicitly identify a shared responsibility for practitioners. In part, this requires some rethinking of the ways in which we conceptualize knowledge and the knowledge gap. For example, shifting from a view of knowledge as information that is transferred to something that emerges from interactions between experts and users (Roux et al., 2006) changes the role of practitioners from one of passive recipient to one of active participant. Solutions to the research-implementation gap can come from interactions originating from both sides, an idea that is reflected in Toomey, Knight, and Barlow's (2017) reconceptualization of the research-implementation gap as a series of spaces capable of supporting interactions between the various stakeholders engaged in conservation decision making.

In this article, we argue that changes in the practice of conservation are an equally important, but often overlooked, part of solutions to the research-implementation gap and require combining tools from multiple decision support frameworks. We focus our recommendations on two forms of learning that practitioners are familiar with through their usage in adaptive management and evidence-based conservation. We illustrate five actions that practitioners can take to support efforts to bridge the research-implementation gap with examples of how evidence-based decision making is operationalized in biodiversity conservation programming at the United States Agency for International Development (USAID). We suggest that careful consideration of how these forms of learning are applied to management decisions can and should empower conservation practitioners to take more active roles in bridging the research-implementation gap.

2 | LEARNING AND UNCERTAINTY IN DECISION MAKING

Making decisions with incomplete information is a common feature of the practice of conservation and lies at the heart of decision theory (Keeney, 1982). When faced with a knowledge gap that introduces uncertainty into a management decision, conservation practitioners also face a programmatic decision about how to allocate resources to address that uncertainty. Should they move forward and learn from what happens? Or should they wait to act until more information is available? Stated in another way, when is it better to invest resources in gaining knowledge *before* a management decision has been made (which we call "ex ante learning") and when is it better to invest resources in learning from the outcomes *after* a management decision has been made (which we call "ex post learning")? Many practitioners will be familiar with the use of these complementary forms of learning because they are key components of decision-support frameworks that are already in use, but they are likely less familiar with the implicit tradeoffs that arise from choices about their use to address uncertainty in management decisions.

Ex post learning is captured in the "learning by doing" component of adaptive management. Adaptive management gained prominence in the late 1970s and 1980s as a structured iterative process for making decisions in the face of uncertainty (Holling, 1978; Walters, 1986). While seemingly straightforward in concept, the implementation of adaptive management has suffered from confusion and disagreement on its application and purpose (Allen, Fontaine, Pope, & Garmestani, 2011). However, there is general agreement that a key feature of adaptive management lies in its use of project outcomes to reduce uncertainty. Often this takes the form of testing hypotheses (or assumptions) underlying particular management decisions (CMP, 2013). We recognize that our focus on learning by doing as a mechanism for reducing uncertainty about a conservation decision is only one aspect of the much broader conceptualization of adaptive management. Adaptive management has been characterized as a two-phase process in which an initial deliberative phase precedes an iterative phase of decision making, monitoring, and assessment (Williams & Brown, 2014). It differs from a simpler do-check-adjust cycle in that knowledge gained from implementation is used to

reduce uncertainty in subsequent deliberative phases (i.e., double-loop learning sensu Argyris & Schön, 1978). As practiced in adaptive management, learning by doing involves generating new empirical data during implementation to address knowledge gaps encountered by decision makers in the deliberative phase (Figure 1a).

Evidence-based conservation emerged in the early 2000s in response to the observation that many conservation decisions were based on intuition and experience, disregarding other sources of information (Pullin & Knight, 2001; Sutherland, Pullin, Dolman, & Knight, 2004). Evidence-based conservation places an emphasis on the use of evidence synthesis as a tool for ex ante learning (Pullin et al., 2016). Ex ante learning uses existing information to address knowledge gaps encountered by decision makers prior to the decision (Figure 1b). An important distinction between ex ante and ex post learning is the use of evidence to reduce decision errors, rather than learning from their detection. While there is also a component of evidence-based conservation that focuses on using projects to generate evidence of effectiveness when the evidence base is weak (Pullin & Knight, 2003), the use of various methods of evidence synthesis as a means of closing the research-implementation gap has a more prominent role in evidence-based conservation compared to other decision-support frameworks frequently used in conservation (Schwartz et al., 2018).

3 | DECISION MAKING AND UNCERTAINTY IN THE RESEARCH-IMPLEMENTATION GAP

All decisions involve choices, and when there is uncertainty in the outcomes of those choices, decisions can turn out to be wrong (Johnson, Blumstein, Fowler, & Haselton, 2013; Table 1). For practitioners, uncertainty manifests in the form of information gaps that arise in the design and implementation of conservation projects. These information gaps may result from deficits in personal knowledge (what a team of practitioners knows) or from deficits in the knowledge base (what the field knows). The research-implementation gap occurs when there is a mismatch between what practitioners know and what can be known from the existing evidence. Evidence-based decision making requires a strong knowledge base as well as a narrowing of the research-implementation gap, which requires both ex ante and ex post learning on the part of practitioners.

Gillson, Biggs, Smit, Virah-Sawmy, and Rogers (2019) explore several areas of complementarity between adaptive management and evidence-based conservation. Here we consider complementarity in the use of these decision frameworks to reduce uncertainty in decision making. In concept, there is no reason why adaptive management

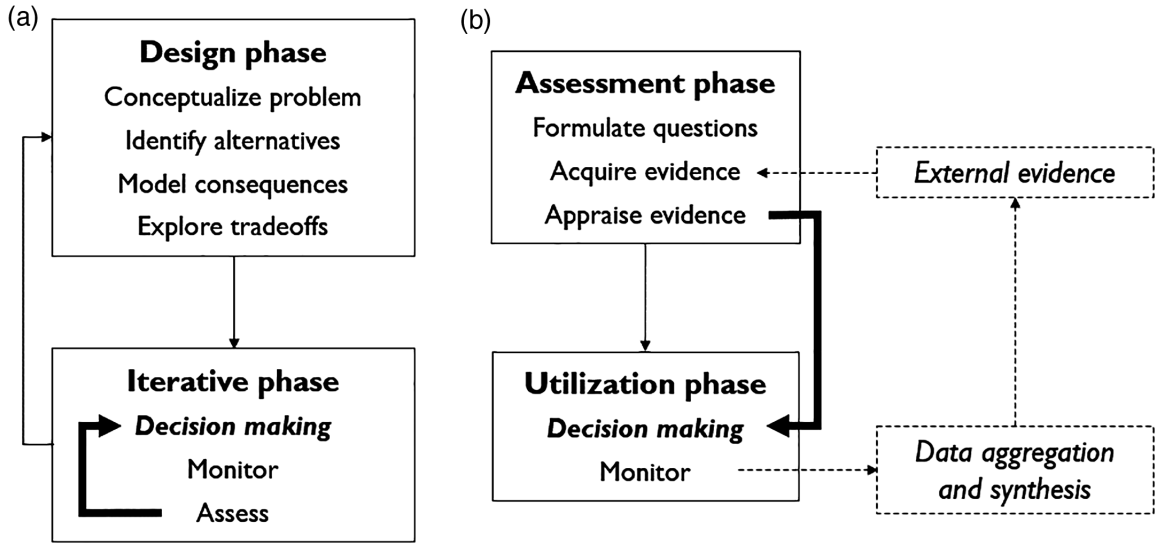

FIGURE 1 Adaptive management and evidence-based conservation emphasize complementary forms of learning (heavy arrows) for addressing uncertainty in decision making. (a) In an information poor environment, adaptive management emphasizes the use of monitoring and assessment to detect decision errors and modify implementation in the iterative phase (ex post learning; backward looking heavy arrow). A second feedback loop informs problem formulation and decisions in subsequent deliberation phases (adapted from figure 1 in Williams & Brown, 2014). (b) Evidence-based conservation places greater emphasis on the use of evidence to reduce uncertainty and minimize the occurrence of decision errors in the utilization phase (ex ante learning; forward-looking heavy arrow). If monitoring data are pushed into the research space, they can be aggregated across projects and synthesized to increase the availability of evidence on effectiveness (see Pullin & Knight, 2003). This feedback loop is conceptually similar to double loop learning in adaptive management, with additional emphasis placed on gathering and critical appraisal of evidence from the broader evidence base

TABLE 1 Four possible decision outcomes depending on the correspondence between the decision makers' assumptions (X) about the state of the world and the actual state of the world (adapted from table 1 in Johnson et al., 2013)

		Actual state of the world	
		X	Not X
Assumed state of the world	X	Correct decision	Type I decision error (misplaced investment)
	Not X	Type II decision error (missed opportunity)	Correct decision

and evidence-based conservation cannot include elements of both ex ante and ex post learning; however, in practice their application frequently leads practitioners to emphasize the use of different forms of learning to address uncertainty. Projects implemented using adaptive management monitor and assess results to adapt implementation and assess the accuracy of assumptions (Salafsky, Margoluis, Redford, & Robinson, 2002; Williams, 2011). Using the iterative cycles of adaptive management for ex post learning can be beneficial in information-deficient contexts. The evidence generated after a decision has been made provides a check on practitioners' prior understanding of the conservation problem and the effectiveness of interventions, but it does not alter the prior probability of a decision error. Whereas in evidence-based conservation, building and using the evidence base to support ex ante learning reduces uncertainty in decision outcomes, reducing the need for practitioners to take on risk associated with learning by doing (Pullin & Knight, 2003).

When there are gaps in the knowledge base, new empirical evidence is required to support ex ante learning. Again, practitioners face a choice. They can select a management action with the information at hand and utilize ex post learning to address the gap, or they delay committing to an action until additional information can be acquired. This latter pathway need not be passive, nor must it require an extended delay. For example, practitioners might commission research or wait for an evaluation of other similar conservation projects to be completed before proceeding. This choice is rarely made explicit in conservation practice, partly because the choice of decision support framework (adaptive management or evidence-based conservation) tends to nudge practitioners toward one form of learning or the other. As a result, practitioners may fail to consider both the return on investment and their risk tolerance for these alternatives before deciding when and how to invest resources in learning to fill information gaps. A decision maker who is risk averse to a misplaced investment (i.e., making a Type I error by committing resources to an intervention that does not work) might commit greater resources to gathering evidence on which to base the initial decision (an ex ante strategy), whereas a decision maker who is risk averse to a missed opportunity (i.e., making a Type II error by delaying or avoiding action when the intervention would have been beneficial) might take immediate action and commit greater resources to detecting and correcting decision errors (an ex post strategy). The view that evidence-based practice and adaptive management can work as nested approaches (Gillson et al., 2009) opens up avenues for practitioners to integrate ex ante and ex post learning into conservation practice.

3.1 | How could a greater emphasis on ex ante learning enhance adaptive management?

Adaptive management is a well-suited approach for conservation action occurring under structural uncertainty arising from deficits in the knowledge base. In this context, learning by doing can be a more direct means to addressing knowledge gaps than delaying a management decision to wait for advances in the knowledge base. However, when a significant research-implementation gap exists, a third alternative is knowledge exchange between research and practice as part of ex ante learning. In evidence-based conservation, the explicit focus on closing the research-implementation gap means that practitioners can focus the learning by doing component of adaptive management on testing assumptions where the knowledge base is weak. This more targeted use of ex post learning speeds up learning feedbacks by prioritizing knowledge exchange over generating new evidence when the primary constraint is a research-implementation gap, so long as practitioners are aware of and have sufficient resources to access the existing knowledge base.

Adaptive management might also adopt principles of question framing from ex ante learning in evidence-based conservation. Well-formulated questions are central to evidence-based practice because they allow practitioners to articulate what information would be useful for decision making and to identify appropriate methods for addressing them (Davies, 2011). Taking the time to figure out the right questions helps practitioners clarify their information needs and query the evidence base. It also allows practitioners to communicate their information needs more clearly with the research community. Similar attention to question framing as part of hypothesis testing

in adaptive management can help practitioners articulate what needs to be learned by doing and increase the usefulness of monitoring and evaluation for future decisions.

3.2 | How could a greater emphasis on ex post learning enhance evidence-based conservation?

Evidence-based conservation relies on "push access" strategies in the form of systematic efforts to compile information from the evidence base and enhance uptake by potential users to close the research-implementation gap. However, push access is frequently constrained by the relevance and quality of information available in the evidence base. Adaptive management provides a useful frame for generating source data for the evidence base. The emphasis on monitoring and evaluation in adaptive management opens implementation to a wider array of design options to test hypotheses underlying program effectiveness in addition to confirming outcomes (Margoluis, Stem, Salafsky, & Brown, 2009b). However, this aspect of adaptive management is underutilized in practice (Fabricius & Cundill, 2014; Grantham et al., 2010). As institutions expand their evaluation systems beyond accountability to encompass learning, the use of ex post learning as practiced through adaptive management could be leveraged to help standardize and aggregate information about individual project performance into larger data sets used to test the effectiveness of conservation interventions more broadly.

To practice evidence-based conservation, practitioners need to know what questions to ask, but identifying the right questions is a recognized challenge for practitioners working in complex programming contexts (Morton & Seditas, 2018). The design tools used in adaptive management to focus ex post learning, including various types of causal models (e.g., Margoluis et al., 2013; Margoluis, Stem, Salafsky, & Brown, 2009a; Qiu et al., 2018), help teams identify the assumptions influencing program decisions. These tools can also help practitioners identify information needs that are potential candidates for ex ante learning in evidence-based conservation. Having tools that support the process of figuring out what a team needs to know and how that information will be used is fundamental to ensuring that the time and resources committed to acquiring additional information prior to decision making are cost-effective (Morton & Seditas, 2018). Using models to distinguish weak assumptions in a conservation project (i.e., those with less evidentiary support) from research-implementation gaps has the added benefit of helping teams direct and prioritize ex post learning investments.

4 | RECOMMENDATIONS FOR PRACTITIONERS

It has been more than 15 years since Pullin and Knight (2001) called for stronger use of evidence to improve the effectiveness of biodiversity conservation programs. By now it is clear that, on its own, improving the availability of evidence, even when that evidence is salient, credible, and legitimate (Cash et al., 2003), is not enough to facilitate broad-scale change in the way that decisions are made (Langer, Tripney, & Gough, 2016). Our experiences with biodiversity conservation programs at USAID (Box 1) suggest that many practitioners have yet to be fully engaged in solutions available from the implementation side of the research-implementation gap. The importance of more fluid connections between researchers and implementers is well-recognized and increasingly supported by intermediaries focused on facilitating the exchange of information across the gap (Farwig et al., 2017; Safford, Sawyer, Kocher, Hiers, & Cross, 2017). Just emerging in this conversation is the explicit role that those managing and implementing conservation programs can play in the space between research and implementation (Toomey et al., 2017). This is a call to practitioners encouraging more strategic use of ex ante and ex post learning, familiar components of adaptive management and evidence-based conservation, in ways that better support the efforts of researchers and scientific institutions seeking to inform the practice of conservation.

BOX 1 Evidence-based approaches to biodiversity programming at USAID

USAID is one of the world's largest conservation donors, working to conserve biodiversity in more than 50 countries around the world (USAID, 2017a). Adaptive management is one of the four core principles of USAID's Program Cycle (USAID, 2018a), the Agency's model for program design and implementation. Since the inception of the Agency's Biodiversity Policy in 2014, USAID has focused on building capacity to design, monitor, and evaluate effective biodiversity programs, while enhancing the evidence base that informs programming decisions. To date, USAID has engaged staff in efforts to bridge the research-implementation gap in conservation by:

1. Influencing the scope and topics of research being produced, and
2. Providing institutional and programmatic support for the use and generation of evidence in biodiversity programs

In the spirit of Knight et al. (2008), who provided an informative set of recommendations for scientific institutions and researchers aimed at strengthening linkages between research and practice, we present five recommendations aimed specifically at practitioners and their institutions: (a) recognize there are risks associated with over-reliance on a single form of learning; (b) use evidence-based conservation and adaptive management as complementary approaches; (c) strengthen ex ante learning with push and pull strategies for knowledge exchange; (d) improve the flow of data from practice to research; (e) use ex post learning to build the evidence base. These recommendations come from our collective experience supporting and participating in different aspects of conservation program design and implementation, and include our experience working for and with USAID. They do not comprise an exhaustive list, and we present them here with the intention of advancing the dialogue between researchers and practitioners. Our recommendations are geared toward practitioners working in organizations that acknowledge the value of new information for improving programmatic outcomes and have systems and processes in place to promote uptake into decision making (i.e., absorptive capacity, see for example Murray, Roux, Nel, Driver, & Freimund, 2011 and references therein). Building absorptive capacity at the organizational level is clearly important for furthering evidence-based practice but is a topic that is outside the scope of this article.

We illustrate our recommendations with examples of how evidence-based decision making is being implemented in biodiversity conservation programming at USAID. We acknowledge that implementing these recommendations places additional demands for time on often already overburdened practitioners and decision makers. In this sense, implementing our recommendations may be aspirational for many. We also recognize that complementary use of ex post and ex ante learning as part of conservation practice is not necessarily straightforward but suggest that practitioners can start by being explicit about the costs (e.g., in staff time) and the benefits (e.g., limiting risks or improving program outcomes) involved.

4.1 | Recognize there are risks associated with over-reliance on a single form of learning

To achieve effective and efficient use of program resources, implementers need to critically examine their options for reducing uncertainty in decision making. Adaptive management can function as a process for testing hypotheses about how conservation interventions work (Grantham et al., 2010), but over-reliance on ex post learning can make programs vulnerable to decision errors in design. Without explicit mechanisms to pull knowledge across the research-implementation gap, practitioners can waste resources testing interventions that the existing evidence base suggests are unlikely to work. We suggest that both ex ante and ex poste learning should be considered when addressing uncertainty. Conflating these two forms of learning can introduce unnecessary risk into programs.

Conservation projects are made up of many interrelated decisions that may reveal a bewildering array of information needs. The relative value of ex ante and ex post learning is likely to differ depending on the types of programming decisions each information need is intended to inform. Practitioners should explicitly combine both forms of learning to minimize the repercussions of a research-implementation gap on project outcomes. How to achieve the appropriate mix may not necessarily be straightforward, and therefore providing guidance and support to evidence users may be required for institutionalizing evidence-based decision making (Morton & Seditas, 2018). As an example, in 2018, USAID published a resource called "Evidence in Action" (produced by two of the authors of this article, NSD and AG, with oversight by DR) to (a) help program teams understand how to gather and appraise evidence and use that evidence to inform decisions as part of USAID's adaptive management framework and (b) generate evidence to fill knowledge gaps in the USAID programming context. This resource models the intentional integration of conservation practitioners' expertise, often acquired through adaptive management of implemented projects, with knowledge from the broader evidence base.

Learning about the system being managed, whether by ex ante or ex post mechanisms, requires a commitment of project resources in contexts where resources are frequently already in short supply. In real-world applications, we acknowledge that there are practical constraints placed on practitioners that may limit their capacity to balance both forms of learning to suit their specific situations. For example, practitioners are required by their funders or institutions to meet certain accountability standards, which may divert resources from investments aimed at learning about the system being managed. Like many of the recommendations used on the research side of the research-implementation gap, mechanisms applied from the implementation side require institutional-level support in their application.

4.2 | Use evidence-based conservation and adaptive management as complementary approaches

Conservation practitioners are accustomed to structuring management decisions and assessing tradeoffs between specified alternatives. Whether they recognize it or not,

practitioners are also making decisions about how and when to invest resources in learning and what tools are best suited to addressing existing knowledge deficits when they design conservation projects. Strict adherence to a single decision support framework may keep practitioners from choosing the best approaches for addressing these deficits (Schwartz et al., 2018). For example, the use of monitoring data to compare a project's outcomes to its intended objectives, a learning approach commonly used in adaptive management, answers a different question (is our project working?) than using evidence from the broader evidence base to select an appropriate conservation intervention (is this intervention likely to work?). One way that practitioners can more efficiently address these multiple information needs is by embedding evidence-based conservation within the adaptive management framework (Gillson et al., 2019).

In reality, practitioners face multiple constraints to addressing existing knowledge deficits when implementing conservation projects. For example, operational policies can limit the time available for acquiring information before key design and implementation decisions must be made. In other instances, reporting requirements may constrain data collection. However, without explicit acknowledgment of the costs and benefits of different investments in learning, practitioners can get caught in a cycle of collecting more and more data—or the wrong data—without adequate consideration of how (or whether) the information will lead to better future conservation decisions. Better awareness of the added value of information for individual conservation decisions, both before and after the decision is made, can help practitioners select among the suite of tools that support learning in the different decision support frameworks used for conservation. In particular, we see value in more explicit consideration of tools focused on closing the research-implementation gap (which are emphasized in evidence-based conservation) as a complement to the iterative learning processes frequently associated with adaptive management. Expanding decision support tools to help practitioners identify the subset of problems that are more amenable to the ex ante approaches emphasized in evidence-based conservation (those where there is good-to-moderate understanding of the problem) and where to build iteration and ex post learning (from adaptive management) into evidence-based approaches (Gillson et al., 2019) is an essential step for maximizing practitioner investment across different forms of learning.

4.3 | Strengthen ex ante learning with push and pull strategies for knowledge exchange

Evidence-based conservation depends on having a body of evidence with which to inform practice. Building an evidence base that can effectively inform implementation decisions requires overlap between the interests of academic researchers and those of practitioners. Identifying and sharing implementation-relevant information needs facilitates interest in addressing them by scientists and funders (Roux et al., 2006). Expanded interest in collaborative approaches to knowledge exchange (Cvitanovic et al., 2015) and the rapid growth in research on conservation effectiveness (e.g., http://www.environmentalevidence.org/journal) are signs that researchers are doing a better job of addressing practice-relevant questions. Here we suggest that several of the strategies used to promote knowledge exchange between researchers and practitioners also help to build a practice-relevant evidence base.

Knowledge exchange processes are often characterized as either push or pull strategies, where researchers push and practitioners pull knowledge across the research-implementation gap (see Roux et al., 2006 and discussion therein). Stronger engagement by practitioners with the research community through formal (e.g., professional conferences) and informal channels (e.g., individual collaboration) can be used as a pull strategy to make researchers more aware of their evidence needs and speed up the rate at which relevant and accessible evidence is produced. Synthesizing and disseminating critically important research themes and questions can be an efficient way for communicating with the research community about perceived evidence gaps (Sutherland, Fleishman, Mascia, Pretty, & Rudd, 2011) either in the published literature (see Sutherland et al., 2006 and Sutherland et al., 2009 for examples) or by producing and disseminating practitioner-led research agendas. As an illustration of the latter, the USAID Biodiversity and Development Research Agenda (USAID, 2015) identified and prioritized policy-relevant research questions that could be transmitted into the research arena and helped identify mismatches between the research base and the information needs of USAID staff and partners. Another example is the compilation of information needs produced by the Australian Government's Great Barrier Reef Marine Park Authority (http://elibrary.gbrmpa.gov.au/jspui/handle/11017/2872).

Formulating questions designed to cross the research-implementation boundary strengthens the quality and relevance of research inputs available for ex ante learning in program design and implementation. However, translating questions coming out of practice into the research arena is not always a straightforward process even for practitioners fully committed to evidence-based approaches (Morton & Seditas, 2018). An additional challenge is that even when researchable questions can be identified, it may be difficult for practitioners to find appropriate fora in which to broadly share them with researchers. The use of push strategies that strengthen end-user involvement in the processes of science

production, either through direct engagement with researchers or with the help of boundary organizations (i.e., organizations that specialize in facilitating knowledge exchange between research and practice; Bednarek et al., 2018), should be viewed as mutually beneficial and encouraged by all stakeholders. In the sustainability sciences, the emphasis has largely been focused on engaging end users in the processes of producing, communicating, and applying knowledge through coproduction and other models of interactive science production (although this view is expanding; see discussion in Wyborn et al., 2019). One application of coproduction is the actionable science model adopted by the United States Department of Interior's Climate Adaptation Science Centers (Beier, Hansen, Helbrecht, & Behar, 2017).

4.4 | Improve the flow of data from practice to research

Roux et al. (2006) advocate for moving beyond push and pull strategies for knowledge exchange to "knowledge interfacing and sharing" between science and management. We suggest that doing so requires reconsideration of the push and pull mechanisms governing the flow of data from practice to research. On the data side, researchers pull data from conservation projects into research, but practitioners lack mechanisms to push their data into the research space. Calls for accountability and transparency have practitioners producing increasing amounts of data, but these data remain largely fragmented and inaccessible and, as a result, rarely inform practice (Keene & Pullin, 2011). An additional issue that can inhibit information exchange is the perceived (or real) risk that practitioners may face in reporting failures or lessons learned. Learning institutions enact systems that distinguish underperformance from knowledge generation. For example, USAID encourages "pause and reflect" activities on a regular basis along the life of its projects (see USAID, 2018b) to create safe spaces where insights about what is and is not working can be shared. Other efforts to improve the practice of monitoring, evaluation, and learning are being advanced by many other organizations in the conservation field.

Monitoring and evaluation, adaptive management, and organizational learning all have the potential to generate information about performance and effectiveness that can feed into the research arena. However, appropriate data must be collected, catalogued, and made available in useful formats to be taken up in formal research projects and ultimately applied to inform implementation decisions. This is an enormous challenge for donor and implementing organizations that often lack (or do not invest in) the data repositories and infrastructure needed to turn project data into empirical evidence. Practitioners will need to balance generating data to address questions about project performance (often focused primarily on accountability) while also generating data that can be aggregated across different projects to build an evidence base about conservation effectiveness. Coordinating these efforts requires a shared vision that is just beginning to emerge in the conservation sector.

Conservation funders have a particularly important role to play in bringing these data sources into the research space because they can coordinate data across project portfolios and facilitate the flow of information from practice. Examples include the World Bank's Projects and Operations database (http://projects.worldbank.org/), the collection of data and reports produced by the Bank's Independent Evaluation Group (http://ieg.worldbankgroup.org/data), and the AidData database. These data have been scarcely used to investigate conservation implementation experiences but hold great potential to increase our understanding of conservation effectiveness (Kareiva, Chang, & Marvier, 2008). Part of the challenge in using these data is that they are not easily mined due to the lack of common reporting standards. Here we echo the call for standardized reporting of the costs of interventions made by Iacona et al. (2018). Fully harnessing the benefits of monitoring and evaluation data requires analysis of as large a body of implementation experience as possible in order to provide robust guidance to inform future programming decisions.

4.5 | Use ex post learning to build the evidence base

Improving the flow of information from practice to research does little to build the evidence base for conservation if that information is of insufficient quality to make reliable inferences about conservation effectiveness. However, most practitioners have not yet adopted a mindset of situating projects within a broader evidence-based model. For example, a recent systematic map looking at the effectiveness of conservation planning found that outcomes from conservation plans are rarely made publicly available and, when they are, the data are frequently of insufficient quality to make robust conclusions about reported outcomes (McIntosh et al., 2018).

Practitioners can and should leverage the capabilities of adaptive management to use conservation projects as research instruments to address questions about conservation effectiveness. This means that ex post learning from monitoring and evaluation should be expected to produce transferable knowledge that extends beyond simply assessing the success of a project in meeting its goals. The changes required in current practice do not need to

be onerous, but they will require practitioners to think carefully about the questions they wish to answer and be more strategic in what and how data are collected. Socializing common monitoring frameworks (such as in USAID's combating wildlife crime toolkit; USAID, 2017b) can promote the alignment of metrics across conservation projects. Furthermore, increased emphasis on management effectiveness evaluation has brought expanded design options to conservation practice that can also be applied to implementation (Margoluis et al., 2009b). Thoughtful research design can reduce the amount of data teams need to collect while simultaneously increasing the internal and external validity of their conclusions. For example, a team collecting data on the yearly incidence of fishing violations in a network of protected areas might structure data collection to examine the association between patrol effort and fishing violations rather than focusing exclusively on indicators of levels of threat. Whenever feasible, practitioners should engage researchers to gain insights into robust frameworks for data collection and analysis.

At USAID, technical assistance can provide additional support to teams interested in using project implementation to generate credible evidence about conservation effectiveness. Two common entry points for technical assistance that we have encountered are (a) helping program teams prioritize and formulate researchable questions, and (b) structuring the decision process about when and how to invest resources into gathering and generating evidence. Teams often benefit from decision support tools that help identify which of their information needs warrant investment in gathering evidence during program design and when to leverage monitoring, evaluation, and learning processes to generate evidence as part of implementation. This is where adaptive management provides a useful frame around program implementation for hypothesis testing and evidence generation. Evaluation is an important avenue for generating evidence for adaptive management within and across projects, but the use of such mechanisms to generate evidence on effectiveness that can be pushed back into the research space remains relatively weak. Connections between researchers and practitioners are supported by boundary spanners and an emerging cadre of translational ecologists (professional ecologists who partner with decision makers to solve environmental challenges) to guide the exchange of good science into informed practice (Enquist et al., 2017; Nel et al., 2016; Schwartz et al., 2017). We suggest there is also an expanded role for boundary spanners and knowledge brokers (who traditionally have served as the interface between producers and users of research) to help practitioners strengthen the usefulness and accessibility of implementation data for research (Cvitanovic et al., 2015). USAID provides some of these services through technical assistance to program teams, but it remains an open question as to whether these boundary-spanning functions will need to be sustained by specialized staff or can become part of the technical capacity maintained by design and implementation teams.

5 | CONCLUSION

Those promoting evidence-based conservation frequently laud advances in the availability of evidence syntheses while lamenting how lack or inaccessibility of data continue to inhibit growth of the evidence base. On the other side of the research-implementation gap, billions of dollars are being invested in conservation programs that are capable of producing (or are already producing) data that could be used to answer questions about conservation effectiveness. A challenge remains in ensuring that these data are systematically transformed into usable and accessible evidence with which to inform future programs.

There are signs of progress. The increased emphasis on coproduction, a model of research where practitioners take a more active role in shaping the outputs of research (Beier et al., 2017; Cash et al., 2003; Cook, Mascia, Schwartz, Possingham, & Fuller, 2013), along with growing practitioner engagement in the space between research and implementation, can help strengthen the connections between conservation science and practice. The use of evidence to appraise and evaluate causal models (Qiu et al., 2018) is now being adopted into adaptive management frameworks (CMP, 2018; TNC, 2016). However, such practices are not widespread which may result in unnecessary risks being taken with conservation investments.

To further advance this progress, we suggest specific ways in which practitioners can engage in processes of knowledge interfacing and sharing at the research-implementation gap. We believe that by applying both ex post and ex ante learning and considering different decision support frameworks, practitioners can help reduce uncertainty around programming decisions. By identifying and sharing practice-relevant questions and engaging in interactive processes for knowledge creation, practitioners can help guide the focus and content of future research activities. Finally, because project implementation offers opportunities for learning that can improve the global practice of conservation, practitioners are uniquely situated for contributing to efforts to build the evidence base on the effectiveness of interventions. We suggest that viewing the research-implementation gap as the shared responsibility of both researchers and practitioners will expedite knowledge exchange at the research-implementation interface. Practitioners already have several tools at their disposal that can help them do so. Expanding the use of these tools to

facilitate broad-scale change in the way that decisions are made will require building additional capacities into conservation programs across scales.

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CONFLICT OF INTEREST

N.S.D. and A.G. work for consulting companies contracted to provide technical assistance to USAID biodiversity programs under management oversight by the USAID operating unit that includes S.C. (current). and D.R. (previous).

AUTHOR CONTRIBUTIONS

All authors were involved in the conceptual development of the manuscript. N.S.D. and A.G. led writing of the manuscript. All co-authors provided feedback on drafts and approved the final version of the manuscript.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article.

ETHICS STATEMENT

The authors are unaware of any ethical issues regarding this work. The manuscript expresses the views of the authors and was reviewed in accordance with the USAID Scientific Research Policy.

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ENDNOTE

[1] For the purposes of this article, we consider practitioners to include anyone engaged in the policy and practice of conservation and resource management, including, but not limited to, implementers, program managers, funders, and policy makers.

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