Arctic National Wildlife Refuge, Alaska

Chapter 3: Implementation Issues

The DOI Adaptive Management Technical Guide (Williams et al. 2007) touched on a number of important issues that are relevant to adaptive management applications and merit a more detailed discussion here. One issue involves scale, especially spatial and ecological scale, and the applicability of adaptive management across scales. The role of resilience, the potential for surprise, and ways to accommodate these concerns are also germane to adaptive decision making. Other issues include an accounting of costs and benefits in adaptive decision making, and the nature and role of learning organizations in implementing adaptive management.

3.1. Geographic scale

One concern in applications of adaptive management is the appropriate scale for decision making. Adaptive management is most visibly associated with big-picture applications that have a high degree of complexity. Prominent examples that refer to adaptive management include:

- river management (Columbia, Platte, and Missouri Rivers [Quigley and Arbelbide 1997, Wissmar and Bisson 2003, Levine 2004, Williams 2006, Freeman 2010]; Glen Canyon Dam on the Colorado River [Melis et al. 2006, U.S. Geological Survey 2008]);
- regional forest management (Rapp 2008, Reeves et al. 2006);
- continental waterfowl harvest management (Williams and Johnson 1995, Williams 2006);
- commercial fisheries (Hilborn 1992, Conover and Munch 2002);
- broad-scale habitat management (National Ecological Assessment Team 2006);
- pest management in forest ecosystems (Shea et al. 2002); and
- water management (Everglades [Holling et al. 1994, Comprehensive Everglades Restoration Plan Adaptive Management Implementation Guide 2011]).

Ecosystem management at this scale involves economic, social, institutional, and ecological linkages across large landscapes with a high degree of heterogeneity. One implication is that these systems are likely to respond in unexpected ways to variable environmental conditions and management practices. Because large ecosystems are susceptible to surprise, adaptive management seems especially appropriate. The importance and high visibility of such projects have led many people to believe that adaptive management only applies to large-scale, complex problems.

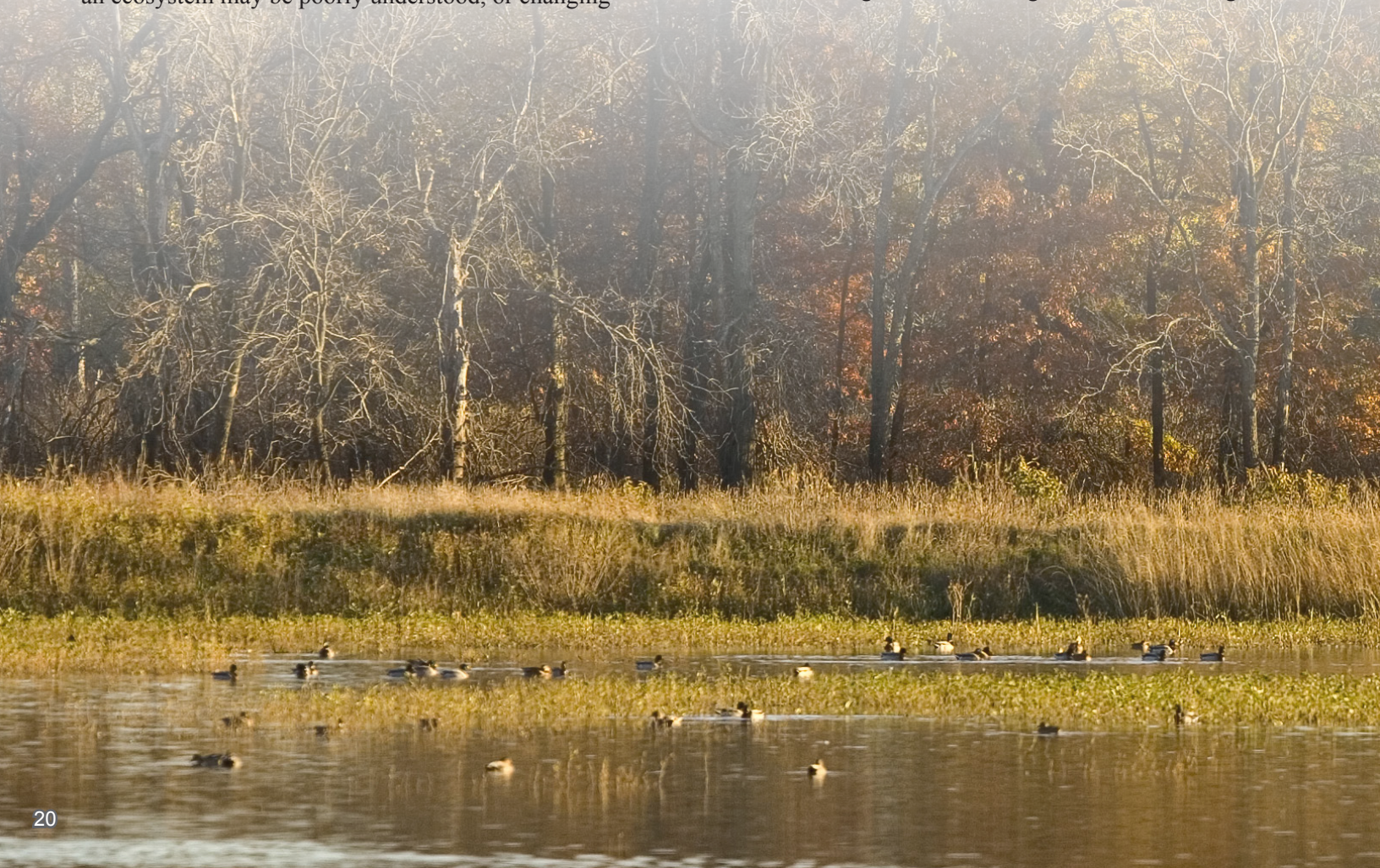
However, adaptive decision making as we describe it here applies equally well to local issues, as long as the basic conditions are met (e.g., see Williams et al. [2007], Moore et al. [2011], and Knutson et al. [2011] for examples). Our case study of red knots and horseshoe crabs in the Delaware Bay illustrates this point. There are probably many more potential applications of adaptive management at local scales, not only because of the prevalence of such problems but also because they can often be framed more easily, their uncertainties can be identified more readily, stakeholder involvement can be facilitated more directly, and management can often be implemented more easily (McConnaha and Paquet 1996).

The point here is that the activities involved in structuring a decision problem and trying to improve management through learning are not in themselves limited by the scale of the problem. Clearly, the specific approaches and procedures used to identify and incorporate the elements in an adaptive application can vary considerably across scales. For example, a local problem with only a few stakeholders, a single objective, and a single source of uncertainty about the impacts of management may require approaches that differ considerably from those needed for a large-scale problem with many stakeholders, multiple objectives, and several sources of uncertainty. Nonetheless, both problems are amenable to a structured, adaptive approach to decision making. Rather than scale, the main issues in deciding when to use adaptive management are whether there is substantial uncertainty about the impacts on management, whether it is realistic to expect that we can reduce uncertainty, and whether reducing uncertainty can actually improve management.

3.2. Surprise, resilience, and flexibility

Surprise, expressed as a "disconnect" between the ecosystem behaviors we expect and those that actually occur (Gunderson 1999*b*), is a feature of virtually all ecosystems. It can arise in several ways. For example, an ecosystem may be poorly understood, or changing environmental conditions may induce new behaviors, or the ecosystem may evolve new responses to management interventions. Within limits, surprise can be anticipated, managed, and reduced. However, it can never be eliminated, even when management is learning-based and carefully framed in terms of objectives, alternatives, and predicted consequences of actions. For example, Peterson et al. (2003) used an example of lake eutrophication to illustrate how an inadequate representation of structural uncertainty, in which critical ecosystem features were not represented in the models, resulted in management that would inadvertently lead to aperiodic cycles of stability and ecological collapse as thresholds to different states of the aquatic system were crossed. The unexpected impact of an invasive species is another example of surprise. In natural resource management the potential for surprise is always there because we never know everything about a resource system, and it never stops adapting to changing circumstances.

One approach that is sometimes proposed to address ecological surprise involves broad-scale surveillance monitoring. The argument is that such monitoring can serve as an "early warning" system for the surprises that inevitably arise as resources respond to changes in large-scale environmental drivers like climate and land use. The challenge is how to design such a monitoring



program, i.e., how to develop effective and efficient monitoring to highlight unknown and unanticipated resource patterns. Because surprises are by definition not predictable, answers to the basic design questions about what, where, when, and how to monitor are not available to guide the monitoring design. That said, any monitoring effort, no matter how it is focused and targeted, presents the opportunity for discovery of unanticipated knowledge. It therefore is smart to explore the data produced by any monitoring effort, including the data produced in adaptive management, for novel patterns and relationships.

Surprise, and the associated issues of uncertainty and resilience, are of major importance in a growing literature that comes under the rubric of "resilience thinking" (Gunderson et el. 1995, Gunderson and Holling 2002, Walker and Salt 2006). The framework of resilience thinking includes the following elements.

- Natural systems are subject not only to reversible short-term change, but also to long-term change that is effectively irreversible. Ecological thresholds exist beyond which reversible change becomes irreversible.

- Ecosystem evolution is characterized by changes across scales that are surprising and often unpredictable.

- Patterns of transformation in ecosystems are driven by slow accumulation of natural and cultural capital followed by rapid reorganization, which leads to disruption of the ecosystem and an increased potential for it to be restructured.

- Ecosystem management can use the principles and practices of adaptive management for learning and adaptive change.

An important conclusion of resilience thinking is that management focusing on only one or a few ecosystem attributes can lead to loss of resilience and an increased vulnerability to unexpected and destructive change. Well-known examples include the intensive management of grazing, which can increase the vulnerability of grasslands to drought; the broad-scale control of certain pests, which can increase the likelihood of devastating outbreaks of other pests; water management for irrigation and flood control, which can increase the vulnerability of riverine systems to large-scale flooding; and intensive management of commercial fishing, which can lead to the unexpected collapse of a commercial fishery. Surprises like these usually are a result of managing in ways that induce stability in targeted ecosystem components in the short term but lead to the loss of ecosystem resilience over the long term, and increase the vulnerability of the system to extremes such as drought, floods, and other major random events.

Some steps can be taken to deal with surprise in the management of ecosystems.

- Expect and account for surprise in decision making. In particular, recognize that in any managed ecosystem, uncertainty and the potential for surprise are implicit in the scenarios under consideration.
- Incorporate models that are based on broadly differing assumptions, with broadly differing predictions.
- Retain enough management flexibility to adapt to surprise when it occurs.
- Manage the system for sufficient resilience to maintain structure and function when external shocks occur.
- Increase the range of ecosystem conditions, management alternatives, and sources of evidence that are considered.
- Use experimental management and monitoring to learn and manage adaptively.

Among other things, a robust application of adaptive management should consider important cross-scale factors and effects when framing a project. There is always some risk in assuming that future system behaviors will mimic those of the past, and in fact, management itself can induce changes in system resilience. It is smart to take these issues into account when formulating an adaptive management project and designing monitoring and assessment.

3.3. Evaluating adaptive management

Although many people have pointed out the limited success of adaptive management in natural resource management (e.g., Stankey et al. 2003, Stankey and Clark 2006), there are no broadly accepted standards by which to recognize and measure success. Weinstein et al. (1997)

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proposed success criteria for specific types of projects such as large-scale wetland restoration efforts, and Marmorek et al. (2006) developed the concept of enabling or inhibiting factors as a way to classify factors that affect adaptive management project success. O'Donnell and Galat (2008) articulated and evaluated some success criteria for adaptive management of riverine systems.

In the DOI Adaptive Management Technical Guide (Williams et al. 2007) a straightforward standard for recognizing success in adaptive management projects was proposed. An adaptive management project is viewed as successful if progress is made toward achieving management goals through the use of a learning-based (adaptive) decision process. This standard contains two essential elements: progress toward achieving objectives, a primary indicator of success for any management strategy; and the use of learning-based management, with the integration of stakeholder involvement, targeted monitoring, agreed-upon objectives, management alternatives, and projections of consequences into an iterative learning cycle.

On the basis of this standard, four criteria were identified for successful implementation in the DOI Adaptive Management Technical Guide.

- First, recognizable progress must be made in achieving management objectives over a reasonable time frame. Of course, management objectives will not always be met with certainty; for example, the outcomes of local management can be masked by larger-scale processes outside the control of management decision making. Thus, management must be judged by the *process* of decision making as well as short-term progress toward desired results.

- Second, monitoring and assessment results must be used to adjust and improve management decisions. The linkage of monitoring and assessment to objective-driven decision making is what defines adaptive management and allows its long-term benefits to be realized. When learning is folded into future management, that in itself is an indicator of success.

- Third, stakeholders must be actively involved in and committed to the decision-making process. This involvement provides a solid foundation for learning-based management and builds support for it. It also gives resource managers the chance to obtain additional information about the resource system and priorities for management.

- Finally, the implementation of adaptive management must be consistent with applicable laws and regulations. This is very important for projects that include federal and state partners and involve statutes like the National Environmental Policy Act, Endangered Species Act, and the Federal Advisory Committee Act (Rodgers 1979).

Costs and benefits. A common criticism of adaptive management is that it demands time and resources. Everyone who has attempted adaptive management knows that engaging stakeholders over the life of a project takes time and effort. Everyone knows that reaching consensus about objectives and management options can be difficult and frustrating, in large part because stakeholders often come to negotiations with strong opinions about what actions to take and what outcomes to expect (Wondolleck and Yaffe 2000). Everyone is aware of the difficulties involved in problem framing, modeling, and identification of uncertainty.

Though the costs of stakeholder engagement, problem framing, monitoring, and so on sometimes seem prohibitive, the costs associated with not making these investments are often unrecognized or unacknowledged (Wildavsky 1988). Without a learning-based approach, management improvements, if they occur at all, accumulate more slowly, thus leaving the system vulnerable to surprising and potentially disruptive behaviors. Among other things, a lack of agreement by stakeholders about scope, objectives, and interventions can by itself cause the project to fail and lead to litigation. In this case the project implementation can be delayed, costs can skyrocket, and the loss of long-term ecosystem values can be very high.

While adaptive management does involve a commitment of time and resources, these costs are compensated by future benefits from better understanding and increased flexibility in dealing with surprise. This contrasts with management in the absence of an active engagement of stakeholders or a consistent framing of the scope, objectives, and other elements of a structured approach. An appropriate analysis of the value of adaptive management involves a comparative assessment of its benefits and costs, including opportunity costs, relative to the benefits and costs of non-adaptive management.

As mentioned earlier, the benefits of adaptive management include management improvements that result from better understanding. But learning also produces external benefits because the knowledge gained from an adaptive management project can be applied to other problems in different settings. How great the external benefits are depends on how significant the knowledge is, and how broadly it is used in other management settings.

In terms of costs, an accurate accounting would include direct management costs as well as the costs of monitoring and working with stakeholders. A simple, non-comparative analysis produces a biased accounting of adaptive management costs because it doesn't recognize the fact that many of the project costs attributed to adaptive management would also be incurred with non-adaptive management. A comparative assessment would consider the costs of adaptive management above and beyond those that would be incurred in any case. This kind of assessment is complicated by the fact that monitoring and stakeholder involvement can change the benefits as well as the costs.

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We propose the following comparative evaluation of benefits and costs, at the level of projects considered individually or in a broader ecosystem context.

At the project level, costs and benefits of an adaptive approach are compared directly to the costs and benefits of a non-adaptive approach to the project. Because monitoring and stakeholder involvement almost always occur at some level in non-adaptive projects, evaluations should focus on any extra costs incurred specifically by the adaptive approach. A careful analysis of costs associated with monitoring and stakeholder involvement may show that the costs of adaptive management are actually less than those of non-adaptive management, over the long term.

At a larger scale, the systematic evaluation of adaptive management addresses the benefits and costs of a group of projects considered as part of a larger ecosystem. As in project-level evaluations, the focus is on comparing adaptive management with other management

Oak savannah, William L. Finley National Wildlife Refuge, Oregon

approaches. However, here the external benefits become more significant, because what is learned from one project can be applied to related projects, and the diffusion of knowledge to other projects becomes an important issue. Adaptive management in a larger systematic context also can lead to reduced monitoring costs as knowledge gained from one project benefits another, thereby reducing the need for duplication of effort. At this level, opportunities for economies of scale from geospatial coordination can be significant. As the problems in managing ecosystems increase in scale and complexity, the advantages of applying adaptive management systematically are also likely to become greater and more apparent.

It is worth re-emphasizing that adaptive management is designed to yield insights about natural resources and their responses to management as interventions occur through time. The process produces improved understanding and management gradually, as monitoring data are assessed and uncertainty is reduced. Among other things, this means that the time frame for an adaptive management project should be long enough to allow for the learning process. Consideration of the necessary time commitment for adaptive management should be a key point of negotiation in deciding whether to use the approach.

3.4. Impediments and alternatives to adaptive management

Regardless of the features that recommend adaptive management, its use in the real world of natural resource management is still evolving. Where it is applied, the view is sometimes that adaptive decision making does not add significant value. If adaptive management makes so much sense in concept, why has it not been implemented more frequently and successfully?

The literature on adaptive management points out many impediments to its success (e.g., McLain and Lee 1996, Walters 1997, Gregory et al. 2006). A partial list includes the following.

- A complex decision-making structure must be in place or be put in place, and technical expertise and support must be available for people who implement adaptive management. Establishing this type of decision-making framework can involve considerable up-front costs.
- There often is institutional resistance to acknowledging uncertainty. Many managers feel that acknowledging uncertainty is tantamount to an admission that they are not competent.
- Managers often believe they already know the actions that are needed, and follow-up monitoring and assessment are unnecessary activities using resources that could be put to better use for conservation on the ground.
- Many people believe that they are already using adaptive management, even when they are not. This occurs most often with projects that involve some ongoing monitoring, in the mistaken belief that monitoring by itself is enough to make a project "adaptive."
- There is extreme risk aversion by many managers, which leads to strategies that are risk-aversive in the near term, with little or no opportunity for learning.
- Management often is short-sighted, emphasizing near-term gains and losses and devaluing long-term management benefits and costs. If the future is heavily discounted, there is little incentive to use adaptive management to learn how to manage better in the future.
- Stakeholders are not engaged in a meaningful way. Without direct involvement, stakeholders can become disillusioned with management practices, withhold support for a project, or mount legal challenges. Yet many managers are reluctant to include stakeholders in decision making.
- There is a lack of institutional commitment to follow through with the necessary monitoring and assessment after an initial start-up of adaptive decision making. Monitoring activities include sampling design, data collection and summarization, database management, and data assessment. Many managers are unable or unwilling to continue these activities for extended periods of time.

These and other impediments (overlapping jurisdictions; conflicting priorities among scientists, decision makers, and stakeholders) can be enough to prevent the successful implementation of adaptive management (McLain and Lee 1996, Walters 1997, Rogers 1998).

For adaptive decision making, organizations must make a transition from the more traditional "command and control" structure to one that is more inclusive, collaborative, risk tolerant, and flexible (Gunderson 1999b, Stankey et al. 2005). The difficulties of making that transformation, including the sustained commitment of leadership and the staffing of skilled practitioners at the field level, should not be underestimated.

With all these challenges, an obvious question is what are the alternatives to adaptive management? Several have been identified (Williams 1997*b*).

- Ad hoc management. This approach could also be called seat-of-the-pants decision making, based on some combination of anecdotal information, the absence of clear management goals, little or no technical foundation for management actions, and inadequate monitoring. It is a variation of trial-and-error management.

- Wait-and-see management. Managers using this approach refrain from interventions for extended periods of time on the assumption that natural variation will provide enough information to understand the consequences of management. The approach avoids the potential for negative impacts of active management, but does not account for decision making and the possibility of learning and resource sustainability through management.

- Steady-state management. With this approach managers take their best guess at an optimal resource state and look for management actions to eliminate deviations from that state. Above and beyond the obvious problem that there really are no equilibrium conditions in natural resources, steady-state management confounds environmental conditions and management impacts, and thereby limits the opportunity to learn by means of management (see Williams 1997*b*, Gunderson 1999*a*). Eventually it leads to loss of resilience and increasing vulnerability to external shock (Gunderson and Holling 2002).

- Conventional state-specific management. This approach involves the use of explicit objectives and models. The approach is based on an assumption that the objectives are appropriate, the resource system is fully observed and understood, and the resource models reflect full understanding. New data are used to track the system's current status; however, structural uncertainty and surprise are not accounted

for in the assessment of management alternatives. The problem is that uncertainty is almost always present, though often not explicitly expressed and sometimes not recognized.

Under the right circumstances, most of these management approaches can be appropriate. Non-adaptive management is reasonable if there is little uncertainty about what actions to take and what results to expect, if effective monitoring is not possible, or if there is no way to feed results of monitoring and assessment back into management strategy. An adaptive approach can be successful only when the basic requirements for implementation can be met (Williams et al. 2007). When they cannot be met, an alternative approach may be more useful and less costly. However, keep in mind that resource systems are never fully understood, and there is always the possibility of unexpected consequences of a management strategy. Even if non-adaptive management is used, it is smart to engage stakeholders actively and maintain enough flexibility in management practice to change the management strategy when the need becomes obvious.

3.5. Organizations and adaptive learning

Adaptive management flourishes in an environment in which surprise is anticipated, learning is promoted, and participatory decision making is the norm (Stankey et al. 2005). But in spite of frequent assertions that adaptive management is being used, and frequent descriptions of learning as an element of management, there has been only limited progress in promoting a connection between learning and management. Documentation of the institutional structures and processes needed to make an adaptive approach work is also limited (Mclain and Lee 1994). For adaptive decision making, organizations must make a transition from the more traditional "command and control" structure to one that is more inclusive, collaborative, risk tolerant, and flexible (Gunderson 1999*b*, Stankey et al. 2005). The difficulties of making that transformation, including the sustained commitment of leadership and the staffing of skilled practitioners at the field level, should not be underestimated.

An institution's recognition of uncertainty as an inherent part of natural resource management is very important. Some hold that adaptive management is not feasible unless the management institutions are willing to embrace uncertainty (Gunderson et al. 1995). Among other things, the embrace of uncertainty means accepting that different viewpoints exist and involving stakeholders with different perspectives in identifying and addressing uncertainties.

At issue here is the structure and context of a learning-oriented organization that can facilitate adaptive decision making. Attributes of a learning organization include the following (Senge 1990, Fulmer 2000, Michael 1995):

- acknowledgement that the world is uncertain and that it often is impossible to predict outcomes accurately;
- realization of the importance of training people in the group process skills needed to work effectively in cross-disciplinary teams;
- positive reinforcement and rewards for experimentation and learning; and
- recognition that surprises and even crises can be opportunities for learning.

Many observers think that the major challenges in adopting adaptive management are fundamentally institutional (Stankey et al. 2005). Institutions are built on major premises and long-held beliefs that are deeply embedded in educational systems, laws, policies, and norms of professional behavior (Miller 1999). There is a natural tension between the tendency of large, long-standing organizations to maintain a strong institutional framework for thinking and decision making, versus adaptive decision making that relies on collaboration and flexibility, awareness of alternative perspectives, acceptance of uncertainty, and use of participatory decision making (Gunderson 1999*a*).

Structuring an organization for learning-based management can be hampered by the widespread belief that adaptive management does not constitute a significant departure from past practices, and involves little more than occasionally changing management actions (Stankey and Clark 2006). One consequence is that not enough attention is paid to institutional barriers, and not enough effort is spent on designing organizational structures and processes to accommodate an adaptive style of management. At a minimum, it is necessary to rethink the notions of risk and risk aversion, and establish conditions that encourage and reward learning by individuals.

3.6. Statutory and regulatory considerations

Adaptive management is an open process of decision making in which stakeholders are directly engaged and decision-making authority is shared among them. One requirement is that objectives and other elements of the decision process are stated explicitly and that they remain open to analysis and debate. A crucial feature is learning over time, and adjusting decisions as understanding improves. However, the use of an adaptive management approach does not preclude the necessity of complying with the statutory and regulatory requirements that apply to a particular program or project. For example, the adaptive management process for dam relicensing should account for the requirements of the Federal Energy Regulatory Commission, or the requirements for the Endangered Species Act and its implementing procedures.

A particular example is the effort by the Fish and Wildlife Service to integrate adaptive management principles into habitat conservation plans under Section 10 of the Endangered Species Act. In this guide, our example of fish conservation in the Etowah River (see appendix) illustrates how this can work. In another example, relicensing of dams by the Federal Energy Regulatory Commission may call for adaptive management to adjust flow regimes as information is gathered about flow impacts on aquatic species at risk. The study of the dam on the Tallapoosa River, described in Chapter 7, is a case in point. Under certain conditions, it is possible to make a permitting process adaptive at the programmatic level. Our examples of energy infrastructure siting and operations suggest how knowledge gained at one site can be applied systematically to decision making at other sites.

Any anticipated federal decision-making contemplated in an adaptive management approach to natural resource management must be supported by analysis prepared according to the requirements of the National Environmental Policy Act (NEPA). Care must be taken to structure analysis pursuant to NEPA, which may include

preparation of an environmental impact statement, to support the decision making contemplated in an adaptive approach to management.

In all these cases, agency officials should invest significant effort in assessing legal issues at two critical stages of adaptive management: (*i*) at the time a decision is made to use adaptive management for a particular project, and (*ii*) at the time the agency seeks to adjust management decisions based on the information derived from monitoring and assessment. Knowing what federal laws and regulations require, and what limitations apply before agency decisions are made, allows stakeholders to anticipate the legal requirements and integrate them into an adaptive management process. Of course, it is important to recognize that some laws and implementing regulations prescribe specific activities and assessments that could limit or even preclude the use of adaptive management.

National Environmental Policy Act. One of the most important statutes for an agency to consider as it implements adaptive management is NEPA. The primary goal of this statute is to ensure that agency decision makers and the public recognize and account for environmental and other related impacts of proposed agency actions. Compliance with NEPA generally involves a series of specific procedural steps, and certain NEPA processes involve public participation and public review and comment on the agency's proposed action and its environmental consequences as disclosed through the NEPA process. In general, federal agencies can take three approaches to compliance with NEPA, depending on the relative significance of environmental consequences anticipated to result from the agency's proposed action. An environmental impact statement (EIS) is required whenever an agency proposes a "major federal action significantly affecting the quality of the human environment." An EIS must include an analysis of alternatives to the proposed action. The actions contemplated for implementation in a particular adaptive management process may rise to the level of a major federal action requiring preparation of an EIS. Other less complex or controversial actions may be addressed under NEPA by a less comprehensive environmental assessment (EA). Under NEPA, the completion of an EA will result either in the identification of possibly significant impacts of the proposed action (and the need to prepare an EIS), or can support a "finding of no significant impact." Finally, some proposed actions can be categorically excluded from preparation of an EIS or EA, if provided for in an agency's NEPA implementing procedures.

An EIS incorporating adaptive management needs to describe clearly how the approach would be implemented. This not only includes the types of actions that are proposed initially, but also the results that are anticipated from monitoring and assessment, and future actions that may be implemented on the basis of those results. Decision makers and the public must be able to see how the adaptive management approach would be implemented, including potential future actions and anticipated impacts on the environment. The anticipated impacts of such potential future actions may either be analyzed in NEPA analysis prepared at the point of the initial decision to take an adaptive approach, or may be considered in NEPA analysis prepared to support a new decision or decisions when it becomes clear, as a result of monitoring and assessment, that such actions are warranted.

As acknowledged in guidance issued by the Department's Office of Environmental Policy and Compliance (ESM No. 10-20, April 23, 2010), adaptive management and NEPA share an emphasis on learning. A common challenge in making adaptive management work in natural resource decision making is that ongoing monitoring and assessment may reveal new information that requires a new decision to be made to alter the management situation. A proposal to make a new decision or take a new action triggers the requirement to comply with NEPA. If the EIS or other NEPA analysis is prepared at the outset of the project using an adaptive management approach, and it anticipates additional decision making and analyzes the possible environmental consequences of subsequent decision making at the outset, then it may be that no new analysis is needed for purposes of NEPA compliance (see 43 CFR 46.145).

In the event that the NEPA documentation prepared at the outset of the project does not, or can not (because of uncertainty), provide such analysis, then additional analysis must be prepared pursuant to NEPA in order to display and analyze the new learning upon which a new set of alternatives is available for decision making. In such a case, the agency may elect to prepare an EA or EIS, which may, if appropriate, be "tiered to," or incorporate by reference, material from the previously prepared NEPA analysis (see 40 CFR 1508.28, 43 CFR 46.140), in order to support the new decisions to be made. In some circumstances, depending on the way the decisional space has been framed, the agency may elect, or may even be required, to prepare a supplement to the NEPA analysis supporting the existing decision, in order to support the new or changed decision (see 40 CFR 1502.9[c]).

When describing alternatives in an EIS, two important issues should be taken into account. The first focuses on the range of impacts of the management alternatives. Here, the effects on the resource can be estimated by analyzing the alternatives that are most and least intrusive, along with a non-action option. These alternatives should encompass the range of impacts and successes associated with the remaining alternatives. By considering such a range of alternatives, one avoids the possibility of choosing an alternative that exceeds the limits of the original analysis, which would trigger additional NEPA review (citation http://ceq.hss.doe.gov/ntf/report/chapter4.pdf).

The second issue focuses on the potential effects of an array of potential management alternatives and the conditions that would lead to the selection of one of them. That is, the effects of each potential alternative are individually analyzed, including specification of the data that lead to selection of the chosen alternative. If effectively planned, an EIS will cover a wide enough range of future possibilities and a clear prescription of the conditions for their use, to preclude the need for additional NEPA analysis, documentation, and public involvement in the future. The overall goal is to analyze the impacts of different management alternatives in a way that sustains maximum flexibility in selecting the appropriate option without triggering the requirement for a new or supplemental NEPA review.

Togiak National Wildlife Refuge, Alaska