



Original Article

Ratcheting up Rigor in Wildlife Management Decision Making

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ABSTRACT The wildlife management institution has been transforming to ensure relevance and positive conservation outcomes into the future. Continuous improvement of decision making is one aspect of this transformation. Managers and policy makers with responsibility for wildlife decisions have an exceedingly challenging job because the set of objectives they wish to achieve is so complex, multifaceted, and often contentious. Many wildlife management agencies desire decision-making processes that are transparent, replicable, engage partners, and communicate effectively with the public. Using a decision science approach offers a framework to allow agencies to achieve these objectives so the decision-making process is consistent with their desires. One can point to many excellent examples of formal decision science applications by state and federal agencies in the United States, but many obstacles hinder systematic approaches to decision making. We describe our observations—based on first-hand experiences—with decision making in wildlife management, present reasons why making decisions is difficult, identify challenges faced by wildlife managers at various levels of governance, and address measures wildlife managers can employ to help overcome these challenges. We acknowledge that no panacea, simple recipe, or one-size-fits-all prescription exists for wildlife management decision making. Nevertheless, we hope that by a) describing how a systematic decision science framework can help agencies achieve their objectives, while simultaneously benefiting stakeholders, managers, and conservation outcomes, and b) providing specific suggestions for overcoming challenges associated with decision making, we will help agencies in the midst of their challenges to improve decision-making processes consistent with their objectives. © 2020 The Authors. *Wildlife Society Bulletin* published by Wiley Periodicals, Inc. on behalf of The Wildlife Society.

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Riley et al. (2002) assert in *The Essence of Wildlife Management* that decision making is the “core work” of a wildlife manager. They argue that decision making is where synthesis of diverse considerations in wildlife management occurs. These considerations include general knowledge of wildlife and human ecology; specific knowledge of the species, habitat, and people in a particular management context; and political implications vis-à-vis the management problem to be addressed. Decision making in wildlife management is a critical process because decisions are the primary outputs of management that lead to conservation

policy and actions. Management simply cannot occur in the absence of decision making at many levels.

There are many objectives related to the process of decision making that agencies may wish to achieve while making management decisions, including transparency, public buy-in, inclusivity, partner participation, replicability, and defensibility of the decision process. Inclusivity and stakeholder–partner participation in the decision-making process is more likely to increase social acceptance of the resulting decision, as well as providing a valuable contribution to the effort (Jones et al. 2016, Robinson and Fuller 2017). Increased transparency in decision making has been shown to increase public trust in decision makers (Grimmelikhuijsen 2010), and to subsequently increase public confidence and buy-in. In science in general, reproducibility and replicability of scientific results are seen as important factors that lead to improving rigor and transparency in scientific research (National Academies of Sciences, Engineering, and Medicine 2019)—these same

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ideals hold for decision processes. Ensuring a defensible (methodologically rigorous) and transparent decision process allows the process to be easily explained to stakeholders. If agencies wish to be transparent, inclusive, engage the public, and have replicable and defensible decision processes, a structured decision science approach can help in achieving these aims. We outline challenges to the decision-making process and describe the structured decision science approach, which may provide some opportunities to help agencies improve their decision-making processes to be consistent with their objectives.

Every decision is made within a decision environment. We describe the decision environment as the wildlife management institution, which exists to produce outcomes that society values by attempting to understand and manage the social–ecological system within which the public wildlife trust is embedded (Jacobson et al. 2010). The institution is composed of formal and informal social, economic, political, and ecological elements and their interactions that together create the framework within which conservation-related decision making occurs, typically requiring consideration of multiple and competing management values, preferences, and alternatives (Jacobson and Decker 2006). Each of these elements is essential; together they provide the context for decision making to affect desired outcomes from the social–ecological system (Fig. 1).

Values used to form objectives in management of the social–ecological system can come from wildlife managers, stakeholders, or political leaders (Keeney 1992). The social

and economic element can also influence the decision-making process, namely market and nonmarket values either directly or indirectly associated with wildlife management (e.g., timber prices and availability of pulp mills can influence wildlife management but may not necessarily be associated directly; Decker and Goff 1987). The political element is a formalization of societal values in wildlife governance; it defines the roles and authority of wildlife management agencies and often bounds management decisions through laws, policies, statutes, budget allocation, or agency directives (Decker et al. 2016). The political element can also influence decision making when well-thought-out management decisions that have considered the array of stakeholder interests are overridden for political reasons, such as the results being unpopular with one or more politically influential special-interest groups (Loker et al. 1994, Rosenberry et al. 2011). Finally, the ecological element of the social–ecological system defines the biophysical state of the system under question. It is important that decision making in wildlife management consider every element of the social–ecological system that the wildlife management institution attempts to manage because strong linkages exist among all of the elements that we describe. Coupled social–ecological systems thinking allows decisions emanating from the wildlife management institution to be comprehensively framed (e.g., see Robinson et al. 2016, 2017).

Wildlife management involves making decisions on management actions that will help to achieve management objective(s); often those involved (e.g., natural resource

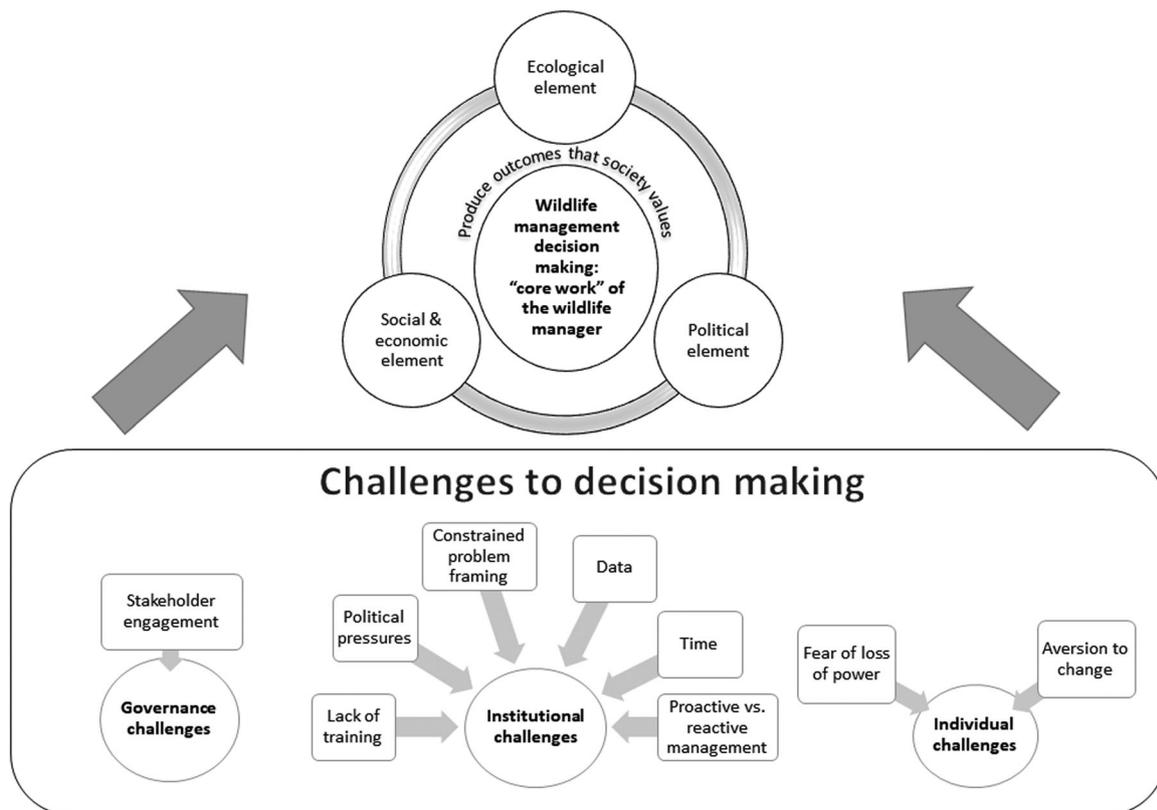


Figure 1. Decision making is the “core work” of the wildlife manager, who seeks to integrate the ecological, social, economic, and political elements of a decision to produce outcomes that society values. Many challenges to decision making exist at multiple levels: governance, institution, and individual.

managers, scientists, elected or appointed officials, stakeholders) are faced with a large number of options. The decision maker can be a wildlife manager, or the wildlife manager may be a delegated authority to make decisions (or recommendations) to be reviewed and adopted by upper administration (e.g., an agency commissioner). Regardless of who is functionally the decision maker, a decision implies that alternatives (or competing management actions) need to be considered in an attempt to best satisfy overarching and sometimes competing objectives. Each alternative is evaluated based on values and preferences of a decision maker as well as preferences of key stakeholders or the public in general (judgment regarding the public good). These different alternatives can lead to different expected consequences or outcomes, predicted based on the best available science. Consequences may be considered good or bad relative to achievement of a particular objective—depending on values of the decision maker and affected stakeholders. Values are at the core of decision making because they define objectives and represent what the decision maker (e.g., wildlife manager) intends to accomplish (Keeney 1992, 1996). We do not suggest that a decision can never be changed or rescinded; in fact, the premise of adaptive management is to update a decision based on learning (Walters 1986). The process of decision making that we outline here involves an explicit evaluation of the tradeoffs associated with different management actions relative to the achievement of the stated objectives.

Attention to improving the process of decision making naturally leads wildlife managers to ask how a decision is judged as good or bad. A good decision is one that focuses on the achievement of known and transparent objectives, and it follows a process that increases the odds of achieving them (Hammond et al. 1999). A good decision should not be judged only on the outcome because the decision maker can never be guaranteed the eventual outcome (Arvai and Froschauer 2010). Instead, a good decision should be judged on the process that was used to arrive at that decision. Unanticipated changes in any of the elements of the social–ecological system (e.g., ecological, social, political, economic) that the wildlife management institution is trying to address can lead to unanticipated outcomes. Given that a manager cannot guarantee the outcome of a decision, having confidence in the process used to arrive at a decision is important. Using a decision-making process that is deliberative, transparent, and consistent is a way to help increase the likelihood that a good decision is made.

Many wildlife management decisions are made that consider elements of a good decision-making process (e.g., articulating objectives and listing possible management alternatives, surveying stakeholders to identify situation-pertinent values), but we suspect that many important decisions are made without a formal or systematic decision-making process. One example of a formal decision-making process is adaptive management—structured decision making for recurrent decisions under uncertainty (Walters 1986). Despite many states mentioning adaptive management in state wildlife action plans, Fontaine (2010) found

that only 25% (of 53 plans reviewed) formally included a framework for how adaptive management would be implemented. Regardless, there has been gradual movement over the past approximately 20 years toward increased use of formal decision-science approaches (e.g., structured decision making and adaptive management) in wildlife management by federal (primarily U.S. Fish and Wildlife Service and U.S. Geological Survey), state, and private natural resource agencies and organizations in the United States. Structured decision making is a formal approach to decision making in natural resource management and it includes a wide range of methods to solve problems and make decisions (Gregory and Keeney 2002, Runge 2011, Gregory et al. 2012). For a nonexhaustive list of examples of use of structured decision making in conservation and management, please see Johnson et al. (1997, 2011), Nichols et al. (2007), Williams et al. (2009), Converse et al. (2011, 2013), Tyre et al. (2011), Moore et al. (2012), McGowan et al. (2015), Robinson et al. (2016, 2017), Sells et al. (2016), O'Donnell et al. (2017), Robinson et al. (2017), and Mitchell et al. (2018). In addition, the U.S. Fish and Wildlife Service adopted Strategic Habitat Conservation, “a framework for setting and achieving conservation objectives at multiple scales based on the best available information, data, and ecological models” (NEAT 2006:29). We applaud this movement toward more formal decision-making processes in the wildlife management institution. However, managers face many challenges when applying decision science approaches, possibly hindering widespread adoption. We highlight below what we feel to be primary challenges to decision making and suggest some ways to overcome them such that managers can engage in decision processes that enable them to meet their objectives.

Why is Increased Emphasis on Improved Quality of Decision Making Important for Wildlife Management?

Wildlife managers participate in decision making in multiple ways at multiple administrative levels. The quality of their contributions can have significant implications for conservation. At lower administrative levels, wildlife managers make annual work plan and day-to-day operational decisions about directing field or on-the-ground scale actions. At higher administrative levels, managers engage in decisions as part of planning processes needed to guide management to meet established goals and objectives. In their function as agents of the trustees for public wildlife resources (e.g., commissions and legislatures) and brokers of scientific knowledge, they play important roles as information sources, interpreters, analysts, synthesizers, and recommendation formulators for policy decisions made by appointed and elected officials who are the legal trustees for public trust wildlife (Smith 2011). Focusing for the moment just on these higher levels of decision making, understanding effective decision making (and therefore how to support decision making) is important under contemporary conventions of good governance (Decker et al. 2016). Characteristics of decision making for management of

public trust resources that make this function of governance defensible include deliberation, transparency, and consistency. Furthermore, a deliberative, transparent, and consistent (i.e., repeatable) process requires an appropriate level of inclusive stakeholder input and engagement.

Sometimes wildlife managers describe good decisions as those that are durable, or that persist over time. This is a valuable trait with respect to resilience in the face of legal or political attempts to scuttle a decision that was made following precepts of good governance. However, this should not be taken to the point where sustaining a decision becomes an objective that blinds a manager to how new information (from science in general, or specific learning that has occurred through monitoring and evaluation of the decision context [e.g., adaptive management]) could help improve conservation outcomes. Therefore, a combination of durability and adaptability are important in wildlife management decision making. Although attention on transformation at organizational and institutional levels has helped to reposition wildlife management for greater relevance and positive conservation effect in the future, many struggles related to decision making persist in the practice of wildlife management today (Decker et al. 2016).

WHY IS DECISION MAKING DIFFICULT?

Decision making is difficult for humans in general—this is not specific to wildlife management. Multiple objectives, complexity, and uncertainty are some of the factors that make decision making difficult (Runge 2011). Managers often deal with complex decisions by gathering the best available science, gathering information from stakeholders, and thinking about what may happen under various management alternatives. Managers may also be influenced by how a similar decision was approached previously in their own agency or in a sister agency, whether or not good decision principles were used. Sometimes, management objectives are not clearly defined, but even when they are, decision making is difficult because humans in general have limited information-processing capacity (Marois and Ivanoff 2005). Many decision makers seek a process that moves away from the normative approach to decision making, where an alternative is chosen that best meets the values of the decision maker (or their perception of the values of stakeholders) without a full and deliberative assessment. We describe major decision-making challenges in general so managers can recognize them prior to them becoming a stumbling block and ultimately so they can overcome them and engage in decision making processes that help them achieve their objectives.

Challenge 1: Multiple Objectives

In some ways, wildlife management is harder than many other decision-making endeavors, because the set of objectives they wish to achieve is so complex, multifaceted, and contentious. Fortunately, the field of decision science offers some valuable tools to grapple with such decisions,

beginning with a thorough articulation and deliberate acknowledgment of the many objectives at stake. Decisions with multiple objectives involve trade-offs among values, or how much a decision maker is willing to sacrifice on achieving outcomes consistent with one value to achieve more of another (Gregory and Keeney 1994). Due to the complexity of natural resource decisions and incorporation of multiple elements of the social–ecological system, objectives are frequently conflicting (e.g., hunter harvest opportunity vs. ability of a state agency to keep deer populations from exceeding objective levels; Robinson et al. 2016). Stakeholder input into the decision-making process commonly reveals that a diverse set of stakeholders hold different values that are reflected in desired objectives that vary widely. A transparent, iterative process for evaluating multiple and often competing objectives, with full knowledge of how values are weighted and inherent in the tradeoffs would likely help decision makers in achieving their desired aims in a decision process.

Challenge 2: Extraordinary Complexity in the Ecological, Social, and Governance Dynamics Associated with Wildlife Systems

Logic and intuition alone may be used to evaluate simple, single-objective decisions, but as the number of objectives (sometimes competing objectives) increases and number of potential actions multiplies in turn, it becomes increasingly difficult to make a coherent decision (Slovic et al. 1977). Our brains simply are unable to do all of the calculations to evaluate the tradeoffs and determine which management alternative best achieves our multiple objectives. Experience and individual knowledge can help inform the decision-making process, but alone are often inadequate when evaluating components of complex decisions. Nevertheless, managers and decision makers may not use tools that enable them to evaluate alternatives and make complex tradeoffs that maximize all decision criteria. As a consequence, they may select management alternatives that do not comprehensively address the full suite of values meant to be represented. Employing decision processes that comprehensively evaluate the predicted performance of all management actions and how likely they are to perform as desired in relation to the stated objectives allows for complex decisions to be evaluated, and ultimately allow a manager to achieve their objectives related to the process of decision making.

Challenge 3: Uncertainty

Most decisions are made under conditions of uncertainty, particularly regarding the uncertainty of the outcomes or consequences of a decision. This uncertainty therefore leads to the inability of managers to fully control the outcomes or consequences of an action. Acknowledging uncertainty is sometimes met with resistance by managers because they may view this as an admission of weakness (Walters 1997). The social–ecological system in which we manage wildlife is extremely dynamic and uncertain, and therefore it is expected that managers will be confronted with many sources

of uncertainty. Uncertainty is the primary reason we do not judge the quality of a decision on the outcome alone. If little uncertainty exists, a decision may be made based on previous knowledge or experience, but decisions become more difficult to make as the level of uncertainty increases. Decision making in an era of global change that operates at large spatial and temporal scales with great uncertainty (e.g., climate change) requires approaches that allow explicit recognition and examination of uncertainty (Polasky et al. 2011, Eaton et al. 2016).

Insufficiently considering the large number of sources or forms of uncertainty may lead to suboptimal decision-making (Regan et al. 2002, 2005). Uncertainty can exist in available data, in not knowing how well each management alternative does in achieving an objective, or more basically how the social-ecological system may change in the future (including changing stakeholder desires). These sources of uncertainty serve to complicate the process of decision making. Often uncertainty exists about the current state or dynamics of the system in question, which can create uncertainty in how the system will respond to a particular management action. Environmental stochasticity or unknowable environmental variation is a form of uncertainty where environmental factors are not predictable, let alone under the control of the decision maker (e.g., disease, extreme weather events). Furthermore, the manager does not always fully control the implementation of an intended management action, and even if they do, any discrepancy between the intent and the actual result of the action can lead to an unintended outcome (i.e., partial controllability; Williams et al. 2002). An example of partial controllability is implementing a harvest regulation to achieve a particular harvest rate, but then hunters do not respond in the way a manager anticipates either in the number of animals harvested or where the hunter chooses to hunt.

It is possible to identify the sources of uncertainty that are most relevant to the decision and use that information to make robust decisions, but it requires explicit recognition of the sources of uncertainty associated with imperfect understanding of the system (Moore and Runge 2012). The decision science framework allows for an explicit incorporation of uncertainty.

What Decision Making Challenges are Specific to Wildlife Managers and How Can They be Overcome?

We organized challenges for decision making that are specific to wildlife managers in a hierarchy, beginning with the overarching level of governance, moving to specific institutional challenges, and finally to the level of the individual participant in decision making (Fig. 1).

GOVERNANCE CHALLENGES

Services that the wildlife management institution offers continue to expand beyond the traditional consumptive uses of wildlife and include nonconsumptive uses (e.g., bird watching, ecotourism, wildlife photography), and increasingly represent contemporary natural resource values. The recognition that funding for wildlife management needs to diversify has agencies looking beyond traditional funding

sources (Jacobson and Decker 2006). These programmatic trends and funding concerns certainly present challenges, but perhaps the more daunting core challenge to wildlife management is that many of the governing bodies in wildlife management have been slow to change to be representative of the diversity of stakeholder interests, which has influenced broad public support (or lack thereof) for, and legitimacy of, wildlife agencies (Decker et al. 2001). Broadening programs to address more public interests in wildlife but not expanding the participation of stakeholders with such interests in the decision-making process cannot be expected to create support for wildlife agencies nor enhance agency credibility. A governance structure that reflects broader interests encourages agencies to develop relationships with a broader stakeholder base, increase public understanding of the complexities of policy making (Herath and Prato 2006), improve perceived agency accountability and responsiveness to public interests, reduce distrust between agencies and stakeholders, and potentially result in new funding for wildlife management (Jacobson and Decker 2008) as well as socio-political support. In addition, shifting the focus of decision making from a “stakeholder” orientation (i.e., people significantly affected by or affecting wildlife or its management) to a more broadly inclusive “beneficiary” orientation (i.e., those who derive benefits from trust management), as suggested by Decker et al. (2016) will help yield more durable but also adaptable conservation outcomes.

Challenge 1: Stakeholder Engagement

There is some dispute regarding both the role and right of the public to participate in the process of decision making, although the advent of good governance norms in civil society are diminishing that ambiguity (Schrader-Frechette 1985, Hare and Blossey 2014). The joint undertaking of decision making, when stakeholders with strong and divergent views are involved, allows for an understanding of the fundamental values and preferences of stakeholders, and makes explicit to stakeholders and decision makers the full complexity of a decision (Belton et al. 2017). How a problem is framed can have a strong influence on stakeholder preferences, so involving stakeholders in the decision-making process from the beginning will increase the likelihood of informed consent by stakeholders (Kahneman and Tversky 2000). Many agencies are very diligent about engaging stakeholders, but it is important to *a priori* define how stakeholder values and information will be used in the decision-making process. Understanding how stakeholder information will be used in the decision-making process can result in changes to how information is elicited from stakeholders. Many wildlife agencies may lack the capacity or capability to engage in the social science inherent in effective stakeholder engagement. Developing this expertise or working with partners (e.g., universities) to conduct systematic stakeholder engagement will help in overcoming this obstacle.

INSTITUTIONAL CHALLENGES

Wildlife management agencies are often complex hierarchical institutions that use a model of delegated authority;

although this is meant to efficiently distribute decision-making authority, it can sometimes be difficult to know where authority for a particular decision will rest. Agencies are also known to be quite bureaucratic and therefore less adaptive than other organizations (Westley 1995). Below we provide some specific examples of common institutional challenges that may arise in wildlife management agencies and organizations:

Challenge 1: Political Pressures

One common challenge for wildlife managers is making decisions while experiencing political pressure (Nie 2004). Managers may feel pressure to maintain relationships with their governing bodies, and when there are strong political interests, it may diminish the ability of a manager to sufficiently analyze a decision using all available ecological and social data. The sphere of authority and influence and decision space of a trustee (i.e., elected and appointed official) is often much broader than just “conservation” or “wildlife management,” so the calculus they use to make decisions often includes factors or criteria of which agency staff are unaware or over which they have little or no influence. Further, some challenges to agency legitimacy and authority tend to be political in nature, and arise when stakeholders feel disenfranchised or neglected and turn to trustees for recourse. There may be valid reasons for trustee oversight on highly contentious decisions, but we argue that in cases when top leaders trump a manager’s decision or recommendation, reasons for doing so should be made transparent, especially if socio-political effects were not considered by managers and are thought by trustees to outweigh ecological effects. However, we recognize that the broader scope of issues and responsibilities facing trustees makes it difficult to clearly explain all trade-offs they are considering when making a decision, particularly when those trade-offs may be politically motivated. Minimizing what is often regarded by managers as “political interference” in decision making can be accomplished by using a broadly inclusive participatory decision-making process that provides a transparent description of clearly articulated objectives, data gathered and analyzed, management alternatives considered, factors weighed in the decision, and the eventual recommended action. This participatory process can also describe factors taken into consideration in judicial oversight because these are the same factors that agency defendants must argue to counter a finding of ‘arbitrary and capricious’ by a court. Indeed, agency decisions are scrutinized in the judicial system, which in some cases lead to overturning a decision; for example, decision to list species as threatened under the 1973 Endangered Species Act (ESA 1973, as amended) may be challenged by claiming that the U.S. Fish and Wildlife Service did not adequately take into account other data and viewpoints (U.S. Department of the Interior 2016). Another example that managers decry as a reduction of their authority and operating space is the rise of ballot initiatives, which puts the voting public as the direct decision maker as opposed to allowing wildlife managers to make decisions (Manfredo et al. 1997, 2017;

Minnis 1998). Implementing systematic decision-making processes should provide decisions that are more resistant to political pressures from parties who seek outcomes more favorable to their interests than alternative processes that are not transparent. To help minimize political interference, trustees or appointed officials should fully understand the inclusive participatory process agency staff use in developing management recommendations and thus be briefed regarding the process before it is used to make a decision, including ensuring they understand the consequences (e.g., broad citizen backlash) if the decision emerging from the process is countermanded. If trustees are supportive of the process being used, they may be more willing to stand behind the decision even if it is not popular with all stakeholders.

Challenge 2: Constrained Problem Framing

Problem framing, or articulating the decision context, is viewed as the most important step in any decision process. When faced with a problem or decision, it is a natural human tendency to immediately begin thinking about the solution, or alternatives, essentially assuming that the problem has already been clearly defined (Keeney 1992). However, a value-focused approach to thinking requires decision makers to carefully consider their values and values of stakeholders by being clear about what they wish to achieve (Keeney 1992). The way that a problem is framed has a large influence on the resulting decision that is made; recognition that problem framing and structuring is critical has fueled discussion regarding problem-framing methods (Keeney 1992, Gregory and Keeney 1994). Framing the problem with one’s preferred solution in mind, rather than thinking broadly, can severely bias the outcome of the decision-making process. Hammond et al. (1998) suggest that the quality of decision making can be improved by continuing to think about how the problem is framed throughout the decision-making process, challenging the original framing of the problem, and attempting to reframe the problem in numerous ways. Framing of the problem may change during the process of decision making, as decision makers gain new insight, or perhaps realize that the original problem was too narrowly defined. It takes critical thinking—and often much of it—to understand and properly frame a problem, but doing so should result in a more robust decision.

Challenge 3: Data

The decision context, including values, preferences, and objectives of decision makers and stakeholders, largely determines science or data needs. Thus, data or science do not drive the decision in the absence of values, preferences, and objectives. Wildlife managers are commonly put in the unenviable position of having an abundance of data, but perhaps data that were collected for another purpose, or do not necessarily relate directly to the decision being evaluated. Wildlife managers may not have the capacity (e.g., lack of staff, lack of relationships with other entities that have needed expertise) to analyze the necessary data sets.

Even if staff are available, analyzing data may not be a priority when compared with other, more immediate responsibilities. At the opposite end of the spectrum, managers often lack relevant data, which can serve as a stumbling block to making decisions. There is a false belief that the absence of data prevents decision making, when in reality, decisions are frequently made in the absence of data. Although data availability may initially represent a challenge, it is not insurmountable. Many methods exist for generating predictions (e.g., models) for how well a particular management action may support the objective(s). Such models can take various forms; they may be conceptual (derived through logic); quantitative, based on empirical field or lab data; or informed by expert opinion (Ayyub 2001). Managers occasionally may find themselves in a situation where they are burdened with too many data sources. In such situations, they may lack resources to adequately analyze and summarize existing information, or an abundance of data sources may make it difficult to discern which sources are most important to the decision being considered and which sources do not improve the quality of the decision-making process. Revisiting clearly stated decision objectives should help prioritize which data sources are most appropriate to use.

Challenge 4: Institutional Lack of Support for Sustained Professional Development

An institutional lack of support for sustained professional development can result in agencies or organizations employing managers and other staff who lack training in decision-making techniques and may not have the breadth of disciplines necessary to engage in new approaches (e.g., lack of training or knowledge of social science theories or methods or relevant analytical skills; Bennett et al. 2017). This lack of training is not surprising; however, the importance of decision making in wildlife management may seem self-evident, yet decision making is not typically included in curricula for students aspiring to careers in our profession (Millenbah and Millspaugh 2003, Kroll 2007). Instead, the management aspect in wildlife management is treated largely as the application of technical knowledge and skills for wildlife (i.e., individual animals and populations) and habitat manipulation. Learning and mastering the

science and art of decision making is left to individual experience, a paradox given the assertion shared earlier that decision making is the “core work” of a wildlife manager (Riley et al. 2002). Agencies wanting to improve decision-making processes could benefit from training managers and administrators and hiring new employees who possess decision-making skills. That starts with prospective employees’ preprofessional education and training.

An immediate step is to change the nature of educational preparation of wildlife conservation and management students so that they receive training in decision making (Johnson et al. 2015). Agencies could urge undergraduate and graduate wildlife programs to consider offering courses in natural resource decision making so future biologists and managers are skilled in decision science methods. This has been a recent focus of the U.S. Geological Survey Cooperative Research Units program, with at least 12 universities now offering courses in natural resource decision making (Table 1).

Wildlife agencies may wish to support continuing education in decision making that allows staff to maintain relevancy in our changing world. Although it may potentially be concerning that the foundation of analytical skills varies widely among managers, a suite of analytical approaches for decision making exists that range from analytically simple to complex. Additionally, there are opportunities for training staff and partnering with decision analysts to carry out the specific modeling components that may be beyond the current expertise of staff. Engaging academic institutions or consultants to assist in specific modeling or analysis components of the decision can be fruitful. Even with increased training of staff, needs for partnerships with academic institutions and nongovernmental organizations who can help with some of the processes and quantitative modeling aspects of decision making can be expected.

Challenge 5: Time

Agencies may not always have the staff time or resources necessary to invest in long decision-making processes. Frequently, agency staff are tasked with time-sensitive decisions that require immediate action, many of which are a result of political pressures. Agencies may perceive the time required to collect desired ecological and social data are at odds with

Table 1. Courses in natural resource decision making taught by the U.S. Geological Survey Cooperative Research Units program.

Cooperative Research Unit	University	Course
Alabama	Auburn University	Structured Decision Making for Natural Resource Management
Colorado	Colorado State University	Adaptive Fish and Wildlife Management
Georgia	University of Georgia	Structured Decision Making and Adaptive Management
Louisiana	Louisiana State University	Structured Decision Making in Natural Resources
Missouri	University of Missouri	Decision Analysis
Montana	Montana State University	Decision Making in Natural Resources
Nebraska	University of Nebraska–Lincoln	Adaptive Natural Resource Management
New York	Cornell University	Decision Making for Natural Resource Management
North Carolina	North Carolina State University	Decision Analysis for Conservation and Management of Natural Resources
Oregon	Oregon State University	Quantitative Decision Analysis for Fish and Wildlife Management
Pennsylvania	Pennsylvania State University	Structured Decision Making and Adaptive Management of Natural Resources
Texas	Texas Tech University	Structured Decision Making in Natural Resources Conservation
Vermont	University of Vermont	Principles of Modeling with Spreadsheets

their need to make rapid decisions (Robinson et al. 2019), particularly if the ecological change is occurring rapidly or considered a crisis (e.g., white-nose syndrome; Wilson et al. 2016). In a decision-making context, the amount of time devoted to a particular decision should be scaled relative to the importance of the decision. Not all decisions require large investment of time or resources. Approaches that may help resolve time-scale issues in decision making include changing the ways in which people perceive and value time and providing incentives that prevent short-sighted behavior, among others (Wilson et al. 2016). In addition, the decision-support tools that are being employed should be tailored to the issue at hand, which may require adapting the processes as necessary based on time or other constraints.

Challenge 6: Proactive Versus Reactive Management

Public-trust management agencies are expected to be reactive to issues, but are wise to strike a balance between reactive and proactive management. Certainly, this is not an easy task, and we are sympathetic of wildlife managers trying to achieve a perfect balance. However, focusing entirely on reactive management results in short-term gains and devalues longer term management options. Planning over a long time or large spatial scales takes a commitment of resources and a level of patience that many agencies may not be willing or able to provide (Wilson et al. 2016). This may be due to a lack of capacity (e.g., time and people), political pressure for more immediate decisions, or an agency culture that values traditional intuition-based approaches over a more structured systems-based approach.

INDIVIDUAL CHALLENGES

Decision making is one of the basic cognitive processes of human behavior (Wang and Ruhe 2007). Cognitive psychologists have studied human decision making, making it well-known that individuals take cognitive shortcuts when making decisions, often using heuristics or satisficing, making judgments that are “good enough” (Simon 1990). Our decisions are also shaped by prior experience because all of our previous decisions provide some information to help guide future decisions (Newell et al. 2007). Relying on prior experience and using heuristics may speed up the process of decision making, but there are many biases introduced in the process if individuals are left to their own devices to make complex multiple-objective decisions, resulting in errors in their decision (Bazerman and Moore 2012). To achieve organizational transformation within an agency, the actions of individuals must change (Stewart 1989, Payne et al. 1993). However, changing human behavior is challenging, especially when related to management decision making. Introducing a systematic process for decision making, using a decision science approach, is a way forward to improve individual challenges associated with decision making such that decisions are comprehensively structured, analyzed, and implemented.

Challenge 1: Fear of Loss of Power

Humans tend to resist change, and one reason for resistance is fearing loss of control and diminished sense of

self-determination (Kanter 2012). Loss aversion is a common reason to resist change: “Because the negative utility of losses is greater than the utility for equivalent gains, people will prefer the default” (Baron and Ritov 1994:479). Decision makers hold the power to make decisions about public trust resources, such as wildlife, for the public good, and some decision makers may believe that a decision-support tool will diminish their power and therefore, are reluctant to invest in a decision-making process. Specific groups of stakeholders may also fear loss of power if the agency historically relied heavily on their input when making decision recommendations, but then changed to a more inclusive decision process that elicits values and preferences from a wider array of stakeholders. All parties involved should understand that decision-making processes and support tools focus on providing support for decision makers, not automated decisions. The decision maker still must make the final decision; therefore, their power is not diminished or revoked. Defensible decision-making frameworks integrate values and facts to provide insight for decision makers, but ultimately it is up to the decision maker to make the decision.

Challenge 2: Aversion to Change

Status quo bias, or a preference for the current baseline has been shown to affect human decision making (Samuelson and Zeckhauser 1988, Kahneman et al. 1991, Thaler et al. 1992), contributing to resistance when new techniques or ways of thinking are introduced. Implementing new approaches to decision making requires change, and individuals may interpret the change as a criticism of how they have conducted past management. This could cause managers to fear accountability for past actions or decisions, and therefore threaten their professional credibility. For example, managers may be reluctant to discontinue long-standing monitoring programs even if they are not designed to inform specific management actions. The hesitancy of managers to cease long-term survey or monitoring programs may be caused by an abundance of historical investment in them (i.e., sunk costs) and by key stakeholders having been convinced of the importance of the monitoring effort. That is not to say there is no role for monitoring—implementing state-based, objective-driven approaches to management may be valuable if monitoring programs are designed to inform conservation and management objectives (Nichols and Williams 2006, Lyons et al. 2008, Lindenmayer et al. 2013) and data are collected with adequate power (Legg and Nagy 2006).

A new approach to decision making may result in an action that changes the work a manager likes and knows how to do well (e.g., long-standing monitoring efforts). In addition, changing from a manager’s intuition decision process to a more systematic or structured decision-making framework may be seen as too much of an investment and result in aversion to changing the way decisions are typically made.

It is attractive to attempt to “keep it simple.” Proponents of this mindset espouse that a more comprehensive approach to decision making can overcomplicate matters and

potentially lead to inaction (“analysis paralysis” gridlock). This may result if an agency tried to take a more rigorous approach to decision making, but were dissatisfied with the experience (for various reasons), so any approach to try again or do something new is suspect.

To overcome resistance to change, it is important to communicate how new approaches to decision making represent opportunities for improvements in management. Aversion to change in an agency can also be addressed through continuing education opportunities for existing staff and the recruitment of new employees who are comfortable with systematic decision-making processes. Hiring staff that have a breadth of training or experience, come from a wide variety of backgrounds more representative of the populace the agency serves, and who may have expertise in “non-traditional” fields such as sociology, economics, and communication, may help create an agency culture conducive to change (Bennett et al. 2017).

Initiatives that Deal Explicitly with Decision Making

We outline 2 (interrelated) initiatives that deal explicitly with decision making in complex systems and highlight how each initiative addresses some of the challenges previously described.

Decision Science Approaches: Structured Decision Making and Adaptive Management.—Structured decision making is a formal method or framework for evaluating decisions using a value-focused approach where values (preferences) of the decision makers and their associated stakeholders are used to generate objectives and guide the decision, with an end goal of aiding the decision maker in finding an optimal management alternative that best meets the stated objectives (Keeney 1992, 1996; Clemen 1996; Gregory et al. 2012). The process focuses on appropriately framing the problem, is participatory, clearly describes the role of stakeholders, and addresses conflicts in the fundamental values of stakeholders (Gregory et al. 2012, Robinson and Fuller 2017). The decision science approach follows the rational model of decision making (Hammond et al. 1999, Bazerman and Moore 2012) and includes the following steps: define the problem or decision context, identify objectives, generate alternatives, rate each alternative on each objective and evaluate consequences, and calculate and choose the alternative with the highest values. A large suite of quantitative tools is available to evaluate complex and multiple-objective decisions that allow decision makers and stakeholders to understand tradeoffs that must be made regarding each objective, as well as how sensitive or robust the decision is to changes in the system, stakeholder preferences, or relative importance assigned to objectives. Adaptive management is a special case of structured decision making that is used when decisions are iterated over space or time and there is uncertainty, which allows for learning about the dynamics of systems and adapting decisions to reflect reduced uncertainty (Williams and Johnson 1995, McGowan et al. 2011). Benefits of using a structured approach to decision making include increased defensibility and transparency by making explicit values and

judgments supported by social, biological, and economic data. By involving stakeholders and considering their values, a relationship of trust and collaboration can develop, resulting in increased support for the recommended decision.

The Manager’s Model.—A Manager’s Model is a structured, situational analysis tool to describe and understand the management system from the perspective of a wildlife manager (Decker et al. 2014). The Manager’s Model explores the interdependent biological, physical, social, and institutional components of the dynamic environment in which wildlife resources are managed. The process includes a) a portrayal of desired future conditions, actual conditions, factors that influence conditions, and known and anticipated interests and concerns to be considered before taking actions; b) a broad view of what is being managed with respect to a particular resource; c) a rich description of management purpose, premise, and context; d) identification and characterization of stakeholders and the effects of management they seek or experience; e) describing assumptions, relevant knowledge, and knowledge gaps, and f) identifying likely suites of management actions and their intended and unintended consequences.

The Manager’s Model is used internally by management teams to develop a common understanding of the elements and drivers of an issue. It is used to understand the management system and inform a decision about management alternatives. The outcome of the Manager’s Model is not a work plan, but provides guidance to identify work plan elements and align them with the team-generated desired future conditions (Decker et al. 2011). The Manager’s Model can be an excellent precursor to engaging in a decision science approach (e.g., structured decision making), whereby the Manager’s Model helps managers understand the system and clearly articulate the problem and objectives, and a structured decision-making framework allows for an evaluation of how well alternatives accomplish the objectives, which then leads to a decision after an evaluation of the tradeoffs.

Continued Improvement for the Wildlife Management Institution

Successful applications of systematic decision-making processes have occurred in wildlife management; we have noted several. However, widespread adoption of formal frameworks for decision making in wildlife management has not yet occurred. We have highlighted some potential reasons for lack of adoption. Adoption of systematic decision-making processes can be aided by taking a few steps. The first step is to recognize and understand challenges to adoption and work to overcome them. Second, understand that implementation of a structured process for decision making does not require a large investment of time or money (Runge 2011); small or partial applications can be tried to build skill and confidence. The minimum desirable elements for success in decision making is clearly defining objectives to solve the conservation or management problem and then designing management alternatives that directly help in achieving those objectives—this is one of the basic

components of the Manager's Model and represents the first 3 steps of structured decision making (defining the problem, objectives, alternatives). The degree to which consequences are predicted and trade-offs evaluated can be scaled relative to the importance of the management problem.

A strategy for gradual adoption of formal decision-making frameworks, guided by some tenets of organizational change, would include first establishing a sense of urgency and identifying a guiding coalition (Kotter 1995) of one or more 'decision champions' within the agency, people who see value in implementing rigorous and transparent approaches to decision making and practice value-focused thinking whereby the objectives of the decision maker are identified and are then used throughout the decision-making process (Keeney 1996). Training "decision champions" in structured decision making and adaptive management (e.g., in workshops, courses at the National Conservation Training Center, university courses in decision making for natural resource management) and the Manager's Model (at workshops), followed by encouraging them to solve small decision problems using the framework will build their confidence and provide practice in how to think through steps of the decision-making process (i.e., identifying the problem, articulating objectives, generating management alternatives, predicting consequences, and evaluating trade-offs). Examples of small problems may include decisions related to allocating staff time to different projects, hiring new staff, or developing a human-wildlife conflict protocol. Being successful in these small decision problems creates short-term wins that keep urgency levels high, which is important because major changes can take a long time and can result in a decline in urgency levels over time (Kotter 1995). Assigning the decision champion(s) the task of developing an agency seminar-series on decision making will allow others in the agency to be exposed to decision-making frameworks. The guiding coalition of decision champions will help set the direction and vision of how the agency should move forward in decision making and then work diligently to broadcast that vision through whatever means necessary, removing obstacles to achieving that vision (Kotter 1995). Staff exposure to decision-making concepts and examples can be increased through seminars, speakers for which may include decision leaders in sister agencies, federal scientists, consultants, or academic partners. The first seminar should provide a general introduction to decision science approaches and subsequent seminars could focus on specific decision-science applications. Generating awareness throughout the entire agency—from the highest levels of administration to managers and biologists—may engender appreciation of decision science methods and allow staff to understand when applying a structured decision framework would be valuable. Eventually this could lead to engraining a whole new way of thinking for the entire agency and institutionalizing change. For that change to happen, it must be clear that the new decision making process has been helpful for the agency and that has been communicated effectively to managers at all levels of the organization (Kotter 1995). For problems that

move beyond the capacity of current staff to tackle—perhaps those that involve large modeling components—collaborating with decision analysts will help in analyzing the decision while at the same time training staff in the tools of decision science. Thinking through problems using the Manager's Model combined with the simple 5-step decision-making approach (problem, objectives, alternatives, consequences, trade-offs) can revolutionize the way that the wildlife management institution functions.

We want to emphasize that stakeholder engagement is an essential element that should not be seen as independent of the decision-making process, but rather embraced as important for informing the process about pertinent values (i.e., objectives), stakeholder preferences for alternative management actions, or factors to consider when making predictions about the effect of management on stakeholder values (e.g., recreation, opportunity to see and shoot harvestable species, hunter crowding). Many agencies survey their stakeholders, but fewer design stakeholder surveys in a way that can be used directly in decision-making processes (but see Robinson et al. 2016, 2017). As we outlined, the 'core work' of the wildlife manager and decision maker is to integrate the ecological, social, economic, and political elements of a decision to produce outcomes that society values. Toward this end, routinely applying formal decision-science processes should be an aspiration of every agency that wishes to improve their decision-making processes to be consistent with their objectives (e.g., transparency, replicability, and defensibility).

CONCLUSION

The work of wildlife managers is demanding and complex. We have highlighted several issues that make decision making difficult in wildlife management, identified key challenges that managers face in making decisions, and described some ways to deal with the complexity of management decision making. For managers wishing to increase transparency, public buy-in, inclusivity, partner participation, replicability, and defensibility of the decision process, we have outlined some steps that agencies may take in adopting formal decision-making processes. Using a decision science approach should ensure that decisions include all relevant aspects of the social-ecological system that the wildlife management institution seeks to understand and manage.

One fundamental change needed in decision making for complex problems that exist at the intersection of ecological, social, and economic spheres is widespread recognition that an explicit framework is useful to arrive at defensible and robust decisions. We acknowledge that no panacea, simple recipe, or one-size-fits-all prescription exists for wildlife management decision making. The wildlife management institution has been evolving and moving toward more rigorous decision making over the past couple of decades, and we are encouraged by this movement. A continued and widespread shift to using a systematic framework for decision making will take time—we believe doing so will maintain or improve agency credibility and legitimacy while markedly advancing the field of wildlife management.

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