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# Monitoring for Ecosystem Management: Implementation at State and Regional Levels

by

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## Abstract

Ecosystem management is a holistic style of environmental management which integrates physical, chemical, biological, political, economic, and social factors in an ecologically-defined region. Because some of the key foundations of ecosystem management are a sound scientific basis for management, an understanding of the functioning of the entire system, and the use of adaptive management, monitoring is an important part of ecosystem management.
Within the past few years, ecosystem management has become a favored approach in United States environmental management, with applications on federal, state, and local levels. This study examined the implementation of ecosystem management in three regions: the Chesapeake Bay, South Florida, and the Pacific Northwest. Program literature was reviewed and program participants were interviewed to determine how ecosystem management was being applied, how monitoring was being used as a tool for ecosystem management, and what factors have led to success or difficulty in implementation. The results of this research were compiled into a summary of general issues facing ecosystem management programs.

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# 1 Introduction

## *1.1 Ecosystem Management*

Traditionally, environmental management, particularly in the United States, has focused on one environmental problem at a time. The Endangered Species Act studies and protects individual species. Air pollution, water pollution, toxic waste, habitat destruction, and other issues have all been treated as separate subjects, each with its own methods, standards, experts, and agencies. Localized issues have been dealt with by local agencies while the federal government has attacked wider-ranging issues.

Recently, however, there has been a move toward a style of environmental management called ecosystem management. This new method acknowledges the fact that all the various aspects of a particular ecosystem are interconnected. In using ecosystem management, a manager tries to preserve the integrity of an entire system, taking into account all its different processes, scales, and functions.

One of the most broad definitions of ecosystem management is provided by Grumbine (1994): "Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term." The Ecological Society of America's Committee on the Scientific Basis for Ecosystem Management defines it as "management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and

processes necessary to sustain ecosystem composition, structure, and function." (Christensen et al 1996)

There are several underlying principles in the practice of ecosystem management (Grumbine 1994, Christensen et al 1996, Interagency Ecosystem Management Task Force 1995, Keystone Center 1996, Moote et al 1994). From a scientific perspective, ecosystem management focuses on understanding the relationships between different environmental health factors, such as air quality, water quality, and species populations. While traditional environmental management tends to separate out these different issues, in ecosystem management they are all studied as parts of the system, and their impact on the overall ecosystem is considered. It is also recognized that this overall system is a dynamic one, with its ideal state being one of constant natural fluctuation.

Another key concept of ecosystem management is the use of natural boundaries to define an ecosystem. This complicates implementation in that an ecosystem management area will usually cross jurisdictional boundaries. In many cases, the management of an ecosystem involves several state, local, and tribal governments as well as federal agencies and other interests. Thus, managing the entire ecosystem as a whole requires coordination of the efforts of these different levels of government.

Use of the ecosystem management approach also entails the formation of a closer relationship between scientific study and management practices, making for a style of management strongly rooted in scientific principles. To implement such a style of management, more communication between scientists and managers is needed, with scientists understanding what management needs to know and managers understanding and using the results of the scientists' work.

Ecosystem management also emphasizes the role of humans in the ecosystem. In ecosystem management, human communities are considered to be part of the system, and their health is viewed as an essential part of ecosystem health. Social, political, and economic

factors are, therefore, included in program goals and issues. Thus, in addition to coordination among the different scientific disciplines, incorporation of the social sciences is also required.

When it comes to the actual implementation of ecosystem management plans, the concept of adaptive management plays a significant role. With adaptive management, rather than developing a plan at the start of a project and sticking to the plan, as is traditionally done, the plan is continually modified to reflect the results of monitoring, research, and analysis. The General Planning Model used by the Interior Columbia Basin Ecosystem Management Project (Figure 1) provides an illustration of how information is fed back into the adaptive management process at several stages. This method allows for more flexibility in planning because it makes it easier for managers to change tracks if it becomes apparent that the initial plan may not be the best one.

All of these factors combine to create a new, potentially more efficient and effective method of environmental management.

## *1.2 Monitoring for Ecosystem Management*

As mentioned above, one of the key ideas in ecosystem management is that management must be based on sound scientific information. To accomplish this, an increased emphasis on monitoring is needed. Performing monitoring, and using its results, on an ecosystem scale, however, can be complicated. An unprecedented level of collaboration and coordination is required. For one thing, data and information must be coordinated and integrated across different disciplines (e.g., air, water, land use, and species) if the interactions between different pieces of the system are to be considered. Also, because the geographic scope of an ecosystem often crosses different jurisdictional boundaries, a variety of agencies from different levels of government, as well as other stakeholders, are often involved.

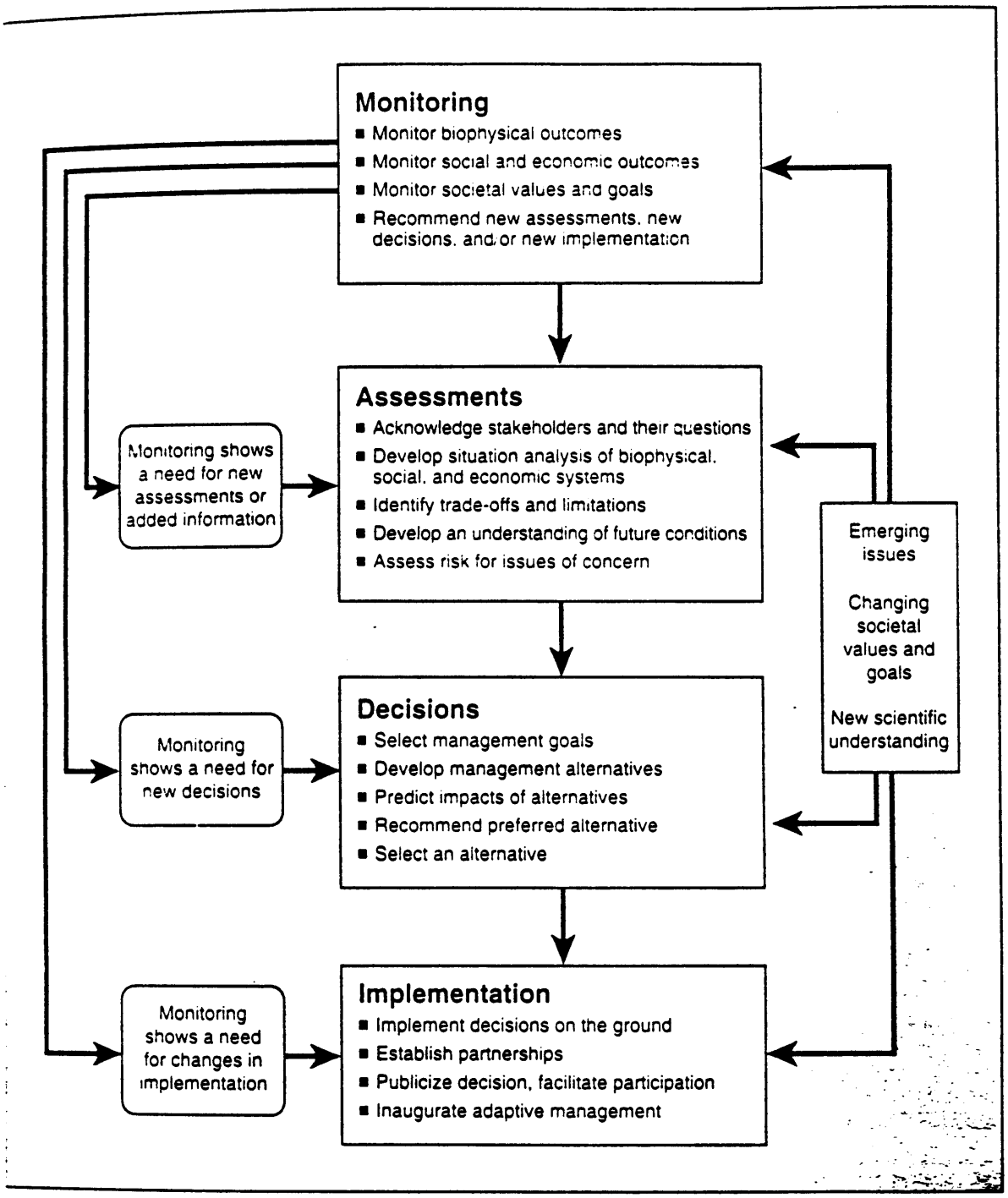


Figure 1 Interior Columbia Basin Ecosystem Management Project General Planning Model

Coordinating the efforts of these numerous players, while difficult to do, is essential to the implementation of ecosystem management.

## *1.3 Structure of This Thesis*

In this thesis, the implementation of ecosystem management and the use of monitoring to further the ecosystem approach is observed through literature review and detailed case-study analysis to determine what can be learned from previous attempts and how those lessons can be applied to newer programs.

Chapter 2 briefly describes the methodology behind the study. Chapter 3 is a review of the current literature on ecosystem management, both from a theoretical point of view and as far as implementation in the United States is concerned. In Chapter 4, each of the case study programs is described in detail. Implementation issues, as described by the interview candidates, are discussed in Chapter 5, and Chapter 6 provides a conclusion.

# 2 Methodology

The purpose of this study is to investigate implementation issues in existing ecosystem management programs, both in general and with respect to monitoring. The lessons learned from these programs can be applied to aid in the successful implementation of future ecosystem management programs and to improve current programs.

The initial step in the investigation was a review of the literature regarding ecosystem management, including theoretical literature, governmental policy documents, and other independent studies. Out of the many programs mentioned in the literature and elsewhere, those from three regions were chosen as case studies for this thesis. The three regions chosen were the Chesapeake Bay, South Florida, and the Pacific Northwest. These areas were selected because they all have large, collaborative ecosystem management efforts which are considered among the most innovative in the country. However, they differ widely from each other with respect to the types of ecosystem being managed, the environmental issues being faced, and the roles of government and other stakeholders in ownership and regulation of land. These differences make it possible to get a varied perspective on the use of ecosystem management.

Another important factor in choosing the case study regions was that, while some current ecosystem management programs are new and still very much under development, all three of the case study programs have been in place for at least three years. The oldest of the three, the Chesapeake Bay Program, has been operating for about thirteen years. Thus these

plans offer the perspective of experience in a relatively new field. We hope to learn from these three well-established and well-recognized programs, and apply those lessons to the implementation of the many newer programs currently in formation.

For each of the three regions, the available literature on the programs was obtained and reviewed. Program participants involved in monitoring were then contacted by telephone, and over thirty people interviewed in person. Much of the factual information about programs came from these interviews. Sixteen participants were also interviewed by telephone to learn more about their perceptions of their programs' implementation of ecosystem management. The participants interviewed were mostly state employees, and the rest were with the federal government. Some were specifically involved in monitoring, but most were more generally involved in ecosystem management. The telephone interviews, which were about 10 minutes long, were used to obtain information and opinions on ecosystem management implementation issues and the use of monitoring for ecosystem management. Participants were also asked what kind of advice they would give to others trying to start ecosystem management programs.

The results of the literature search and interviews were then synthesized in an analysis of factors which can affect the success of different aspects of ecosystem management.

# 3 Literature Review

## *3.1 Ecosystem Management in Theory and Policy*

### 3.1.1 Historical Background and Theory

Many of the concepts behind ecosystem management have been around for decades. Even as early as the 1930s and 1940s, some of the basic tenets of the approach had begun to appear in ecological literature, as is discussed by Grumbine (1994). A 1932 study of the Ecological Society of America's Committee for the Study of Plant and Animal Communities suggested that a nature sanctuary program should protect not just particular species but entire ecosystems, that a variety of ecosystems should be protected, and that the dynamic nature of the ecosystems should be considered. The 1940s conservationist Aldo Leopold, often cited as a founder of the ecosystem management concept, believed that people should treat the land as a "whole organism" in order to maintain its productivity and value (Salwasser 1994).

Interest in ecosystem management continued to develop throughout the 1950s and 60s. With the advent of the 1970s environmental movement, the principles began to be put into practice more. For example, during the 1970s 325 biosphere reserves were established by UNESCO's Man and the Biosphere Program, an initiative which incorporated some of the principles of ecosystem management (Haeuber 1996). The 1970s also saw the first use of the ecosystem approach in the Great Lakes region. Support for ecosystem management

continued to grow during the 1980s, and by the late 1980s the idea was prevalent in the ecological literature.

It was not, however, until the 1990s that the approach began to appear in broad usage. One explanation for the recent increase in enthusiasm toward the approach is that it has become apparent in recent years that current methods of environmental management are not always effective. Consequently, people have come to believe that a major paradigm shift such as the change to ecosystem management will be necessary to make environmental management effective (Slocombe 1993, Haeuber 1996). Haeuber (1996) also claims that "the last 25 years of increased environmental awareness in the United States, and the policy and regulatory changes it engendered, addressed the easily picked, 'low-hanging fruit' of environmental issues, cleaning up the most obviously polluted airsheds and waterways, for example. The generation of environmental issues now upon us, however, are defined by greater political, economic, social, and even cultural complexity." According to him, ecosystem management provides a more appropriate tool for dealing with these complex issues.

The rising popularity of the idea of sustainable development, considered by many to be one of the bases of ecosystem management (Christensen et al 1996), has also contributed to the popularity of ecosystem management.

Francis (1993) states that "the increasing use of the phrase 'ecosystem management' seems to reflect a partial abandonment of some underlying beliefs associated with the exploitative use of nature for purely utilitarian purposes." This movement toward greater environmental consciousness was given power by the change of federal administration in 1992, which brought in an environmentally-focused President and Vice President and a Democratic Congress (Haeuber 1996). The interest of the current administration in ecosystem management has caused a vast increase in its application on the federal level.

### 3.1.2 Ecosystem Management in United States Policies

In recent years, the concept of ecosystem management has been broadly embraced by the United States government. This endorsement is apparent in several federal policy documents. A few examples are provided here.

One federal entity whose work particularly illustrates this focus on ecosystem management is the Interagency Ecosystem Management Task Force. Over the past few years, the Task Force has produced a set of three documents entitled "The Ecosystem Approach: Healthy Ecosystems and Sustainable Economies." (Interagency Ecosystem Management Task Force 1995) These documents provide an overview of the concept of ecosystem management, descriptions of ecosystem management practices in several areas, and suggestions on how to further the use of the approach.

The Committee on Environment and Natural Resources, a committee of the executive-level National Science and Technology Council, has also addressed ecosystem management priorities (Baker 1996). The Committee's Ecosystem Working Group has identified a set of Ecological Research Priorities for achieving the national goal of understanding and protecting ecological systems. Priorities include understanding the interactions between natural processes and human activities and providing environmental policy solutions.

The Environmental Protection Agency has also contributed to ecosystem management policy by developing a watershed approach incorporating the basic concepts of ecosystem management (Browner, 1996). This approach, intended to be implemented at the state and local level with guidance from the EPA, focuses on management of hydrologically defined watershed areas. The guiding principles of the approach include partnerships, a geographic focus, and sound management based on strong science and data.

## *3.2 Ecosystem Management in Practice*

Much of the existing literature on ecosystem management consists of description and analysis of current ecosystem management programs. Yaffee et al (1996) found over 600 ecosystem management programs in the United States alone. Presented here are descriptions of a number of programs taking place in the United States and elsewhere.

### 3.2.1 Federal Programs

The United States government is currently involved in several initiatives which emphasize and encourage ecosystem management on a national level. It has been estimated that at least 18 federal agencies are currently exploring the ecosystem management concept (Haeuber 1996).

The EPA has been involved in ecosystem management through implementation of its watershed approach. Watershed management is a type of ecosystem management in which the ecosystem is defined by the boundaries of a watershed, that is, by an area which channels all its water to one outlet point, such as a river or a lake. The EPA's watershed approach is currently being applied through the National Estuary Program, the Clean Lakes Program, the Great Lakes Program, the Gulf of Mexico Program, and a wellhead protection program (Perciasepe 1996). In addition, assistance is provided to state and local programs wishing to implement a watershed approach.

The National Biological Service (NBS), which was itself started in order to integrate biological research within the Department of Interior, has also been implementing programs to encourage the use of ecosystem management (Reichman and Pulliam 1996). One of these is the NBS Ecosystems Initiative, begun in 1993, which has provided funding to new ecosystem management programs. In addition, programs such as the National Biological Information

Infrastructure and the Gap Analysis Program aid in the collection, integration, and analysis of scientific information on a nationwide scale, providing a scientific basis for ecosystem management.

The U.S. Fish and Wildlife Service (FWS) has been using an ecosystem approach in its fish and wildlife conservation activities since 1994 (Beattie 1996). The Service's goal under this approach is to "contribute to the effective conservation of natural biological diversity through perpetuation of dynamic, healthy ecosystems." (Beattie 1996) Underlying principles include inter-disciplinary and multi-stakeholder coordination, decisions based on sound science, and flexibility and innovation. The Service has delineated 53 ecosystem units based on watershed boundaries, and each of these units has an ecosystem team of FWS personnel. The teams work with stakeholders to determine goals and strategies and implement collaborative projects.

The Bureau of Land Management has also shown a commitment to ecosystem management. Its "operating principles" for ecosystem management, defined in a publication called *Ecosystem Management in the BLM: From Concept to Commitment*, include using the best available scientific information, involving stakeholders, taking an interdisciplinary approach, and practicing adaptive management (Dombeck 1996). Regional BLM programs using ecosystem management approaches include the Pacific Northwest Forest Plan, the Pacific Salmon and Steelhead Recovery Strategy, and partnership programs in a number of other regions.

The USDA Forest Service (FS) makes the claim of being "the first agency in the federal government to adopt an ecological approach to the management of public lands." (Thomas 1996) This occurred in 1992, with a statement by Chief F. Dale Robertson that "an ecological approach will be used to achieve the multiple-use management of the national forests and grasslands." A 1994 publication, *The Forest Service Ethics and Course to the Future*, emphasized ecosystem sustainability as a goal of the FS. Steps taken toward ecosystem

management include enhanced collaboration, assessments of large geographic areas, integration of information at multiple scales, and training of personnel.

### 3.2.2 Regional Programs

In addition to their broad, national initiatives, most federal agencies are also involved in regional ecosystem management programs. These regional programs generally encompass large, multi-state ecosystems, and often involve, in addition to the federal government, state and local governments and other stakeholders. Two notable examples of such programs are the Chesapeake Bay Program and the Pacific Northwest Forest Plan. Other regional programs are taking place in the Gulf of Mexico, the Ohio River Valley, the Northeast forests, and the Midwest prairie pothole region (Yaffee et al 1996).

The Gulf of Mexico Program, started in 1988 by the EPA, is an interagency effort to restore and protect the gulf's ecosystem while allowing its continued use by people. The program identifies threats to the area, and finds and implements solutions to those problems. Approximately 200 projects have been funded so far. A 1992 "Partnership for Action" document was signed by the governors of Florida, Alabama, Mississippi, Louisiana, and Texas representatives of eleven federal agencies, and the chair of the program's Citizens Advisory Committee.

The Ohio River Valley Ecosystem Team was formed in 1994 by the U.S. Fish and Wildlife Service. The team, made up of 35 FWS representatives, is in the process of developing action strategies for dealing with a number of issues in the area. Other federal and state agencies, non-profit organizations, universities, and other partners will be involved in the implementation of the strategies. The team is also developing a baseline GIS of the area.

The Northern Forest Lands Council was formed based on the recommendation of the 1988 Northern Forest Lands study, funded by the U.S. Congress and guided by a four-state

(Maine, New Hampshire, Vermont, New York) governors task force. The council, started in 1990 and funded by Congress for four years, had four members from each state and one from the USDA Forest Service. It produced a final report in 1994, giving 37 recommendations for what could be done to maintain the area's forests. Several of the recommendations are now being implemented in a voluntary manner at the state and federal levels.

The Prairie Pothole Joint Venture (PPJV) was started in 1987 by the U.S. Fish and Wildlife Service as part of the North American Waterfowl Management Plan, a joint effort of the United States and Canada. The goal of the program is to, through habitat restoration, increase waterfowl populations in the region, which includes areas of Iowa, Montana, Minnesota, North and South Dakota. The PPJV Steering Committee, which included representatives of the FWS, state wildlife agencies in the five states, and five conservation organizations, produced an overall plan in 1989. Within this framework, individual projects are developed and implemented within each state by participating agencies and organizations.

### 3.2.3 State Programs

In addition to the federal and regional programs, there have also been several state-level ecosystem management programs introduced in the past few years. One of these is the State of Florida's ecosystem management program, one of the programs examined in the South Florida case study.

Another state taking an ecosystem approach is Louisiana, where the Coastal Wetland Planning, Protection, and Restoration Act of 1990 established an interagency task force to implement the restoration of Louisiana's coastal wetlands (Interagency Ecosystem Management Task Force, 1995). The six-member task force, which represents a partnership between the state and five federal agencies, is implementing a coordinated approach to restoration.

The Prince William Sound project, started in the aftermath of the 1989 Exxon Valdez oil spill, is an example of ecosystem management in Alaska. Since the spill, two organizations, the Copper River Delta Institute and the Prince William Sound Science Center, have been established to facilitate research related to integrated ecosystem planning and management in the area (Slocombe 1993).

In central Arizona, the Verde River Greenway Project was started by Governor Bruce Babbitt in 1986 (Yaffee et al 1996). The project, which is coordinated by the Arizona State Parks, has among its goals the conservation, protection and enhancement of the ecological resources of the Verde River. In 1990, the project was expanded through the introduction of the Arizona Heritage Fund, which provides funding for land acquisition as well as ecosystem monitoring and management.

In New Hampshire, a steering committee representing diverse interests was used to develop an ecologically-focused forest resource plan for the state. The group, whose 28 members included landowners, the forest industry, state resource agencies, and property rights and environmental groups, outlined a vision for the future of the forest. Another group of 45 people provided an assessment of the forest's current ecological, social, and economic status. Based on this information, the steering committee is producing a forest plan which will direct state forest policy for the next ten years.

### 3.2.4 Local Programs

Because of its emphasis on collaboration and stakeholder involvement, ecosystem management is often used on a local level, in citizen-based programs. The Applegate Partnership in Oregon, which will be described in the Pacific Northwest case study, is an example of such a program that was started by local stakeholders.

Another example of a local program started by residents of the area is the Malpai Borderlands Group. Formed in the early 1990s in an area of southeastern Arizona and Southwestern New Mexico (Keystone Center 1996), the Group addresses environmental concerns such as landscape fragmentation and loss of biological diversity. It was started as a small group of ranchers and environmentalists, and continues to be primarily a landowner group. Other participants involved in the group's efforts include local, state, and federal agencies, the University of Arizona, The Nature Conservancy, and The Animas Foundation.

In eastern New York, the preservation of the Albany Pine Bush (APB) barrens has likewise been primarily a local initiative. A group of local citizens formed an organization called the Friends of the Pine Bush (now Save the Pine Bush, Inc.) in the 1960s. By purchasing land and by suing developers, the group has saved hundreds of acres of land from development. The Albany Pine Bush Preserve Commission was created in 1988 by the state legislature, and includes members from The Nature Conservancy, the towns of Colonie and Guilderland, the city of Albany, the New York State Department of Environmental Conservation, and the New York State Office of Parks and Recreation, as well as private citizens. Goals of the preserve include protecting the APB's ecology and providing an educational and recreational resource for the public.

In Marathon County, in Central Wisconsin, an ecosystem management initiative has recently been started by the county government. Forest plans have been written for county-owned forest lands since 1966, but the latest plan is the first to take an ecosystem approach. An advisory committee consisting of landowners and representatives of recreational and environmental interests, loggers, timber industry, local government, and the Wisconsin Department of Natural Resources has been formed to advise the forestry recreation and zoning committee.

### 3.2.5 International Programs

The implementation of ecosystem management has certainly not been confined to the United States. Provided here are a couple of examples of joint United States-Canadian programs for ecosystem management, but the approach is by no means limited to North America. Ecosystem management programs can be found all over the world.

Some North American ecosystem management programs have been collaborative efforts between the United States and Canada for management of lands on the border. In fact, one of the most long-standing ecosystem management programs is that in the Great Lakes region. The Great Lakes Water Quality Agreement between the United States and Canada states the purpose of the agreement to be to "restore and maintain the physical, chemical, and biological integrity of the waters of the Great Lakes Basin Ecosystem," with the Great Lakes Basin Ecosystem defined as "the interacting components of air, land, water and living organisms, including man," within the specified geographic region (Francis 1993). A current application of that ecosystem approach is in the 43 Areas of Concern (AOCs) that have been identified in the region since 1973. In 1985 it was recommended by the Great Lakes Water Quality Board of the International Joint Commission that Remedial Action Plans, or RAPs, be created and implemented in each region using the ecosystem approach defined in 1978 (Mackenzie 1996). The 1978 approach continues to be applied to this day.

Another joint United States/Canadian project is the Crown of the Continent ecosystem program, taking place in the Waterton Lakes and Glacier National Parks Biosphere Reserves in southwestern Alberta and north-central Montana (Slocombe 1993).. A recent emphasis on regional management of the area has emerged, and in 1991 a Crown of the Continent ecosystem was defined and an interagency Crown of the Continent Board and Ecosystem Center proposed.

# 4 Case Study Regions

## *4.1 Chesapeake Bay*

### 4.1.1 Introduction

The Chesapeake Bay is one of the most prominent features of the mid-Atlantic region of the United States. The largest estuary in North America, it is 332 km long, and its drainage basin covers 165,800 square km of land in six states (Maryland, Virginia, Pennsylvania, New York, West Virginia, Delaware) plus the District of Columbia (Chesapeake Bay Program 1995 (2)). This large, unique ecosystem supports a wide array of species and subecosystems.

In addition to being of ecological significance, the Chesapeake is also very valuable to the local economy. Not only does its scenery support tourism in the area, the bay is also famous for its production of seafood. The Chesapeake Bay provides much of the country's supply of crabmeat, as well as being home to other commercially viable species such as striped bass, American shad, and oysters.

However, the stresses of population growth and increasing exploitation of the Chesapeake Bay's resources have been causing more and more problems for its ecosystem in recent times. Excess nutrients contributed by everything from effluent from sewage treatment plants to runoff from over-fertilized farmlands to deposition from air pollution have caused eutrophication in the bay, with all its attendant problems. In addition, toxic pollutants from

industrial and urban sources, overfishing, and increased sedimentation due to land use changes have also caused ecological degradation.

As a result of all these stresses, the bay is beginning to show signs of wear and tear. Populations of underwater grasses are dwindling, due to the blocking out of sunlight by increased suspended sediment and by excess algae resulting from eutrophication. Striped bass populations reached such a low point by 1985 that a moratorium placed on fishing was the only way to save the species from total eradication in the area. Oyster harvests from the Bay are now down to 1% of historic levels (Chesapeake Bay Program 1995 (2)). The depletion of the oyster population has a particularly negative impact in that, in addition to effecting a reduction in harvests of an important commercial species, it has also caused a loss of filtration capacity, making it harder for the Bay to deal with further pollution.

All these conditions are indicators of the general degradation of the Chesapeake Bay ecosystem. Fortunately, since the 1970s a significant effort has been made to reverse this destruction and restore the bay to a healthy state.

### 4.1.2 The Chesapeake Bay Program

In the 1970s, growing concern over the condition of the Chesapeake led the United States Congress to call for a comprehensive study of the condition of the Chesapeake Bay. The study found that the bay was indeed degraded and in particular identified three major problem areas: nutrient overenrichment, dwindling underwater grasses, and toxic pollution. In response to this study, the states of Virginia and Maryland formed the Chesapeake Bay Commission, a legislative advisory commission, with a goal of collaborating to assess the condition of the bay and begin to restore it to health.

In 1983, the original Chesapeake Bay Agreement was signed, initiating the Chesapeake Bay Program (CBP). There were six signatory partners: the U.S. Environmental Protection

Agency, the State of Maryland, the Commonwealths of Pennsylvania and Virginia, the District of Columbia, and the Chesapeake Bay Commission.

The agreement established an Executive Council and an Implementation Committee to design and oversee policies for the bay area. The Executive Council, made up of cabinet designees of the governors of the three states, the mayor of Washington, and the EPA's Regional Administrator, would meet at least twice a year and would be responsible for the formation of collaborative policies to save and protect the bay and its living resources. The Implementation Committee, made up of representatives of the involved agencies, was to be responsible for carrying out these policy plans. This committee was divided into several subcommittees, each addressing a particular issue (Figure 2). To facilitate coordination of the regional program, the EPA formed a Chesapeake Bay Program office in Annapolis, Maryland.

A few years later, when a better understanding of the issues facing the bay had been obtained, a second Chesapeake Bay Agreement was created. This agreement, signed in 1987, set forth more specific goals and objectives for the program. Probably the most radical and widely recognized part of the 1987 agreement was a commitment to achieve a 40% reduction in the inflow of nutrients to the bay by the year 2000 (Chesapeake Bay Program 1987). Such a specifically designated target outcome is not frequently found in environmental restoration policies. The agreement also specified activities concerning intergovernmental collaboration, called for a coordinated Bay-wide species monitoring plan, and recommended more of an emphasis on local participation.

In 1992, a set of amendments to the Chesapeake Bay Agreement was signed. Recognizing that meeting the 40% nutrient reduction target would require an expanded local and state role for the program, the amendments focused on the use of tributary strategies to reduce pollution inflows. The amendments also addressed other emerging issues such as the role of air deposition as a contributor to the nutrient overenrichment problem (Chesapeake Bay Program 1992).

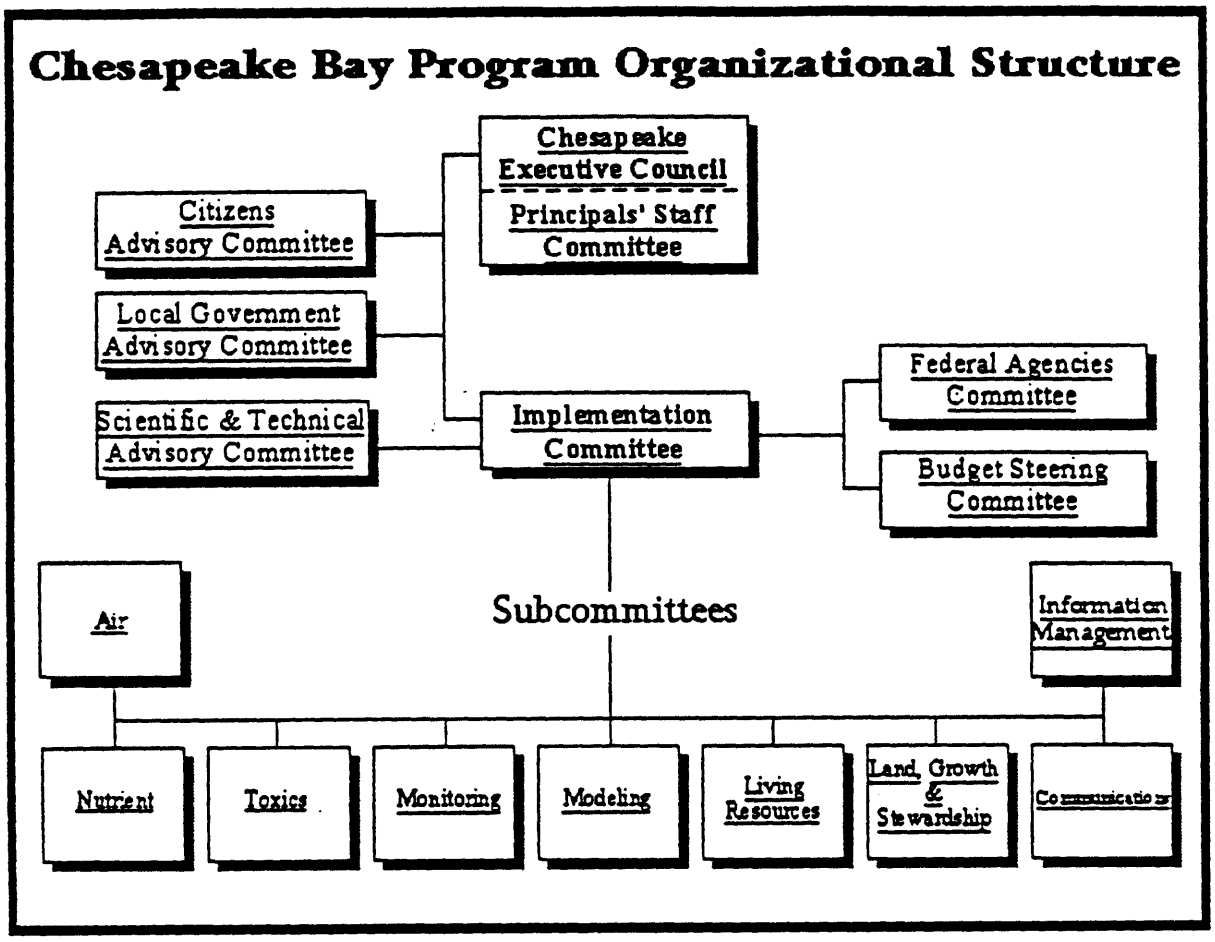


Figure 2 Chesapeake Bay Program Organizational Structure

In addition to the initial agreement signatories, a number of other partners have since become involved in the Chesapeake Bay Program, including other federal agencies, universities, and non-profit environmental organizations. A 1994 Federal Agencies Agreement was signed by senior officials from 25 federal agencies (Chesapeake Bay Program 1994). One particularly active partner has been the National Oceanographic and Atmospheric Administration (NOAA), which has been involved in the CBP since 1984 and has even had an on site office at the Baltimore CBP office since 1991. The United States Geological Survey has also become very involved in the bay, coordinating its $1 million Chesapeake Bay Ecosystem Initiative with the efforts of the CBP.

*Monitoring*

One of the first steps taken by the Chesapeake Bay Program, in 1984, was the pulling together of a group of experts to decide what the bay's most pressing monitoring needs were and identify significant gaps in the existing monitoring system. All stakeholders were involved in the decision of what to monitor in the Bay. Not only was input received from monitoring personnel of all involved agencies, but the connection between monitoring and decisionmaking was also acknowledged by having the decisionmakers who would use the data participate in the design of the monitoring program.

Currently, monitoring in the CBP is coordinated by the Monitoring Subcommittee, one of the subcommittees of the Implementation Committee. This subcommittee, which has representatives from federal, state, and regional agencies as well as universities, has an ongoing role of deciding what the monitoring priorities are for the area and coordinating multi-jurisdictional monitoring efforts. The subcommittee also assists the ecosystem management process by promoting multi-disciplinary interpretation and reporting of data. Its other responsibilities include tracking individual monitoring programs to reduce the number of

overlaps and gaps between programs, making sure that the format and quality of the data from various agencies is compatible, and ensuring communication of and access to data.

While all levels of government are involved in monitoring in some way, it is generally executed and coordinated at the state level, where monitoring of tributaries and other parts of the basin generally takes place. The federal government provides about 50% of the funding for state-based monitoring and also plays a significant role in monitoring of the bay's mainstem. Local governments are involved through stream programs, water quality monitoring, and other activities. Citizen monitoring occurs through the Chesapeake Bay Citizen Monitoring Program, which is coordinated by a non-profit environmental organization called the Alliance for the Chesapeake Bay. The coordination and integration of all this data is the responsibility of the Monitoring Subcommittee.

The main focus of the CBP for monitoring purposes is water quality. However, there has also been an effort to coordinate monitoring of other factors as well, in an attempt to view the bay region more holistically. Elements of the ecosystem now being monitored include habitat, submerged aquatic vegetation, benthic communities, phytoplankton, and zooplankton.

One significant non-water element of the bay is its living resources base, which is especially important to the Chesapeake because of its impact on the area's economy. This factor has been the focus of NOAA's involvement in the Chesapeake Bay over the past ten years. NOAA's role has included performing stock assessments, integrating various state surveys of living resources and of fisheries catches, and incorporating all this living resources data into the main CBP database. In addition to this effort, the Chesapeake Bay Stock Assessment Committee is working on developing a long-term, consistent monitoring plan for living resources.

Another non-water-quality factor which has received increased attention in recent times with respect to its effect on the Chesapeake is air pollution. As it has become more apparent that deposition from air pollution is making a significant contribution to nitrogen pollution in the bay, more attempts have been made to synthesize air pollution information with other Bay

monitoring. An air quality coordination group is now integrating air and water quality information to investigate the impact of air quality problems on the bay ecosystem.

Land-based issues have also had a significant impact on the region, with agricultural runoff accounting for eighty percent of nitrogen and phosphorus entering the bay. In recognition of the significance of this effect, the CBP's approach has included a focus on land use. Programs are in place to encourage the use of agricultural best management practices and individual monitoring and research projects on the effects of such practices have been carried out. In addition, an effort to study riparian zone impacts is under way in Pennsylvania, in coordination with the state government.

Although these different projects operate fairly independently of each other, the information obtained through them is being integrated through models of the bay. The CBP is considered to have one of the most sophisticated watershed models in the world, providing a theoretical understanding of how the bay works and what the ramifications of different actions could be.

Some new, totally integrated cross-media projects are also being started up in the CBP. A strategic plan for cross-media monitoring is currently being developed to facilitate the goals of looking at the Bay from an ecosystem management point of view and better meeting the information needs of managers. Another program is pulling together a group of experts from different areas of expertise to aid in the integration and interpretation of different kinds of information and data. This group, which would consist of both federal and state officials, would eventually like to communicate through the Internet. Initiatives such as these, although not fully under way, are among the most innovative applications of the ecosystem management concept in the Chesapeake Bay at this time.

The management of all the data and information produced by the various agencies and projects in the CBP is one of the more daunting tasks the program faces, but progress is slowly being made in this area as well. Standards for quality, format, and choice of parameters have been set to make the integration of data from different regions and agencies easier.

In addition, data from a number of sources are being collected and stored at the CBP's Annapolis office. A few somewhat specialized databases have already been constructed for the storage of this information, using agency formats such as CHESSEE, STORET, and WATSTORE. The planning of an overall database for all the Chesapeake data is also under way, under the lead of the Data Center Workgroup of the Monitoring Subcommittee. This is a particularly challenging project in that it involves dealing with what one participant called a 'vast' amount of data, too much to manage in any practical manner at one central location. Thus the current plan is to produce a distributed database on the World Wide Web, in which all participants would enter, store, and retrieve their own data. A workshop was held in June 1996 to discuss recommendations for the format of such a database, to be called the Chesapeake Information Management System, and the Susquehanna River Basin Commission (SRBC) and the Interstate Commission on the Potomac River Basin (ICPRB) have expressed interest in coordinating the database formation process. The use of Geographic Information System (GIS) software to organize the data has also been proposed. With continued support, this database could become a very useful tool.

The ultimate purpose of all this monitoring is to aid in the process of managing the Bay. Thus the next key step is the dissemination of information to managers, another role which the CBP has taken on. Data and information are routinely presented to decisionmakers at various levels of government within the bay, and access to other data can also be gained through the CBP Data Center. In addition, reports are presented to the Executive Council at its annual meeting.

### 4.1.3 Other regional programs

*The Susquehanna River Basin Commission*

Ninety percent of the water in the upper Chesapeake Bay is provided by inflow from the Susquehanna River, which flows through Maryland and Pennsylvania. Because of this connection, the condition of the Susquehanna's 75,000 square mile basin has a large influence on the health of the Chesapeake Bay. Thus monitoring the Susquehanna is an important part of monitoring the Bay.

Most monitoring of the Susquehanna River is performed by the Susquehanna River Basin Commission (SRBC), a federal interstate compact commission. The SRBC is one of only two federal interstate compact commissions in the United States, the other being the Delaware River Basin Commission. Set up by legislation in the federal government and the Maryland, Pennsylvania, and New York legislatures 25 years ago as a 100-year commission, the SRBC includes the three states and the federal government as equal partners in its agreement. It currently acts as the primary water resource management agency for the Susquehanna River Basin. In addition to its roles in flood management and water supply issues in the basin, the SRBC also performs monitoring of the river.

The SRBC's most extensive water quality monitoring program is its CBP involvement, which is funded by Pennsylvania's Chesapeake Bay Implementation Grant. The commission conducts baseline monitoring at 6 river and stream sites within Pennsylvania, measuring a number of water quality parameters including nutrients, sediment, and toxics levels. It also has a 12-station Interstate Water Quality Monitoring Program which measures water quality where streams or rivers cross the New York, Pennsylvania, and Maryland borders. In addition to its water quality monitoring, the SRBC also has an annual microinvertebrate monitoring program.

All these programs provide essential information to the CBP on the water entering the bay. The results of the SRBC's monitoring are sent to the CBP and used to see the effects of nutrient reduction efforts in Pennsylvania and to calibrate the bay model.

Another way the SRBC is assisting the CBP is by providing a reevaluation analysis of long-term, large-scale trends in water and habitat quality in an attempt to assess the effects of current programs. This will aid in evaluation of the effectiveness of the program to date and help the CBP to use an adaptive management approach.

The desire to manage more holistically in the Chesapeake has also led to an SRBC project called the Integrated Assessment of Water Quality & Biological Conditions in the Susquehanna River Basin. This assessment, in addition to reviewing and consolidating current monitoring efforts and integrating their databases, will make recommendations for future monitoring programs.

*The Interstate Commission on the Potomac River Basin*

The Interstate Commission on the Potomac River Basin (ICPRB) is one of several interstate river basin commissions which are similar to the SRBC but differ in that the federal government is not a partner. The ICPRB performs water quality monitoring of the Potomac River, and some of this data is also utilized by the Chesapeake Bay Program.

### 4.1.4 State Participation

Each of the three states involved in the Chesapeake Bay Program has set up some kind of mechanism for interacting with the CBP, and for monitoring and decisionmaking with regard to that state's part of the bay watershed. In addition to participating in the regional plan, some states also have ecosystem management programs of their own.

### 4.1.5 Virginia

*Virginia Department of Environmental Quality*

Virginia, one of the two states directly bordering the Chesapeake Bay, participates in the CBP through a Chesapeake Bay Program Office within its Department of Environmental Quality (DEQ).

Efforts taking place through the DEQ have included nutrient and toxics pollution reduction plans, and a tributary strategy for the Potomac River Basin. An assessment of the Shenandoah-Potomac basin was performed with the participation of local government.

Monitoring is one of the core budget items within the DEQ's CBP office. The state does regular monitoring for water quality parameters such as nutrients, dissolved oxygen, and temperature. Other relevant factors such as plankton, benthic communities, and toxics contamination are reviewed more sporadically. The DEQ itself does about 40% of its own monitoring, and 60% is done by contractors who bid for a contract to collect, analyze, and report the information. The information is then sent to the CBP's data center, in addition to being entered into the DEQ's own water quality database.

### 4.1.6 Maryland

*Maryland Department of Natural Resources*

The agency primarily responsible for Maryland's contribution to the Chesapeake Bay Program is the Maryland Department of Natural Resources (DNR).

The DNR performs routine water quality monitoring related to the Bay Program, collecting water samples which are then analyzed by the Chesapeake Biological Laboratory at the University of Maryland and sent back to the DNR for quality assurance and analysis processes. Some subcontractors, including the United States Geological Survey (USGS) and the Academy of Natural Sciences, also perform monitoring. Data regarding the bay is sent to the CBP data center.

*Maryland Water Monitoring Council*

A non-CBP-related program performing monitoring coordination in Maryland is the Maryland Water Monitoring Council, which was created based on the recommendations of the federal Interagency Task Force on Monitoring Water Quality. Maryland is the first state to have a water monitoring program which follows through on this ITFM recommendation. The council, which is six months old, is notable because it focuses on local government involvement, providing resources to local governments and promoting exchange between state and local programs.

*Ecosystem Management Council*

Maryland's own state-level Ecosystem Management Council was formed in January 1996 as one of four cross-functional teams within the DNR. So far, the council has created an ecosystem management report and proposed an integrated natural resource management plan. The council is currently working with the EPA Region III office to produce an atlas of various natural resources in the Chesapeake Bay area. In addition, it is attempting to work toward a hierarchical system of operations which would integrate smaller geographical regions within larger ones, thus coordinating different scales of information. It is still unclear how this system

would tie in with the work of the CBP, because the Ecosystem Management Council is still in its formative stage, but both parties hope to form a collaborative relationship.

### 4.1.7 Pennsylvania

Although the state of Pennsylvania does not actually border on the Chesapeake Bay, a large portion of the bay's drainage basin is in this state. More than 52% of the freshwater that reaches the Chesapeake Bay runs off Pennsylvania land, entering the bay through the Susquehanna and Potomac Rivers (Pennsylvania Department of Environmental Protection 1990). Runoff from Pennsylvania's plentiful agricultural areas makes a significant contribution to the bay's nutrient overenrichment problem.

*Pennsylvania Department of Environmental Protection*

Pennsylvania's Department of Environmental Protection has a CBP office within its Bureau of Land and Water Conservation, which works with the CBP to reduce the adverse impacts of Pennsylvania agriculture on the bay.

The main focus of the DEP's activities has been working with farmers to reduce the effects of agriculture on water quality in the Chesapeake Bay's tributaries. The state CBP office, the EPA's CBP office, and the U.S. Department of Agriculture collaborate with County Conservation Commissions to educate farmers on the use of Best Management Practices (BMPs) to reduce nutrient runoff without reducing productivity. Farmers can be reimbursed for up to 80% of the cost of implementing BMPs. In addition, the Chesapeake Bay Nonpoint Source Pollution Abatement Program was started in 1985 with the goal of reducing the amounts of nutrients and topsoil runoff from Pennsylvania farms to the bay. So far these

programs been successful in promoting a positive attitude toward BMPs on the part of farmers and in implementing the use of BMPs in many areas.

The DEP uses its monitoring funds to pay the Susquehanna River Basin Commission (SRBC) and the Interstate Commission on the Potomac River Basin (ICPRB) to monitor its rivers and determine the impact of these agricultural efforts and other factors. These agencies have been performing baseline monitoring of nutrients and other water quality parameters in Pennsylvania since late 1984. In addition, the state has a Pennsylvania Water Quality Network of 73 stations at which routine monthly sampling is used to monitor water quality trends. This program is coordinated with the SRBC program, with the two agencies sharing responsibilities where their networks overlap. Put together, these programs provide an extensive network of water quality monitoring stations on the major Chesapeake Bay tributaries.

The data collected by the DEP is used to show trends in water quality in the rivers and to monitor the progress of the Pennsylvania water quality management program. The data is also sent to the CBP and used in calibrating the program's model of the bay and in checking on progress toward the nutrient inflow reduction goals of the 1987 agreement.

### 4.1.8 Local roles and local programs

*Local Involvement in the Chesapeake Bay Program*

The CBP, from its first agreement in 1983, has always acknowledged the role of local governments. In 1988, a further commitment to involving local governments was made with the formation of the Local Government Advisories Committee (LGAC).

The LGAC, made up of 20 local government officials, meets quarterly. Its role is to improve communication between the CBP and local governments, both by bringing the concerns and recommendations of local governments to the attention of the CBP and by

informing those local governments about the activities of the CBP. It also facilitates the provision of technical assistance to local governments and provides a local government perspective in policy development

The role of local governments was again emphasized in 1992 with the decision to attack nutrient overenrichment problems at the tributary level. This undertaking led to an increased focus on local governments, whose assistance was required in initiating nutrient reduction plans in all the bay's tributary streams and rivers.

Most recently, in 1995, a Local Government Partnership Initiative was signed in recognition of the fact that accomplishing a 40% nutrient reduction would have to involve participation by the 1,653 local governments located in the region (Chesapeake Bay Program 1995). The initiative made an official commitment to more clearly defining the role of local governments in the Program and establishing stronger relationships and more coordination with local governments. An outreach program was developed to more directly engage local governments in the program's efforts, and opportunities to give local governments technical and financial assistance were sought out.

The Local Government Advisories Committee has continued to play an active role in the past few years. One of its most recent projects is the "Chesapeake Bay Communities: Making the Connection" effort. A book by that name has been published, listing and describing some of the more innovative and successful local government programs in the Bay, and a conference was held in October 1996 (Hodges 1996). Both the book and the conference are intended to help local governments learn from other local governments' successes. In addition, the conference involved discussions between local governments and CBP officials concerning what the Bay Program has to offer local governments and what they have to offer the program.

*Examples of Local Programs*

There have been many successful local programs in the Chesapeake Bay. These programs, a number of which are listed in the CBP "Making the Connection" book (Hodges 1996), involve activities ranging from educational programs to tree plantings to stream monitoring. Some of them are particularly notable for their achievements in fostering cooperation between various interests in the region.

One of these programs is the Chesconessex Creek Watershed Project in Virginia's Accomack County. The program involves a partnership between the county, a nonprofit organization called the Alliance for the Chesapeake Bay, Virginia's Chesapeake Bay Local Assistance Department, and the CBP. Within the program, volunteers monitor for water quality and biological indicators in the watershed, and the results are analyzed and used by both the county and the CBP. This volunteer program both augments the monitoring data available in the area and provides an educational experience for the volunteers.

Another watershed-based program in Virginia is the Chickahominy Watershed Project. The Chickahominy Watershed Alliance, which includes the Alliance for the Chesapeake Bay and the U.S. Fish and Wildlife Service, studies the effects of both human and natural influences on the watershed. This effort provides an important step toward the integration of data which is central to ecosystem management, and with funding coming from federal, state, and local sources, it is a truly integrated program.

The Tiber-Hudson Watershed Partnership in Ellicott City, MD, a citizen partnership, has sponsored activities including water quality monitoring, cleanups, and educational efforts. Like other local partnerships, it works in collaboration with a variety of partners from government, business, and non-profit entities.

Another Maryland program, the Swan Creek Restoration Initiative, likewise involves local, state, and federal partners. This initiative is working to improve aquatic resources in the

Swan Creek area, and activities include surveys of water quality, fish, and benthic communities.

These programs, and the many others like them, show how useful it can be for federal, state, and local interests to join together in grassroots efforts. The integration of such programs with larger-scale programs such as the CBP could serve to increase the monitoring efficiency and general effectiveness of regional programs.

*County Involvement in Pennsylvania*

In Pennsylvania, one important way local government is involved in the Chesapeake monitoring program is through County Conservation Districts. There is one conservation district in each county in Pennsylvania and they are "responsible for the management of a county's soil, water, and related natural resources." (Pennsylvania Department of Environmental Protection, 1990) Although technically a subdivision of the state government, these districts receive a large portion of their funding (as much as 50%) from the county and their boards of directors are appointed by the county commissioners. Each seven-member volunteer board of directors includes both farmers and members of urban communities. The conservation districts are responsible for a significant amount of water quality monitoring in Pennsylvania, and report their data back to the state, which then uses it for the Chesapeake program.

*Maryland Tributary Teams*

A notable method of local government involvement in Maryland is the use of tributary teams. These teams, made up of citizens and local governments, are facilitated by the Maryland DNR and Department of Agriculture. They track the progress and implementation of the state's tributary plan, with each tributary team producing its own annual reports.

## *4.2 Pacific Northwest*

### 4.2.1 Introduction

The economy of the Pacific Northwest has always depended heavily on the exploitation of natural resources such as timber and fish. Forest cutting practices have been going on since the 1800s and the arrival of the first white settlers (Forest Ecosystem Management Assessment Team). Fishing has been practiced even longer by American Indian tribes.

As such activities have expanded, however, they have begun to affect biodiversity in the area both by directly diminishing species populations and by disturbing habitat. This situation has caused the area to become a center of controversy in recent years. Tensions have become high between those who wish to preserve the natural environment of the area and those whose livelihoods depend on its exploitation.

The region has faced a number of specific environmental problems lately, mostly related to the destruction of natural ecosystems by deforestation and by the effects of development. Several native species are suffering from lack of habitat due to both the destruction of forests (particularly old-growth forests) and the introduction of the infrastructures necessary for a growing population. The grizzly bear, gray wolf, and salmon are just a few of the species under stress in the Pacific Northwest.

The complexity of the task of trying to preserve this region's biodiversity and ecosystem integrity while maintaining its economy has led to the formation of a number of regional programs and partnerships. Ranging from the broad federal President's Forest Plan to the locally-driven Applegate Partnership, these initiatives are trying to examine the large number of issues involved and come up with management methods that are satisfactory to all players.

### 4.2.2 Regional Programs in the Pacific Northwest

*The Pacific Northwest Forest Plan*

The Pacific Northwest Forest Plan, also known as the President's Forest Plan, is the most visible, well-publicized regional program in the Pacific Northwest. It was introduced as a result of the 1993 President's Forest Conference, an attempt to break the 'gridlock' occurring in the area and to better coordinate the activities of the various federal agencies involved. The main goal of the program is sustainable use of the area's forests, wildlife, and waterways, preserving the integrity of its ecosystems while still allowing the human population to support itself.

Following the Forest Conference, a 1994 Record of Decision was produced by the federal agencies involved outlining the Forest Plan. A Regional Interagency Executive Committee (RIEC) including the regional heads of the Forest Service (FS), Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), National Parks Service (NPS), Bureau of Indian Affairs, and Environmental Protection Agency was created to head the program, and a Regional Ecosystem Office (REO) was established in Walla Walla, Washington.

As one of the first steps in implementing the Forest Plan, the Forest Ecosystem Management Assessment Team, one of three interagency working groups, created an assessment of the region which looked at all aspects of the ecosystem, including social and economic factors. The team included scientists and technical experts from a variety of disciplines associated with the FS, BLM, EPA, FWS, NPS, NMFS, and area universities. The assessment covered all FS, BLM, and NPS lands in the range of the northern spotted owl.

This integrated effort over a large region was the first step in data coordination for ecosystem management of the Pacific Northwest.

The current monitoring framework for the Forest Plan includes four types of monitoring. Implementation monitoring determines whether the intended plan was followed in an area. Effectiveness monitoring concerns whether the desired results were achieved. Validation and research monitoring are used to further investigate the cause and effect relationship between management actions and the results that are noted.

Monitoring is coordinated by a Research and Monitoring Committee, made up of full-time scientists working in the Regional Ecosystem Office and a standing group of agency liaison officers. The committee is responsible for determining research and monitoring priorities and looking into how the results of monitoring can better be used in planning and practice. The use of GIS is being explored by a GIS team, also located in the REO (Interagency Ecosystem Management Task Force 1995 (3)).

*Interior Columbia Basin Ecosystem Management Project*

The Interior Columbia Basin Ecosystem Management Project (ICBEMP) was jointly established by Chief of the Forest Service and the Director of the BLM in response to one of the directives in the President's Forest Plan, to "develop a scientifically sound and ecosystem-based strategy for management of Eastside forests." (Haynes et al 1996)

The goals of monitoring within the ICBEMP are to reduce uncertainties, test assumptions, and effect changes in management direction, with the ultimate purpose being to guide management decisions. One of the program's priorities is to interpret and manage data so that it will be more useful in making decisions.

Monitoring is managed by a Science Integration Team (SIT), one of six topic teams. The team includes federal employees from the FS, BLM, EPA, US Geological Survey, and Bureau of Mines, and is located in Walla Walla, Washington. The SIT has developed a

scientific framework, conducted assessments, and generated an integrated assessment of the entire basin (USDA Forest Service 1996).

*Pacific Northwest Research Program*

The Pacific Northwest Research Program is a research program coordinated by the EPA and intended to address the specific ecological problems of the northwest region and generally to develop the understanding and approaches needed to implement ecosystem management anywhere.

The program has worked with state and tribal governments to determine the types of scientific information most needed in the region. In addition, the EPA has collaborated with state and local governments, community groups, private landowners, and other interested parties on various projects. One of the objectives of the program is to expand the use of ecosystem management concepts beyond federally owned lands.

*Blue Mountains Natural Resources Institute*

The Blue Mountains Natural Resources Institute was started by stakeholder groups in the area, who approached the managers & scientists at the FS about putting together a partnership. The goal of the Institute is "to enhance the long-term economic and social benefits derived from the natural resources of the area in a way that is ecologically sensitive & sustainable." (Blue Mountains Natural Resources Institute 1997) In addition to being a cooperative effort between Forest Service managers and scientists, the BMNRI is also a partnership between a large number of stakeholders, with 80 partners currently involved from federal, state, and local government, private companies, universities, and other interests. The 20-member board of directors has members from all levels and all areas (Blue Mountains Natural Resources Institute 1997).

The focus of the BMNRI is meeting the area's information needs. It gathers information and finds gaps in that information that need to be met. In addition, research is performed by the Institute on the effects of different management actions on the ecosystem.

One of BMNRI's programs, the Grande Ronde Model Watershed Program, is implementing a comprehensive approach to watershed management by promoting more coordination between existing programs in the Grande Ronde Watershed. The watershed program includes an investigation of the possibility of a comprehensive GIS system including air quality, climatic, water quality and quantity, land use, and other types of data, and a number of current GIS players within the area have expressed interest in participating.

*Lower Columbia River Estuary Program*

In 1990, the states of Oregon and Washington started the Lower Columbia River Bi-State Water Quality Program, an evaluation project aimed at providing an assessment of the state of the Lower Columbia River, which is the Washington-Oregon border. The program, whose Steering Committee had members from Washington, Oregon, the EPA, the USGS, and the Northwest Power Planning Council, collected and evaluated data on the river and produced an Integrated Technical Report. The Steering Committee made recommendations for further action based on the results of the evaluation.

The Bi-State Water Quality Program disbanded in 1996, upon completion of these tasks, but its work led to the formation of the Lower Columbia River Estuary Program, one of seven recently-added programs in the National Estuary Program. This new program has a nine-member policy committee including representatives from the Washington Department of Ecology, the Oregon Department of Environmental Quality, the Governors' Offices of the two states, the EPA, local governments, and Indian tribes. Its Management Committee has 31 members, with representatives from all interested constituent groups on the river.

One of the five workgroups appointed by the Management Committee is a scientific and technical workgroup. This workgroup is currently developing a request for proposals for a long-term monitoring program which will look at water quality, sediments, bioaccumulation, and other factors related to the river.

*R-EMAP and the Coastal Range Ecoregion*

The Regional Environmental Monitoring and Assessment Program (R-EMAP) is a component of the EPA's national Environmental Monitoring and Assessment Program (EMAP). The main objective of R-EMAP is to apply EMAP principles to smaller-scale projects in collaboration with state and local governments (USEPA Office of Research and Development 1993).

The R-EMAP program is being applied to the Pacific Northwest in an assessment of wadable streams in the Coast Range ecoregion, which includes coastal areas of Oregon and Washington (EPA Region 10 1993). The Environmental Services Division of EPA's Region 10 is coordinating the project, in collaboration with the Washington Department of Ecology and the Oregon Department of Environmental Quality.

*Pacific State Marine Fisheries Commission*

The Pacific State Marine Fisheries Commission is a multi-state collaboration which has been involved in creating a Recreational Fisheries Information Network (RecFIN). The network has been formed by putting together existing data. While it took six or seven years to reach the current level of coordination, the program as it exists has been called the 'best collaboration ever' by a participant.

*StreamNet*

The Coordinated Information System/Northwest Environmental Database, renamed StreamNet in 1996, is a data management program for stream data in the Pacific Northwest. The goal of the project is to "create, maintain, enhance, and provide public access to a regionally consistent set of fish, wildlife, and related resource data that is directly applicable to regional policy, planning, and management." (StreamNet 1996)

StreamNet is a cooperative effort in four states (Oregon, Idaho, Washington, and Montana) involving state, federal, and tribal agencies. The project, initiated by the BPA and managed by the Pacific State Marine Fisheries Commission, manages data using electronic databases. A Steering Committee made of coordinators from participating agencies manages the interagency communication and collaboration needed to keep the program going and ensure that all participants' needs are met.

### 4.2.3 State Involvement

As mentioned above, state participants are involved in a number of regional, collaborative programs in the Pacific Northwest. In addition, there are a number of ecosystem management-type programs taking place within state agencies in the region.

### 4.2.4 Washington

*Integrated Landscape Management*

The Integrated Landscape Management (ILM) program is a holistic management program that was started in the Washington Department of Fish and Wildlife. The program,

which focuses on the Lewis-Kalama Watershed in southwest Washington, involves a cooperative plan developed among landowners, the public, and fish and wildlife managers. The focus is on the use of data for management planning and adaptive management purposes. It brings together a variety of fish and wildlife related data, and considers all factors in the watershed including people. Some of its accomplishments so far include a species inventory and a GIS system (Yaffee et al 1996).

*Washington Aquatic Biodiversity Consortium*

The Washington Aquatic Biodiversity Consortium was developed as a plan to assess aquatic biodiversity in Washington State at large geographic scales. Its goals were to coordinate and compile existing data on aquatic biodiversity and provide a statewide assessment. A number of state agencies, including the Department of Natural Resources, the Department of Ecology, and the Fish and Wildlife Department, were involved. Unfortunately, because of funding problems, it is unclear what will happen with this program in the future.

*Information Integration Project*

The Washington Department of Ecology (DOE) is currently implementing a department-wide Information Integration Project (. The product of this integration will be a multi-media, cross-functional Geographic Information System. Data on water, air, hazardous waste, industries, waste sources, and regulatory issues will be included. Some layers obtained from other agencies such as the Fish and Wildlife Department and the Department of Natural Resources are also being included, as are data from local and volunteer monitoring programs and from tribes.

### 4.2.5 Oregon

*Willamette Valley Livability Forum*

The Willamette Valley Livability Forum began with a recommendation to the governor of Oregon by a blue-ribbon panel. Its purpose is to bring together the business community, private citizens, local, state, and federal government, and university efforts in the Valley. The forum has 60 members and an 8 to 12 member Steering Committee. It is coordinated by a Forum manager and an assistant in the Oregon Progress Board

One of the Forum's first tasks was to inventory existing and proposed studies and planning efforts in the Valley. It had a conference in 1994 called "Partnerships for the Willamette Valley's Future," and is planning to have another major conference and come out with a State of the Valley Report in 1998. Currently there are many local projects going on in connection with the Forum, all coordinated with each other under a shared overall vision. By collaborating on an overall plan for the region, participants in this program are pooling their resources for an ecosystem management-based plan.

*Elliott State Forest Management Plan*

The Elliott State Forest Management plan is part of the Oregon Department of Forestry's effort to use ecosystem management in its forest planning process. This effort was started when the Oregon State Land Board directed the Oregon Department of Forestry to use an ecosystem approach in managing state forests. In 1992, an integrated forest plan was developed for the Elliott State Forest. The final plan was introduced in 1995. The program involves collaboration between federal, state, and university players (Yaffee et al 1996).

*Oregon Coastal Salmon Restoration Initiative*

The Oregon Coastal Salmon Restoration Initiative, announced by the Governor of Oregon in October 1995, has as its mission the restoration of fisheries to a productive, sustainable level. It is also intended to serve as a "model for intergovernmental and community-based collaboration and partnerships."

### 4.2.6 Local Roles and Local Programs

*Applegate Partnership*

The Applegate Partnership was originally started by two residents of the Applegate River Watershed in southern Oregon. These two founding members, an environmentalist and a logger, wanted to get away from the antagonism surrounding environmental issues and develop a cooperative community effort for watershed health. In addition to members of the community, participants from the FS, the BLM, and state and county governments are involved in the partnership.

The effort, based on trust and communication between parties, has been successful at promoting better communication between private landowners, government agencies, and community members. It has been active in promoting restoration projects, merging data in a GIS map of the area, and informing watershed residents about environmental issues.

*Eastside County Coalition*

The Eastside County Coalition is a group of counties which organized into a coalition to facilitate the counties' involvement in the Interior Columbia Basin Ecosystem Management Program. The coalition covers a broad geographic range, including counties in Idaho and Montana as well as Washington and Oregon.

## *4.3 South Florida*

### 4.3.1 Introduction

South Florida's coastal and wetland ecosystem is an area widely regarded as a valuable natural resource. In addition to having value in and of itself, the beauty of Florida's natural environment also plays a role in the success of the area's booming tourism industry.

It is this very tourism industry, combined with Florida's growing population, that is proving to be one of the area's primary environmental threats. The stress of an increasing number of people trying to withdraw fresh water for human consumption is causing water shortages not only for humans but for the ecosystem as well.

Another major human impact on fresh water sources has been that of agriculture. Diversion of water for irrigation of crops further reduces the available supply for the ecosystem. Agriculture is also a pollution factor in that runoff from agricultural lands contributes excess nutrients to the ecosystem. Eutrophication and other signs of this pollution can be seen as far away as the Florida Bay system and its coral reefs.

A third human-caused factor which has severely affected the South Florida ecosystem is the canal system built by the Army Corps of Engineers for its Central and South Florida Project. These canals were built in 1948 as part of a flood control mechanism to protect people

living in the area. The Everglades, however, depend on natural flow patterns, including meandering rivers and sheet flow. These flow patterns were disrupted by the canal project, and the result has been an overall degradation of the Everglades ecosystem.

Interest in preserving the ecosystem has been present for about as long as destructive influences have. For example, the Everglades National Park was established in 1948. A more recent preservation effort is the Florida Keys National Marine Sanctuary. This interest in saving the area's ecosystem has been continued through a number of current regional preservation and restoration efforts.

### 4.3.2 The South Florida Ecosystem Restoration Effort

Concern over the degradation of South Florida and the desire to return it to its natural state led several federal agencies to sign an Interagency Agreement on South Florida Ecosystem Restoration in 1993. The agreement created a South Florida Ecosystem Restoration Task Force, made up of high-ranking officials. The task force was to be responsible for ecosystem restoration programs, including an ecosystem-based science program, multispecies recovery plans, and specific restoration projects, and would meet at least semiannually.

The Task Force also established a Field-Level Management and Coordination Working Group. This working group was charged with formulating and implementing policies to meet the ecosystem restoration goals of the Task Force.

The Task Force and Working Group originally involved only federal players because the limitations of the Federal Advisory Committees Act made it too difficult to involve other governments and stakeholders directly. However, in 1995 FACA was modified by the Federal Unfunded Mandates Act to allow exemption of intergovernmental programs from FACA, and this led to state representation in the Task Force and the Working Group. The Task Force now

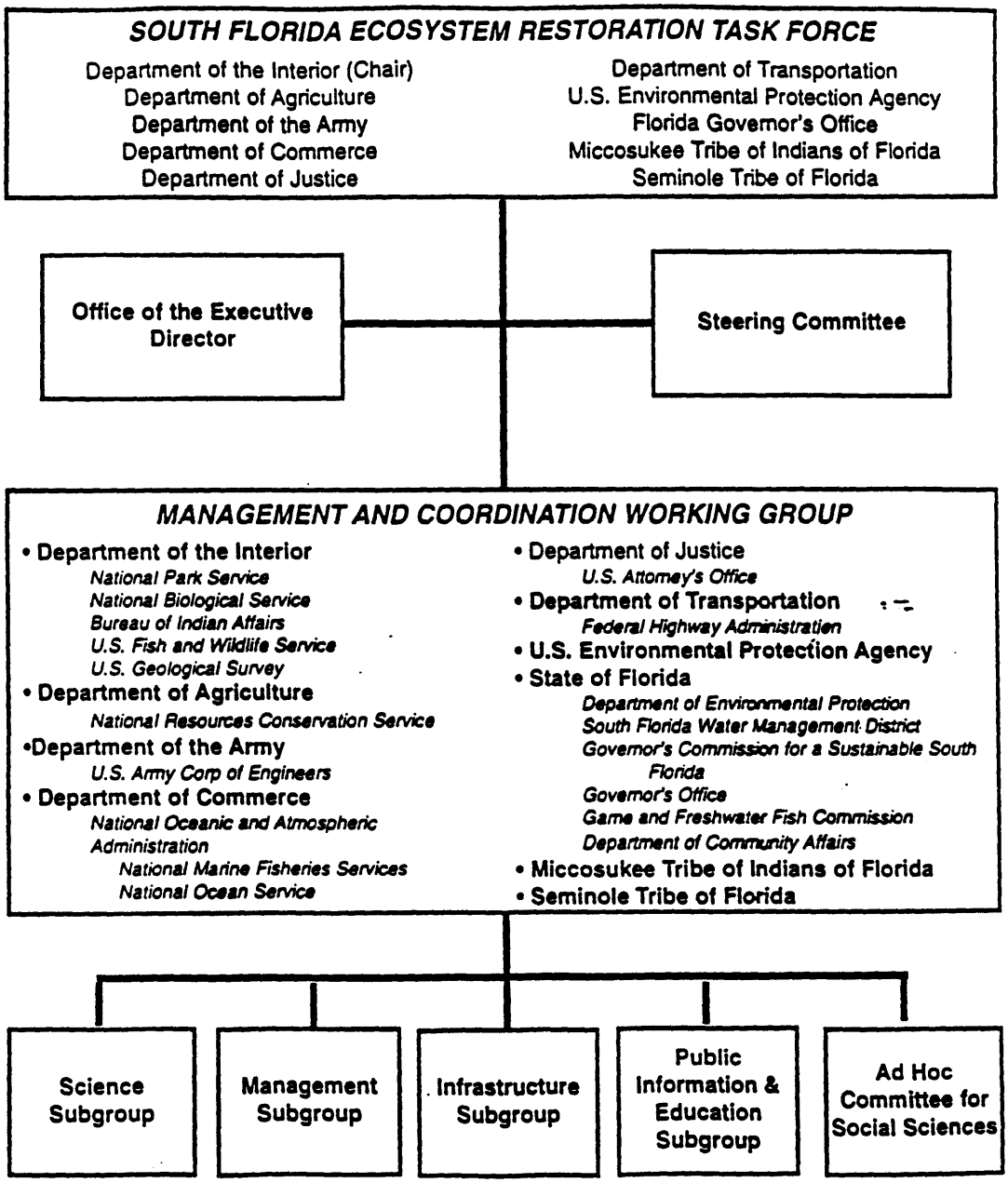


Figure 3 South Florida Ecosystem Restoration Organization

has federal, state, local, and tribal representatives, and there are also state members in the Working Group (Figure 3).

*Monitoring*

One of the priorities of the Working Group is a comprehensive, coordinated ecosystem research plan, and another is an ecosystem-based science program. Implementing these concepts is a difficult task, however, because there are several agencies involved in monitoring in South Florida. In addition to the federal agencies involved in the area, the state DEP, the South Florida Water Management District, local counties, and the area's universities all perform monitoring. Coordinating all these projects is a major undertaking. The Science Committee, one of four subgroups of the working group, is currently working on making this happen.

A manual of current programs and a spatial database are being developed in a collaboration between the NOAA, the National Biological Survey, the Florida DEP, and the South Florida Water Management District (SFWMD). A joint GIS system is also being developed through the Governor's Commission for a Sustainable South Florida. A computerized information base is being developed by the National Oceanic and Atmospheric Administration (NOAA) and the Florida Department of Environmental Protection. All these data integration projects, together with those being sponsored by other programs, help to pull together the various sources of information in South Florida.

### 4.3.3 Other Regional Programs

In addition to the South Florida Ecosystem Restoration Effort, there are a number of other collaborative programs currently taking place in south Florida.

*Lake Okeechobee*

The restoration of Lake Okeechobee is being performed through a collaboration between the South Florida Water Management District and the COE. The program is currently investigating such factors as agriculture, exotic species, and hydroregulation, and is using a model called the Water Analysis Simulation Program (WASP) to study their impact on the lake. While the project is led by the SFWMD, the COE's Waterways Experiment Station (WES), a leader in lake and watershed modeling, plays an important role.

*Kissimmee River Restoration*

The Kissimmee River Restoration (KRR) project is the largest river restoration project in the world. This project is another collaboration between the SFWMD and the COE, with the SFWMD buying the land for the project and the COE restoring it. Included in its activities is the Ecological Evaluation Program, which is studying the response of the ecosystem to restoration efforts. Using a diverse group of indicators including biological, physical, chemical, and hydrologic factors, the evaluation compares current conditions to a baseline.

*The Everglades Restoration Effort*

The Everglades restoration project, which involves many agencies on several levels, is aimed at providing a systemwide restoration of the Everglades ecosystem, with particular emphasis on the restoration of natural hydropattern and water quality. The cleanup of the Everglades was initiated by a federal lawsuit of the state over the degradation of the Everglades National Park, but participants say it has resulted in a more cooperative federal/state relationship. The framework for the restoration is laid down by the Everglades Forever Act, a

piece of state legislation requiring the DEP and the SFWMD to work together on the restoration. The South Everglades Restoration Alliance, which is coordinated by the SFWMD, involves officials from ENP, the SFWMD, the US Fish and Wildlife Service, and the COE.

The role of monitoring in this effort is mostly to track the results of the restoration effort and to provide data to be used in an adaptive management approach. Monitoring parameters include water quality and exotic species, as well as effectiveness of efforts like agricultural Best Management Practices (South Florida Water Management District). Monitoring is particularly focused on hydropattern and water quality because they are considered the basis for a healthy water ecosystem.

Another important use of monitoring data in the Everglades program is in fueling models. There are several models of the area under construction. The South Florida Water Management Model predicts the hydrologic effects of various amounts of rainfall. The Natural Systems Model provides the same kind of information for a natural Everglades system without canals, which is useful in determining the hydropattern goals of the restoration. The Everglades Management Model uses various parameters to predict changes in vegetation patterns with changes in water flow, and the Across Trophic Levels Simulation System predicts effects of different management scenarios on higher trophic levels in the system, such as fish and birds. All of these models are used in determining the best strategies for action.

*Florida Bay*

The Florida Bay restoration program started three years ago as a collaboration between several government agencies and Florida International University. The COE, NOAA, and USGS are all involved in the restoration effort, along with state agencies including the SFWMD. The various agencies involved divide up tasks and responsibilities, including monitoring, based on their available expertise and resources. In addition, they share data between programs, thus pooling their resources to provide a more complete picture of the bay.

The collaboration is partly coordinated by the Florida Bay Program Management Committee, which was mentioned by several SFWMD employees as a very successful program. In fact, some people, including those involved in the project, claim that it is possibly the most effective means of collaboration being used in the Florida Bay area. The committee, made up of representatives from all involved state and federal agencies, brought in a "Scientific Peer Review Team" to help them develop an overall monitoring plan focusing on the most important issues in the bay. The representatives are responsible for making sure their agencies' actions are in tune with this overall plan.

*Mercury in Florida Bay*

A three-agency mercury monitoring project in 1989 detected high levels of mercury in Florida Bay. This finding led to the formation of a Governor's Mercury in Fish and Wildlife Task Force. A state/federal/private consortium has spent $12-15m over five years on cleaning up mercury contamination (Florida Department of Environmental Protection mercury fact sheet).

Presently, there is little understanding, in general, of the fate and transport of mercury in the environment, much less of the specific causes of the problem in Florida. Consequently, further research and monitoring is needed before the problem can be solved. As part of this research effort the DEP measures mercury levels in the atmosphere, the SFWMD monitors the water, and the Fish and Game Department keeps track of contamination in wildlife. The USGS and the EPA are also involved in the program. All of the participants meet twice a year to share data and discuss strategies.

*Florida Keys Ecosystem Monitoring Integration Project*

The Florida Keys Ecosystem Monitoring Integration Project, led by the NOAA National Ocean Service and the DEP's Florida Marine Research Institute, is intended to provide better coordination of monitoring information for the Florida Keys. This regional project involves long-term ecological monitoring of the Florida Keys area and a database of all data related to the Keys area. Started in response to the Florida Keys National Marine Sanctuary and Protection Act's call for long-term ecological monitoring and database efforts, the program is currently working on a GIS database of all monitoring projects, current, past, and planned, in the area. The database will be used both to coordinate information and to determine the area's monitoring needs.

### 4.3.4 State Participation

The state of Florida has been highly involved in the South Florida ecosystem restoration effort since it began, despite receiving official recognition only recently. In addition, the state has its own ecosystem management program in place.

*Florida Department of Environmental Protection*

In the past few years, the DEP in Florida has been developing an innovative ecosystem strategy which will affect all its actions. This strategy, which was developed by an Ecosystem Management Working Group using input from a number of government officials and citizens, is a voluntary framework to make the DEP work better by following the principles of ecosystem management. There are four 'cornerstones' to the program: place-based management; common sense regulations; cultural change; and foundations of science,

monitoring, and other tools (Florida Department of Environmental Protection 1995). The ecosystem strategy is being implemented by an Office of Ecosystem Planning and Restoration, whose responsibilities include ecosystem monitoring and research and cooperation with other entities.

The ecosystem management program has identified 24 pilot ecosystem management areas (EMAs), all defined by ecological boundaries. Within these areas, a system of 'place based management' is being implemented. The goals of place based management include modifying management practices to reflect the findings of monitoring and evaluation and integrating efforts with local and private entities (Florida Department of Environmental Protection 1995). The USGS, the Forest Service, and the Soil Conservation Service are all involved in EMAs.

Each EMA has its own management team and working group. Each area also has a monitoring team which determines what monitoring is currently occurring, what should be happening, and how to prioritize and allocate monitoring resources in the area.

Monitoring plays a significant role in the overall ecosystem plan as well. In fact, one of five anticipated results of ecosystem management described in an early document was an "unprecedented statewide environmental resource monitoring database and network to provide accurate, up to date information on the state of the environment to decision makers at all levels of government as well as private citizens." (Florida Department of Environmental Protection 1995) Some of the foundations for ecosystem management recommended by the strategy are also related to monitoring. One of these foundations is the production of a statewide natural resources atlas to consolidate the available GIS data from the DEP, the Florida Game and Freshwater Fish Commission, Florida's five Water Management Districts, and other agencies. Others include the introduction of a statewide biological and chemical monitoring program at the EMA level and an inventory of biological, hydrologic, geological, and air resources. Goals of the program also include determining what monitoring is occurring and should be occurring,

and developing a comprehensive monitoring effort to reduce redundancy and gaps and standardize monitoring data.

The monitoring system now underway prioritizes the area's monitoring needs. When funds for monitoring become available, they are used for whatever is considered the highest priority need. In this way, the different agencies involved can make sure the most pressing needs for monitoring are addressed. Coordination of this effort occurs through a Scientific and Technical Committee which is responsible for, among other things, implementing data management and sharing and the use of GIS. Monitoring results are being used to determine the effects of management actions and modify them appropriately in an adaptive management approach.

A number of participants are involved in the collaborative monitoring approach. Cities and counties perform some water quality monitoring, while wildlife is monitored by a variety of agencies including the Florida Game & Fisheries Commissions, the federal Fish & Wildlife Service, and universities. A springs monitoring program involves the USGS as well as cities, counties, and water management districts. The DEP, in addition to performing some monitoring itself, coordinates the program and facilitates communication among these entities.

*Governor's Commission for a Sustainable South Florida*

The Governor's Commission for a Sustainable South Florida was started in 1994 by an executive order of the Governor of Florida. Its overall goal is to work toward a healthy South Florida ecosystem through a collaborative program. Its 47 members include representatives from federal, state, local, regional, tribal, public interest, business, agricultural, and urban interests. Initially, federal members were not allowed to vote, but since the modification of FACA and the introduction of state members to the federal task force, federal representatives have been allowed to participate as full members in this state commission as well.

The commission operates by pulling together different stakeholders in a consensus-based approach. Its main role is to advise the governor, who then gives input to the regional Task Force and Working Group based on that advice.

The priorities of the commission include coordinating spatial data and coordinating research with federal agencies. The commission has done research on ecosystem restoration, urban restoration, and drainage issues. Its Science and Research Advisory Committee, made up of federal, state, local, and regional scientists, has the role of coordinating research priorities of state and federal agencies in South Florida.

*The South Florida Water Management District*

In 1972, the Florida legislature divided Florida into five Water Management Districts (WMDs) based on watershed boundaries, of which the South Florida Water Management District, or SFWMD, is the largest (South Florida Water Management District 1996). The role of the WMDs is to manage water supply and quality, environmental protection and enhancement, and flood protection.

The SFWMD has been monitoring hydrological data since 1949 (when monitoring was initiated as part of the COE's Central and South Florida Project), and water quality for two decades. It controls a network of 30 stations for pesticide and toxics monitoring, 400 water quality monitoring stations, and 6-700 hydrologic stations, one of the largest monitoring networks in the world.

The District also collaborates with federal and local government agencies in its monitoring programs. For example, its pesticide and toxics monitoring stations are run in cooperation with Dade and Broward Counties. In addition, while the District does routine water quality monitoring over a wide geographic range, Dade County does the monitoring in its more developed areas and the USGS helps monitor specific areas that need closer attention. The Everglades National Park and the Indian tribes also do some of their own water quality

monitoring. The US Fish and Wildlife Service performs some wildlife and toxics monitoring. A program involving the SFWMD, the DEP, ENP and others coordinated reconnaissance flights to identify wading bird populations and other factors, with all the participating agencies involved in funding and executing the program. The SFWMD has also collaborated with the Army Corps of Engineers on the Comprehensive Review Study of the Central and South Florida Project, or Restudy. In addition, the District has interacted with the federal Task Force and Working Group.

The data collected by the SFWMD is, after a 6 month quality assurance process, incorporated into a central database called Remo, which can be remotely accessed by anyone with appropriate computer capabilities. It is used by all the federal agencies in the area. Local governments use it to determine water levels as an aid in regulation. Some environmental groups not only use the data but also augment it with their own data. The database includes all the District's basic monitoring data, and work is being done to modify it so research data can also be included. In addition, all the SFWMD monitoring stations are on a GIS, so most of the data is collected in GIS-compatible formats.

In addition to being used by the SFWMD itself, the data is also used by federal agencies. In particular, the NPS uses SFWMD data on a daily basis to update its models of the Everglades National Park (ENP). Local governments also use data on water levels to regulate their jurisdictions' withdrawal of water from aquifers. In addition, individuals, especially consultants, also draw on the data. The SFWMD also encourages open-literature publication, so that knowledge gained through the program reaches an even wider audience than just those who actively seek it.

*Florida Geographic Information Board*

Started in 1985, the Florida Geographic Information Board (FGIB) and Growth Management Data Network Coordinating Council are part of a voluntary program that attempts

to coordinate the efforts of all Florida-based agencies and programs with regard to geographically-based data. The board consists of policy-level representatives of various agencies, including the Water Management Districts, state, county, and city governments, while the technical advisory council identifies issues to be addressed by the board. The basic idea is to provide a structure for communication between agencies, in order to avoid overlap and gaps, and to collaborate when possible. For example, the program has aided agencies in pooling their resources for such capital-intensive programs as satellite imagery and aerial photography. This kind of collaboration may be saving the agencies involved as much as $14 million.

One of the long-term goals of the FGIB is to produce an integrated GIS of spatial data for the state. This database, which is currently being tested, would be a distributed system, based on the World Wide Web, with data stewards from each agency coordinating data in their area of expertise. The database would use an automated library system which can collect metadata from participants and catalogue it.

The FGIB works with the Federal Geographic Data Committee (FGDC) on data standards, and is one of several state cooperating groups which have been officially affiliated with the FGDC's National Spatial Data Infrastructure effort.

### 4.3.5 Local roles and programs

As mentioned in earlier sections, county and city governments play a role in water quality monitoring programs in Florida, as well as being users of data produced by federal and state agencies. Local governments are also involved in more direct ways with restoration efforts.

The South Florida Water Management District works closely with local governments through its Planning Department. Because the Everglades and Florida Bay restorations involve

the acquisition of considerable amounts of land in South Florida, local government support can be very helpful. Local governments assist in the preservation effort by holding off changes in development or use of land until the agencies can acquire it. Dade, Broward, and Palm Beach Counties are especially essential in this respect, since critical areas are within those counties. As part of the collaboration, the counties also participate in the decision of what land the SFWMD should purchase. The SFWMD is always trying to encourage more local participation in this effort.

The Governor's Commission for a Sustainable South Florida is also working with local governments in the urban areas of southern Florida as part of its Eastward Ho! program. This program's goal is to encourage the rebuilding of the eastern, urban areas to prevent urban sprawl to the west of the cities.

# 5 Implementation Issues

## *5.1 Defining Ecosystem Management*

An agency's practice of ecosystem management is highly influenced by its definition of ecosystem management and understanding of how it applies to the agency's mission. Therefore the first couple of questions interviewees were asked concerned how they defined ecosystem management and how it was being used in their agency.

While people's concepts of ecosystem management varied somewhat, there were several key points which showed up in most or all of the definitions. The most prevalent point was that ecosystem management takes a holistic view, considering all the parts of an ecosystem and the interactions between those parts. Participants talked about looking at the whole system, considering interactions between species and their environment, going beyond management of a single part of the landscape, aiming management towards all physical, chemical, and biological characteristics, and taking a broad view. The word 'holistic' was actually used by four of the sixteen people interviewed.

Because many of the people and programs considered were water-focused, the term 'watershed management' was used by several interviewees to describe their agencies' versions of ecosystem management. This emphasis on natural boundaries also appeared in a more general sense, as in one participant's description of ecosystem management as the "management of natural environmental units."

The focus on natural environmental systems was also apparent in the goals of a number of ecosystem management programs. Program goals included maintaining natural biological communities and managing land in a sustainable manner. Several interviewees spoke of their role as specifically involving stopping damage to, protecting, or enhancing the natural system.

Monitoring and the use of science were mentioned by some participants as important tools to achieving this kind of protection and preservation. One interviewee included in his definition the use of sound ecological principles for long-term planning, and another talked of the scientific challenge of understanding the ecosystem.

Going beyond the scientific aspect of ecosystem management, several people's definitions also specifically addressed agency roles. A particular theme that appeared was the involvement of a number of agencies and levels of government. One interviewee said that ecosystem management involves using a combination of federal, state, and local priorities, while another talked of trying to solve a problem across political boundaries.

There was a good deal of variety among the definitions of ecosystem management offered, most notably that different participants focused on different aspects of ecosystem management depending on their experience with it. However, the key concept of holistic management runs through all the definitions, and all the ecosystem management attributes mentioned in the theoretical are included in some form or another. Clearly there is some consensus as to what ecosystem management means.

## *5.2 Implementing Ecosystem Management*

Nearly all participants answered yes when asked if their agency or program was trying to use an ecosystem management approach, but most were also quick to note that they had not quite fully attained ecosystem management yet. People felt that their agencies were heading in the direction of ecosystem management and learning as they went along. Several said that

ecosystem management was currently being practiced imperfectly and could be done better. Even those who did not feel that their agencies were currently using an ecosystem approach saw the use of such an approach as one of the agency's goals.

The ways ecosystem management was being used varied from region to region, but all the practices followed from the general concepts of ecosystem management. As in the definitions of ecosystem management, the idea of looking at the whole system also appeared frequently in descriptions of current practice. The geographic organization of programs, the use of multi-media approaches, and the involvement of a number of agencies and other stakeholders were all presented as evidence of the presence of an ecosystem approach.

Geographically, ideas such as place-based management and the use of watershed districts were brought up by participants as examples of how ecosystem management was being used in their regions. Participants from some projects spoke of agencies or programs based on regional or natural boundaries as foundations for an ecosystem approach.

A multi-media, multi-issue approach was also mentioned by several people as being a part of the implementation of ecosystem management in their agencies. Several participants mentioned trying to include a variety of ecosystem health factors in their analysis and management. Others talked of trying to go beyond a programmatic or project-by-project nature, and of trying to get away from being focused on a single issue such as endangered species. Some agencies were still focused on whatever characteristic was the initial basis of the project or agency, but even these agencies were considering how other factors interacted with the one they were concerned with.

In addition to being inclusive of a number of scientific issues, programs were also inclusive of a variety of players or stakeholders. Some agencies worked with other agencies, both at the same level of government and at other levels. Others included stakeholders such as businesses, the public, and environmental groups. The general theme that appeared, however, was collaboration between a number of interests.

## 5.3 Using Monitoring

In addition to discussing the general use of ecosystem management in their projects, participants were asked to describe how monitoring was used as a tool for ecosystem management. Several themes emerged, related to both what was monitored and what purpose the monitoring served.

One main distinguishing characteristic of monitoring for ecosystem management was the broad variety of factors monitored. In addition to traditional monitoring values such as water and air quality, factors such as biological health and habitat were being considered. Attempts were being made within several programs to evaluate the overall health of the ecosystem by looking at a variety of factors.

In addition to the types of monitoring used in their ecosystem management programs, several participants also emphasized how monitoring information was used. One of the primary uses of monitoring and research within ecosystem management programs was to learn about the ecosystem and about ecosystem management. Several programs were using monitoring to understand the problem they were facing and to define critical areas of impairment. Taking into consideration the interactions between different factors required the acquisition of basic information because so little was known about those interactions. This was also true for certain species and other elements that were previously not given much attention.

Monitoring, in addition to being used to fuel a basic understanding of the ecosystem, was also used throughout the management process in several projects. Research was conducted by some programs to learn about the ecosystem management approach itself and how it could best be used. In several programs, monitoring data was used to determine the success of management techniques, and whether progress was being made towards the original goal. This evaluation was then used to decide what to do next. The plan could be continued as it was, stopped, or changed based on the new information. One participant said that, because of

this adaptive management process, monitoring was the essential ingredient in his agency's ecosystem management project.

## *5.4 Barriers to Implementation*

### 5.4.1 Time and Money

When people were asked what the barriers were to implementation of ecosystem management in their agency, several common factors came up. Most people brought up issues concerning time and money. At least ten of the sixteen interviewees specifically mentioned such problems.

While the biggest complaint about money was that there was not enough of it, some more specific budgetary issues were also mentioned. For example, one person saw line item funding as a barrier because funds could not be changed from one area to another, a policy which made it difficult to manage multi-disciplinary ecosystem management projects. Another complained that a limited budget made it necessary to prioritize issues, but it was difficult to decide what the priorities should be because of the lack of general understanding of the ecosystem.

As with money, the major complaint regarding time was the lack of it. One of the other time issues mentioned was that people had expectations of short-term results, so it was difficult to find money for a long-term investment like ecosystem management. A couple of people also brought up the fact that a lot of time was needed to change people's mindsets and get everyone to believe in the project, making the process of starting up a program slow.

### 5.4.2 The Need to Change Attitudes and Mindsets

The need for cultural change appeared as an issue both within agencies and between different players. Changing people's attitudes and mindsets turned out to be both time consuming, as mentioned above, and difficult.

Within the agencies trying to implement an ecosystem approach, the need to coordinate various media or issues formed a barrier. The traditional method of operation for most agencies involved addressing one issue at a time. This paradigm existed in everything from mandates to funding to people's individual mindsets. Consequently, a major paradigm shift was required to implement a coordinated program. One person even considered getting employees to look at the whole ecosystem to be the main barrier to ecosystem management.

As a result of this difficulty, some programs which were attempting to use an ecosystem management approach were actually only considering those factors directly related to a particular species or issue. This is not a true ecosystem approach. However, as one person said, it may not be necessary to combine all aspects of the ecosystem, but may be sufficient to focus on one issue while keeping others in mind.

Getting past traditional mindsets to be more inclusive became even more difficult when the ecosystem management project involved collaboration between a number of agencies. Several different agency jurisdictions may be included in any one ecosystem, and the objectives of those agencies may not be the same. The historical pattern of interagency relationships played a role in this in some cases, because of the difficulty of coordinating the efforts of agencies and individuals that previously were not on good terms. Particular problems mentioned included dealing with the different terminology used by different players, finding common ground, and agreeing on a goal.

### 5.4.3 Dealing with Complicated Issues

Implementing ecosystem management involves dealing with a number of complicated issues. Participants found that this made implementation difficult , with the newness of the approach and its comprehensiveness having particularly strong effects.

One difficulty found with using such a new approach was that there was not always agreement on the meaning of the term 'ecosystem management.' Two people said their agencies encountered problems because it was unclear what ecosystem management was. This lack of a clear definition led to controversy and even caused some stakeholders to fear the idea of ecosystem management.

In most cases, however, difficulty was found to result from the comprehensive nature of the ecosystem management approach. One source of problems was the consideration of human factors. A key ingredient in ecosystem management is full recognition of role of people in the ecosystem. When applied, this departure from past management styles was a source of difficulty for several interviewees' agencies. Incorporating social and political issues into environmental management was found to be a major challenge, especially since many of the people involved in such projects were scientists without any background dealing with such issues.

The most common problem encountered having to do with the complicated nature of the approach, however, was a lack of scientific understanding. Considering everything that affects an ecosystem involves tracking a large number of factors and interactions, and several agencies found that they lacked knowledge of many of these. One person even felt that, in dealing with larger and larger systems, eventually a level of complexity was reached that exceeded people's capacity of understanding.

### 5.4.4 Monitoring Barriers

In interviewees' descriptions of monitoring practices it became apparent that a number of barriers were encountered specifically related to monitoring. These barriers generally paralleled the more general ones. For example, the key monitoring barrier mentioned by several people was the lack of money and resources to support a comprehensive monitoring program.

Another problem was a lack of scientific understanding. Because monitoring had previously had a regulatory or single-issue focus, the existing monitoring methods did not provide the information or understanding needed to determine priorities for ecosystem monitoring. Consequently, it was difficult to determine how best to monitor ecosystem health.

## *5.5 Elements Leading to Success*

Interviewees were also asked to describe what elements contributed to the ecosystem management program's success. Key factors included recognition of the validity of the concept and involvement of a number of parties.

### 5.5.1 Recognition

Probably the most basic ingredient for success mentioned by participants was a basic recognition of the need to look at whole ecosystems. Several people spoke of the need for understanding, within the agency, of the benefits of a broad approach. Another closely related factor was willingness of agency personnel to move toward ecosystem management.

In several cases, the move to a broader emphasis was facilitated by key staff people. Success was often attributed, at least in part, to a few good people who understood and were committed to the idea of ecosystem management.

Also considered important in several programs was higher-level recognition. "Commitment at the highest level" was mentioned by several people, and included support from figures such as the agency director, the governor, or the federal government.

The importance of the recent national focus on ecosystem management was also apparent, with both federal policies and federal laws being recognized as important sources of support. Examples of helpful measures included the Endangered Species Act, the National Environmental Policy Act, and the EPA's watershed protection approach. Federal involvement not only made people take notice of the idea but also, through successful pilot programs, provided evidence that ecosystem management really could work.

Showing that the approach could work was also mentioned as a method that could be used within an agency. One participant found that showing people results caused them to buy into the idea, and that this was especially effective with business stakeholders. In another agency, a pilot effort was found to be very useful in learning about the process of ecosystem management. Yet another agency built credibility by building on what was learned as ecosystem management progressed.

### 5.5.2 Communication and Involvement

The other main theme among success factors was communication with and involvement of various participants. Good communication within the agency, between agencies, and with the public and other stakeholders was considered very important.

Within an agency or project, communication between people in different disciplines was essential in taking a holistic approach. For example, one regional program was considered helpful because it brought people from different disciplines together.

Likewise, communication between agencies in a region was also considered important. Efforts to collaborate across jurisdictions and involve other agencies and other levels of government were mentioned as beneficial to success. Inter-state, state-federal, and state-local partnerships were also lauded by participants. One practical benefit of better communications between agencies was that the agencies could work more efficiently and get more out of their funding by leveraging their resources on common issues.

In addition to the involvement of different government entities, the involvement of other stakeholders was also deemed essential in several programs. Activism on the part of conservation organizations and citizens committees was helpful in pushing progress along and holding the agency accountable to its intentions. Educating and involving the public were also considered important steps. One participant said that involving people in decisions and having voluntary programs gave them a sense of ownership in the program and helped the agency avoid later conflicts.

## *5.6 Advice to Those Starting Ecosystem Management Programs*

The last question the interviewees were asked was what advice they would give to someone who was trying to start an ecosystem management program. As with the other questions, several key themes emerged. Most of the advice built on the experiences mentioned earlier in the interviews, offering practical guidance on how to learn from the lessons of existing programs.

### 5.6.1 Start Out Small

At least five people stressed the importance of not taking on too much at once. Trying to start off with a large ecosystem all at once, according to these people, is too much to deal with. Rather, it was suggested to break the region down into small areas such as watersheds or communities or to start with a pilot program. It was emphasized that the initial goals must be kept small enough to be accomplished with the available staff and resources to avoid frustration. As one interviewee put it, "Don't try to save the world all at once."

### 5.6.2 Develop Clear Objectives

The need to have clear objectives, developed by consensus, was also emphasized. The reasons given for this included the lack of understanding of what ecosystem management is and the tendency for different stakeholders to have different priorities. Thus, several people recommended that the first step should be to develop a set of common goals, taking into account the different priorities of different stakeholders in the area. One person also recommended signing a memorandum of agreement giving one entity the responsibility of overseeing the program, to avoid turf battles later in the process.

### 5.6.3 Have A Solid Scientific Basis

Several people also emphasized the importance of the scientific basis of the program. Good science and monitoring and current information were stressed as important parts of a successful program. Also emphasized was good management of available information to make it both available to and usable by the various stakeholders in the area.

### 5.6.4 Involve Everyone

As in the descriptions of success factors, the importance of involving all agencies and stakeholders was emphasized. One participant said "it takes getting everyone involved" to have a successful ecosystem management program. Thus, involving people from different disciplines, from different agencies, and even from non-government entities was considered essential.

The use of a multidisciplinary team was suggested as a way to involve all disciplines. More generally, it was suggested that a broad approach be taken, and that a strong base of support be developed within the agency.

Interagency relations were also mentioned, with suggestions to work on developing coordinative relationships with other agencies and to be proactive in outreach efforts to other agencies. Coordination was also endorsed by one participant as a way to leverage resources.

A large number of recommendations were made regarding involvement of the public. It was recommended by one interviewee that a conscientious effort be made to reach out to different constituent groups and get the public involved. The use of volunteer and citizen monitoring was encouraged by a couple of people. Another person talked about the importance of having people with good people skills to run meetings and perform outreach.

### 5.6.5 Be Patient

One final piece of advice offered by several interviewees was to be patient. As one person said, impatience in a slow-moving process such as starting an ecosystem management program leads to disappointment. It takes a lot of time and energy to get everyone involved and get a comprehensive project off the ground. Several people emphasized the need to be "in it for the long haul," because there are no short-term answers and a commitment must be made

to the long term to have an effect. One interviewee's main piece of advice was, "You need three attributes to do this: patience, persistence, and a really good sense of humor."

# 6 Conclusion

While the concept of ecosystem management has been around for decades, it has come into widespread implementation only recently. Within the past few years, a large number of ecosystem-based programs have been appearing the United States. A few of the larger and longer-lived ones are the Chesapeake Bay Program, the South Florida restoration effort, and the several regional programs taking place in the Pacific Northwest.

Many lessons have been learned by the participants in these programs. Their experiences offer insight into scientific, political, and procedural issues affecting the implementation of ecosystem-based programs. What has been learned in these programs can be applied to the establishment and improvement of ecosystem management programs in the future.

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