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Commentary

A Collaborative Approach to Bridging the Gap Between Wildlife Managers and Researchers

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ABSTRACT Although most wildlife professionals agree that science should inform wildlife management decisions, disconnect still exists between researchers and managers. If researchers are not striving to incorporate their findings into management decisions, support for research programs by managers can wane. If managers are not using research findings to inform management decisions, those decisions may be less effective or more vulnerable to legal challenges. Both of these situations can have negative consequences for wildlife conservation. We outline a collaborative research-management approach to bridging the gap between wildlife managers and researchers. We describe differences in perspectives, perceptions, and priorities between managers and researchers; outline how and why the divide between researchers and managers has likely occurred and continues to grow; and present specific strategies and recommendations to foster stronger collaborations between managers and researchers. We advocate increased synergy between managers and researchers based on a shared vision of conservation and a collaborative structure that rewards researchers and managers. Most importantly, we suggest that relationships and communication between managers and researchers must be established early in research development and decision-making processes, fostering the trust needed for collaboration. Institutions and agencies can facilitate these relationships by creating opportunities and incentives for integrating collaborative research into management decisions. We suggest this approach will strengthen ties between researchers and managers, increase relevance of research to management decisions, promote effectiveness of management decisions, reduce legal challenges, and ultimately produce positive, tangible, and lasting effects on wildlife conservation.

KEY WORDS co-development of science, joint ventures, research steering committees, structured decision-making, wildlife management, wildlife research.

Science has served as a foundational building block of the field of wildlife management and conservation since its inception over a century ago. For example, Theodore Roosevelt's 1910 doctrine of conservation declared that science should be used as a tool for the conservation of natural resources (Leopold 1933). This idea is also echoed in The Wildlife Society's mission to "…sustain wildlife populations and habitats through science-based management and conservation" (The Wildlife Society 2015:1) and

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in the North American Model of Wildlife Conservation, which underscores that "science is the proper tool to discharge wildlife policy" (Organ et al. 2012:2).

Although most wildlife professionals agree that science should inform wildlife management decisions, there is a disconnect between researchers (who develop science-based knowledge) and managers (who implement management and conservation actions based on research or other considerations). The disconnect is not new (Howard 1968) and it has been suggested that it is worsening over time (Sands et al. 2012). Researchers often are of the opinion that their findings are not used or are even disregarded by managers (Prendergast et al. 1999), whereas managers feel as if they are not receiving the information they need from researchers (McNie 2007, Gibbons et al. 2008). Indeed, there is empirical evidence that most conservation and management decisions are not based on scientific evidence (Pullin et al. 2004, Sutherland et al. 2004, Cook et al. 2010, Artelle et al. 2018). Although we recognize that research-based recommendations are often balanced against political, economic, and social forces during the decision-making process, research findings often can be under-valued compared to these forces even though implementation of research is ultimately necessary to achieve management objectives. If research is not used to inform management decisions, there is the potential for such outcomes to be less effective or more vulnerable to legal challenges with consequences for the conservation of wildlife (Gill 1985). In a time of unprecedented challenges facing wildlife populations and ever-shrinking resources to address those challenges, research that is cost-effective and relevant is increasingly important to making effective management and conservation decisions. Although several wildlife professionals, including researchers and managers, have provided suggestions for bridging the gap between research and management (Sands et al. 2012), many feel that little progress has been made. It is thus essential that the wildlife profession confronts this disconnect and improves the integration of research and management.

We posit that connecting research and management is about strengthening relationships and communication between managers and researchers early in the research development and decision-making processes. We argue that this connection will result in a more collaborative, integrative, and efficient approach to the research and the integration of the results into the management of wildlife. Analogous recommendations have been advocated in collaborating with indigenous partners (Adams et al. 2014), in producing actionable science that facilitates adaptation to climate change (i.e., coproduction; Armitage et al. 2011, Beier et al. 2017), and in natural resource decision-making (Enquist et al. 2017). Our objectives are to describe differences in perspectives, perceptions, and priorities between managers and researchers; outline how and why the divide between researchers and managers has likely occurred and continues to grow; and present strategies and recommendations to foster stronger collaborations between managers and researchers. Our focus in this commentary is on state and federal wildlife managers and all university researchers. We recognize, however, that other relationships between researchers and managers occur. For instance, many government wildlife agencies have in-house research branches and there are 38 states that have United States Geological Survey (USGS) Cooperative Fish and Wildlife Research Units housed at universities. Other programs such as the Cooperative Wildlife Research Laboratory at Southern Illinois University, and the Partnership for Ecosystem Research and Management at Michigan State University also have clear connections between researchers and managers. Although such programs can differ from universities in important ways, we think much of our discussion below is relevant to the manager-researcher relationships they facilitate.

FACTORS CONTRIBUTING TO THE DISCONNECT: PERSPECTIVES AND PRIORITIES

Managers and researchers operate under different demands, constraints, communication realms, and reward systems. Effective communication stems from knowledge of shared terminology and concepts, and an individual's ability to predict the attitudes and responses of another individual (Gigliotti et al. 1992, Leong et al. 2008). A mistaken belief that terms, concepts, and attitudes are similarly understood by managers and researchers can lead to poor communication, making constructive engagement and collaboration difficult (Gibbons et al. 2008).

As trust managers of the wildlife resource, public wildlife managers make decisions and recommendations to attain the goals set by the trustees (often appointed or elected officials such as wildlife commissioners) on behalf of the public, beneficiaries of the resource (Smith 2011). Depending on the agency, managers include a variety of career-track wildlife professionals such as biologists, supervisors, and administrators of natural resource staff (e.g., national forest supervisors). A manager's reward system emphasizes that they meet legal, social, and professional expectations while providing management and conservation benefits (e.g., environmentally and socially sustainable populations, increased hunting opportunities), and satisfaction to their constituents (e.g., the general public, elected officials, stakeholders). Managers must make decisions under sometimes severe budgetary, social, and political constraints (Bailey 1982, Karl et al. 2007) while also being transparent and accountable for their agency's actions. Uncertainties further complicate the decision-making process: biological information can be sparse or include high statistical uncertainty (McDonald-Madden et al. 2010), the environment is stochastic, and social data on public attitudes and acceptance may be insufficient. Differences in perspectives between on-the-ground managers and agency leaders can all subvert effective decision-making because agency leaders sometimes do not have the scientific background to appreciate the ecological and social realities that managers face. Further, managers are routinely required to make decisions on very short time scales, forcing them to rely

on their own experience, others' expertise, or scientific literature that may be out-of-date or may not be transferable to a different ecological system or specific decision (Kareiva et al. 2002, Briggs 2006).

Researchers strive to generate a broad knowledge base by addressing questions related to wildlife ecology and human dimensions using frameworks within the scientific method (Gill 1985). In addition to conducting research, scientists in the university setting are expected to obtain funding, train young professionals, teach undergraduate and graduate courses, and provide service to their institution. The reward system for university researchers is based primarily on tenure, merit raises, and scientific recognition. To meet the institutional demands of tenure and promotion, researchers focus heavily on securing funding, publishing in high-impact journals, and contributing to scholarly duties outside the university. Their reward system generally does not emphasize the value of informing management. Instead, their research tests general ecological or social hypotheses, identifies novel processes and patterns, and develops innovative techniques. The emphasis on conceptual research questions that provide generalizations rather than specific answers to site-specific problems may not overlap with the interests of managers (Sands et al. 2012). Further, researchers generally focus their research questions on a single or very few aspects of a system, which often limits a researcher's ability to address complex management issues. Research outputs can also take years to become available because of the time needed to define the problem, fund and conduct the study, and publish the results.

FACTORS CONTRIBUTING TO THE DISCONNECT: SPECIFIC CASES

The disconnect between managers and researchers can develop in several ways beyond not acknowledging each other's frames of reference (Roux et al. 2006, Sands et al. 2012, Cook et al. 2013). Here we outline specific circumstances that contribute to the disconnect and illustrate how strengthening collaboration between managers and researchers results in sound wildlife management.

First, researchers may conduct applied research but they do not engage with, or incorporate input from, managers from the onset. In some cases, researchers address a problem that they see as important, and when completed they expect a manager to put the results to good use. In this situation, the research question itself may not align with a manager's informational needs (e.g., research on foraging behaviors may not help a manager specify actions for species recovery), may misinterpret the ecological or social system (e.g., research findings for one population under one harvest regime may not predict responses of other populations harvested differently), or may evaluate courses of action that are socially or politically infeasible (e.g., sustainable harvest rates suggested by ecological research may contrast with a social imperative to reduce the size of a population). Without adequate, early input from managers, the specific context needed to inform management decisions or programs may not be enough to render information useful to the manager.

Second, when managers become frustrated with the relevancy of research products and want answers to specific questions, they develop and conduct their own studies, often without full consideration of experimental design and statistical analyses. For instance, when research findings from another study system do not appear to apply to a local area or population, a manager may initiate a study to ensure the results are relevant. Researchers often shy away from such studies as they view them as largely confirmatory without sufficient novelty to warrant publication. When an agency does research and does not collaborate with those with expertise in study design and appropriate analyses, results may lack the rigor to be defensible in court. The results also may not be widely available to other managers and researchers if the results remain in agency reports rather than in technical series or publications.

Third, researchers and managers do not account for each other's vastly different communication realms when interacting with each other. Managers often spend a significant amount of time communicating with the public using accessible terms, whereas researchers spend most of their time communicating with other researchers (e.g., at scientific conferences) using specific jargon. It can be difficult for managers to stay current on rapidly evolving research paradigms, techniques, and terminology, while also translating research findings to the public so they can see the justification for a management decision. Many researchers are not rewarded for communicating their research to non-scientists, whereas those that take a step in that direction often do not have the expertise or time to do it effectively. The burgeoning fields of translational ecology (Enquist et al. 2017) and science communication (Fischhoff 2013) are promising trends that may help ameliorate this challenge for university researchers, provided they can incorporate these services into their grants and research programs.

Finally, researchers often fail to translate their results into usable end-products accessible to managers (e.g., spreadsheets, geographic information system [GIS] layers, decision tools). For instance, complex population or habitat models published in scientific journals often cannot be replicated or implemented by a manager unless they are accompanied by an interactive interface and documentation. Research products also may not provide managers with the ability to assess what-if scenarios (e.g., if management option B is selected over management option A, what does the model predict?). Importantly, managers often do not have appropriate time to fully distill research findings from multiple publications even if they have access to the full range of scientific journals used by researchers (Sands et al. 2012). Researchers that do not plan for and follow through on making their research directly accessible to managers contribute to the disconnect and perpetuate the perspective that even when research is pertinent, it is unusable for management decisions.

These 4 situations can have a range of consequences, from missed opportunities to a breakdown in trust between individual researchers and managers. Trust is a multifaceted concept in which an individual is willing to become

vulnerable to the behavior of another individual based on an expectation that the other individual will perform beneficial actions (Smith et al. 2013, Stern and Coleman 2015). Trust is built on effective interpersonal communication and experiences (i.e., rational trust), mutual understanding of beliefs and values (i.e., affinitive trust), and agreed-upon operational systems (i.e., procedural trust) such as structured decision making (SDM; see below), where both parties achieve their objectives. Without trust, common ground disappears and the proverbial walls go up or are reinforced, exacerbating the disconnect and making it difficult for researchers and managers to work together to meet shared goals, even when ideal opportunities arise. Furthermore, trustful relationships have important ramifications for the role of researchers in providing research that challenges current practices or norms. Researchers that challenge management practices without a collaborative relationship with managers will rarely produce change. If anything, naïve researchers who challenge management without providing accessible research might serve to polarize a management issue, not only eroding the credibility of researchers, but increasing mistrust among managers and ultimately precluding meaningful research contributions to wildlife conservation. In contrast, research conducted in collaboration with managers builds the trust on which changes in policy can take place, even when management paradigms are challenged.

A COLLABORATIVE SOLUTION: THE CHANGES TO BE MADE

We advocate increased synergy between managers and researchers based on a shared vision of conservation and a collaborative structure that rewards researchers and managers. Many managers and researchers undoubtedly have experience with productive research-management collaborations, but wildlife management and research enterprises operate independently. We argue that managers and researchers equally need to take steps to understand and merge these 2 worlds if we are to make wildlife management and conservation more effective.

First, managers and researchers would benefit if they worked closely together throughout the entire research process (Finch and Patton-Mallory 1993, Pohl et al. 2010). This starts with co-identifying appropriate research questions to address the problems determined by managers. For example, management agencies often compile lists of informational needs. After such a list is compiled, researchers can work with managers in the framing of research questions to ensure the needed information will be delivered. Effective communication starts with initial meetings and one-on-one sit-downs that facilitate direct communication on specific informational needs, provide context on why information is needed, and identify constraints (Jacobson et al. 2013, Gordon et al. 2014). Directly involving managers in the development of research at all stages of a project can promote mutual appreciation, understanding of design aspects and limitations, and ownership of the outcomes, which then may be more likely to be implemented (Cash et al. 2003). In turn, researchers gain a better understanding of the broader context in which the management questions are posed and need to be addressed. For instance, a manager may need to know the change in population size of a given species over time. This question may not immediately lend itself to a meaningful research project in the eyes of a researcher. But if the researcher and manager work together to understand why this question is important and the ecological uncertainty behind it, they may be able to frame the issue in a way that meets the needs of the manager while also allowing the researcher to address novel questions that can lead to important ecological insights (e.g., identifying the interactions among limiting factors of the population). Such collaborations may lead to examining alternative hypotheses or management prescriptions, resulting in strong inference and reliable knowledge (Romesburg 1981), that better support management decisions (Britt et al. 2018) and help mangers be transparent in the face of uncertainty (Beier et al. 2017). We argue that this not as difficult an endeavor as it may initially appear, but that it requires good listening skills, mutual respect for each other's needs, and flexibility. We submit that to do this successfully, both parties need to come together early in the project's development.

A closely related issue is that short timeframes for agency decision-making often conflict with the time required to produce reliable research results. By the time managers recognize key information or inference needs related to a given management decision, there may be insufficient time for rigorous study design and inference. Yet in many cases, the decision cannot wait. Although the immediate decision-making timeframe may be short, researchers can use their knowledge of other scientific studies to provide insights to improve such decisions and develop a study that provides the necessary information. Researchers working with managers in such situations also establish trust and co-ownership of the issue being decided upon, and enhance research design within a management context and thereby managers' support for the research. Many management decisions are repeated in time or in space. Co-designed research arising from these situations can be directly incorporated into future iterations of the same or very similar decision-making contexts, while also providing the opportunity for academic productivity and achievement.

Second, we suggest that both research institutions and agencies need to absolve barriers, provide incentives, and reward engagement if we are going to close the gap between research and management (Briggs 2006, Knight et al. 2008). In academic institutions, these ends could be achieved by changing our viewpoint on the value of research productivity, and recognize this in the reward system. For example, universities could go beyond assessing effects of researchers based on the number and journal impact factor of publications (Beier et al. 2017) to using metrics in merit and promotion that indicate how well research products are integrated into management decisions, influence regulations and policy, or produce demonstrable on-the-ground conservation gains (Arlettaz et al. 2010). Such a shift in

approach, we suggest, would go a long way in promoting a direct link between research and management. For instance, the USGS Research Grade Evaluation process now considers "Participating in applying the research to important management and policy decisions" as an important indicator for evaluating the scientific effect for their researchers (U.S. Office of Personnel Management 2006:18). Inviting managers to serve on graduate student committees, encouraging students to contribute to agency newsletters and in-house publications (Noss 1997), and incentivizing internships where students work directly with managers on a day-to-day basis are other possibilities that promote synergy between researchers and managers. Encouraging student attendance and the presentation of their research at state or provincial chapters of professional societies such as The Wildlife Society will connect student trainees with practicing professionals. For example, as part of the federally funded Collaborative Research and Training Experience Program (CREATE) in Canada, students are expected to directly participate in internships with industrial or government agencies during their education. Institutionalizing the value of these collaborations within university systems, when evaluating current faculty and recruiting professors, students, and other researchers, will be key in closing the gap. For instance, the recent hiring of a Director of the Wildlife Biology Program at the University of Montana who previously had a career with a state wildlife management agency may help facilitate these changes. Lastly, funding agencies can play a role by holding researchers accountable for actionable science, science translation for managers and policy makers, and ensuring end-users are identified and their participation in the design and outcomes of the research are clear.

Third, a collaborative research-management approach also requires that agencies provide managers the time, resources, and rewards to collaborate with researchers. This may include rewarding participation in research directly in annual reviews, and allotting time in work plans to organize round tables with researchers to discuss informational needs, serve on graduate student committees, and take training on products and tools produced by researchers. For example, agencies could coordinate regular meetings with researchers where the agency outlines changing management priorities or issues of growing management concern and their associated informational gaps. Other options might include inviting researchers to attend management coordination meetings, field days, and other agency gatherings, and facilitating researchers spending time within agencies during their sabbaticals or on release time to engage in specific management issues. Providing managers with easy access to journals and extension bulletins (Fazey et al. 2005, Merrill 2015) and supporting their attendance at conferences and workshops are also key. Finally, agencies that reward continuing education specific to wildlife science and that provide workshops, short courses, and access to webinars to managers will help facilitate synergy between managers and researchers. We do recognize the challenge of promoting these activities among the competing demands on a manager's time, but argue that flexibility in work plans to incorporate them will go a long way to bridging the gap between researchers and managers.

A COLLABORATIVE SOLUTION: FRAMEWORKS FOR IMPLEMENTATION

We provide 3 frameworks to facilitate the changes stated above and empower the collaborative research-management approach to wildlife management. These frameworks are largely built on promoting procedural trust (Stern and Coleman 2015) that establishes a space for interpersonal trust to develop. The common theme in the 3 examples is that they each require managers and researchers to work and communicate directly with each other in recurring forums, so that shared progress can be achieved and recognized.

Structured Decision Making

Structured decision making (Hammond et al. 1999, Gregory et al. 2012, Runge et al. 2013) is useful when a decision needs to be made or management resources need to be allocated, with defined roles for components of a decision such as laws, regulations, human values, and science. Structured decision making reduces a decision to a series of logical steps, including identifying the problem that needs to be addressed, defining objectives and constraints for solving the problem, developing alternative approaches or decisions to achieve the objectives, and formally evaluating which alternatives are most effective, efficient, and realistic. Structured decision making is valuable because it is explicit and transparent, and formally incorporates scientific knowledge and uncertainty. Although SDM does not require involvement by researchers, SDM explicitly links decision making with the potential for resolving associated uncertainties through research—thus, offering the opportunity for closer collaboration among managers and researchers. Less directly but perhaps equally as important, SDM also fosters a common understanding between researchers and managers about how research can effectively inform management decisions.

This approach was notably effective when it was used to craft a conservation management plan for polar bears (*Ursus maritimus*; U.S. Fish and Wildlife Service [USFWS] 2016). The Polar Bear Recovery Team consists of a variety of vested stakeholders, including managers and researchers, and the recovery planning process included a strong science-management connection related to population conservation and reducing threats to persistence (USFWS 2016). For example, Regehr et al. (2017*b*) developed a state-dependent modeling and management framework to help ensure subsistence harvest does not result in population declines, while considering loss of sea-ice habitat due to climate change. Through SDM, the team integrated this research into conservation planning tools, which have been used to inform subsistence harvest levels (Regehr et al. 2017*a*, 2018). In this case, rigorous and contemporary population modeling techniques were developed and published by a team of researchers and managers, and techniques have been applied to actual decisions about take of this listed species. Mutual investment by researchers and managers in understanding and

implementing SDM can build strong collaborations that would otherwise be difficult to achieve.

Research Steering Committees

Research steering committees are useful forums for managers and researchers to jointly determine priority research topics, questions, and projects that address the needs and working environments of both groups. They provide the space for managers to articulate and prioritize informational needs, and an environment where managers and researchers can collaboratively develop research projects. These collaborative interactions can foster a joint understanding of the utility of each research project, increased ownership of research projects, improved opportunities to incorporate research into management decisions, and a joint understanding of how applied research can meet the reward systems of both parties.

For example, a research steering committee approach has been successful within Montana Fish, Wildlife and Parks. After 10 years of implementation there has been an increase in collaborative projects with other agencies and entities, in funding for research priorities, and in the integration of adaptive decision-making frameworks and science support teams charged with integrating research findings into wildlife management decisions. This steering committee has been successful because it provides a mechanism for wildlife managers to determine research priorities and ensure research stays focused on information needed to improve management effectiveness. The committee provides a forum to evaluate and prioritize research projects using standard criteria on a regularly scheduled basis, creating common expectations among managers and researchers for input and discussion. Such steering committees do have drawbacks such as slow turnaround time due to the increased number of people reviewing proposals and project ideas, and difficulty in accommodating large collaborative efforts that have otherwise already identified their priorities. However, the benefits of the collaborative environment outweigh these drawbacks, as seen in the tangible outcomes in Montana.

Joint Ventures and Initiatives

Joint ventures and initiatives are useful forums for addressing shared issues that span jurisdictional boundaries. Joint ventures and initiatives are collaborations among academic, state, federal, and non-governmental entities that address management issues at regional or landscape scales (Sands et al. 2012). The collective nature of joint initiatives helps prioritize research projects, acquire and leverage funding, and facilitate science-based decision-making and adaptive management, which are key to linking research outcomes with future management actions (Sands et al. 2012).

For example, the Western Association of Fish and Wildlife Agencies' Mule Deer Working Group comprises one management representative from each western state and Canadian province. Collectively they develop strategies to address mule deer (*Odocoileus hemionus*) conservation by streamlining communication among managers and researchers, sharing information and expertise through workshops led by researchers, and collaborating with researchers to synthesize and translate information across jurisdictions in publications and documents readily usable by managers (Sands et al. 2012, Mule Deer Working Group, Western Association of Fish and Wildlife Agencies 2018). Similar initiatives have been successful in managing migratory species (e.g., The North American Waterfowl Management Plan; Roberts et al. 2018) and species of concern (e.g., collaborative efforts to conserve sage grouse).

CONCLUSION

Closing the gap between research and management in the wildlife field is about strengthening relationships between managers and researchers so that research is responsive to management needs, research improves the effectiveness and defensibility of management decisions, and professional rewards for managers and researchers are realized. Such collaborations result in effective management decisions with tangible and lasting effects on wildlife and society. In most cases, the development of a collaborative research-management framework is a result of individual managers and researchers increasing communication and building trust, and institutions creating opportunities and rewards for enhancing working relationships that lead to collectively producing and integrating research into management decisions. Researchers and managers have a shared goal of conserving wildlife and the habitats they depend upon through collaborations that yield rewards to both parties. We think this common ground constitutes the starting and ending point for successful collaborations in the wildlife profession.

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