Contributed Paper

Linking Knowledge to Action in Collaborative Conservation

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Abstract: *Authors have documented a "research-implementation gap" in conservation. Research intended to inform conservation practice often does not, and practice often is not informed by the best science. We used the literature on policy learning (i.e., literature attributing policy change to learning) to structure a study of how practice is informed by science in collaborative conservation. We studied implementation by U.S. states of state wildlife action plans. On the basis of 60 interviews with government and nongovernmental organization representatives, we identified 144 implementation initiatives for State Wildlife Action Plans that were collaborative. We conducted case studies of 6 of these initiatives, which included interviews of key individuals and analysis of written documents. We coded interview transcripts and written documents to identify factors that influence availability and use of scientific information. We integrated these factors into a model of collaborative conservation. Although tangible factors such as funding and labor directly affected the availability of scientific information, practitioners' ability and willingness to use the information depended on less tangible factors such as the quality of interpersonal relationships and dialogue. Our work demonstrates empirically that relationships and dialogue led to: (1) the sharing of resources, such as funding and labor, that were needed to carry out research and produce information and (2) agreement among researchers and practitioners on conservation objectives, which was necessary for that new information to inform action. Our findings can be understood in the context of broader concepts articulated in the policy-learning literature, which establishes that social learning (improving relationships and dialogue) provides the foundation for conceptual learning (setting objectives) and technical learning (determining how to achieve these objectives).*

Keywords: conservation planning, governance, policy learning, restoration

Vinculación del Conocimiento y la Acción en Conservación Colaborativa

Resumen: *Diferentes autores han documentado un "vacío de investigación-implementación" en la conservación. La investigación que intenta informar a la práctica de la conservación a menudo no lo hace, y la práctica a menudo no es informada por la mejor ciencia. Utilizamos la literatura sobre aprendizaje de políticas (i.e., literatura que atribuye cambios en políticas al aprendizaje) para estructurar un estudio de cómo la práctica es informada por la ciencia en conservación colaborativa. Estudiamos la implementación de planes de acción para vida silvestre en estados de E.U.A. Con base en 60 entrevistas con representantes de organizaciones gubernamentales y no gubernamentales, identificamos 144 iniciativas de implementación de Planes de Acción Estatales para Vida Silvestre que fueron colaborativas. Realizamos estudios de caso de 6 de estas iniciativas, que incluían entrevistas a individuos clave y el análisis de documentos escritos. Codificamos las transcripciones de las entrevistas y los documentos escritos para identificar factores que influyen en la variabilidad y uso de la información científica. Integramos estos factores en un modelo de investigación colaborativa. Aunque factores tangibles, como el financiamiento y labor, directamente afectaron la disponibilidad de información científica, la habilidad y disponibilidad de practicantes para utilizar la información dependió de factores menos tangible como la calidad de relaciones interpersonales y de diálogo. Nuestro*

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trabajo demuestra empíricamente que las relaciones y el diálogo llevaron a: (1) compartir recursos, como el financiamiento y la labor, que fueron necesarios para llevar a cabo el proyecto y producir información y (2) acuerdos sobre objetivos de conservación entre investigadores y practicantes, lo cual fue necesario para que la información nueva informe a la acción. Nuestros hallazgos pueden ser entendidos en el contexto de conceptos más amplios articulados en la literatura de aprendizaje de políticas, que establece que el aprendizaje social (mejora de relaciones y diálogo) proporciona el fundamento del aprendizaje conceptual (fijar objetivos) y el aprendizaje técnico (determinación de cómo alcanzar esos objetivos).

Palabras Clave: aprendizaje de políticas, gobernabilidad, planificación de conservación, restauración

Introduction

Friedmann (1987) defined planning as linking knowledge to action. Planning is integral to conservation, and conservation objectives are more likely to be achieved when knowledge informs actions. However, scientific knowledge is not always linked to conservation action. Research intended to inform conservation practice often does not, and practice often is not informed by the best science.

Knight et al. (2008) documented a "research-implementation gap" in conservation planning. Focusing on the selection of areas for nature reserves, they identified instances in which research intended to improve conservation practice did not. They demonstrated that numerous tools developed to guide conservation assessment typically are not applied in the selection of nature reserves.

Others note the research-implementation gap in other conservation contexts. Tear et al. (1995) argue that recovery plans for endangered and threatened species in the United States often were not biologically defensible or informed by research. Linklater (2003) documented that during a period of rapid decline in rhinoceros (*Rhinoceros unicornis*, *R. dondatcus*, *Dicerorhinus-sumatrensis*, *Ceratotherium simum*, and *Dicerosbicornis*) populations, research was dominated by laboratory studies rather than ecological studies that might have better increased the success of conservation efforts. Higgs (2005) notes there is a research-implementation gap in ecological restoration.

Many reasons are offered to explain this gap. Research that scientists believe might inform practice may not address the questions most relevant to practitioners (Stinchcombe et al. 2002). Practitioners may not recognize or understand the work of researchers or may dislike prescriptive approaches (Prendergast et al. 1999). Implementation funding (Prendergast et al. 1999) and communication and collaboration may be inadequate (Cabeza & Moilanen 2001; Stinchcombe et al. 2002; Roux et al. 2006). Limited attention may be paid to linking research results with practice (Knight et al. 2006*b*). Researchers may not understand how their work relates to political, technological, economic, and cultural factors that influence conservation (Ehrenfeld 2000; McNie 2007).

Our objective was to identify factors that influenced the availability and use of scientific information in collaborative conservation (conservation involving multiple organizations and individuals). Rather than focusing on situations in which science and practice were not effectively linked, as others (Tear et al. 1995; Linklater 2003; Knight et al. 2008) have done, we studied initiatives that were widely considered successful (i.e., resulted in outcomes that contributed to objectives) and explored the mechanisms underlying their success. We considered the roles played by different actors in these cases and the conditions that led to conservation action, including the availability and application of scientific knowledge.

We drew from the policy-learning literature to provide the theoretical foundation for our study. Numerous authors have demonstrated the importance of learning in environmental decision making (Sabatier 1988; Fiorino 2001; Lauber & Brown 2006). Fiorino (2001) and Glasbergen (1996) identified 3 types of learning: technical learning, conceptual learning, and social learning. Technical learning involves efforts to develop new policies to accomplish existing objectives, but does not include changing the objectives. In conservation, technical learning leads to selecting actions to achieve particular conservation objectives. For example, technical learning could contribute to actions that improve the probabilities of persistence of given species at particular sites.

Conceptual learning leads to the development of new objectives and new ways to define a problem. As conceptual learning occurs, objectives are debated, the way people think about issues changes, and new concepts are developed. In conservation, conceptual learning involves selecting and prioritizing particular ends that actions will be designed to accomplish. For example, conceptual learning could contribute to identifying the highest priority species, ecosystems, or sites for conservation.

Social learning focuses on relationships and the quality of dialogue among stakeholders. Many authors use *social learning* to describe the process by which knowledge is developed through interactions between individuals. In the policy-learning literature, the term is used to describe learning about how to improve interactions and relationships between individuals and groups. It entails learning how to promote effective communication and interaction. In conservation, social learning involves identifying and engaging new collaborators or existing collaborators in new ways. For example, social learning could contribute to establishing an interagency task force to coordinate actions across sites.

Many authors calling for a closer connection between scientific research and conservation practice argue that research should contribute to conceptual learning (e.g., such as prioritizing ecosystems or species for conservation) and technical learning (e.g., determining which management techniques are likely to benefit particular ecosystems or species) (e.g., Linklater 2003; Knight et al. 2008). Relatively less emphasized is the relation between science and social learning. All 3 learning types contribute to action, but the dominant types of learning change as initiatives evolve (Glasbergen 1996; Fiorino 2001). Social learning provides the foundation for technical and conceptual learning (Lauber & Brown 2006); developing effective conservation objectives and actions depends on fostering good working relationships between organizations and individuals and effective forums for dialogue.

The role of social learning in linking scientific knowledge to action reflects the importance of collaboration in conservation. Linking knowledge to action often requires many individuals and organizations, including scientists and practitioners, to work together. Consequently, understanding the conditions under which science informs action can be aided by understanding collaborative conservation and the conditions that foster it.

Our objective was to identify factors that influence the availability and use of scientific information in collaborative conservation. Because the policy-learning literature shows that the contribution of learning to conservation involves several related processes operating at different levels, we believe that the factors influencing the availability and use of scientific information need to be viewed as elements of the factors contributing to conservation outcomes. Therefore, we identified these factors contributing to tangible conservation outcomes and assessed the role of availability and use of scientific information in conservation.

Methods

We analyzed data from collaborative implementations of state wildlife action plans (SWAPs) in the United States. Each state fish and wildlife agency prepares a SWAP as a condition for receiving federal funding for certain conservation activities. These plans are intended to be comprehensive and thus exceed the capacity of any individual state fish and wildlife agency to implement unilaterally. Consequently, collaboration has been important in achieving SWAP priorities. We conducted our work in 2 phases. First, we identified collaborative SWAP implementation initiatives and characterized their desired outcomes. Second, we conducted case studies of 6 of these initiatives to develop a model of the collaborative conservation process and to explore the relations between elements in the process, including the relation between knowledge and practice.

To identify collaborative SWAP implementation initiatives, we conducted telephone interviews with 60 individuals knowledgeable about SWAP implementation. We selected these individuals on the basis of recommendations from representatives of governmental and nongovernmental organizations or from lists of SWAP coordinators within state fish and wildlife agencies (typically one in each state). We identified some respondents by asking people in our interviews to recommend others engaged in SWAP implementation efforts. Respondents held a range of positions within state fish and wildlife agencies (often but not always SWAP coordinators), other government agencies, and nongovernmental organizations involved in SWAP implementation. Interviews included open-ended questions in a semistructured interview format. We conducted all interviews between June and September 2008; each lasted approximately 1 h. We asked respondents to identify the collaborative SWAP implementation initiatives with which they were familiar. For each initiative identified, we asked what the goals of the initiatives were; how successful they were; and what factors contributed to their success. The levels of success of initiatives were based on perceptions of respondents. The criteria used to judge success varied among respondents somewhat, but in all cases respondents considered initiatives successful if they led to outcomes that contributed to conservation.

We made an audio recording of each interview. We selected 30 of the recordings that reflected a range of initiative types for transcription. We reviewed interview transcripts and recordings and developed a system for categorizing initiatives according to their intended outcomes: tangible conservation outcomes (species, habitat, or ecosystem restoration or land protection) or increased capacity for conservation (generation of information, funding, or labor resources or agreements among collaborators on conservation needs or strategies).

From the 144 initiatives identified in the telephone interviews, we selected 6 for intensive study that were representative of the diversity of goals, regions, and geographic extents of initiatives. All 6 were considered successful by our informants. Including multiple sites increased our ability to generalize our findings to comparable settings. Findings (about the factors that contributed to conservation outcomes) that were similar at sites with diverse goals and contexts were considered more robust.

Two initiatives, the Grand River Grasslands (Missouri and Iowa) and the South Puget Sound Prairie Restoration initiative (Washington), focused on restoration of prairie ecosystems, habitat, and species. The Nebraska Legacy Project focuses primarily on habitat restoration. This project is a statewide initiative whereby the Nebraska Department of Game and Parks works with other organizations to encourage voluntary conservation by private landowners in highly valued or "biologically unique landscapes." The Vermont Fish and Wildlife Department and Agency of Transportation have been collaborating to incorporate conservation measures (providing for passage of fishes and terrestrial animals, protecting habitat for key species) in transportation infrastructure. The Montana Conservation and Restoration Partnership is a statewide collaboration among state, federal, and local government agencies, nongovernmental organizations, landowner groups, and industry to build capacity for implementing Montana's Comprehensive Fish and Wildlife Conservation Strategy. The Southeast Regional Partnership for Planning and Sustainability oversees an initiative to develop a candidate conservation agreement for gopher tortoise (*Gopherus polyphemus*) restoration in Florida, Alabama, Georgia, and South Carolina. This U.S. Department of Defense-led initiative involves upper level administrators from state and federal agencies.

Between November 2008 and April 2009, we conducted in-person interviews with key individuals involved in each of these collaborative initiatives. Interviews lasted approximately 1 h, followed a semistructured format, and included a series of open-ended questions on perceptions of initiative success; organizations involved and their roles (e.g., who approved conservation actions, provided information needed for decisions, and implemented conservation actions); factors contributing to success (e.g., funding, information, agreement on objectives); and how these factors originated. We interviewed 15 people associated with the Grand River Grasslands, 11 with the South Puget Sound Prairie Restoration Initiative, 8 with the Nebraska Legacy Project, 8 with the Vermont Wildlife-Transportation Agency partnership, 14 with Montana Conservation and Restoration Partnership, and 7 with the gopher tortoise restoration effort. Initial respondents were selected based on recommendations of individuals we interviewed in the first phase of our research. We asked these respondents to identify others who played large roles in the projects in which they were involved. We continued this process until our respondent pool adequately reflected the range of perspectives and available information about each case. We defined adequacy as the point at which respondents no longer provided new information.

We made audio recordings and transcribed all interviews, except for 4 cases in which respondents preferred not to be recorded. The transcripts were coded (Miles & Huberman 1994) (i.e., broken into segments, which were assigned to descriptive categories). One set of categories focused on the outcomes the initiatives were attempting to achieve. This set was also used to categorize outcomes following the first set of interviews. A second set of categories reflected factors contributing to conservation outcomes.

We used Folio Views for Windows 4.3 to retrieve coded interview transcript segments and determine the relations among segments within the transcripts. This process identified respondent perceptions of the relations between conservation outcomes and factors contributing to the outcomes. On the basis of the results of the analysis of these relations across the initiatives, we organized factors contributing to conservation outcomes into a model of the collaborative conservation process. This model reflects our respondents' thinking about how conservation outcomes are produced in collaborative conservation and includes factors contributing to the use of scientific information in conservation practice.

An 8-member advisory group composed of representatives from state and federal agencies and nongovernmental organizations, all of whom were familiar with SWAP implementation, participated in a 2-day workshop in 2009. We presented preliminary study results to the group. Through facilitated discussion, the group offered input for refining our results and inferences. These suggestions were used to improve interpretation of our data.

Results

Collaborative Conservation Model

On the basis of data gathered during the interviews, we developed a model depicting the elements and processes in successful collaborative conservation in the SWAP implementation initiatives (Fig. 1). This model illustrates the role of scientific information in collaborative conservation and the factors on which its use depends. The model has 12 components (grey boxes in Fig. 1) in 5 categories (conservation outcomes, actions, necessary resources, enabling processes, and social foundation).

The conservation initiatives we studied sought to protect land or restore species, habitat, or ecosystems. In some cases, whether these outcomes were achieved would not become evident until years after a particular initiative had been completed. Conservation outcomes were achieved through actions, including manipulation of species, habitats, or ecosystems (e.g., vegetation removal, species translocation, or captive breeding) or land acquisition and easements.

Actions required resources, such as funding and procurement of a labor force. The selection of actions depended on the information available on which to base them, which included both information from scientific research or theory and experiential knowledge. When the information base was limited, it was sometimes enhanced through research or efforts to synthesize and disseminate information (efforts that also depended on labor and funding).

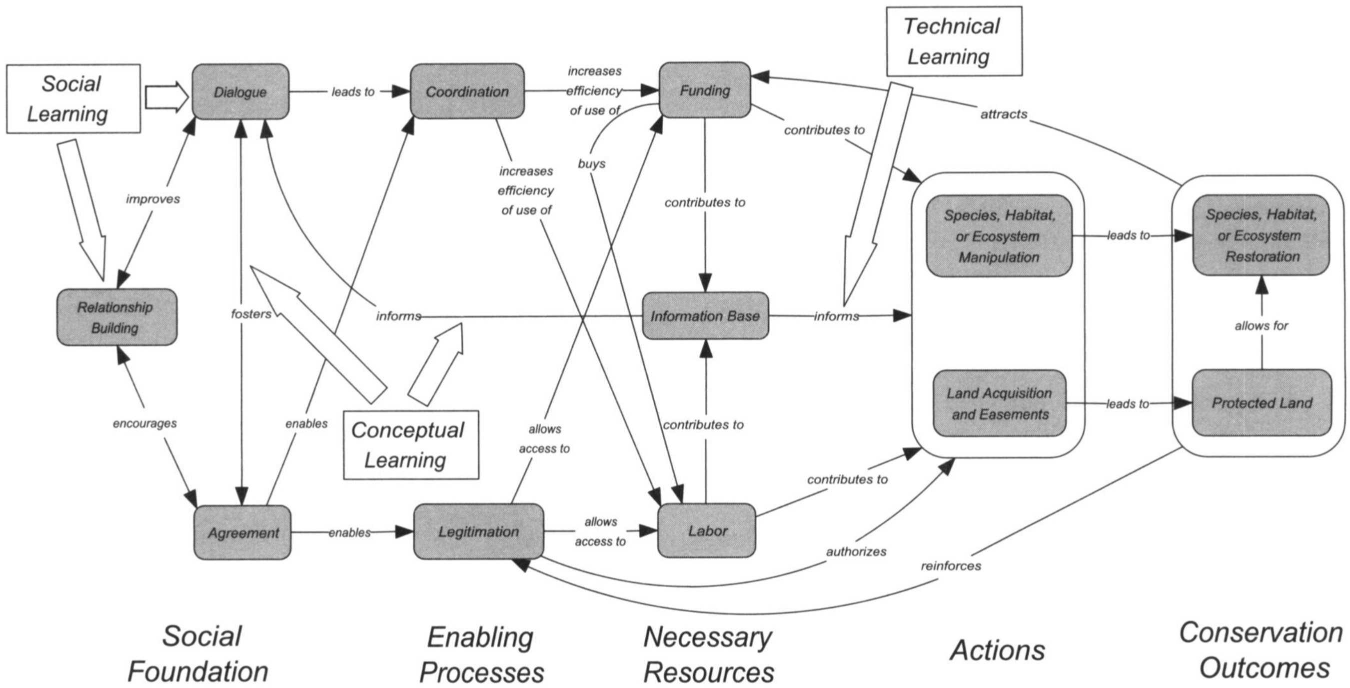

***Figure 1.** Model of the collaborative conservation process derived from interviews of participants in collaborative initiatives to implement state (U.S.A.) wildlife action plans.*

Collaborative conservation also required enabling processes. One such process was legitimation (i.e., securing support or approval from those with authority or influence, including government officials, nongovernmental organizations, landowners, or other members of the public). Legitimation of an initiative allowed for access to resources and contributed to authorization of conservation actions. Collaborative conservation initiatives were also enabled by coordination of activities. Coordination involved joint decision making among collaborators about how they could most efficiently use their combined funding, labor, and information resources to achieve their common objectives.

Collaborative conservation initiatives depended on relationships and dialogue among collaborators and others. Relationships and dialogue contributed to agreements about what collaborators hoped to accomplish and what actions they would take to accomplish it. Agreement provided a foundation for legitimizing conservation work and further enabled coordination of activities.

This array of factors influenced the success of collaborative conservation, and scientific information was only one component in the array. Understanding the factors that influence the availability and use of scientific information depends on understanding how scientific information relates to these factors. We used this model to help us understand how these factors affected the link between science and practice.

The factors in our model related to the policy-learning framework, which provided the theoretical foundation for this study. Within our model technical learning was represented in the link between information and actions. Technical learning occurred when information was incorporated into the selection of actions. Conceptual learning was represented by the links between information, dialogue, and agreement. Conceptual learning occurred when information contributed to the conversation about what was to be accomplished. Much of the rest of the model depicted social learning (improvement of relationships and dialogue) and the processes and conditions it fostered. These features of the model are explored in the next section.

Availability and Use of Scientific Information

The factors linking scientific knowledge to practice in our model fell into 2 categories: those that affected the availability of scientific information and those that affected its use. The rest of our results are organized according to these factors in the model. We present representative interview excerpts that demonstrate the importance of particular factors in the results. Letter codes identify the cases (GRG, Grand River Grasslands; NL, Nebraska Legacy Project; PS, South Puget Sound Prairie Restoration; VT, Vermont Fish and Wildlife-Transportation partnership), and numbers are the interview respondent within that case.

Labor and Funding

Labor and funding had the most direct influence on the availability of scientific information. Although rarely identified explicitly by our respondents as important, it was evident that availability of scientific information depended on the efforts of individuals engaged in conservation initiatives. Sometimes these individuals carried out research projects. For example, in one case research by collaborators helped foster agreement on conservation priorities, which led to conceptual learning.

> The state had a couple of plant species ... they thought ... should be federally listed. We started looking at it more closely [through research] ... The golden paintbrush ... its numbers at every single population we monitored were going down ... There was a lot of serious conservation threats ... We were ... able, in 1997, to put ... golden paintbrush on the endangered species list as a threatened plant (PS-1).

Research conducted by collaborators also evaluated whether management actions might help achieve conservation priorities, which led to technical learning. For example, informal research helped refine restoration techniques.

> I literally wrote the book as we went along. We literally, by trial and error, had to figure out what was going to work and what wasn't going to work. It was a slow process, and what works one year doesn't work the next year. The technical part of it we were ...writing as we went along (GRG-3).

Research was not the only way individuals made scientific information available. In many cases, individuals contributed expert opinion.

> The BULs [biologically unique landscapes] ... were defined entirely by science. [P]eople ... gave their opinion of what the science was. We had expert opinion ... The way we decided where those boundaries were were where species records were, as well as expert opinion .... So where the boundaries of those came was very science based (NL-1).

Funding, particularly research funding, was widely recognized as essential to making scientific information available.

> We worked with TNC [The Nature Conservancy] to make the request for the funding, and the money was given to TNC to hire [a researcher] to do that prairie inventory ... What we've all learned over the years is oftentimes we launch ... these big initiatives without a good inventory of what we have to work with, and this [our inventory] gives ... a pretty good starting point (GRG-7).

> There was a project on Interstate 91 that involved the decommissioning of an old rest area and some other improvements ... It happened to be in an area where we have the single known population of the black racer snake [in Vermont], which is an endangered species [in the state]. And VTrans [the Vermont Agency of Transportation] was very good to work with on that one ... They funded the radiotelemetry study of the snakes ... They made adjustments to the design of the project ... They went above and beyond the call (VT-3).

Funding and labor were critical for making scientific information available, but did not ensure the willingness or ability of practitioners to apply that information. The factors that most frequently contributed to the use of information were captured in the "social foundation" of the model (Fig. 1).

Agreement and Relationships

Analysis of interview data indicated that relationship building and dialogue led to agreement about conservation objectives and strategies. This agreement directed how labor and funding were used. Agreement may be linked to the interests of collaborators. One respondent noted it was much easier to encourage needed research by scientists when shared interests were present.

> [In the past] I had almost zero luck in getting cooperation from university folks ... That ... changed dramatically a couple of years ago by a number of hires that the university did ... Up until a couple of years ago professors in biology and botany and so forth were the same ones that I had when I was there 20 years before and they finally started retiring. There had been a generation of professors come in who are schooled in conservation biology ... Instead of being old and entrenched in their own ways of doing things, they're actively out looking for new and applied projects and it's just been night and day. So all of a sudden it's like there's been all kinds of expertise and graduate students interested in cooperative studies (PS-3).

Another respondent argued that research results would not be applied by practitioners if agreement on conservation needs did not exist.

> We're thinking about what the vision of the Conservancy's role is ... in 5, 10, 15 years from now. And it's really intriguing for me to see others ... postulating that ...we'll succeed by just telling people what needs to be done ... Just promote science and answer the questions, and we'll just guide and tell people what to do. ...I don't have 100% confidence that this is sufficient (PS-5).

Of the elements depicted in our model, respondents most consistently identified personal relationships as crucial to applying scientific information in conservation.

> One gentleman ... recently retired, used to say that conservation is 90% relationships and 10% science, and that's what it boils down to. You can have the best science, but if you can't maintain good rapport in a relationship, you're not going to get anything done (GRG-07).

Respondents indicated that relationships are important because people often are not willing to use information unless they are confident about the credibility of its source.

> We really wanted to have our findings adopted and implemented by land managers ...[W]e brought in all the land managers ... throughout the region as cooperators on the project, and it's been highly successful as a result. Everybody's been brought ... onto the sites they're trying to manage, so they can ... see how the results are coming along and apply them accordingly. From my perspective, it was an extremely effective approach, both from an experimental, scientific perspective and from a restoration-implementation perspective, which if you don't get both, you haven't succeeded (PS-3).

Relationships appeared to be particularly important when practitioners did not have complete control over the resource of interest, such as conservation initiatives on private lands. In these cases, relationships influenced private landowners' willingness to adopt new conservation practices informed by science.

> We're doing a lot of this work on private lands. These are people who are very traditional folks. I come from a farming family. So, I understand what they're thinking, and there's a certain level of distrust, and so it takes a long time to build a relationship to where you trust this biologist who is coming and suggesting that you burn your prairie because, heaven forbid, you don't put fire on the landscape (NL-1).

Consequently, successful conservation may require cultivating relationships.

> I think sometimes things come out of Lincoln [the capitol of Nebraska] pretty structured ... This is the way it's supposed to be ... You bring out all these algorithms to say this is what a BUL [biologically unique landscape] looks like. But when you get out on the land, you have to go beyond that. You have to have more flexibility in how you reach out [to people] because you might be working over here 30 miles west of that BUL this year and back in it next year and the whole time you're building a relationship up and down the river (NL-3).

Subjects indicated that maintaining and cultivating relationships led to cooperative efforts to gather scientific information and that the information gathered had tangible conservation benefits. In Vermont, for example, efforts to cultivate relationships between the Department of Fish and Wildlife and the Agency of Transportation led to a study of a site's contribution to snake conservation, and results of the study informed conservation actions.

> We had a site where we located a population of this very rare snake in the state ... Their location was VTrans [Agency of Transportation] land, and it was a piece of land ... scheduled to be developed into a truck-weighing station and salt shed. ... [W]e had the avenue of communication, and information was communicated ... And that became a collaborative effort where we studied the value [for the snake] of the site that was to be developed and what it was providing to the snakes, and ... what we can do to proactively mitigate that impact ... [W]e decided we needed to create replacement for the habitat .... We did that without the legal pressure of a permit, and we did that with the cooperation of Fish and Wildlife, VTrans, and Parks and Recreation (VT-2).

Relationships expanded capacity for conservation not only by increasing acceptance of scientific information, but also by making additional resources available. These resources enabled practitioners to act on recommendations from scientists.

> I think previously we were pretty good at making solid ecological and scientific recommendations, but weren't able to then take those and do something on the ground. [He] expanded the collaboration to bring in some funding and some people and volunteers ... to get work done on the ground. Everybody knew Scotch broom was a problem on the prairies. We didn't have a good way to tackle it on a very big scale ... That led to collaboration ... [and] pretty significantly increased the capacity (PS-4).

Resources made available by these relationships increased capacity for applying scientific knowledge in conservation and increased capacity to generate additional knowledge through research.

> During the course of ... relationship development, we started to talk with VTrans about the fact that all of this information that we're relying on to make decisions ... on roads in Vermont is coming from other parts of the country ... We really need to ... spend the time and money to [do] research here in Vermont ... and not continue to rely on ... science from other parts of the country that may ... not have a realistic application here. They funded the black racer study. They funded an evaluation of a passive structure that was installed on another state highway .... They funded the recently completed graduate study ... on the Bennington Bypass crossing structure to the tune of nearly $400,000. That all came out of their budget and was a collaborative research project between us and VTrans (VT-3).

Discussion

We sought to identify factors that determine how science influences practice in initiatives that successfully implemented elements of SWAPs. We established that relationships and dialogue were fundamental both to making scientific information available and to increasing the probability of its use. We empirically established the mechanisms by which relationships and dialogue affected other variables. Relationships and dialogue led to the sharing of resources depicted in our model, such as funding and labor, that were needed to carry out research and produce information. Agreement among researchers and practitioners on problem definition was necessary for that new information to be applied in conservation decision making. Our model shows there are direct links among relationships, dialogue, and agreement.

Our findings help clarify the mechanisms that link social learning, conceptual learning, and technical learning (Lauber & Brown 2006). Results of previous work show that the development of relationships and dialogue (social learning) is often necessary to define conservation problems in constructive ways (conceptual learning) and that relationships, dialogue, and a common problem definition are all needed to identify acceptable actions that will help accomplish conservation objectives.

Thus, relationships between scientists and practitioners fulfill multiple roles, and achieving a common vision of the conservation problem to be addressed is a critical step in ensuring that science informs practice. Lauber et al. (2011) reported that social networks in collaborative conservation serve different functions during different periods, but that achieving a common vision of the problem to be addressed is necessary before action can be taken. As collaborative initiatives get underway, relationships help establish a common agenda. After that common agenda is achieved, relationships are necessary for sharing information and resources to achieve common aims.

Roux et al. (2006) argue that relationships between scientists and practitioners are important because of the nature of knowledge and that considering knowledge as something that can be transferred from scientists to practitioners is not useful. Rather, they view knowledge as something that needs to be produced in a collaborative learning process, in which the meaning of information is negotiated. Only through such an approach can the misunderstandings and tensions that often exist between scientists and practitioners be reduced, paving the way for science to be applied.

Others recognize the importance to conservation of relationships and dialogue between researchers and practitioners (e.g., Prendergast et al. 1999), although their conclusions typically are not based on empirical data such as we present here. Balmford (2003) maintains that stakeholders are important too and argues that the link between research and practice depends on the integration of capacity building, stakeholder engagement, and planning for implementation from the beginning of conservation initiatives.

Knight et al. (2008) call for integrating research within a larger operational model of conservation planning in order to eliminate the research-implementation gap. Both Knight et al. (2006*a*) and Brunckhorst (2000) present models that depict the wide variety of factors and activities that influenced the probability research will inform practice. Knight et al. (2006*b*) and Knight et al. (2006*a*) in particular emphasized the importance of relationship building, dialogue, and reaching agreement among collaborators.

Increasing the probability that conservation is guided by science depends on the recognition that science is only one of many elements that determines whether conservation will be successful. Although tangible factors such as funding and labor are crucial, our results demonstrate that the availability and use of scientific information also depends on whether conservation initiatives have been legitimized by authorities, the degree of coordination among actors in the conservation arena, and actors' agreement about conservation objectives. Relationships and dialogue are perhaps the most fundamental of the factors affecting the availability and use of scientific information. In other words, our findings show that social learning (improving relationships and dialogue) is as important to successful conservation as conceptual learning (setting conservation objectives) and technical learning (determining how to achieve these objectives).

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