Chapter 12
Monitoring and Adaptive Management

12.1 Introduction

This chapter discusses two aspects of the framework of a program for protecting wetlands: 1) *monitoring results*, determining the effectiveness of the program (Step 4) and 2) *adaptive management*, a feedback mechanism for making improvements to the program if needed (Figure 12-1). Monitoring and adaptive management have often been low on the list of priorities for local jurisdictions. Funding, the availability of staff, and technical issues make establishing a monitoring program difficult for some jurisdictions. In addition, monitoring may also expose what are perceived as failures and may require changes that are difficult or unpopular (Washington State Joint Natural Resources Cabinet 1999).

However, the benefits of a successful monitoring program and the changes that may result from it can be substantial. Many actions taken to protect and manage wetlands have to be considered as experiments because we have not tracked their success in the past.

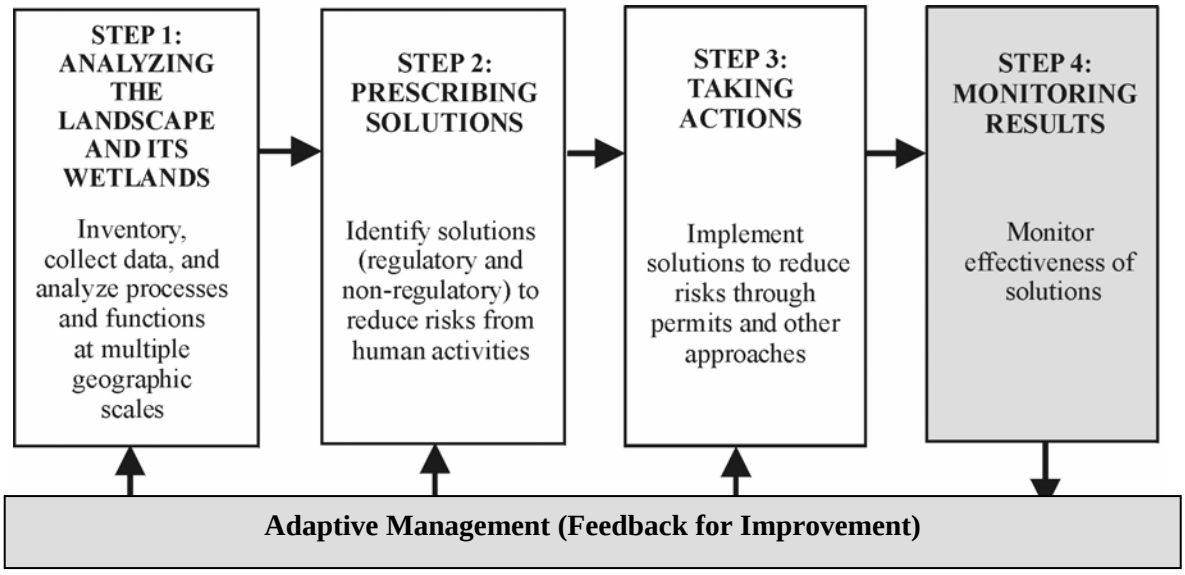

Figure 12-1. Monitoring is Step 4 of the four-step framework discussed in this volume, and Adaptive Management provides feedback for improving wetland protection programs (shaded box).

We do not know, or fully understand, all the cause and effect relationships between human actions on the land and the functions performed by wetlands (see Chapters 3 and 4 in Volume 1). Thus, we cannot fully predict the outcome of actions taken to protect and manage wetlands, other natural resources and critical areas, as well as landscape processes. Monitoring the effectiveness of protection measures in the context of adaptive management is the most efficient way to face this uncertainty. Adaptive management is a commitment by a local government to change approaches for protecting and managing wetlands and to redirect resources as warranted by new information. A willingness to make improvements to address insufficiencies identified through this monitoring step is important.

The focus is to monitor the effectiveness of solutions identified and actions taken in Steps 2 and 3 (described in previous chapters) and make changes as needed. The process is iterative as shown in Figure 12-2. The goal is to implement a system for modifying past decisions, if needed, that is based on information generated from monitoring the specific actions taken and on any scientific information that is newly available. Plans, regulations, and other actions should be reconsidered if the monitoring data show there are further losses of wetland functions and values. This will help to reduce cumulative impacts to wetlands and other resources.

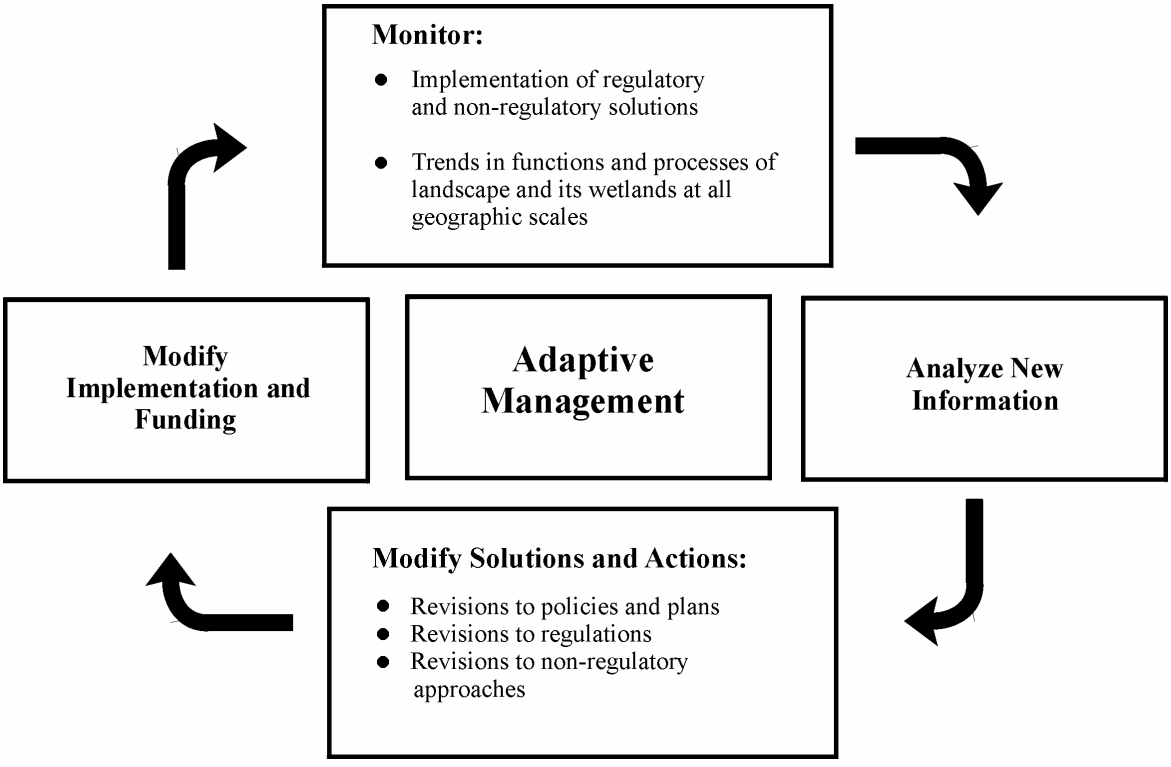

Figure 12-2. Conceptual representation of how wetlands can be protected and managed using adaptive management. Adaptive management implies that the process does not end with the completion of the four steps but keeps cycling.

12.2 What Should Be Monitored?

Monitoring associated with protecting and managing wetlands by local jurisdictions can be divided into three categories, as listed below. All aspects of monitoring are important in providing feedback to guide decisions for adaptive management. If the functions and values of wetlands are not adequately protected, managers need to know whether this results from inadequate implementation, inadequate standards, or inadequate strategies.

- **Monitoring trends** tracks landscape processes and wetlands over time at all geographic scales and records changes in functions and values at individual wetlands. The monitoring should determine if the goals and objectives established for the wetland resource by a local jurisdiction are being met. Monitoring trends is critical in interpreting the effectiveness of efforts to protect and manage wetlands. By monitoring trends, it is possible to document if cumulative impacts continue to occur.

- **Monitoring implementation** addresses the extent to which plans have been implemented and the extent to which regulatory and non-regulatory actions proposed in those plans and regulations have been taken. This type of monitoring provides a basis for tracking the actions taken and for quality assurance.

- **Monitoring the effectiveness of strategies** addresses how effectively the complete program, not just individual plans and actions, meets explicit objectives or conditions desired for the future.

Different approaches are needed to monitor at different geographic scales because the type of data collected is different. In addition, the objectives of a monitoring program may be met in many different ways, not all of which require extensive collection of data. It is not the intent of this chapter to describe the different monitoring approaches and methods that can be used. These will depend on the wetland resources present in a local jurisdiction, the goals and objectives set by that jurisdiction, the solutions they propose, and the actions they take.

The following sections outline some of the basic questions that need to be addressed when monitoring for an adaptive program for wetlands.

12.2.1 Monitoring Trends in the Resource

The goal of monitoring trends in wetlands is to understand if, and how, the landscape and site-specific processes that control structure and functions within a wetland(s) have been altered as a result of changes in land use. The resource needs to be monitored at all geographic scales used in the analysis of the resource (i.e., the contributing landscape, the management area, and the site scale).

The analysis can be undertaken using the guidance discussed in Chapter 5. Regardless of the methods used, however, there is one major question that needs to be addressed through monitoring: *Have changes in land use altered landscape processes to the extent that they impact the functions of wetlands in a jurisdiction?* Changes to processes and functions can be either negative (indicating further degradation), no change (indicating efforts at protecting existing levels of processes and functions are working), or positive (indicating that efforts at restoration are succeeding).

Monitoring trends at the landscape scale involves identifying:

- If the major sources of water to wetland(s) and flow paths have changed (either degraded or restored)
- If the major sources of sediment have changed
- If the major sources of nutrients have changed
- If the major sources of toxic compounds have changed
- If there has been an increase in the fragmentation of wildlife habitats

Monitoring trends at the wetlands themselves involves tracking how the functions and values of each individual wetland within a jurisdiction have changed. Continuously monitoring all wetlands, or even a random subset of them, in a jurisdiction is optimal but may not be feasible because of the cost. In the absence of such a program, it is suggested that a local jurisdiction track trends by analyzing the wetland assessments that applicants submit when they propose actions at individual sites. Qualitative trends can be tracked by noting the overall changes in the functions of wetlands being proposed for alteration within each hydrogeomorphic class (depressional, riverine, etc.) or wetlands of particular concern such as bogs and mature, forested wetlands.

The restoration of wetland functions at sites used for restoration should also be monitored to determine if the objectives of the projects are being met.

12.2.2 Monitoring the Implementation of Protection Measures

Monitoring implementation addresses the extent to which the solutions or actions proposed for protecting and managing wetlands, as developed in Step 2 (Prescribing Solutions), have actually been put into practice or carried out.

12.2.2.1 Monitoring Implementation at the Scale of the Contributing Landscape

Whether monitoring the implementation of solutions needs to take place at the scale of the contributing landscape depends on whether the contributing landscape falls entirely within the jurisdiction or if it includes several jurisdictions. In the former case, monitoring the contributing landscape is actually the same as monitoring the management area, described below. If the contributing landscape spans several jurisdictions, then monitoring at this scale is needed and should be based on the objectives of the plans and solutions developed among the jurisdictions.

It is not possible in this document to cover how to monitor all the possible watershed plans, regional plans, actions taken as a result of various partnerships, etc. However, it is important that each objective identified in such plans should have associated with it measures for monitoring its implementation. For example, a watershed plan may have an objective that all jurisdictions in the watershed adopt the same method for rating wetlands to ensure that wetland functions are characterized in the same way throughout the watershed. Monitoring this objective would involve examining the adoption and implementation of the chosen wetland rating system.

12.2.2.2 Monitoring Implementation at the Scale of the Management Area

Monitoring the implementation of solutions developed for the management area is a matter of keeping accurate records of the actions taken by the jurisdiction to protect and manage wetlands, and a commitment to compile and analyze the data at specified intervals. The analysis should include the actions actually taken compared to the solutions and actions proposed in the original comprehensive plan, critical areas ordinances, shoreline master programs, etc. For example, a critical areas ordinance may state that each permit that will result in a wetland impact requires that the wetland be rated on its functions and values. Monitoring the implementation of this would require an examination of how many permits were issued with a completed rating as well as how many were issued without a rating.

This type of monitoring should also be applied to non-regulatory programs. For example, if a jurisdiction has a program to acquire conservation easements on lands that it considers important to maintaining landscape processes, it should monitor how many easements have been acquired compared to the total number needed. Table 12-1 lists some of the common solutions used by jurisdictions in protecting and managing wetlands.

Table 12-1. Monitoring common solutions to protecting and managing wetlands at the scale of the management area. These are only a few examples, not an inclusive list of all that a jurisdiction should monitor.

Action	What to Monitor
Zoning	Number of zoning variances permitted
Development standards for areas sensitive to disturbance	Number of variances permitted
Setbacks, such as buffers or "no-spray" zones, to protect resources	Number of variances to setbacks permitted Number of violations
Preservation of important wetlands	Number of acres with conservation easements or fee title
Conservation of wetland resources	Number of acres enrolled in Current Use Taxation program or other applicable programs
Voluntary restoration of wetlands	Number of acres and types of functions successfully restored

12.2.2.3 Monitoring Implementation at the Site Scale

Monitoring the implementation at the site scale is a matter of keeping accurate records of the permits approved and other actions taken at individual sites. This includes, for example, monitoring the success of follow-up site visits, compliance with permit conditions, restoration efforts, and enforcement actions. The review of the scientific information presented in Volume 1, Chapter 6, highlighted the fact that many projects that compensate for impacts to wetlands are not successful because there has been no follow-up. Therefore, follow-up on projects is very important. As previously mentioned, this data can be used to ascertain general trends regarding the effectiveness of wetland protection and management in the jurisdiction.

12.3 Adaptive Management

Adaptive management has been defined in various ways since its development in the early 1970s. Different people and organizations continue to have somewhat differing views of the best definition for their purposes. In order to bring some consistency and clarity, the following working definition for this concept is used here:

> *Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of previous policies and practices.*

As mentioned earlier in the chapter, the goal of adaptive management, in the context of protecting and managing wetlands, is to implement a repetitive process for making decisions that is guided by scientific information that is newly available and data collected and analyzed through the monitoring program. The iterative nature of the process is shown in Figure 12-2. The results of the monitoring program provide the basis for revising past decisions, and these improved actions and solutions are subsequently monitored to determine their success in meeting the jurisdictions goals for protecting resources.

Adaptive management is based on the assumption that managed ecosystems are complex and inherently unpredictable. The approach incorporates the fact that, at present, humans do not know enough to adequately manage environmental resources. Adaptive management, from this perspective, treats management policies and practices as experiments, and it serves to assess the responses of natural resources as human behavior changes (Lee 1999). The goal is to learn and change objectives as needed. However, this has often not been considered the mark of a good manager, who is rewarded instead for steadfast pursuit of objectives (Lee 1999). The important point to stress is that adaptive management will only work if there is a willingness to actually change polices and practices as a result of monitoring.

Some of the characteristics of adaptive management are:

- Acknowledgement that there is still much uncertainty about what policy or practice is best for solving each particular issue related to protecting and managing wetlands
- Careful design and implementation of a monitoring plan designed to reveal the knowledge that is currently lacking
- Monitoring of both the resource itself and the implementation of plans and practices used to protect the resource
- Analysis of the outcomes of policies and practices in terms of the original objectives
- Incorporation of the results into future decisions

A brief history and additional resources for adaptive management

The text below is adapted from the University of Oregon (http://oregonstate.edu/instruction/anth481/ectop/ecadm.html).

C.S. Holling and several colleagues developed the concept of adaptive management at the University of British Columbia's Institute of Resource Ecology in the late 1960s. Adaptive management reached the scientific literature in Holling's book, *Resilience and Stability of Ecological Systems*, published in 1978. The emphasis of the Holling approach is to experiment to learn the boundaries of natural systems. Holling and his colleagues worked with resource managers in British Columbia on a number of management experiments and workshops designed for public participation, thereby testing the process.

Adaptive management became an important concept in resource management in the United States when K.N. Lee introduced it to the Northwest Power Planning Council in 1984. Lee studied adaptive management with Randall Peterman, who in February 1984 gave a talk about experimental management. Subsequently, different forms of adaptive management have become part of the Northwest Forest Plan, the Oregon Plan for Salmon and Watersheds, the Oregon Department of Forestry Plan to manage state forests, and many other processes for resource planning.

For additional information on adaptive management, see:

Holling C.S. 1978. Adaptive Environmental Assessment and Management. John Wiley & Sons. New York, New York.

Walters, C. 1986. Adaptive Management of Renewable Resources. The Free Press.

Lee, K.N. 1993. Compass and Gyroscope. Island Press. Washington D.C.

Lee, K.N. 1999. Appraising adaptive management. Conservation Ecology 3(2): 3: http://www.consecol.org/vol3/iss2/art3

The Collaborative Adaptive Management Network: http://www.iatp.org/AEAM/index.html