Adaptive management of prairie grouse: how do we get there?

by Cameron L. Aldridge, Mark S. Boyce, and Richard K. Baydack

Abstract Managing prairie grouse has been largely a reactive process without any "true" management experiments being implemented, thereby limiting our ability to learn from management and enhance conservation efforts for declining prairie grouse populations. In a few cases where the potential existed for a passive or active adaptive approach, monitoring was insufficient to detect effects of changes in management practices. Similar problems appear to occur at planning stages in attempts to implement adaptive management for prairie grouse populations, preventing proper consideration of sound adaptive experiments that advance learning. Successful adaptive management begins with stakeholder gatherings following a policy planning process, which includes many steps, beginning with goal identification and understanding of uncertainties and culminating in model simulations to understand potential management policies. By following this process, the opportunity to implement successful management experiments can be enhanced. We discuss the successes and failures of prairie grouse management using 2 case studies, 1 for prairie sharp-tailed grouse (*Tympanuchus phasianellus*) in Manitoba and 1 for greater sage-grouse (*Centrocercus urophasianus*) in southern Alberta. We describe ways in which active adaptive management could improve our understanding of prairie grouse population declines and outline a policy planning process that, if followed, will allow adaptive management to be successfully implemented, enhancing prairie grouse management and conservation.

Key Words adaptive management, Alberta, *Centrocercus urophasianus,* conservation plans, grazing, greater sage-grouse, habitat, Manitoba, policy planning, prairie sharp-tailed grouse, *Tympanuchus phasianellus*

Prairie grouse have been declining throughout North America over the last century (Braun et al. 1994; Braun 1998; Connelly et al. 1998; Applegate et al. 2000*a*, *b*). Some of the most marked declines have been recorded for sage-grouse (*Centrocercus* spp.; Braun 1998) and greater prairie-chickens (*Tympanuchus cupido*; Applegate et al. 2000*a*) over the last few decades. Prairie grouse population declines are associated with direct loss of habitat and continued fragmentation and degradation of existing habitat (Braun et al. 1994). Management efforts have been relatively unsuccessful, and populations continue to decline. As a result, several species or distinct

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populations in Canada and the United States have been petitioned or listed as threatened or endangered (Anonymous 2000, Aldridge and Brigham 2003). Too often, prairie grouse managers have taken a wait-and-see or trial-and-error approach (Hilborn 1992, Halbert 1993). This has limited our ability to learn about population regulation and habitat limitations. We believe that adaptive management (Holling 1978, Walters 1986, Walters 1997*b*), appropriately implemented, could identify sound alternatives for prairie grouse populations, advance our learning, and improve management policies to benefit prairie grouse populations. In this paper we present background on the history and idea of adaptive management. We discuss why many adaptive management strategies have failed and illustrate how and why it is important to develop an approach for implementing management policies for prairie grouse within an adaptive framework. We use 2 case studies to illustrate our points, one for prairie sharp-tailed grouse (*T. phasianellus*) in Manitoba and one for greater sage-grouse (*C. urophasianus*) in Alberta.

History of adaptive management

Buzz Holling, Carl Walters, and Ray Hilborn developed the concept of adaptive management in 1974 through a series of workshops (Ludwig and Walters 2002). The concept was aimed at building models to understand uncertainties associated with natural resources, and involved managers, policy-makers, and scientists in the process (Holling 1978, Walters 1986). Walters and Hilborn (1976) introduced the idea of adaptive resource management in 1976. They pointed out that experimentation was the most reliable means of understanding uncertainties in resource systems, and that comparing alternative models should form the basis of management, experimental design, and monitoring of the resource system (Holling 1978).

The adaptive policy process involves stakeholders and begins by integrating existing knowledge and scientific information into dynamic models used to make predictions about impacts of alternative management practices (Holling 1978, Walters 1986, Walters 1997*a*). Practices are re-evaluated and adjusted as new information is obtained from current management (Holling 1978, Walters 1986, Walter 1997*b*). Adaptive management is essentially learning by doing (Haney and Power 1996, Walters 1997*b*), placed in the framework of experimental design with feedback from the learning stage back into the doing stage. This concept is not new; most managers, scientists, and wildlife biologists are aware of adaptive management. However, it is a poorly understood concept that is difficult to apply and often inappropriately applied (Walters 1997*b*, Wilhere 2002).

Adaptive management definitions and misconceptions

The 2 key components of adaptive management are 1) management is effectively set out as an experiment with a sound experimental design, and 2) a direct feedback loop exists between science and management (Halbert 1993). Essentially, adaptive management is the incorporation of the scientific method (experiments) into a management framework (policy decisions). This differentiates adaptive management from traditional trial-and-error or learn-as-you-go management (Hilborn 1992, Halbert 1993). Managers and stakeholders involved in conservation planning processes often disregard this fact and think of adaptive management simply as sound management or management with a willingness to change (Wilhere 2002). Others see it as flexible management, an opportunity to contest policies they consider objectionable (Wilhere 2002). Bormann et al. (1999:506) defined adaptive management as "an approach to managing natural systems that builds on learning—based on common sense, experience, experimenting, and monitoring—by adjusting practices based on what was learned."

Although adaptive management has become a popular idea among management agencies and can be useful when implemented correctly, in practice it is often used as a buzzword and never implemented.

Adaptive management can be implemented at various levels, the simplest of which is called reactive management, similar to trial-and-error management (Hilborn 1992). In this case, changes are driven by stimuli external to the management system, such as politics, lawsuits, and public opinion (Bormann et al. 1999). As a result, conflicts often arise due to multiple stimuli, resulting in haphazard management (Bormann et al. 1999, Roe and Van Eeten 2001). Many wildlife management decisions, both old and current, have been made based on reactions, and most of them resulted in crisis management, with one policy often trying to correct crises created by earlier management decisions (Bormann et al. 1999, Roe and Van Eeten 2001). Reactive management is unreplicated and lacks statistically valid experimental design, often producing unreliable information (Hurlbert 1984, Wilhere 2002). This often results in implementation of single policies or strategies that are assumed to be suitable without evaluating the policies or comparing alternative strategies or controls.

In contrast to reactive management, passive adaptive management involves long-term monitoring and learning from a gradually evolving management strategy (Walters 1986, Hilborn 1992), but typically lacks scientific rigor (i.e., no replication, no controls, no randomization; Hurlbert 1984, Wilhere 2002). This relatively simple and inexpensive approach involves measuring responses relative to what happened in the past (learning from experience; Roe and Van Eeten 2001), but understanding of causal relationships is limited (Bormann et al. 1999). This process often becomes reactive trial-and-error management, when funds committed to monitoring are removed (Bormann et al. 1999). Passive adaptive management can be useful in systems that have a high degree of natural variability (Halbert 1993); large enough natural perturbations can be measured and correlated to disturbances. However, if processes other than management are causing the variability (i.e., environmental variability like weather patterns), it can make causal relationships difficult to discern.

Finally, active adaptive management is a rigorous form of the concept (Walters 1986, Hilborn 1992) that occurs through parallel learning (Bormann et al. 1999). This approach differs in that management policies are designed, replicated, and tested against each other. Management is essentially achieved through a series of controlled experiments (Walters 1997*b*, Bormann et al. 1999, Roe and Van Eeten 2001), identifying cause-and-effect relationships between management activities and changes within the system (Wilhere 2002). This promotes rapid learning and the formation of optimal policies that will guide future management (Wilhere 2002) and prevents the broad application of any single policy that may or may not work, possibly preventing the alteration of future management (Walters 1997*b*).

The primary difficulty with implementing an active adaptive management strategy is replication, making it difficult to use in a single or unique system (Walters 1986), (e.g., small endangered populations; Boyce 1993). One option may be to implement various management strategies in separate subpopulations (Boyce 1993), possibly comparing treatment effects between areas with similar characteristics. In this case, it would be difficult to control for spatial variation, but replication of treatments may be achievable.

Another approach for adaptive management of small populations is the Before-After-Control-Intervention (BACI) design, originally identified by Green (1979). With this design, variability in the system is monitored prior to intervention. In adaptive management applications, the key elements of a BACI design include replication, controls, and monitoring both before and after management intervention. In cases where management policies will take place at the scale of the entire population (i.e., small populations), replication is impossible. However, management actions can be compared using an information–theoretic approach. By framing treatments in the context of multiple working hypotheses (Chamberlin 1890, Anderson et al. 2000), hypotheses would consist of a series of a priori candidate models, management options outlined during policy planning meetings (Walters 1997*b*, see below). If a particular strategy achieved a biologically meaningful goal (Reed and Blaustein 1995), such as an increase in population size of a predefined magnitude, then the strategy should be considered successful, regardless of the statistical significance of the experiment. With this comparative approach, the adaptive management process is still used and biological goals can be tested.

Female sage-grouse sitting on her nest under silver sagebrush (*Artemisia cana*) surrounded by grass and forbs. Photo by Cameron L. Aldridge.

Reasons adaptive management fails

Adaptive management can fail for a variety of reasons (Walters 1997*a*, Moir and Block 2001). The major flaw is that the process rarely progresses from the model development stage to the design and implementation of field experiments. Walters (1997*a*) participated in 25 adaptive management planning processes, only 7 (28%) of which resulted in large-scale management experiments; 2 (8%) had well-planned experimental designs with controls and suitable replication. Walters (1997*a*) suggests that experiments often are opposed by people protecting self-interests in management bureaucracies, and proponents of adaptive management need to be forceful and expose these groups and their interests to public scrutiny. This will help to keep the adaptive management process on track and maintain the sustainability of public resources. Value conflicts arise from the necessity of involving all stakeholder groups with an interest in the resource in the decision-making process, each potentially possessing different values, morals, and opinions (Walters 1997*a*).

Adaptive management needs effective implementation of experiments, which may be expensive or risk-prone (Macnab 1983, Halbert 1993, Walters and Green 1997, Walters 1997*a*) compared with baseline options, especially when threatened or endangered species are involved. Public agencies by nature are risk-averse and manage for the status quo (Halbert 1993). However, if risk-averse status-quo management (Halbert 1993) is not benefiting a threatened species, then adaptive management presents a viable option. Identifying uncertainties early in the planning stages (see below) will eliminate individual or multiple management options that may pose risks (Walters 1997*b*).

Even if experimental designs are implemented, adaptive management often fails because the information feedback loop (monitoring and evaluation) is broken (Moir and Block 2001). Thus, learning is inhibited and there is no evolution of management policies. This loop typically is broken because managers are looking (by necessity) for short-term responses and feedback from management policies (Moir and Block 2001). To avoid such conflicts, the realization that responses to management may be longer term needs to be identified by stakeholders during initial policy planning to avoid such conflicts.

Below, we present 2 case studies in which attempts were made to implement adaptive management strategies for prairie grouse. Both attempts failed to successfully implement adaptive management; however, we feel there are important lessons to be learned from our experiences.

Case Study 1: Manitoba sharp-tailed grouse

In Manitoba a pilot project for sharp-tailed grouse habitat management using principles of adaptive management has been underway for a number of years. The program is a partnership approach involving a local nonprofit organization, the Sharptails Plus Foundation, in association with the University of Manitoba and the Manitoba Department of Conservation.

Estimates of sharp-tailed grouse in Manitoba indicated a decreasing population, although they are still at relatively high levels when compared to other North American populations (Froese 2002). Habitat alteration was suggested as the cause of the long-term decline (Baydack 1996). In more southerly areas of the province, agriculture had eliminated historically important cover types, particularly shrubland and woodland; in central areas, fire suppression and reduced grazing had caused shrubland and woodland to increase above historic levels (Berger and Baydack 1993). In central areas such as Manitoba's Interlake region, sharptails were thought to have thrived historically in diverse vegetative cover, roughly equivalent to an equal one-third mix of grassland, shrubland, and woodland (Bird 1961). This historical composition has changed throughout the province, most notably with respect to shrubland composition, which is nonexistent in many areas (Berger and Baydack 1993).

To address the effects of habitat alterations on sharp-tailed grouse populations, a private, nonprofit organization, the Sharptails Plus Foundation (SPF), was created in Manitoba in the early 1990s. It is volunteer-based, comprised of relatively influential citizens whose overall goal has been to enhance the habitat condition for sharp-tailed grouse and thereby influence population levels throughout the province. Although the primary focus of the organization is on sharp-tailed grouse, members recognize that their work will affect many other species and communities, hence the "Plus" designation in their name. In the early 1990s, Sharptails Plus began to implement a variety of habitat-related programs across Manitoba with the help of a Technical Advisory Committee of ecologists, agrologists, and land managers. Their Private Lands and Pilot Projects Program was developed with the intent that it be implemented using concepts of adaptive management.

The program was based on several important underlying concepts. Cooperation with agriculture was essential for achieving effective sharp-tailed grouse habitat management. Landowners were seen as having reasons for doing what they do, and they are, in effect, the real habitat managers in much of Manitoba. Sharptails Plus recognized that understanding the motivation for landowner decisions about habitat and wildlife on their property was important. Similarly, Sharptails Plus recognized that biological data generally were lacking about how to best manage a parcel of land to meet sharp-tailed grouse needs. Finally, landowners needed to continue to manage their holdings, regardless of whether the "final" biological answer could be provided. The Technical Advisory Committee of Sharptails Plus noted that this created an opportunity to implement an adaptive management program that utilized the best available local knowledge from landowners and biologists to reach prescriptions that could be tested against each other. Steps in Sharptails Plus's Private Lands Program included the following:

1. Interested landowners in target locations were identified.
2. STP Technical Advisory Committee (biologists, agrologists, land managers) assessed existing habitat along with individual landowners.
3. Habitat objectives were established for each location in consultation with landowners, generally based on the percent cover of woodland, shrubland, grassland, and cropland, compared to the historic one-third levels.
4. Independently, the STP Technical Team and landowners developed their own habitat-management treatment recommendations for each location based on their individual reasoning.
5. Land parcels were randomly allocated to each "competing" management option, resulting in an overall Adaptive Farm Management Plan.
6. Management treatments were monitored, evaluated, and refined annually using both biological and economic measures. Budgetary constraints prevented radiomarking grouse to track their response to changing vegetation over time and limited monitoring to attempts to locate sharp-tailed grouse leks and nest sites. If leks were located near treatment sites, at least 5 counts of sharptail abundance were recorded annually in spring within 0.5 hour of sunrise, and these counts were compared over time and among treatments. Vegetative measurements were taken before and after treatments in spring, summer, and fall at every treatment site, using a nested-block design as described in Froese (2002). Measurements were dependent on the treatment applied and included vegetation composition, structure, height, rate of growth, percent kill of unwanted species, and others. Economic analyses of treatments also were performed annually and compared over time (Froese 2002).

A variety of management treatment options were available for consideration at every location, including: rotational and pulse grazing, delayed mowing and haying, leaving increased edge, planting shelterbelts and woodlots, prescribed burning, mechanical removal of vegetation, chemical removal of vegetation, and food plots.

The program has been operational in Manitoba at 4 locations (near the communities of Plumas, Lundar, Chatfield, and Vita) for the past 5 years. Preliminary results revealed the following trends:

- Landowners seem generally satisfied with the outcomes, which have resulted in increased forage use for their cattle and an apparent increase in sharp-tailed grouse abundance, although increased monitoring (i.e., daily or twice daily) of activity on leks in spring and use of radiomarking has been suggested.
- Most landowners considered an indicator of success to be whether a sharp-tailed grouse lek was actually established on their properties, often a difficult expectation to achieve.
- Biological indicators of success related to attainment of desired cover composition (percent cover in woodland, shrubland, grassland, cropland), which generally has been possible.
- Management treatment options proposed by biologists were no better in achieving vegetative cover composition "success" than those suggested by landowners.
- Monitoring of economic indicators suggested that incentive programs would be necessary to offset increased costs to farm operations. However, estimated costs of treatments likely were higher than would be expected due to the cost of smaller-scale experimental procedures used to formulate estimates.

On the basis of the success of the program to date as perceived by landowners, the Private Lands and Pilot Projects Program will continue in Manitoba into the foreseeable future. Although the Sharptails PlusFoundation is finding that financial requirements continue to be relatively high compared to their available resources, they believe the program is useful to ensure local support for conservation measures and to increase the area of coverage within the province. The program is recognizing that dedicated landowners are the real key to success in managing sharp-tailed grouse on private lands in Manitoba

Two-day-old sage-grouse chick in good escape cover. Photo by Cameron L. Aldridge.

and, perhaps more importantly, that dedicated landowners are at least as successful as biological managers in knowing the best practices for their landholdings. Therefore, a pressing need exists to encourage the release of this valuable local knowledge onto the prairie landscape so as to enhance management of wildlife habitats for future generations.

This case study represents a good initial attempt at managing declining sharp-tailed grouse numbers and was successful in achieving some of its goals. The program began using a collaborative planning process (Walters 1997*b*) and set out to improve habitat for sharp-tailed grouse by creating habitats similar to historical times when sharp-tailed grouse were more abundant, with an equal one-third mix of woodland, shrubland, and grassland. Most management techniques appeared to be successful at achieving vegetation goals; however, the process was limited from the beginning, when funds for grouse evaluations could not be allocated. Realistically, the program should be evaluated by how successful it was at creating habitats beneficial to, and used by, the birds—hence, increasing population numbers. In addition, other measures of biodiversity could have been incorporated into the monitoring programs so as to provide additional indicators of success for management decision-making.

Case Study 2: Implementation failures of Alberta sage-grouse adaptive management

The greater sage-grouse in Alberta has experienced some of the highest rates of decline of any known sage-grouse population (66–92% over the last 30 years; Aldridge and Brigham 2001, 2003), and the species is listed as endangered at both the provincial and federal levels. Research completed in 1999 suggested that limited residual cover and litter buildup was limiting the population through poor chick survival and low nest success (Aldridge and Brigham 2001, 2002). To document the role of range management, it was recommended that a variety of stocking rates be used in 2000–2001 in an attempt to enhance litter buildup and residual cover for sage-grouse and that the response of the vegetation and sage-grouse be monitored.

The goal of this management experiment was to assess the effect of grazing on nesting success of sage-grouse. We (C.L.A. and M.S.B.) designed the experiment with replicate treatments using 3 stocking rates (all various levels lower than current rates) and had many sites that maintained current stocking rates (controls). We chose sites (treatments and controls) with similar grazing histories and previous stocking rates, season, and duration of grazing. Treatments were randomly allocated (bounded by landowner participation) and replicated over different pastures, allowing us to compare management treatments (stocking rates) against each other and controls. Individual nest sites located within each treatment unit (pasture) would be grouped and the size of the treatments and controls kept similar, albeit limited to the size of currently utilized pastures. However, the effect of treatment size also could have been incorporated into the experimental design to test for an effect of treatment size (see step 4 below). A nested design was used to avoid pseudoreplication (Hulbert 1984), with each additional nest site within a treatment increasing our power to detect differences. Below, we highlight why this approach has failed, then describe how the process still may be implemented by adopting a collaborative adaptive process (Walters 1997*b*).

A new oil well being drilled in prime endangered sage-grouse habitat in southeastern Alberta. Photo by Cameron L. Aldridge.

In spring of 2000, with fears in the ranching community about the pending Canadian Species At Risk Act (SARA) and its potential consequences for management, scientists suggested that Alberta Sustainable Resource Development (SRD) and the Canadian Wildlife Service (CWS) hold public forums with local ranchers. The 2 organizations were to work under the umbrella of the CWS Endangered Species Habitat Stewardship program to approach landowners who might be interested in participating in adaptive sage-grouse range-management experiments. Due to a lack of funds from government agencies in summer 2000 and the sensitive and political nature of the pending endangered species legislation, this uncoordinated approach failed and only added to local landowner concerns about outsiders attempting to manage their land.

In 2001 SRD collaborated with the Alberta Conservation Association (ACA) to develop management strategies. However, at this point there was no involvement by Alberta Public Lands, the agency charged with managing the public lands that constitute >80% of current sage-grouse habitat in southern Alberta. The ACA had a habitat management program, called Native Prairie Stewardship, expanding into the area, which provided opportunity for collaboration. The program's focus was on developing and implementing sound range management to improve residual cover and litter for wildlife (important for nest success and chick survival of both sage-grouse and sharp-tailed grouse). The program worked with individual ranchers to develop range-management plans for each participating ranch and then helped to focus new management initiatives, assisting landowners with cost of implementation.

This program had limited monitoring and evaluation components, both important parts of the initial design process, as well as management policies themselves. As the program continued into 2003 under the premise of enhancing and protecting critical habitat for both sage-grouse and sharp-tailed grouse, some post-hoc songbird counts were added in an attempt to evaluate the effectiveness of the program. However, without suitable evaluations, there is no way to ensure that management initiatives achieve desired ecological goals.

At roughly the same time, the Nature Conservancy of Canada (NCC) began signing conservation easements in the area and developing management plans with the notion of protecting sage-grouse habitat. Like the Native Prairie Stewardship program, limited evaluation is associated with the NCC program. Both programs develop conservation management plans that are private landowner agreements and do not allow others access to the management plan or actions. By creating independent ranch-management plans void of experimental treatments and preventing access to management policies, currently radiomarked sage-grouse on these ranches could not be used to understand how grouse respond to management initiatives, preventing an adaptive approach involving evaluation and subsequent evolution of management strategies.

As a result of these activities and proposed management, Alberta Public Lands also became involved in sage-grouse management. They began their own initiatives to address the decline of sage-grouse, unconvinced that grazing was related to those declines. This resulted in 5 different agencies developing management strategies for sage-grouse and effectively overwhelming landowners with sage-grouse issues, causing them to close their doors to ongoing research. As a result, SRD coordinated a public meeting with landowners, researchers, the ACA, and Public Lands in spring 2002. This resulted in the formation of a Provincial Recovery Action Group (RAG) designed to bring together science, management, industry, and landowners in a collaborative effort aimed at implementing adaptive management strategies for the recovery of sage-grouse in Alberta. Walters (1997*b*) suggests that this is the first step in the policy-planning process necessary for the successful implementation of adaptive management (see summary below). This process will incorporate evolving economic and social concerns as well as new biological information pertaining to the system, an important process in adaptive management (Haney and Power 1996).

Delays in implementation continued as Alberta Public Lands refused to embrace the uncertainty about grazing, insisting there was not enough information to begin adaptive trials. Adaptive management should embrace this uncertainty, allowing for further understanding of the system through the implementation of a series of sound experimental management policies. However, Public Lands undertook its own research, including background range inventories, developing a sagebrush-soils classification, performing water-impediments studies, and performing a historical grazing-practices study. While retrospective studies may provide some insights, management experiments were postponed. Walters (1997*b*) points out that if policy-design processes begin by attempting to identify all scientific uncertainties about a system, then that process will fail on the simple fact that there is an infinite number of uncertainties. The goal of adaptive management is to embrace these uncertainties through experiments, increasing our ability to learn about the system.

The RAG is now showing signs of progress. After appointing a moderator familiar with the adaptive management process in late 2002, the group is approaching management following methods similar to Walters' (1997*b*) policy-planning process, albeit 3–4 years after the initial investment of funds by 5 different agencies and stakeholders. The RAG was able to bring together industry and conservation representatives, managers, scientists, and landowners for the planning process.
Representatives and their organizations have all bought into the process, most committing long-term to the RAG. Currently, the group is developing models to predict the outcomes of certain policies and management options, aimed at identifying and understanding uncertainties within the system (see steps 2 and 3 below). While adaptive management most often fails prior to implementing experiments (Walters 1997*a*), by following an adaptive policy-design process similar to that outlined by Walters (1997*b*; see below), the RAG will be able to identify sound management options and will have the opportunity

to implement those options as a series of experiments with suitable monitoring and evaluation components.

These 2 prairie grouse examples illustrate how important it is to have local involvement and "buy-in" at the policy-planning stages of adaptive management (Freyfogle 1998) and how easily the process can fail without it. Below, we discuss how one might implement a successful adaptive management policy and avoid the same mistakes we encountered during the policy-planning stages, prior to implementing any management experiments.

Implementation of successful adaptive management

Implementing an adaptive management policy begins with stakeholder gatherings and identification of all elements, variables of interest, management acts, objectives, indicators, time horizons, and spatial extents (Holling 1978). This is often one of the most difficult steps to undertake, but a concerted effort to involve all stakeholders at the beginning of the process will reduce the chances of failing at later stages and provide a sense of ownership to the decisions for each group involved. Ensuring that conservation groups, local landowners, industrial representatives, and managers stay committed to adaptive management processes over the long term can be difficult, especially given the turnover of individuals within most agencies and the fact that local landowners have limited time to commit to such efforts. This is where having an independent facilitator familiar with adaptive management and policy planning can reduce the length of the process and time commitments. This moderator needs to be meticulous in recording details of process developments, obtaining commitments from agencies and organizations at the beginning of the process. Timelines for implementing management strategies, including monitoring, evaluation, and review of the adaptive process, and commitment of funds from groups involved must be identified and outlined up front in management or conservation plans being developed. This will provide structure to the adaptive management process and ensure long-term involvement of individuals and commitment of financial resources from each group, even when personnel changes occur. We believe that if individuals and organizations involved with managing prairie grouse populations adopted similar methods, learning about prairie grouse populations would be advanced and habitat management problems could be addressed more effectively.

Once stakeholders come together, the first step is to define policy options and identify policy performance measures (Walters 1997*b*). This is where management options are identified and uncertainties about those outcomes and consequences are outlined. These options can vary over space and time; thus it is useful to define a ballpark scale for treatment comparisons. If management is directed at a single species, one must consider the scale(s) at which the species is likely to respond to the management. For example, if one implemented cattle exclosures to enhance prairie grouse nesting habitats, careful consideration would have to be given to the size of patch managed that may elicit responses by grouse. Implementing grazing practices can be difficult at scales other than those at which pastures are typically managed. Thus, one must think about the scale at which management occurs, as well as the scale at which a biologically meaningful response is likely to occur. The goal of adaptive management should be to seek out untested options and to evaluate new methods, not to find a cookbook best-prescription. Policy planning should include performance measures for each strategic option (Walters 1997*b*). This likely will include measures such as economic costs and benefits, ease of implementation, likelihood of success, and others, as well as the original biological goals (Walters 1997*b*).

The second step in the policy-planning stage is to identify major uncertainties by trying to predict the outcomes of policy alternatives (Walters 1997*b*). The candidate set of policy options identified in the first step is used to generate models and simulations to predict each policy's impact on desired performance measures (Walters 1997*b*). These predictions should not be considered as simple static comparisons; they need to be temporal predictions, because uncertainties in the importance of time scales will inevitably arise (Walters 1997*b*). This process should remove policies not directly relevant to the questions at hand and those likely to fail to begin with. In the sage-grouse case study, the Native Prairie Stewardship Program attempted to improve range habitat conditions for livestock (and wildlife) by creating several watering sources in upland habitats to more evenly distribute cattle. While this might have reduced grazing impacts in important mesic sage-grouse brood-rearing habitats, increasing cattle activities in upland areas could have negatively affected nesting success for sage-grouse. Thus, this management strategy would likely have been identified early during the planning process as problematic and been modified or abandoned altogether.

The third step in Walters' (1997*b*) process involves screening of models to define a good set of policy treatments. This is the process of weeding out policies that are not worth testing because they may have hidden pitfalls or deleterious cumulative impacts that would prevent the achievement of management goals. The modeling processes identified in step 2 will help to identify these hidden pitfalls.

Aerial display of the Sharptails Plus Foundation project at the Narcisse Wildlife Management Area, Manitoba. Photo by Patrick J. Caldwell.

Step 4 involves partitioning the landscape into experimental units at scales appropriate to the uncertainties (Walters 1997*b*). Walters suggests that 2 questions be posed at this stage: 1) What portion of the land should be devoted to each of the basic treatment regimes? and 2) How large should each experimental unit be? This is also the stage at which uncertainties about the size of experimental treatments can be tested and included as an experimental unit. For our sage-grouse grazing-intensity example, we proposed to implement several treatments with different levels of grazing pressure for comparison. Concurrently, or as an independent experiment, tests for the optimal treatment patch size could be conducted. The amount of replication would depend on the size of experimental units, potentially limiting the number of management policies that could be tested. With an endangered prairie grouse population, the population could be divided into an experimental unit and a control. However, this is where implementing the BACI design (Green 1979) may also be useful.

Next, the temporal and spatial scales at which key responses should be monitored must be considered (Walters 1997*b*). This is where science and management often are in direct conflict, but where they should be in harmony (Johnson et al. 1997). The priority should be to develop a sound and replicated experimental design that addresses, as directly as possible, the question(s) at hand. One must also remember that the time scale is an issue and answers to management questions may not be available immediately after implementation. This is where long-term commitments of individuals, organizations, and funds, as identified early in the planning stages, can ensure the successful identification and thus implementation of adaptive management.

Walters (1997*b*) encourages the use of Adaptive Environmental Assessment Modeling (AEAM; Holling 1978, Walters 1986) as the sixth and final step in his policy-planning process. Adaptive Environmental Assessment Modeling is a stakeholder-involved evaluation process that uses simulation modeling to predict future conditions (Holling 1978, Walters 1986). Maintaining the involvement of a wide range of stakeholders gives each of them ownership in the plan and strengthens the adaptive management process.

For both of the prairie grouse case studies we presented, attempts to implement sound adaptive management experiments failed. This is not uncommon. Most attempts to implement adaptive management in a variety of different systems tend to fail in the planning stages, prior to implementing experiments (Walters 1997*b*). However, by following the policy-planning steps we have presented, common mistakes in the planning stages can be avoided and the most appropriate management policies meeting biological, economic, social, and political goals can be identified, advancing the adaptive management process to the experimental phase, where management policies are implemented. By definition, adaptive management is an evolving process. To complete the full adaptive cycle, management strategies must be evaluated following the monitoring strategies outlined in the planning process. As new understandings occur, management strategies need to evolve and incorporate new information.

Conclusions

To our knowledge, experimental adaptive management has yet to be successfully used as a tool to advance learning and management of prairie grouse populations. More broadly, adaptive management seldom is successful with about 75% of policy-planning processes failing to implement adaptive management as experiments and less than 10% possessing sound experimental design with suitable replication and controls (Walters 1997*a*). Although adaptive management has become a popular idea among management agencies and can be useful when implemented correctly, in practice it is often used as a buzzword and never implemented. Ludwig and Walters (2002) suggest that this may be a defensive measure by bureaucrats attempting to demonstrate that change is occurring without actually changing anything. Adaptive management sets out to embrace uncertainties within a particular system, resulting in an increased understanding of the system by managing through experiments (Holling 1978, Halbert 1993). This allows appropriate common-sense policy decisions to be identified (Ludwig and Walters 2002).

Adaptive management can be expensive, but balances have to be achieved between contributing available funds toward habitat protection and allocating funds for adaptive management (Wilhere 2002). For adaptive management to succeed, there must be a commitment to long-term monitoring and evaluation that promotes learning and feedback into management strategies. Walters and Green (1997) suggest that approximately 20% of funds allocated to any management plan need to be set aside for monitoring and evaluation. Unfortunately, most habitat conservation plans lack sufficient monitoring to evaluate their success (only about 5% of plans created in 1999 had a suitable monitoring component [Kareiva et al. 1999]). Large government conservation initiatives typically do not promote the inclusion of monitoring in management plans. For instance, in 2000 the Canadian Wildlife Service implemented a 5-year, $45 million Habitat Stewardship Program aimed at protecting at-risk species and their habitats through conservation actions. However, guidelines for the program prohibit the use of funds to evaluate the strategies. The importance of monitoring and evaluation in management is frequently misunderstood, and failure to document consequences of management often results in the failure of many adaptive management plans. The most successful information technology companies in the world (XEROX, Kodak, IBM, and AT&T) recognize the importance of research and development, typically reinvesting about 10% of corporate earnings back into research and development (Gill 1997).

The management of prairie grouse needs an adaptive framework, and we recommend using Walter's (1997*b*) adaptive policy-planning process as a guideline to ensure that the process does not fail in the planning stages and that sound management options are identified. This process will enhance the probability of sound management experiments being implemented with suitable monitoring and evaluation components. Both case studies we present here are excellent examples of how lack of a coordinated effort will give rise to independent and possibly harmful management policies that lack scientific rigor and appropriate monitoring and evaluation components. However, the Alberta sage-grouse example also shows that following an adaptive policy-planning process (the RAG) can prevent the most common problems stalling the adaptive process (involving stakeholders, identifying and implementing sound experimental policies) and allow policy alternatives to be modeled and compared, thus identifying uncertainties. This process will allow management to be implemented as sound scientific experiments, the goal of adaptive management.

Conservation plans developed by groups of stakeholders to identify management priorities have been undertaken for many prairie grouse populations (C. E. Braun, Grouse Inc., personal communication), an important initial step in the adaptive management process. However, like most habitat conservation plans, prairie grouse plans typically lack suitable monitoring and evaluation programs. Even if working groups successfully identify and implement conservation actions, uncoordinated implementation of actions has made it impossible to identify appropriate methodologies to assess impacts on population numbers, as with the Gunnison sage-grouse conservation plan (Anonymous 1997). Structuring management policies as adaptive experiments should be a priority for individuals and organizations managing prairie grouse populations.

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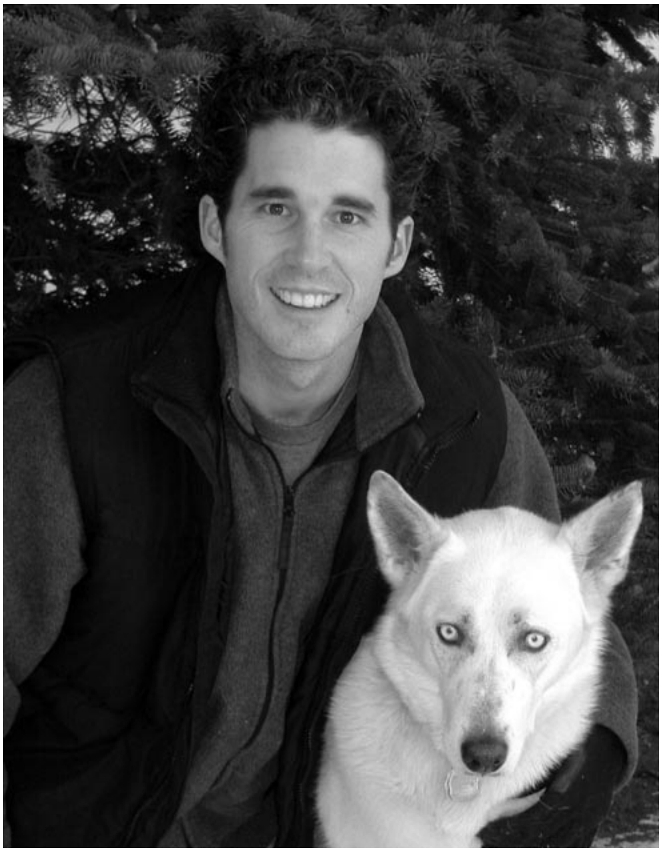

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