

Chapter 5: Other Operational Issues

In the course of writing this technical guide, contributors and reviewers raised a number of important issues that do not fit naturally into other chapters, but nevertheless merit discussion. Because no document can address all the issues that might arise in adaptive management, DOI bureaus and offices may wish to develop their own planning and implementation guidelines, tailored to specific legal and institutional contexts and focused more directly on relevant authorities.

5.1. Uses of Information in Natural Resource Management

When considering the application of adaptive management, it is important to account for both learning and progress in achieving management objectives, as well as the possible tradeoffs between them. As indicated earlier, learning in adaptive management occurs through the comparison of model-based predictions against information from monitoring. The role played by monitoring, and the information produced from monitoring, is essential in adaptive management.

Several different approaches to resource management can be distinguished, depending on the relative emphases on learning and management objectives (38). Management approaches can range from an exclusive focus on management objectives with no concern for information and learning, to an exclusive focus on learning with little regard for achieving management objectives (60). The most extreme example of the latter is the use of management in a rigorously designed experiment, where the goal is to maximize the precision of contrasts among management treatments.

Management in the absence of systematic monitoring

In this situation, decision making is loosely focused on management objectives, and is based on prior experience, intuition, expert opinion, etc. Monitoring and assessment are not used systematically in decision making, so there is little or no opportunity for learning. This situation occurs more frequently than many believe. For example, managers often feel that their understanding of a resource system is sufficient for them to make smart

decisions, and anecdotal information about resource status is all that is needed to inform those decisions.

Management based on resource status

Here the focus of decision making is on achieving management objectives, with little or no recognition of uncertainty in the decision making framework. Monitoring and assessment focus primarily on resource status, rather than the understanding of ecological processes. This approach is sometimes misidentified as adaptive management, presumably because the measures of resource status obtained through monitoring are considered in management actions. A great many multi-year resource applications are of this kind. However, few of these applications specifically focus on learning about the processes that control system dynamics.

Passive adaptive management

In this case uncertainty is recognized in the decision making framework, but the focus is on the achievement of management objectives, with learning as an untargeted byproduct. Ongoing monitoring programs focus on resource status as well as other system attributes that are useful for improved understanding through time, and assessment produces estimates of resource attributes that are used for learning. Because decision making is not focused specifically on learning, the rate of learning is likely to be substantially lower than with a more proactive approach.

Active adaptive management

Decision making involves the active pursuit of learning, either through experimental management that focuses directly on learning, or quasi-experimental management that focuses simultaneously on learning and achievement of management objectives. Both approaches anticipate the effect of management on the rate of learning, and both are included under the rubric of “management by experiment.” Monitoring focuses on resource status as well as other system attributes needed to improve understanding through time, and assessment produces estimates of resource attributes that can be used for learning.

It should be emphasized that both active and passive adaptive management utilize management interventions in a learning process. The key distinction between the two approaches is the degree to which decision makers anticipate the influence of management on learning, and the degree to which management is used proactively to accelerate the rate of learning.

Figure 5.1 orders the management approaches described above with respect to their emphases on learning. Several points can be made. First, adaptive approaches to management place a greater emphasis on uncertainty and learning than non-adaptive decision making. Second, non-adaptive management is oriented solely on management objectives, whereas adaptive management considers learning as well. Third, passive adaptive management places a stronger emphasis on learning than non-adaptive management. As a general rule, it makes little sense to manage adaptively to reduce uncertainty, if uncertainty is not at issue in the management problem. When uncertainty does limit effective management, there often is substantial value in managing adaptively (see Section 2.1 for additional discussion on this point).

As a general rule, adaptive management is most useful when the consequences of management are uncertain, but objectives are clear and the potential for management intervention is high.

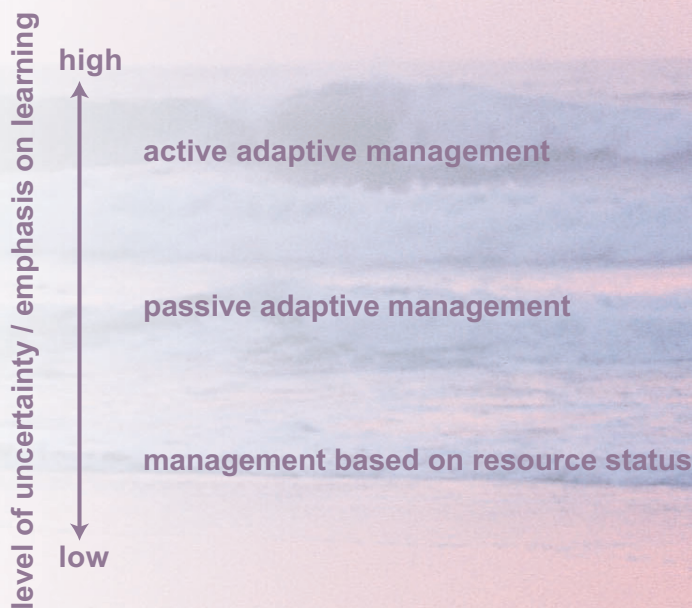


Figure 5.1. Priorities in different management approaches. Not shown is management in the absence of monitoring, which devalues learning and focuses only loosely on management objectives.

5.2. Accounting for Uncertainty in Adaptive Management

An important concern is how to represent and account for uncertainty in applications of adaptive management (61,62). At a minimum, four sources of uncertainty influence the management of natural resource systems.

Environmental variation is the most prevalent source of uncertainty, and is largely uncontrollable and possibly unrecognized. It often has a strong influence on natural resource systems, through such factors as random variability in climate.

Partial observability refers to uncertainty about resource status. An obvious expression of partial observability is the sampling variation that arises in resource monitoring.

Partial controllability expresses the difference between the actions targeted by decision makers and the actions that are actually implemented. This uncertainty typically arises when indirect means (for example, regulations) are used to implement a targeted action (for example, setting a harvest or stocking rate), and it leads

to the possible misrepresentation of management interventions and thus to an inadequate accounting of their influence on resource behavior.

Structural or process uncertainty concerns a lack of understanding (or lack of agreement) about the structure of biological and ecological relations that drive resource dynamics.

Environmental variation, partial observability, partial controllability, and structural uncertainty all limit a decision maker's ability to make informed management decisions (Fig. 5.2). Special emphasis is given in adaptive management applications to structural or process uncertainty. However, the other forms uncertainty also can be incorporated in an adaptive management project, depending on their importance. For example, a typical approach to environmental variation is to include environmental conditions in the resource models in an adaptive management project (Fig. 5.2), with probabilities assigned to different values of the relevant environmental variables. In this way model behaviors will reflect environmental variation, as will the projected responses to management actions. Environmental variation therefore ramifies through the decision making process, as projected responses to management guide the selection of management actions.

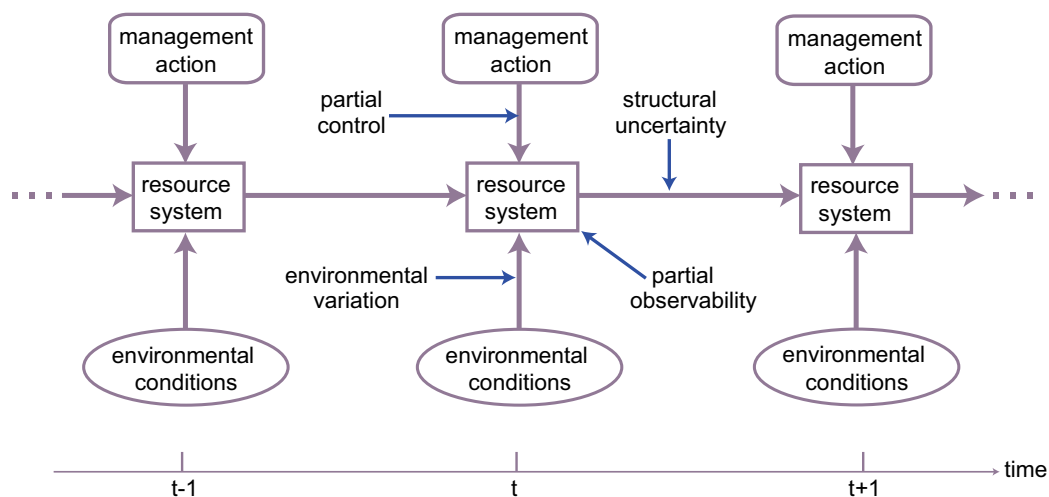


Figure 5.2. Uncertainty sources in natural resource management. Partial control limits the influence of management actions. Environmental variation affects resource system status and dynamics. Partial observability limits the recognition of system status. Structural uncertainty limits the ability to characterize system change.

5.3. The Measurement of Learning

Much has been said about learning in the preceding chapters, but questions remain about how learning actually is achieved and recognized. In Chapter 3, uncertainty was described in terms of different hypotheses about how a resource system responds to management actions, along with models imbedding these hypotheses and their associated measures of confidence. As evidence accumulates through monitoring, confidence grows in the models (and their associated hypotheses) that accurately predict responses to management, and confidence declines for models that are poor predictors. It is through the sequential comparison of predictions against monitoring data that the adequacy of a hypothesis about biological and ecological processes is gradually revealed. A comparison of hypothesis-based predictions against evidence is an essential feature of scientific investigation, and a key reason why adaptive management is described as “science-based.”

Questions remain about possible mechanisms for updating the confidence in a particular hypothesis. Generically, at each point in time one can use a measure of the difference between the response predicted by a model and the response estimated with monitoring data. A small difference indicates a good fit for the model, and a large difference indicates a poor fit. These differences can be calculated for each model after each post-decision monitoring event, and used to update confidence levels of the models through time. Depending on the desired rigor, an updating protocol can be fairly simple or technically complicated (63).

5.4. Learning Organizations

Learning in adaptive management derives from management actions, and is used in turn to inform subsequent actions. But many important issues about how best to facilitate learning are framed in terms of adaptive institutional arrangements, structures, and processes—features that are often lacking in traditional management (64). Despite frequent assertions about the use of adaptive management and the depiction of learning as a key element in applications, there has been limited progress in making adjustments to promote learning institutionally (48).

The notion of technical and process learning bears directly on the concept of learning-based organization, the institutional framework for adaptive management. At the heart of both an adaptive management project and the learning-based organization that supports it is the explicit

recognition of uncertainty as a key attribute of natural resource management. Indeed, adaptive management is not feasible unless the relevant management institutions have the capability and willingness to embrace uncertainty (47). Among other things, embracing uncertainty means recognizing different views of a managed system, as well as a direct involvement of stakeholders who have different perspectives, and a commitment to shared decision making that allows uncertainty to be reduced.

At issue here is an organizational structure and context that can promote and facilitate an adaptive approach to resource management. Attributes of a learning organization include the following:

- acknowledgement that the world is uncertain and that failure to predict outcomes accurately is common.
- recognition of the importance of training people in group interactions and collaboration.
- positive reinforcement and rewards for experimentation and learning.
- recognition that surprises and even crises can be opportunities for learning (65).



In fact, many observers think that the major challenges facing adaptive management are fundamentally institutional (8). Institutions are built on major premises and long-held beliefs that are deeply imbedded in educational systems, policies, and norms of professional behavior (66). Yet Senge (4) argues that a learning organization is "... where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together." There is a natural tension between the tendency of large, long-standing organizations to maintain a strong institutional framework for thinking and decision making, and the need in adaptive management for an open, collaborative approach that recognizes alternative perspectives, embraces uncertainty, and utilizes participative decision making (67).

Structuring a learning-based adaptive organization can be handicapped by a pervasive belief that adaptive management does not constitute a significant departure from the past, but is only a process of adjusting over time (51). One consequence is that little attention is given to the institutional barriers to its implementation, and little effort is expended on the redesign of 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 to promote conditions that encourage, reward, and sustain learning by individuals.

5.5. Realistic Expectations for Adaptive Management

Adaptive management is designed to produce gradual improvements in management through a stage-wise process that promotes incremental learning. However, there is nothing prescriptive in the notion of adaptive management about the length of time required to see substantive improvements in understanding and management. In some cases it may be possible to recognize improvement in only one or a few cycles of the adaptive cycle (Fig. 3.3). In others, learning occurs much less rapidly. Several conditions can influence the rate of learning, including the size and complexity of the resource system, the number and extent of management alternatives, and the sources and magnitudes of uncertainty.

Of interest here is the influence of the management approach itself on rates of learning. As mentioned above,

learning can be accelerated by the use of active adaptive management, which utilizes management interventions proactively for the purpose of learning. Learning rates are maximized when interventions are imposed in an experimental context that includes randomization, replication and experimental control. Under these circumstances, contributions to resource objectives are temporarily postponed so that understanding can be attained as quickly as possible (68). Even here, however, environmental variation, partial controllability, partial observability, and the magnitude of structural uncertainty can slow the accumulation of knowledge, and thus impede the improvement of management.

One caveat about adaptation and the rate of learning should be mentioned here. We have described adaptive management in terms of a cycle of decision making, monitoring, and assessment that aims at reducing structural uncertainty (Fig. 3.3). Uncertainty is reduced gradually in adaptive management, through the sequential evaluation of hypotheses and accretion of knowledge about them. However, the accretion of knowledge is clearly undermined if the resource system changes more rapidly than the rate of learning about it. Even if system structure and processes remain relatively stable, the identification of strategies to achieve management objectives is undermined if the objectives change more rapidly than adaptive management can learn how to achieve them. The point here is that for adaptive management to be effective, the need to reassess and possibly change set-up phase components (stakeholders, objectives, alternatives, models, monitoring) should be less frequent than the iterative cycle of technical learning (decision making, monitoring, and assessment) (Fig. 3.4). Otherwise, learning cannot keep pace with changes in the structure of the resource system and changing stakeholder values and perspectives.



smallmouth bass

Key Points

- ❖ Active and passive approaches to adaptive management can be distinguished from other management approaches based on their treatment of uncertainty and emphasis on learning.
- ❖ Multiple sources of uncertainty can influence resource systems and alter the capacity to manage them.
- ❖ Learning is advanced by the sequential comparison of model predictions against monitoring data, whereby confidence in an underlying hypothesis is based on the relative accuracy of model predictions.
- ❖ The practice of adaptive management flourishes in a learning organization that is open to surprise, accommodates risk, and encourages and rewards learning.
- ❖ Learning in adaptive management proceeds most rapidly when pursuit of resource objectives is temporarily postponed so that management interventions are implemented according to an experimental design.