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Report to Subcommittee on Interior and Related Agencies, Committee on Appropriations, House of Representatives

March 2003

# SOUTH FLORIDA ECOSYSTEM RESTORATION

## Task Force Needs to Improve Science Coordination to Increase the Likelihood of Success

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GAO-03-345

March 2003

# SOUTH FLORIDA ECOSYSTEM RESTORATION

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**Highlights**

Highlights of GAO-03-345, a report to the Chairman and Ranking Minority Member, Subcommittee on Interior and Related Agencies, Appropriations Committee, House of Representatives

### Why GAO Did This Study

Restoration of the South Florida ecosystem is a significant federal and state priority, requiring the development and use of extensive scientific information. GAO was asked to report on the funds spent on scientific activities for restoration, the gaps that exist in scientific information, and the extent to which scientific activities are being coordinated.

### What GAO Recommends

In order to improve the coordination of scientific activities for the South Florida ecosystem restoration initiative, we recommend that the Secretary of the Interior, as chair of the South Florida Ecosystem Restoration Task Force (Task Force), clarify the plans and documents the Science Coordination Team (SCT) needs to complete and the time frames for completing them, as well as evaluate the SCT's staff resources and allocate sufficient staff to carry out its responsibilities. We are also making recommendations to improve working relations between the Task Force and the SCT.

In commenting on the draft report, the Department of the Interior agreed with the premises of our report that scientific activities need to be coordinated better and that the SCT's role needs to be clarified. Interior said that ultimately the Task Force needs to review and approve actions on GAO's recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-03-345.

To view the full report, including the scope and methodology, click on the link above. For more information, contact Barry Hill at (202) 512-3841.

### What GAO Found

From fiscal years 1993 through 2002, federal and state agencies spent $576 million to conduct mission-related scientific research, monitoring, and assessment in support of the restoration of the South Florida ecosystem. Eight federal agencies spent a little less than half of this amount, or $273 million. The South Florida Water Management District—the state agency most heavily involved in the restoration initiative—spent $303 million. With this federal and state funding, agencies made progress in developing information and the adaptive management tools necessary for restoration purposes. "Adaptive management" is an approach for improving resource management that uses models and monitoring as tools to improve the probability of achieving restoration goals. In particular, scientists state that they identified the key factors responsible for ecosystem degradation, such as altered water flow patterns throughout the ecosystem.

While scientific understanding of these restoration issues has improved, significant gaps remain in the scientific information and adaptive management tools needed, that, if not addressed soon, will hinder the success of restoration. Gaps in the development of scientific information, such as information on the risks of contaminants to plants and animals in the ecosystem, may prevent action to address risks to the entire ecosystem or to one or more of its regions. Gaps are also present in the development of adaptive management tools—such as models and a comprehensive monitoring plan based on key indicators—that allow scientists to assess how the implementation of restoration projects and plans affect the ecosystem and whether this implementation is resulting in successful restoration. The development of these tools is important to allow scientists to track the progress of restoration.

Restoration of the South Florida ecosystem is being coordinated and facilitated by the Task Force, formed from participating federal, state, and local agencies and tribal entities. The Task Force is responsible for coordinating scientific activities for restoration, but has yet to establish an effective means of doing so, thereby limiting the extent to which restoration decisions can be based on sound scientific information. The Task Force established the SCT to coordinate the science activities of the many agencies involved in restoration, but it did not give the SCT clear direction on which of the responsibilities were a priority for supporting the Task Force, contributing to the SCT's inability to accomplish several of its most important tasks. Further, unlike other restoration initiatives, the SCT works as a voluntary group with no full-time and few part-time staff. Recognizing its resource limitations, the SCT has focused on a few priority responsibilities. Without first clarifying the responsibilities of the SCT and then providing it sufficient resources to accomplish these responsibilities, the Task Force cannot ensure that scientific activities are being adequately coordinated, or that key scientific information is available for restoration decisions.

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## Abbreviations

| | |
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| CESI | Critical Ecosystem Studies Initiative |
| CROGEE | Committee on Restoration of the Greater Everglades Ecosystem |
| RECOVER | Restoration Coordination and Verification |
| SCT | Science Coordination Team |
| STAR | Science to Achieve Results |
| WRDA | Water Resources Development Act |

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**United States General Accounting Office**
**Washington, D.C. 20548**

March 18, 2003

The Honorable Charles H. Taylor
Chairman
The Honorable Norman Dicks
Ranking Minority Member
Subcommittee on Interior and Related Agencies
Committee on Appropriations
House of Representatives

South Florida, famous for the vast expanse of the Everglades wetlands, is an 18,000 square mile (about 11.5 million acre) area that includes a broad range of natural habitats, 6.5 million people, and significant tourist, agricultural, and other industries. Development of the state's varied natural resources has spurred the growth of South Florida's population and economy, but at the same time, caused the deterioration of its ecosystem and its natural areas. Restoration of the South Florida ecosystem has been a significant federal and state priority throughout the 1990s and into the new century. While efforts to restore parts of the ecosystem began earlier, the Water Resources Development Act (WRDA) of 1996 formally established the South Florida Ecosystem Restoration Task Force (Task Force) to coordinate and facilitate the efforts of the many federal, state, and local agencies and tribes participating in restoration projects.[1] The Task Force—with the assistance of a working group formed of managers from federal, state, local, and tribal entities in South Florida—has identified the need to achieve three overall goals—improving water, improving habitat, and making development compatible with the ecosystem—to help achieve restoration. They have also identified over 200 restoration projects designed to help restore the ecosystem. It will take as long as 50 years and as much as $15 billion to complete the many related restoration projects—the ecological effects of which may not be known until many years thereafter.

Because of the long-term nature and complexity of the initiative, the Task Force has identified key guiding principles for managing the restoration initiative and its many related projects. One of these principles is that decisions about restoration projects and plans will be based on

[1]Fifteen federal agencies are involved in restoration; 10 of them fall under 5 departments. Two Native American tribes, 7 Florida agencies or commissions, 16 counties, and scores of municipal governments are involved in the effort as well.

sound scientific information. Scientific information is an umbrella term that includes the results of research and monitoring to identify how and why the ecosystem has been damaged, as well as assessments that integrate available research and monitoring results to help restoration managers make decisions about what actions should be taken to help restore the ecosystem. The Task Force has also adopted a process called "adaptive management"—an iterative approach for improving resource management that recognizes that because scientific information is imperfect and, as decisions are implemented based upon best available science, a structure must be in place to acquire better information and adjust the implemented actions accordingly to improve the probability of achieving the goals of restoration. Such a process requires the development of key tools—such as models, continued research, and monitoring—to provide a baseline and periodically track and assess ecosystem health to provide managers with updated information on the effects of management actions designed to achieve restoration. By participating in and providing information for restoration efforts, scientists can help define and measure the progress of restoration and the success of individual restoration projects and plans.

To help coordinate the science needed for the restoration initiative, the Task Force established a Science Coordination Team (SCT) in 1997.[2] It gave the team responsibility for recommending research plans and priorities and to facilitate the integration, synthesis, and application of the best available scientific information for restoration. The SCT is comprised of at least 14 members: 7 members of the South Florida Ecosystem Restoration Working Group (Working Group) and 7 scientists from key agencies participating in the restoration effort. In addition, Working Group members can nominate additional members to the SCT.

In this context, you asked us to (1) identify the source and amount of federal and state funding for scientific activities, the purpose of these activities, and progress made in gaining scientific information for the restoration; (2) determine the extent to which gaps exist in key scientific information and the adaptive management tools needed for restoration; and (3) assess the process used to coordinate scientific activities and information central to restoration.

[2]In 1993, the Task Force formed a Science Subgroup; this team was subsequently reformed as the Science Coordination Team and given a charter with a broad range of responsibilities.

Among the efforts undertaken to respond to these objectives, GAO gathered and analyzed funding data for 1993 through 2002 from federal agencies that conduct scientific activities in South Florida and the state's South Florida Water Management District (District). Because the agencies do not routinely track data by category of science activity, agency officials provided their best estimates of the funds spent in specific science categories. Throughout this report, unless otherwise noted, all years are fiscal years, rather than calendar years.[3] GAO also analyzed documents related to 10 key restoration projects and plans. The projects and plans were selected based on their cost (the majority could cost over $100 million), the diversity and extent of geographic areas they affect, and the status of their implementation. Because the projects are a subset of the more than 200 restoration projects, the analysis is not meant to be generalized to the remaining projects. GAO further analyzed the SCT charter and other documents and examined other similar restoration efforts, such as the effort to restore natural areas around San Francisco Bay in California and Chesapeake Bay. GAO's scope and methodology is more fully discussed in appendix I.

## Results in Brief

From 1993 through 2002, federal and state agencies spent $576 million to conduct mission-related scientific research, monitoring, and assessment in support of the restoration of the South Florida ecosystem. Eight federal agencies spent a little less than half of this amount, or $273 million. The Department of the Interior, the largest federal participant, spent about $139 million, the majority of which it directed toward research, such as studying how federal lands would be affected by changing water levels. The South Florida Water Management District—the state agency most heavily involved in the restoration initiative—spent $303 million. One major focus of the District's work has been Everglades and Florida Bay research, including efforts to develop different techniques to improve water quality in the ecosystem. With this federal and state funding, agencies have made progress in developing information and the adaptive management tools necessary for restoration purposes. In particular, scientists state that they have identified the key factors responsible for ecosystem degradation, such as altered water flow patterns throughout the ecosystem. For example, using systemwide models, scientists have a better understanding of the

[3]Throughout this report, unless otherwise noted, dollars have been adjusted to fiscal year 2002 dollars. Further, the fiscal year for federal agencies and the South Florida Water Management District runs from October through September.

amount and distribution of water in the ecosystem both before and after it was altered by drainage. From this information, scientists have been better able to evaluate alternatives for managing the water in the ecosystem and have identified actions that can be taken to restore the amounts and distribution of water to more closely reflect natural conditions.

While scientific understanding of these restoration issues has improved, significant gaps remain in the scientific information and adaptive management tools needed for restoration, that, if not addressed soon, will hinder the success of restoration. The gaps in the development of scientific information may prevent action to address risks to the entire ecosystem or to one or more of its regions. One such gap is the lack of information regarding the amount and risk of contaminants, such as fertilizers and pesticides, in water throughout the entire ecosystem. If this information is not available, scientists cannot determine whether fish and other organisms are being harmed by these contaminants or whether the redistribution of water will introduce potentially harmful contaminants to parts of the ecosystem that are relatively undisturbed. Lacking this information, scientists and managers do not know whether they are constructing a specific restoration project that could increase the harm to plants and animals that live in the ecosystem. Gaps are also present in the adaptive management tools—such as models and a comprehensive monitoring plan based on key indicators—that allow scientists to assess how the implementation of restoration projects and plans affect the ecosystem and whether this implementation is resulting in successful restoration. The development of these tools for the adaptive management approach is important to allow scientists to track the progress or success of restoration and identify when changes are needed in restoration projects and plans to ensure that restoration goals are achieved.

The Task Force is responsible for coordinating scientific activities for restoration, but has yet to establish an effective means of doing so, thereby limiting the extent to which restoration decisions can be based on sound scientific information. The Task Force established the SCT in 1997 to coordinate the science activities of the many agencies involved in restoration. The Task Force charged the SCT with a variety of responsibilities, such as identifying gaps, recommending research plans and priorities to fill those gaps, ensuring the development of monitoring plans, and synthesizing scientific information for the Task Force. Best practices for effective coordination and management require the development of plans within specific time frames; however, since the creation of the SCT nearly 6 years ago, the Task Force has not yet specified

the requirements for the plans the SCT is expected to produce. Task Force officials indicated they were focused on getting approval of a key plan to improve water amounts and distribution in the ecosystem. Furthermore, unlike other restoration initiatives, the SCT works essentially as a voluntary group with no full-time and few part-time staff. Recognizing its resource limitations, the SCT has focused on a few priority responsibilities, such as sponsoring science conferences on restoration topics, and has set aside other important responsibilities, including development of a science plan and a comprehensive monitoring plan. In 2000, the SCT reported to the Task Force that it could not carry out all of its broad responsibilities given its limited resources. After nearly 3 years, the Task Force has not yet fully addressed the SCT's concerns. Without first clarifying the responsibilities of the SCT and then providing it sufficient resources to accomplish these responsibilities, the Task Force cannot ensure that scientific activities are adequately coordinated or that key scientific information is available for restoration decisions.

Because multiple federal and state agencies are involved in scientific activities for restoration and scientific information and adaptive management tools are critical to inform decision making for South Florida restoration, we are recommending that the Secretary of the Interior, as chair of the South Florida Ecosystem Restoration Task Force, clarify the broad responsibilities of the SCT. In addition, we are recommending that once SCT responsibilities are clarified, the Task Force and Working Group should evaluate the SCT's staffing needs, ensuring that the SCT has sufficient resources to carry out its responsibilities.

In responding to a draft of our report, the Secretary of the Interior—who acts as chair of the Task Force—agreed with the premises of our report that scientific information needs to be coordinated better and that the SCT's responsibilities need to be clarified. The Secretary stated that action on the specific recommendations that we made ultimately needed to be discussed and agreed to by the members of the Task Force. The Secretary agreed to bring these recommendations up for discussion at the next meeting of the Task Force.

## Background

The South Florida ecosystem is an 18,000 square-mile area extending from the Chain of Lakes and the Kissimmee River through Lake Okeechobee to the coastal areas of the Caloosahatchee and St. Lucie rivers, Florida Bay, Biscayne Bay, and the Florida Keys. Included in this area are the Everglades, Big Cypress National Preserve, and the only living coral reef in North America. Before human intervention, freshwater flowed south from Lake Okeechobee to Florida Bay in a broad, slow-moving sheet. The quantity and timing of the water's flow depended on rainfall patterns and on slow releases of water stored naturally in the ecosystem. Even during dry seasons, water stored throughout the ecosystem supplied water to the wetlands and coastal areas. Although these lands were—and still are—largely sustained by water and contain a mix of wetland vegetation, they also include important dry land areas called uplands with woody vegetation. Before it was altered by development, the ecosystem provided habitat for many species of wading birds and other wildlife, including Woodstorks, Roseate spoonbills, manatees, the American crocodile, and the American alligator—all of which depended on the natural pattern of water flow. Dry lands provided habitat for many other types of species, including bald eagles, indigo snakes, and the Key deer and rabbit.

The South Florida ecosystem is also home to 6.5 million people and supports a large economy of agriculture, tourism, and industry. South Florida's wetlands were first developed for agriculture and industry in the late 1800s, but more extensive efforts were required to store water for severe droughts, such as those that occurred in the 1930s, and to protect the area from drenching hurricanes, such as those that occurred in the late 1940s. In 1948, Congress authorized the U.S. Army Corps of Engineers to build the Central and Southern Florida Project—a system of more than 1,700 miles of canals and levees and 16 major pump stations—to prevent flooding and intrusion of saltwater into freshwater aquifers on the Atlantic coast. The project, which was constructed mostly in the 1950s and 1960s, reduced the natural north-south flow of water in the ecosystem and created an east-west flow to support agricultural and urban development. The engineering changes that resulted from the project and subsequent agricultural, industrial, and urban development reduced the Everglades ecosystem to about half its original size, causing detrimental effects to wildlife habitats and water quality. The loss of habitats has caused sharp declines in native plant and animal populations, placing many native species at risk. Figure 1 shows the historic and current flows of the Everglades ecosystem as well as the proposed restored flow.

**Figure 1: The Everglades—Past, Present, and Future**

Location of the restoration initiative

**Past flow**

In the past, water flowed in a broad sheet south from Lake Okeechobee to Florida Bay and the Gulf of Mexico. Water also crossed the coastal ridge to Biscayne Bay.

**Present flow**

Canals of the Central and Southern Florida project drain to the east and west coasts. Water in these canals does not drain to Florida Bay, and thus the bay has reduced water flows.

**Future flow**

In the future, water will be stored and sent south and southwest to South Florida's remaining natural areas.

Source: South Florida Water Management District.

Beginning in the late 1980s, the federal government began a series of actions to restore the South Florida ecosystem. In the Water Resources Development Act of 1992, Congress directed the Corps of Engineers to review various reports on the Central and Southern Florida Project to determine whether the project could be changed to improve the South Florida ecosystem. In 1993, to coordinate the Corps' effort and the input of other federal agencies that had an interest in the review, the federal agencies participating in the restoration established a South Florida Ecosystem Restoration Task Force. Congress formally created this Task Force in the WRDA of 1996, which also expanded it to include state, local, and tribal members and designated the Secretary of the Interior as the group's chair. One of the duties of the Task Force is to develop consistent policies, strategies, plans, priorities, and actions for restoring the South Florida ecosystem. Finally, the Corps' review resulted in the Comprehensive Everglades Restoration Plan, which Congress approved as a plan for restoration in the WRDA of 2000. As shown in figure 1, the plan will attempt to reverse much of the flow of water back to a more historic north-south pattern.

The Task Force established the following three overall goals for achieving restoration:

- *Get the water right:* restore more natural hydrologic functions to the ecosystem while providing adequate water supplies and flood control. The goal is to deliver the right amount of water, of the right quality, to the right places at the right times.

- *Restore, protect, and preserve the natural system:* restore lost and altered habitats and change current land use patterns. Growth and development have displaced and disconnected natural habitats. In addition, the spread of invasive species have caused sharp declines in native plant and animal populations. Currently, 69 native plant and animal species, which are native to the ecosystem, have been federally listed as threatened or endangered.[4]

[4]Sixty-eight of these species were listed by the Fish and Wildlife Service and one was listed by the National Oceanic and Atmospheric Administration.

- *Foster the compatibility of the built and natural systems:* find development patterns that are complementary to ecosystem restoration and with a restored natural system. The goal is to achieve (1) development practices that limit habitat fragmentation and support conservation; (2) flood-protection and water supplies that are maintained at current levels (and may be augmented); (3) quality of life that includes clean air and water suitable for fishing, drinking, and swimming; (4) land planning and other planning that enhances and preserves the natural system; and (5) agricultural and urban practices that do not damage the ecosystem by improper disposal of wastewater.

These three overall goals are expected to be accomplished as a result of implementation of over 200 different projects and plans that, collectively, the Task Force believes will restore the ecosystem to conditions as close as possible to those that existed prior to the construction of the Central and Southern Florida Project.[5] While some of these 200 projects and plans have been initiated, many more projects and plans are just beginning to be implemented. For example, the first goal, getting the water right, will be accomplished in part by the construction of 55 projects that will modify the Central and Southern Florida Project to enlarge the region's freshwater supply and to improve the delivery of water to natural areas.[6] Ten of the projects and several pilot projects, which were authorized in the WRDA of 2000, are now in the planning stages. In addition, the Corps and the State of Florida are developing a Comprehensive Integrated Water Quality Feasibility Study to identify ongoing water quality efforts and to identify actions that will be needed to improve water quality for restoration purposes.

The second restoration goal—restoring, protecting, and preserving the natural system—will be accomplished through restoring natural hydropatterns and through the implementation of the Fish and Wildlife Service's South Florida Multi-Species Recovery Plan (a plan to help restore habitats and species); land acquisition plans by federal, state, and local

[5]The irreversible physical changes made to the ecosystem make restoration to pristine conditions impossible. The restored Everglades will be smaller and somewhat differently arranged than the historic ecosystem.

[6]The original number of components in the Comprehensive Everglades Restoration Plan was 68; the Corps and the District have reorganized the components to group those that are logically connected. For example, components around Lake Okeechobee have been combined into one project. The number of projects may continue to change for reasons of efficiency and sequencing of projects.

agencies; and the Task Force's strategy to assist agencies in controlling invasive species. The third goal—fostering the compatibility of the built and natural systems—will be achieved largely through the coordination of state and local land and water supply planning. This goal involves such efforts as improving comprehensive planning and growth management; continued acquisition, protection, and linkage of park, recreation, and open space; developing sustainable agriculture, such as applying best management practices to remove nutrients from agricultural water that runs off of the land and into canals, rivers, and ultimately freshwater and coastal wetlands and the ocean; and maintaining or improving flood protection service.

One of the Task Force's principles for accomplishing restoration is to use scientific information to guide restoration decisions. Science refers to several different disciplines—biology, chemistry, geology, hydrology, ecology, and social sciences—all of which play a role in providing scientific information for restoration. Scientific information can be the results of research and monitoring, or assessments that integrate available research and monitoring results, such as the environmental assessments that agencies are required to conduct under the National Environmental Policy Act. Scientific research involves conducting "cause and effect" experiments, either through field or laboratory studies that investigate the cause of specific natural conditions. The development of mathematical models to simulate various ecosystem functions is also a type of research, although models can also be used to help scientists assess ecosystem conditions. Monitoring provides information developed from physical observation or samples of a resource—for example, a water sample or a bird count—over a period of time, which allows the identification of trends that may occur in that resource over time.

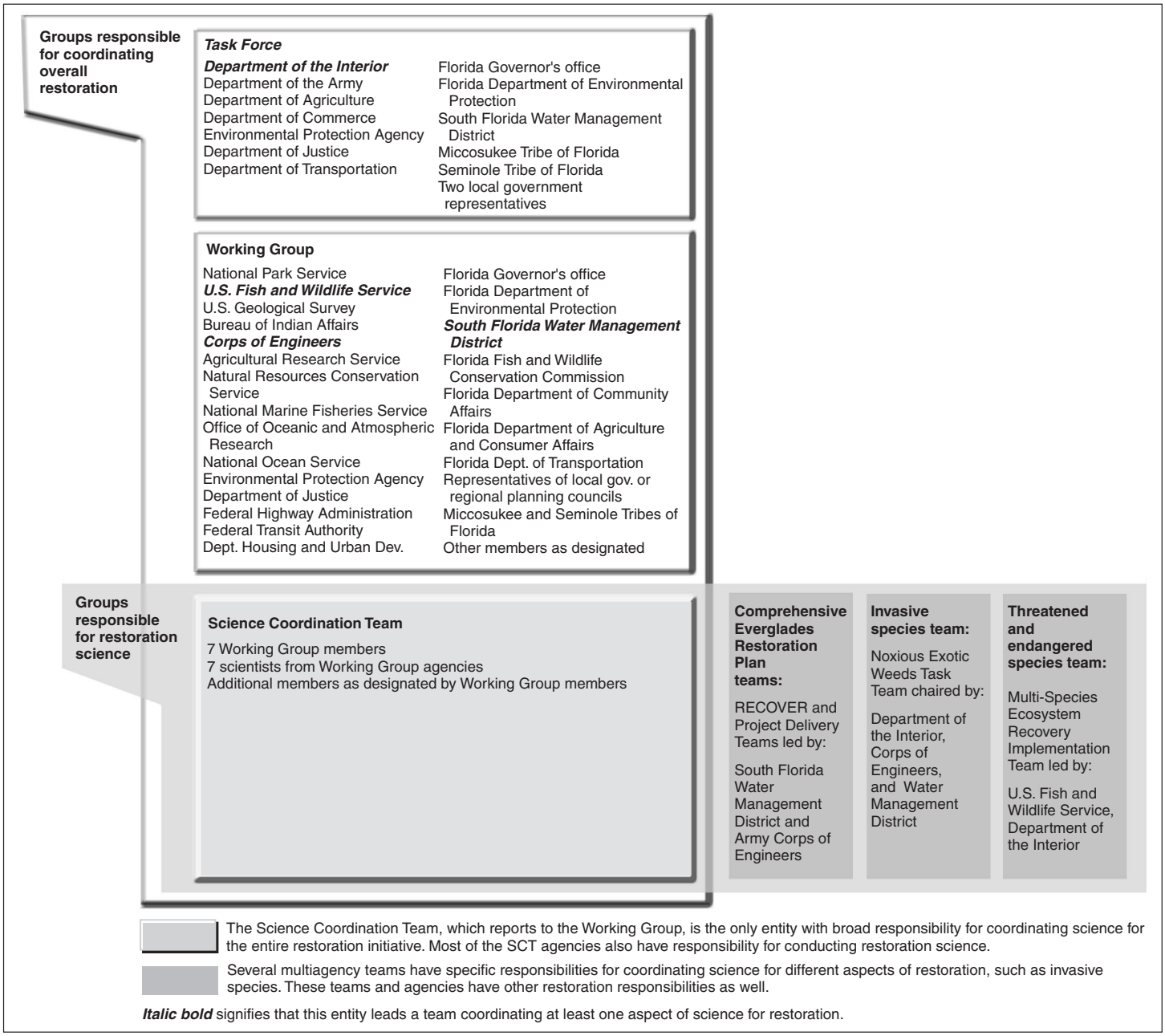
Because of the complexity of the ecosystem and efforts underway to restore it, and the urgency to begin the long-term ecosystem restoration effort, not all of the scientific information that is needed is available to make restoration decisions. As a result, scientists will continually need to develop information and restoration decision makers will continually need to review it. According to the Task Force, scientists participating in restoration are expected to identify and determine what information is needed to fill gaps in scientific knowledge critical to meeting restoration objectives and provide managers with updated scientific information for critical restoration decisions. Generally, decisions about restoration projects and plans have been—and will continue to be—made by the agencies participating in the restoration initiative. To provide these

managers—as well as its own members—with updated scientific information, the Task Force endorsed the use of a process called adaptive management, which involves the (1) development of performance indicators of the key factors causing the ecosystem to be degraded and the key ecosystem characteristics to be restored; (2) a long-term monitoring plan to track the status and trends in measures and indicators, research to help understand factors that affect measures and indicators, and assessment of monitoring and research data to determine whether restoration actions are successful; and (3) feedback so that managers will know what management changes may be needed.

The SCT is the primary group responsible for coordinating agency science activities—to address information gaps and the adaptive management process. As the restoration initiative has progressed, the Task Force and participating agencies have created other groups with science coordination responsibilities, although these groups are more narrowly focused than the SCT (see fig. 2).[7]

[7]The Task Force and Working Group have also incorporated three regional science groups that have been created to coordinate research on particular regions of the ecosystem. These groups are modeled after the Florida Bay Program Management Committee, which coordinates scientific research for the unique area that includes Florida Bay, a triangular estuary bounded by the mangroves in Everglades National Park, the Florida Keys, and the Gulf of Mexico that receives water that drains from the Everglades.

**Figure 2: Groups Responsible for Coordination of South Florida Ecosystem Restoration and Restoration Science**




Source: Task Force (documents), GAO (presentation).

As part of the implementation of the Comprehensive Everglades Restoration Plan, the Corps of Engineers and the South Florida Water Management District established the Restoration Coordination and Verification (RECOVER) program to assess, monitor, and evaluate progress in implementing the plan. As part of this responsibility, the RECOVER program is to ensure that scientific information is available to make decisions on the effect of the plan on the ecosystem. In addition, the Corps and the local sponsor plan to establish a Project Delivery Team for each of the 55 restoration projects that they will construct. Each team can include scientists from other agencies for the purposes of identifying scientific information that is relevant to the design of the project and to identify information that is not available and needs to be developed. To carry out the Multi-Species Recovery Plan, the Fish and Wildlife Service created a multiagency, multiparty implementation team called the Multi-Species Ecosystem Recovery Implementation Team, which is responsible for identifying and prioritizing actions that can be taken to help recover species that are threatened or endangered under the federal Endangered Species Act. To coordinate and implement scientific information on invasive species, the Task Force created a team called the Noxious Exotic Weed Task Team and plans to create a second team, called the Noxious Exotic Animal Task Team, to address invasive animals.

In addition to these teams, the Task Force worked with the National Academy of Sciences to form the Committee on Restoration of the Greater Everglades Ecosystem (CROGEE), which is responsible for providing the Task Force with independent scientific and technical reviews for several elements of the restoration, including restoration of marine areas and ecological indicators. The CROGEE existed prior to the passage of WRDA 2000, which authorizes the creation of an independent scientific group that will review progress toward achieving the goals of the Comprehensive Everglades Restoration Plan and that will assess and report to Congress on the ecological indicators and other measures of progress in the plan. The Secretary of the Army, the Secretary of the Interior, and the Governor of Florida plan to jointly establish the independent scientific review provisions of WRDA 2000 by entering into a 5-year contract with the Academy of Sciences.

## Federal and State Agencies Spent $576 Million on Science for the South Florida Ecosystem and Made Progress in Some Areas

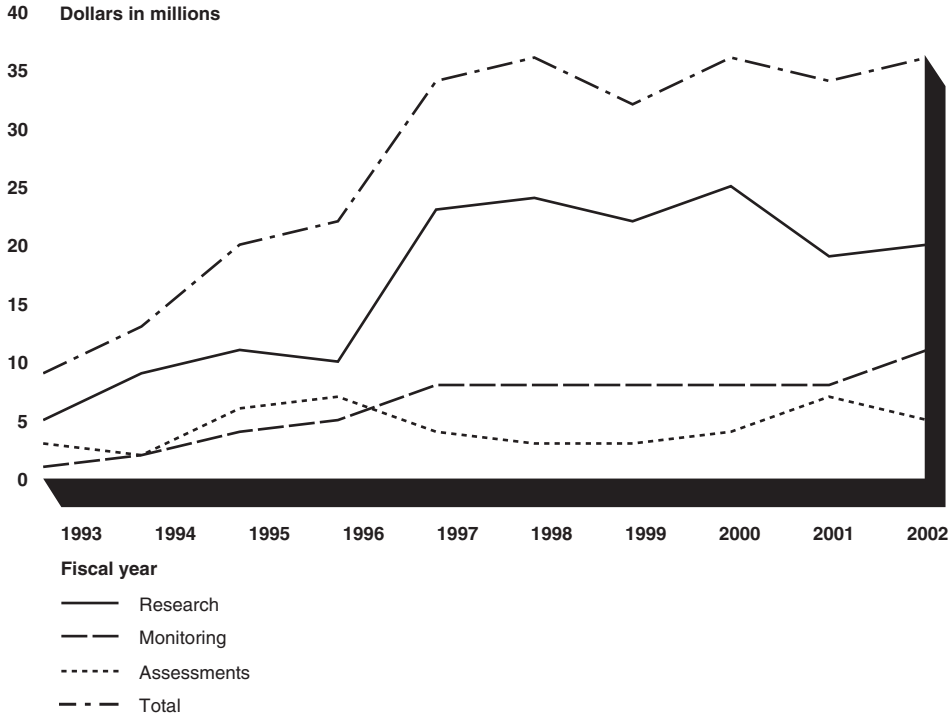
Federal and state agencies spent $576 million from fiscal years 1993 through 2002 to conduct mission-related scientific research, monitoring, and assessment in support of the restoration of the South Florida ecosystem. Eight federal departments and agencies spent $273 million for science activities, with the Department of the Interior spending $139 million (50 percent) of the funds.[8] Federal expenditures, which increased by more than 34 percent from 1996 through 1997, have remained relatively constant since. The South Florida Water Management District—the state agency most heavily involved in scientific activities for restoration—spent $303 million during the same period. The state's expenditures increased steadily from 1993, with significant increases in 2000 and 2002. The federal and state funds have helped scientists make progress in developing scientific information and adaptive management tools related to the first goal of restoration—getting the water right. A detailed table of the funding by federal and state agencies since 1993 is presented in appendix II.

### Federal Agencies Spent $273 Million on Science for the Restoration Initiative

Eight agencies spent a total of $273 million to develop scientific information for the South Florida ecosystem since 1993. The agencies involved in scientific activities for the restoration are the Department of Interior's National Park Service, U.S. Geological Survey, Fish and Wildlife Service, and Bureau of Indian Affairs; the Department of Commerce's National Oceanic and Atmospheric Administration; the Department of Agriculture's Agricultural Research Service; the Department of the Army's Corps of Engineers; and the Environmental Protection Agency. The agencies' expenditures for research, monitoring, and assessment are provided in detail in appendix II. Echoing the increased federal attention to restoration efforts, federal expenditures for science activities—which include research, monitoring, and assessments—rose from $9 million in 1993 to $34 million in 1997 and have remained relatively steady since (see fig. 3).

[8]Although 15 federal agencies participate in the restoration initiative, 8 of these agencies are involved in scientific activities.

**Figure 3: Federal Expenditures by Science Activity, Fiscal Years 1993 through 2002**




Source: Federal agencies (data), GAO (analysis).

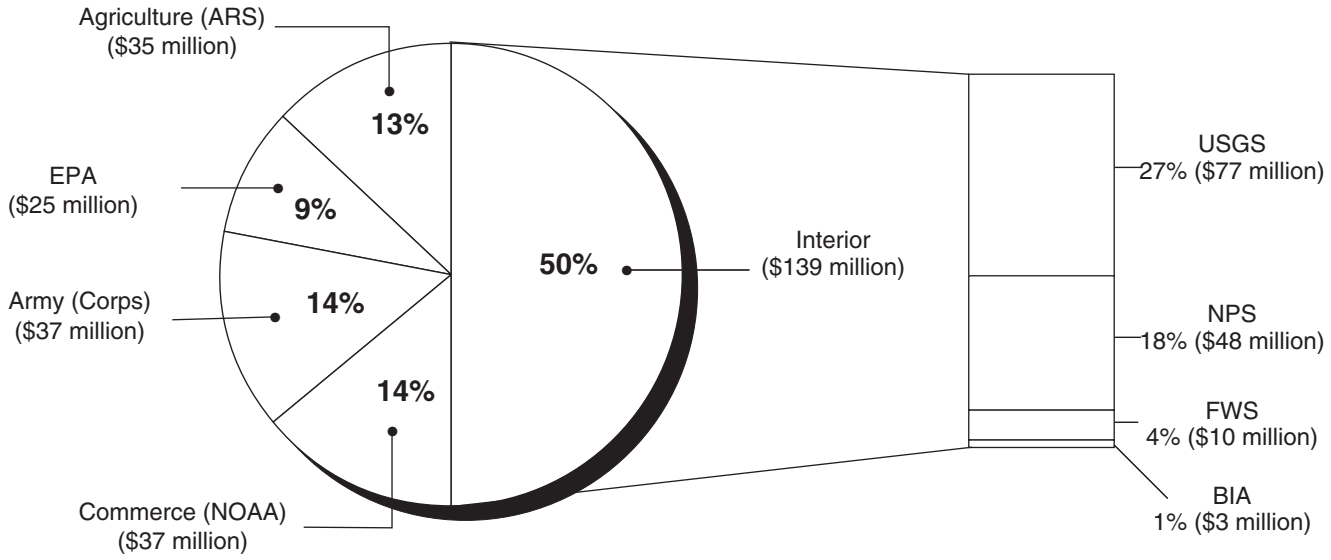
Note: All dollars have been adjusted to fiscal year 2002 dollars.

Federal agencies spent $166 million (61 percent) on research activities, $64 million (23 percent) on monitoring activities, and almost $43 million (16 percent) on assessment activities from 1993 through 2002. As shown in figure 3, expenditures have increased since 1993, with a jump in expenditures in 1997. The jump resulted from an increase in funding provided for research activities by Interior and the Corps. That year, Interior began funding its Critical Ecosystem Studies Initiative (CESI), a program designed to accelerate the development of scientific information associated with areas of importance to Interior, such as Everglades National Park. In the same year, the Corps increased its spending on research for a few key water projects designed to provide restoration benefits.

## Interior Spent Half of the Federal Funds Designated for Science Activities

The Department of the Interior spent half of the total federal funds expended for science activities for restoration. Figure 4 shows the total amount and percent of funds spent by the 8 federal agencies for science activities from 1993 through 2002.

**Figure 4: Total Federal Expenditures for Science Activities by Amount and Percent, Fiscal Years 1993 through 2002**




Source: Federal agencies (data), GAO (analysis).

Note: Total federal expenditures for science activities for fiscal years 1993 through 2002 equaled $273 million. Individual dollar figures and percentages may not total because of rounding. All dollars have been adjusted to fiscal year 2002 dollars.

Four agencies in the Interior Department—the U.S. Geological Survey, National Park Service, Fish and Wildlife Service, and the Bureau of Indian Affairs—were responsible for $139 million or more than 50 percent of federal funding for science activities for South Florida. The U.S. Geological Survey spent $77 million—the most of any federal agency—primarily on its Placed-Based Studies Program, which provides information, data, and models to other agencies to support decisions for ecosystem restoration

and management.[9] The U.S. Geological Survey focused the program on the following five scientific areas

- the historic ecosystem—how it functioned and its plants and animals;
- the hydrological models that describe water flow through the Everglades, both above and below ground;
- the ecological models that determine the effect of altered water flow on several individual species, such as the Cape Sable seaside sparrow and the Florida panther (both federally listed endangered species);
- the mapping of the physical features of the natural system; and
- the effects of contaminants, such as mercury, on biological, geological, and chemical processes in the Everglades.

In addition, U.S. Geological Survey also supports a Web site that provides access to the reports, publications, and data that it produces for restoration.

One example of the research conducted by the U.S. Geological Survey is a study in Florida Bay using clamshells to determine the age of sediment and to further determine the salinity of the bay in corresponding periods. The data and information collected from this study provide an ecological history of Florida Bay and can be linked to historical rainfall data. This allows scientists to determine the historical range of salinity for different parts of the bay, which can in turn be used to establish the amounts of freshwater flow from the mainland that would best recreate those conditions.

[9]The U.S. Geological Survey's Placed-Based Studies Program was established to provide sound science for resource managers in critical ecosystems such as South Florida.

After the U.S. Geological Survey, the National Park Service spent the second largest amount of funds within Interior and the federal government—about $48 million. The National Park Service spent the funds for its CESI program, begun in 1997 to accelerate research needed to provide scientific information for the restoration initiative. Because two particular Corps water projects are expected to provide restoration results within the next few years for public lands such as Everglades National Park and others, the National Park Service focused the CESI program on conducting research and gathering information to understand the potential effects of these projects, funding hydrologic modeling, ecological modeling, ecological processes, and water quality studies in the project areas.[10] The largest portion of CESI funding has been spent on research to characterize the predrainage ecosystem and to define the current conditions of the ecosystem. CESI funding has also been spent on identifying indicators for monitoring the success of restoration of Everglades National Park, other parks and public lands, and on developing models and tools to assess the effects of water projects on these natural lands.[11]

The Fish and Wildlife Service and the Bureau of Indian Affairs spent the remainder of Interior's funds, about $10 million and $3 million respectively. The Fish and Wildlife Service spent the majority of its funds to develop the Multi-Species Recovery Plan, which documents the actions needed to help recover 68 of the federally listed species in South Florida.[12] The Bureau distributed its funds to the Miccosukee and Seminole Tribes of Florida—whose lands are located within the ecosystem—for the tribes to conduct research and to plan for water quality and distribution systems on their tribal lands.

[10]These projects—the Canal 111 (C-111) and Modified Water Delivery projects—are under construction and are designed to improve the flow of water into the eastern part of Everglades National Park.

[11]In addition, a small portion of CESI funds has supported restoration management and planning efforts, including support for the CROGEE.

[12]Although there are 69 threatened and endangered species in South Florida, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service is solely responsible for one species, Johnson's seagrass, which is not included in the Multi-Species Recovery Plan. The National Oceanic and Atmospheric Administration also shares the responsibility, with the Fish and Wildlife Service, for five different species of sea turtles, all of which are included in the Multi-Species Recovery Plan.

Both the Corps of Engineers and the National Oceanic and Atmospheric Administration spent approximately $37 million each, primarily on research activities. The Corps focused its $37 million on developing and running models for water projects that it is building for Everglades restoration. For example, the Corps has used hydrological models to examine many different alternative configurations for the C-111 project near the eastern boundary of Everglades National Park. The National Oceanic and Atmospheric Administration focused its $37 million on research activities such as studying the conditions of coastal and ocean areas surrounding South Florida. One major use of this research is to determine the effect of inland restoration efforts and changing freshwater flow on Florida Bay and its habitats. For example, the National Oceanic and Atmospheric Administration is conducting research that will enable scientists to understand environmental problems such as the die-off of seagrass in Florida Bay and the deterioration of mangroves along the southern coast of Florida.

Two other federal agencies—the Agricultural Research Service and the Environmental Protection Agency—spent the remaining $60 million in federal funds. The Agricultural Research Service used a portion of its $35 million to conduct research on biological control and management of invasive pest plant species in South Florida. In particular, the agency focused its research on identifying and collecting natural enemies for development of biological controls of Melaleuca—a hardy, fast-growing invasive tree imported from Australia that overruns natural vegetation in the ecosystem. In addition, the Agricultural Research Service spent some of its funds on developing strains of water-tolerant sugar cane in an effort to make agriculture more compatible with the higher water levels expected with restoration actions and has also developed hydrological models for agricultural lands in South Dade County that will be most affected by restoration actions. In contrast, the Environmental Protection Agency spent most of its $25 million on monitoring the conditions of seagrass, the Florida Keys coral reef, and water quality in the Florida Keys National Marine Sanctuary. The Environmental Protection Agency has also conducted research on the sources and distribution of mercury contamination in the ecosystem.[13]

[13]Not included under the Environmental Protection Agency are its Clean Water Act grants and its Science to Achieve Results (STAR) grants, which total approximately $13 million and $10 million, respectively. The agency's Clean Water Act grants are provided for ecosystem research, monitoring, and assessments of water quality. Some of the agency's STAR grants are provided for ecosystem research in South Florida.

In addition to conducting scientific activities, some federal agencies provide grants to universities to conduct scientific activities related to restoration in South Florida. For example, CESI has granted money to the University of Florida to support a monitoring program for the American crocodile in Everglades National Park to help study the animal as an indicator of ecosystem health for restoration. Other entities, such as the National Science Foundation, also provide grants for science in South Florida.[14] For example, the foundation has funded the Florida Coastal Everglades Long-Term Ecological Research Program through Florida International University to ensure long-term funding for ecosystem research in South Florida. The study has received $700,000 annually since 2000 and will continue to receive this much per year for a total of 6 years; the grant will be reviewed every 6 years for renewal of funding.[15]

While total expenditures for federal agencies' science activities generally increased over the past 10 years, some agencies' expenditures decreased. For example, expenditures by the Environmental Protection Agency decreased from $4.4 million in 1998 to approximately $816,000 in 2002 (approximately 80 percent). The agency's expenditures decreased due to the discontinuation of funding for its monitoring program—the South Florida Regional Ecosystem Monitoring and Assessment Program—as well as some of its mercury contamination research programs.

## Key State Agency Has Spent $303 Million on Scientific Activities for the Restoration Initiative

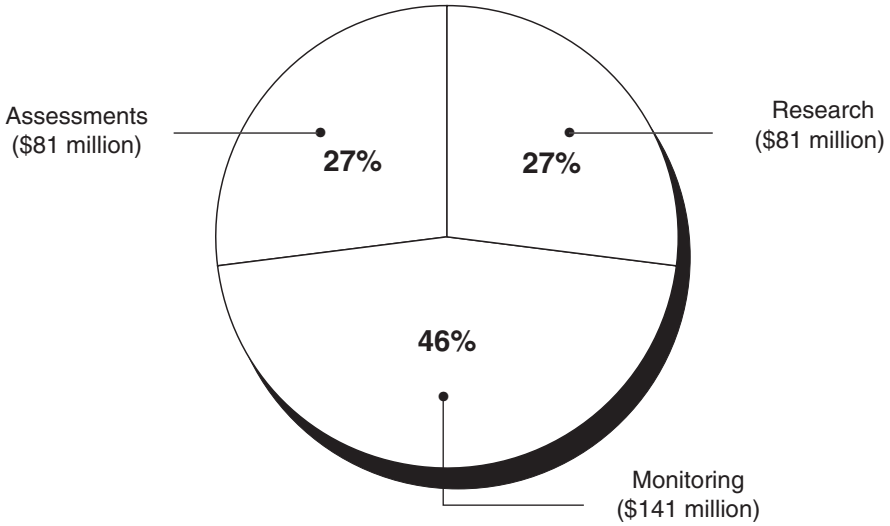
In addition to the $273 million spent by federal agencies for science-related activities, the State of Florida's South Florida Water Management District provided $303 million for such activities from 1993 to 2002. The District spent much of its funding on scientific activities related to water projects in line with its major responsibility to manage and operate the Central and Southern Florida Project and water resources in the ecosystem. The District spent nearly half of its science funding—$141 million—on

[14]We did not obtain total funding dollars on the amount of grants being given by the National Science Foundation in South Florida because the National Science Foundation tracks its grants by scientific discipline—such as geography, biology, ecology, or environmental engineering—not by the geographical region in which the work in being conducted.

[15]Base funding for the Long-Term Ecological Research Program is $700,000 per year for 6 years. In addition, participating programs have the opportunity to apply every year for supplemental funding for educational programs and equipment. These supplements average approximately $50,000 per year. The Florida Coastal Everglades Long-Term Ecological Research Program has received approximately an additional $50,000 per year funding from the National Science Foundation since its inception in 2000.

monitoring activities including water quality monitoring for which the District is responsible (see fig. 5).

**Figure 5: Percent of District Expenditures for Research, Monitoring, and Assessments for Fiscal Years 1993 through 2002**




Source: Federal agencies (data), GAO (analysis).

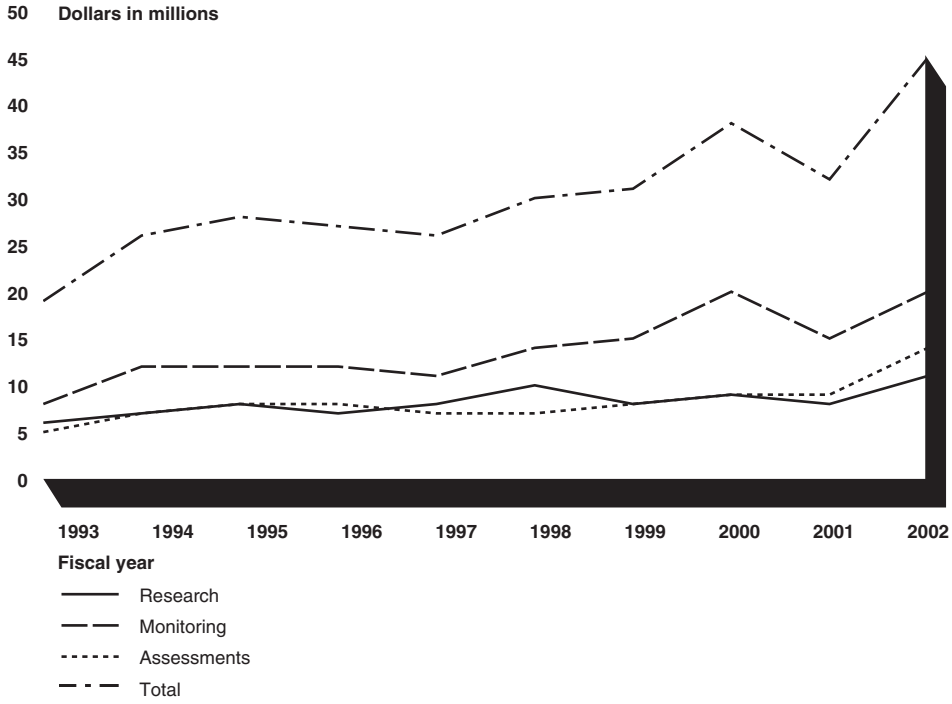
Note: Total District expenditures for science activities for fiscal years 1993 through 2002 equaled $303 million. Because the South Florida Water Management District does not routinely track funds by these three categories of science activities, District officials provided their best estimates of the funds spent in these categories. All dollars have been adjusted to fiscal year 2002 dollars.

The District spent over a quarter—$81 million—of its funding on assessments of the ecosystem related to water projects in South Florida, such as the C-111 project. It spent the same amount on research activities, including efforts to develop different techniques to improve water quality in the ecosystem and hydrologic modeling. For example, the District spent approximately $34 million to conduct research on advanced treatment technologies and on the optimization of storm water treatment areas, all of which are systems that remove nutrients such as phosphorus from urban and agricultural storm water runoff that flows into natural areas including Everglades National Park.

The District's total annual expenditures for science activities, like total federal expenditures, have increased steadily since 1993. The District's

total expenditures for scientific activities rose from $19 million in 1993 to $46 million in 2002, with two funding increases in 2000 and 2002 (see fig. 6).

**Figure 6: District Expenditures for Science Activities, Fiscal Years 1993 through 2002**




Source: Federal agencies (data), GAO (analysis).

Note: Because the South Florida Water Management District does not routinely track funds by these three categories of science activities, District officials provided their best estimates of the funds spent in these categories. All dollars have been adjusted to fiscal year 2002 dollars.

In 2000, the District spent more funds on assessments and monitoring related to actions it took to help restore Lake Okeechobee by lowering its water levels and on continued monitoring associated with historic drought conditions. In addition, the District spent additional funds on increased monitoring of storm water treatment areas. The 2002 increase resulted in part from ongoing implementation of its Everglades restoration projects and special appropriations received from the state for Lake Okeechobee and estuary restoration initiatives.

## Federal and State Agencies Made Progress in Developing Information and Tools for Restoration Purposes

Federal and state agencies used their funds to make progress in developing scientific information and adaptive management tools. In particular, scientists made progress in understanding historic and current hydrological conditions and developed tools that allow them to forecast the effects of water management alternatives on the ecosystem. Specifically, scientists developed hydrological models that provide a picture of the amount, timing, and distribution of water in the ecosystem before and after it was altered by drainage. These models were used to assess alternative configurations for the Comprehensive Everglades Restoration Plan. The information and models developed will help achieve the first restoration goal, which is to get the quantity, quality, distribution, and timing of water in the ecosystem right.

Scientists have also made significant progress in developing information on mercury, a contaminant that affects water quality and the health of birds, animals, and humans in the South Florida ecosystem. The presence of mercury in South Florida fish was highlighted as a problem for wildlife in 1989 by the Florida Department of Health, and in 1993, scientists identified mercury contamination as one of the alarming ecological threats to the altered ecosystem. Since then, scientists have conducted research that linked local, regional, and global information on mercury and helped identify the root causes of the mercury problem. In general, this information improved understanding of the sources, transformations, and fate of mercury in the Everglades. More specifically, scientists determined that atmospheric sources account for greater than 95 percent of the mercury that is added to the ecosystem. As a result, scientists confirmed that regulatory actions taken to reduce incinerator emissions of mercury were appropriate action to help reduce mercury in the ecosystem.

Scientists also made progress in developing control techniques for one serious invasive species and reducing the effects of excess nutrients on the natural system. First, scientists developed a biological control that by 1999 had helped to reduce the acreage of Melaleuca present on natural lands in South Florida by 26 percent. Second, scientists helped to design over 41,000 acres of storm water treatment areas constructed by the state and to optimize best management practices applied by farmers and ranchers to their fields. These areas and practices have been used to reduce the amount of excess nutrients—in particular phosphorus—in water running off agricultural fields into natural areas in South Florida.

## Gaps in Scientific Information and Adaptive Management Tools Remain—That If Not Addressed, Could Hinder Ongoing Restoration Efforts

While scientists have made progress in developing scientific information, they have also identified significant gaps in scientific information and adaptive management tools that, if not addressed in the near future, will hinder the overall success of the restoration effort. Gaps in the development of scientific information may prevent action to address risks to the entire ecosystem, specific regions of the ecosystem, or to areas around individual projects. For example, scientists need to know, but have little information on, the amount and risk of contaminants such as fertilizers and pesticides in water throughout the entire ecosystem. Without this information, scientists cannot determine whether fish and other organisms are being harmed by these contaminants or whether the redistribution of water will spread the potentially harmful contaminants to parts of the ecosystem that are relatively undisturbed. In addition, scientists and managers cannot determine whether a restoration project has the potential to increase the levels of contaminants in parts of the ecosystem. Gaps are also present in the development of certain adaptive management tools, such as models and a comprehensive monitoring plan, that are based on key indicators, which allow scientists to assess how the implementation of restoration projects and plans affect the ecosystem and whether this implementation is resulting in successful restoration. The only systemwide-monitoring plan that does exist is one put together for the RECOVER program focusing on the objectives of the Comprehensive Everglades Restoration Plan. Without these types of tools, scientists can neither track the progress or success of restoration nor identify when changes may be needed to restoration projects and plans to ensure that restoration goals are achieved.

### Current Research Does Not Fully Address Ecosystem Threats or Individual Project Information Needs

Existing gaps in scientific information prevent scientists and managers from assessing ecosystem health and limit their ability to implement particular restoration projects and plans. Although the restoration initiative seeks to return the ecosystem as close as possible to the conditions that existed prior to its drainage, scientists remain concerned over the uncertainties associated with the biological and ecological conditions that existed and that could exist again in a restored ecosystem. In our review of 10 ongoing projects and plans related to restoration, scientists identified gaps in information for 6 of the projects that will potentially hinder restoration if not filled. Four of these projects and plans have information gaps that have the potential to affect large parts, if not the entire, ecosystem and two projects have gaps that will make it difficult to

implement particular restoration projects within the time frames and budgets allotted for them.

## Research Needed to Fill Ecosystemwide Gaps

In our review of restoration projects and plans, scientists identified the need for information on two areas—invasive species and water contaminants—that, if not developed, will potentially hinder ecosystem health. Table 1 shows the four projects and plans that we reviewed that revealed information gaps and their effects.

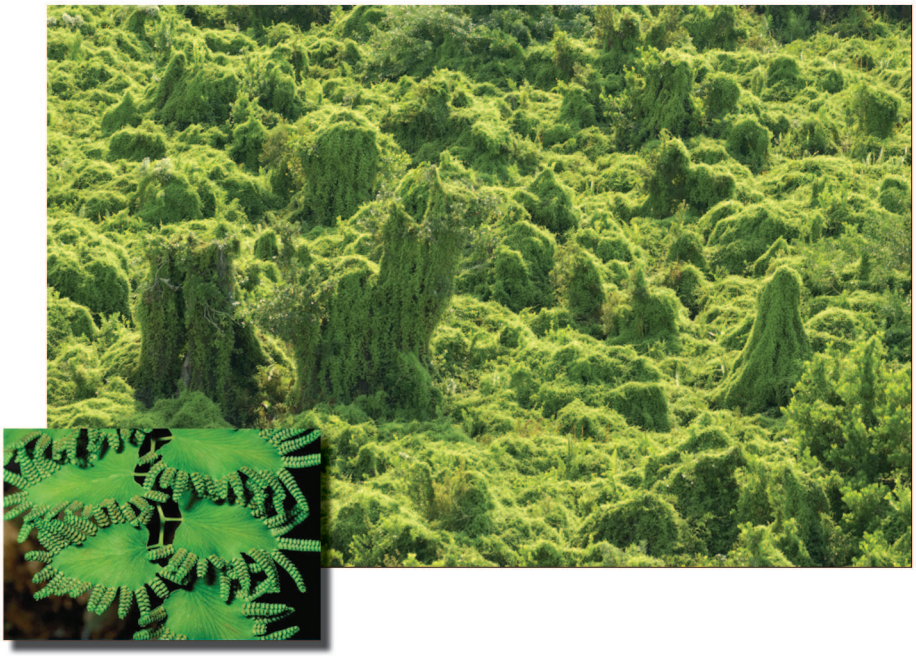
**Table 1: Gaps in Information and the Effects of the Gaps**

| Project/plan and purpose | Information gap | Effect of information gap |
|---|---|---|
| *Exotic plants plan:* To develop a comprehensive strategy for agencies to address invasive plants in South Florida | Information on (1) controls for species present or likely to invade the ecosystem and (2) the detection of new invasive plants. | Without controls, invasive plants will devastate some natural areas, undermining the benefits of other projects designed to achieve restoration benefits. |
| *Canal 111 (C-111) project:* To increase flows in the southeastern portion of Everglades National Park, improving wetland habitat for wading birds and other species. | Information on the presence and effects of contaminants—such as heavy metals, pesticides, and other chemicals—in other areas of the ecosystem. | Without information on the types, amounts, and potential risks of contaminants in water and sediment, scientists and managers cannot tell whether they might distribute contaminants to other areas. |
| *Wastewater Reuse Pilot Project:* To study the use of treated wastewater to supplement water in natural areas. | Information on detecting and analyzing the effects of pharmaceutical contaminants—that is hormones, steroids, and antibiotics and other chemicals that are not removed with water treatment technology. | Without information on such contaminants, scientists and managers do not know if water that is planned as supplemental supply for natural areas such as Biscayne Bay would be of sufficient quality. |
| *Storm Water Treatment Area 1-East:* A constructed wetland used to remove excess nutrients—particularly phosphorus—from agricultural and other runoff water. | Information on ways to optimize the removal of phosphorus from runoff water. | Without such information, scientists and managers could not achieve the low levels of phosphorus needed to restore the ecosystem using this technology, resulting in continued degradation of native sawgrass habitat, a type of vegetation important for a restored ecosystem. |

Sources: Federal agencies (data), GAO (analysis).

Invasive species—harmful plants and animals that are not native to an ecosystem—hinder attempts to restore native species, including threatened and endangered ones, in South Florida by strangling native plants and depriving native animals of their habitat and food sources. Examples of invasive species already known to exist in South Florida include Melaleuca, Brazilian pepper, the Asian swamp eel, and the Old World climbing fern. Information is needed on control methods for the invasive species that are already present and those that are likely to invade the ecosystem and on methods for identifying newly introduced species before they cause extensive harm to the ecosystem. For example, scientists and managers reported that insufficient research on control methods has allowed the Old World climbing fern to spread throughout parts of the ecosystem. The fern has covered increasing amounts of native vegetation—about 28,000 acres in 1993 and about 109,000 acres in 1999. Growing over trees and shrubs, the fern smothers whole plant communities, altering water movement and increasing the risk of fire (see fig. 7). Without additional information on control and detection, scientists stated that invasive plants and animals will continue to devastate parts of the ecosystem, thereby hindering the success of restoration.

**Figure 7: Old World Climbing Fern Smothering Vegetation**



Source: South Florida Water Management District.

The Old World climbing fern forms dense mats, growing over trees and shrubs and smothering whole plant communities. The fern is shown close-up and from an aerial view in Everglades National Park.

A second area that has the potential to impede restoration efforts is the presence of contaminants that could affect water and sediment quality, and thus, the entire ecosystem's health. Scientists are concerned that the heavy use of fertilizers and pesticides near natural areas in South Florida increases the discharge of chemical compounds into natural areas. Contaminants found in South Florida are heavy metals, pesticides, fertilizers, and other chemicals that are transported by water and soil and deposited in sediments. When discharged into natural areas, contaminants are absorbed by organisms such as aquatic insects, other invertebrates, and fish that live in the water and sediment, affecting the survival and reproduction of those organisms and those that feed on them. Information that is needed on contaminants includes the amounts of contaminants that are applied and could be discharged into the environment, the amounts that persist in water and sediments, and the risks faced by organisms living in areas with contaminants (even low levels on a long-term basis).

Information on analytical methods is needed for one specific type of contaminant, pharmaceuticals, including antibiotics, hormones, and steroids that remain in water even after treatment. Information is also needed for another specific category of contaminants—nutrients such as phosphorus—that cause undesirable changes to vegetation by increasing the growth of cattails that replace native sawgrass. Information that is needed on nutrients includes how to optimize techniques already developed to reduce phosphorus to lower levels. If information in these areas is not developed, poor water and soil quality may continue to degrade habitats and harm the plants and animals that are part of the ecosystem.

No single agency has primary responsibility for developing the scientific information needed to address problems regarding invasive species or contaminants for restoration. Although these areas may be systemwide priorities, agency science programs may have different priorities, in part, because of their different missions and objectives. As a result, systemwide information on these areas is difficult to develop. While scientists from several agencies participating in the restoration have conducted limited studies, no comprehensive research or research plans have been implemented. For example, the National Park Service granted money for research on the amounts and types of contaminants that exist around the C-111 project and that could be moving into Everglades National Park, and the National Oceanic and Atmospheric Administration granted funds for research on contaminants that might flow from C-111 into Florida Bay. While the results of these limited studies indicate the need for more systemwide work on screening for contaminants that may be moved by changes to water management projects, little work has been done to address this issue on a systemwide basis.

## Information Needed to Support Individual Restoration Projects

Two of the 10 projects that we reviewed required additional scientific information to ensure that the projects, as designed, would achieve restoration at the local level. Scientists have identified gaps in scientific information that, if not addressed, may delay the projects while the information is developed or that may require the projects to be changed after they are implemented, which could increase costs associated with the projects. Table 2 shows the two projects, the information needed, and the effects of the information gaps.

**Table 2: Gaps in Information Related to Individual Projects**

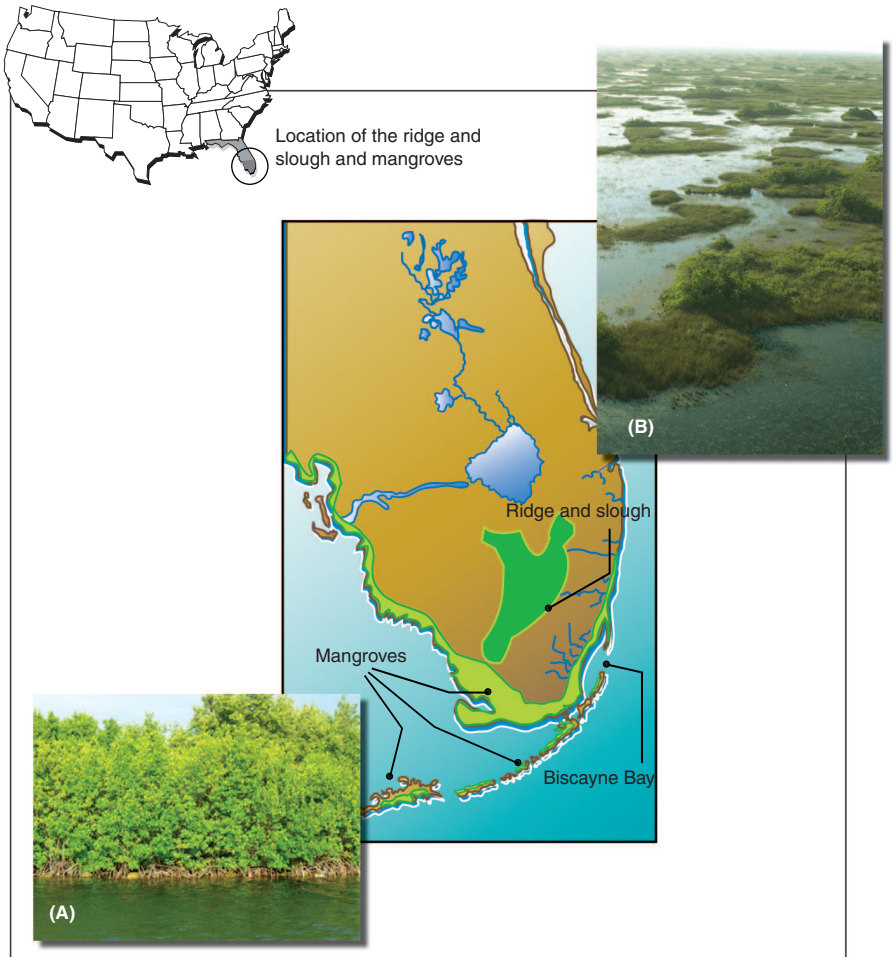
| Project and purpose | Information gap | Effect of information gap |
|---|---|---|
| *Biscayne Bay Coastal Wetlands project:* To promote more gradual flow of freshwater into Biscayne Bay, by restoring tidal creeks along the bay, thus reducing salinity levels and improving habitat for oysters and fish. | Information on saline concentrations in the bay. | Without salinity levels for coastal areas of the bay, scientists cannot determine how to design the project to optimize freshwater flows into the bay to restore it. |
| *Modified Water Delivery project:* To restore water to Northeast Shark River Slough on the eastern side of Everglades National Park to improve wetland habitat for birds and animals. | Information on tree islands and the effects of water "flow" on tree islands and ridge and slough habitat. | Without information on the level of water needed to sustain the formation of the islands without flooding them, the removal of levees cannot be optimally designed. The lack of information also affects a related project, the decompartmentalization of levees in the state's water conservation areas. |

Sources: Federal agencies (data), GAO (analysis).

Scientists working on the Project Delivery Team for the first project, the Biscayne Bay Coastal Wetlands project, identified the need to acquire information on salinity levels along the coast. The project seeks to restore more natural freshwater flows into the Biscayne Bay, which have been disrupted by the canals and operations of the Central and Southern Florida Project. The coastal wetlands project will help restore the estuarine conditions of the bay by recreating coastal creeks through the mangroves fringing the bay and restricting the effects of pulses of freshwater that are emptied periodically from canals into the bay (see fig. 8). Information on salinity would allow scientists to determine the amount and timing of water that should be released into the bay to create more natural conditions. This information would enable the scientists to determine how many tidal creeks need to be restored as part of the project design and would help them identify where the tidal creeks should be located. Without this information, the project design cannot be finalized and land acquisition cannot be completed for the project. Although the project has a conceptual design and land is being acquired according to it, a more detailed design is needed to assure that the right lands are acquired for the project.[16]

[16]Lands in the vicinity of the project are already subject to development pressures. An administrative law judge determined in January that the Lennar property, a 516-acre parcel near Biscayne Bay, can be developed with homes despite potential plans for the wetlands project.

**Figure 8: Mangrove Habitat and Ridge and Slough Habitat with Tree Islands**




**A.** Mangroves, a mosaic of different types of trees and shrubs, provide an interface between more saline coastal waters and the freshwater marshes in South Florida and are a valuable habitat for several endangered invertebrates, including the manatee and the American crocodile.

**B.** Tree islands, found in this well-preserved ridge and slough area, are small forests of trees and shrubs and consist of peat soil above the surrounding marsh. These islands provide an important home to many mammals and are a site for wading and migratory birds.

Source: Mangroves, GAO; tree islands, South Florida Water Management District.

Scientific information is also needed to support the Modified Water Delivery project, which has been ongoing for many years and has been delayed primarily because of land acquisition conflicts. The Modified Water Delivery project and a related project in the Comprehensive Everglades Restoration Plan are expected to increase the amount of water running through the eastern part of Everglades National Park, lower water levels on state and tribal lands to the north of the park, keep agricultural lands to the east of the park dry, and restore an important type of habitat called "ridge and slough" habitat. This habitat, which is one of the signature habitats native to the Everglades, is thought to be essential to maintain the rich diversity of habitats necessary for Everglades plants and animals. Ridge and slough habitat contains slightly elevated, north-south ridges dominated by sawgrass, interspersed with sloughs, which are open water areas with sparse vegetation. This ridge and slough habitat may also have "tree islands," which have woody vegetation more suited to dry areas than wetlands and serve as important habitat for some species (see fig. 8). High water levels have destroyed many tree islands, areas that scientists seek to restore. However, scientists identified the need for continued work to understand the dynamics of tree islands and recently identified the need to understand the role of flowing water in the creation of ridge and slough habitat and its associated tree islands. If the information is not developed, the project designs may be delayed or inadequate, forcing scientists and managers to spend time redesigning projects or making unnecessary modifications to those already built. For example, a larger portion of the levees, roads in the vicinity of the Modified Water Delivery project, and other barriers may need to be removed to increase the flow of water if scientists develop information demonstrating the need.

According to scientists and managers, even though adaptive management allows for changes to be made to projects as new information becomes available, it is still best to design projects with as much of the important scientific information as possible to prevent the costly alteration or removal of projects or potential damage to the ecosystem. The Corps and the District are relying on some, if not most, of the scientific work needed to be accomplished by other agencies such as the Geological Survey, the National Oceanic and Atmospheric Administration, the National Park Service, or the South Florida Water Management District. However, agency science programs are generally driven by research cycles that last from 3 to 5 years, which limits the opportunities to start new work or to make the results available for decisions.

## Key Adaptive Management Tools Are Needed to Apply Science to Restoration Decisions

Key tools needed for effective adaptive management have not yet been developed, including (1) a comprehensive monitoring plan for key indicators of ecosystem health and (2) mathematical models that would allow scientists to simulate aspects of the ecosystem and better understand how the ecosystem responds to restoration actions. Indicators and a monitoring plan were missing for the two plans we reviewed and models were missing for three projects we reviewed. Without such tools, the process of adaptive management will be hindered by the fact that scientists and managers will be less able to monitor key indicators of restoration and evaluate the effects created by particular restoration actions.

### Key Indicators and a Comprehensive Monitoring Plan Are Not Yet Developed

While scientists have established indicators and a monitoring plan for the Corps' Comprehensive Everglades Restoration Plan, which is designed to help achieve the first goal of restoration (getting the water right), they have not done so for the other restoration goals—restoring, protecting, and preserving the natural system and fostering the compatibility of built and natural systems. Indicators are particular features of the ecosystem—such as wading birds, vegetation, or water quality levels—that characterize or represent the conditions of the ecosystem that scientists and others participating in restoration would like to restore. These indicators or features are monitored to determine the degree to which they are changing—thereby indicating whether the ecosystem is changing in the desired direction.

The Corps and the District, in implementing the Comprehensive Everglades Restoration Plan under the 2000 WRDA, established the RECOVER program to carry out an adaptive management program with a monitoring plan for water-related projects and habitat.[17] Neither the Task Force nor the participating agencies have developed a similar program for plans associated with the two other restoration goals. As a result, scientists have not established a full set of indicators or a monitoring plan for goals two and three of the restoration. Table 3 shows the gaps in indicators and monitoring plans.

[17]RECOVER officials use the term performance measures to describe the set of natural and human system elements that they will measure to assess the success of the Comprehensive Everglades Restoration Plan. Restoration officials use the term indicators to refer to a subset of these measures that will show progress toward ecosystem restoration. We use the term indicators to refer to the underlying performance measure as well as the indicator.

**Table 3: Gaps in Indicators and Monitoring Plans and the Effects of the Gaps**

| Plan and purpose | Gap in indicators and monitoring plans | Effect of missing tool |
|---|---|---|
| *South Florida Multi-Species Recovery Plan:* Identifies actions needed to save 68 threatened and endangered species and habitat for these species. | Indicators for endangered species and a range of related habitats and a monitoring plan to determine whether actions have helped them. | Without indicators and a long-range monitoring plan for a range of threatened and endangered species—including habitat indicators—scientists will have a more difficult time knowing whether species are recovering because of restoration actions. Without the monitoring information, scientists cannot provide information for adaptive management decisions. |
| *Exotic plants plan:* To develop consistent monitoring methods and control methods for agencies in South Florida. | Indicators and a monitoring plan for invasive exotic species. | Without indicators and a long-range monitoring plan for the species that most threaten the ecosystem, scientists cannot provide information about how to adapt management decisions. |

Sources: Federal agencies (data and analysis), GAO (analysis).

The Task Force has adopted restoring, protecting, and preserving natural habitats as its second restoration goal, but has not ensured the development of a monitoring plan for carrying out this goal. The Fish and Wildlife Service—the agency leading species recovery efforts—has established a multiagency, multidisciplinary team to identify actions that can be taken to recover multiple species. In addition, the Fish and Wildlife Service monitors the status of all threatened and endangered species, and the RECOVER program has selected particular species as indicators of success for implementing water projects; however, these are not the equivalent of indicators and monitoring of the range of habitats that exist in South Florida. For example, although indicators and a monitoring plan for key wetland species have been selected, they have not been selected for upland species. Scientists have also not developed indicators or a monitoring plan for invasive species or for the changes in the extent of wetland vegetation and coverage, both of which are related to the second restoration goal, to restore the natural system. While the Task Force's invasive species team is attempting to unify the agencies' diverse methods of detecting and monitoring invasive species, it has not identified indicators of the range and amount of invasive exotic species or developed a monitoring plan to track relevant indicators.

Indicators of significant ecosystem conditions such as the condition of uplands and related monitoring plans need to be developed before the process of adaptive management—tracking changes in the ecosystem and making necessary changes to restoration actions—can be successfully accomplished. Even though the restoration initiative and the various programs will be implemented over a long period of time, scientists stated that it is important to establish current (baseline) conditions as quickly as possible and to begin monitoring to develop sufficient data on which to base analyses of trends. Analyzing trends is difficult without sufficient data and may lead to inaccurate or indeterminate conclusions. Further, if the set of indicators is not comprehensive—that is, if it excludes significant parts of the ecosystem or does not allow the tracking of important management actions—then the adaptive management process will not be comprehensive nor will it indicate the success of restoration.

## Important Models Are Needed

As with monitoring plans, models are also important tools for carrying out adaptive management because they allow scientists to forecast and evaluate the potential effects of proposed restoration actions. In our review of restoration projects and plans, scientists identified the need for several important models—including three for Florida Bay, Biscayne Bay, and systemwide vegetation. Models are mathematical representations of physical conditions and processes; for example, scientists use a model to determine how much water is available in different parts of the ecosystem based on rainfall amounts, water levels in canals, and the amount of water available from groundwater. They can be simple, requiring a few calculations or data transformations, or they can be extremely complicated, requiring data collection for tens or hundreds of variables. Table 4 shows the gaps in models that scientists stated are needed to support restoration efforts.

**Table 4: Gaps in Modeling Tools and the Effects of the Gaps**

| Project/plan and purpose | Gap in modeling tools | Effect of missing tool |
|---|---|---|
| *Florida Bay Feasibility Study:* To study options for improving water management for Florida Bay, including the development of a hydrodynamic model of the bay. | Hydrodynamic model of the bay. A hydrodynamic model shows the circulation of water, including the changing depth of water, and shows changes in water quality, such as salinity, related to circulation and depth. | Without such a model, scientists will have a more difficult time determining the effects of adding water—from the water management changes associated with water projects in South Florida—to the bay. They also cannot determine salinity and water quality levels that may affect seagrass, algae, and organisms in the bay. |
| *Biscayne Bay Coastal Wetlands project:* To promote more gradual flow of freshwater into the Biscayne Bay, by restoring tidal creeks along the bay, thus reducing salinity levels and improving habitat for oysters and fish. | Hydrologic model and an associated groundwater model. | Without hydrologic and groundwater models of the project area, scientists do not know how much groundwater is available for the bay—which in turn affects salinity levels—or how it will be altered by the project. |
| *Modified Water Delivery project:* To restore water to Northeast Shark River Slough on the eastern side of Everglades National Park to improve wetland habitat for birds and animals. | Ecological/vegetation models. | Without a model, or several models, to help assess the change in vegetation that results from different hydrological conditions, scientists and managers will have more difficulty in determining the possible changes that will occur in the ecosystem as a result of proposed restoration actions. |

Sources: Federal agencies (data and analysis), GAO (analysis).

Scientists stated that a model is needed to help them understand the conditions of Florida Bay. The restoration of the South Florida ecosystem includes the restoration of the bay, which has been subject to die-off of its seagrasses and increased algae blooms and which will receive increased flows of freshwater as changes to inland water management occur. Scientists, in trying to prevent such die-offs and algae blooms, anticipated that a model would show the circulation of the bay and should forecast changes in water quality conditions to enable them to understand what changes in water management—that is increased or redistributed freshwater flows—will bring to the bay. The model is needed relatively

early in the restoration process to help explain how changes in the bay relate to changes in the flow of water from inland areas, which will change as the Comprehensive Everglades Restoration Plan projects are built and operated.

Scientists also pointed to two other models that are needed: a linked hydrologic and groundwater model for Biscayne Bay and an ecological model for vegetation in the ecosystem. The hydrologic and groundwater models for Biscayne Bay would show how much water flows underground in the vicinity of the Biscayne Bay Coastal Wetlands project and will allow scientists to determine how the inflows will change salinity levels off the coast, changing habitat for vegetation, fish, and oysters that they are attempting to recover. An ecological model, or a set of interconnected models or indices, would enable scientists to show how changes in water management will cause changes in the different types of vegetation in the ecosystem. Because the ultimate purpose of restoration is to restore habitats and species, scientists are interested in such a model to help them assess the effects of various alternatives for managing and restoring flows of water.

Without these models, scientists have a difficult time determining the effects of changes on ecological and biological resources. Scientists need modeling tools available in time to help them analyze the changes that occur as a result of implementing restoration projects and plans. All three models are currently being developed but they have not been satisfactorily completed. For example, a hydrodynamic model of Florida Bay has been developed, but because of the variability of the bay (containing at least 27 distinct basins created by shallow mudbanks) the model does not satisfactorily represent the bay's conditions. In addition, according to scientists, insufficient efforts were made to include in the model the comments from the multiple agencies involved in scientific activities in the bay. Similarly, although the agencies responsible for assessing the changes on vegetation have stated they need some sort of tool to analyze changes in vegetation, limited tools are available. Several agencies have developed ecological models for different regions of the ecosystem or animal species, but these models are in various stages of completion. In seeking to complete models for use in assessing restoration actions, several scientists and managers cautioned that the models should be developed to provide tools for analyzing the changes to the ecosystem that result from restoration actions and decisions, not simply to demonstrate new models or modeling techniques.

## The Task Force Lacks an Effective Means to Coordinate Science Activities

The WRDA of 1996 requires the Task Force to coordinate scientific research for South Florida ecosystem restoration; however, the Task Force has not established an effective means to do so, diminishing assurance that key science information will be developed and available to fill gaps and support restoration decisions. Although the Task Force's Working Group established the SCT in 1997 and gave it broad responsibilities for coordinating scientific activities for restoration, they did not clearly identify the plans that the SCT needs to produce to help fill gaps in scientific information or establish processes through which the Task Force and Working Group would support the SCT's planning and reporting efforts. Furthermore, unlike coordination entities for other major restoration initiatives, the SCT has operated for the most part without any full-time or part-time staff and must accomplish its functions through volunteer efforts. With limited direction and few resources, the SCT prioritized its efforts to focus on a few of its responsibilities. For example, the SCT sponsored science workshops over the past 6 years and developed reports synthesizing key issues, such as improving water flow and increasing sustainable agriculture. However, in doing this, it set aside most of its other important responsibilities, including prioritizing research needs and developing a science plan and a comprehensive monitoring plan.

### Task Force Established the SCT with Broad Responsibilities but Did Not Specify Requirements or Processes for Planning and Reporting

Although the Task Force's Working Group created the SCT as a science coordination group, it did not give clear direction on which of its responsibilities are a priority for supporting the Task Force and the Working Group, contributing to the SCT's inability to accomplish several of its most important functions. According to restoration managers and scientists, the SCT's main responsibilities, included in its charter, are planning scientific activities for restoration, ensuring the development of a monitoring plan, synthesizing scientific information, and conducting science conferences and workshops on major issues such as sustainable agriculture or contaminants. However, the Task Force and Working Group did not specify what plans the SCT should develop and update periodically, or establish processes through which to provide management input to the SCT or to ensure that significant scientific issues discovered by the SCT would be reported. Without these planning and reporting requirements and processes, the SCT has focused on other responsibilities and has not completed a science plan, a comprehensive monitoring plan, and more reports synthesizing diverse scientific information. Because the SCT has not fulfilled these responsibilities, the Task Force cannot ensure that (1) important gaps in scientific information are identified; (2) the highest

priority science activities are identified and conducted; (3) a comprehensive monitoring plan is in place to track the progress of restoration projects and plans and to manage them adaptively; and (4) relevant scientific data has been synthesized into information that is useful in helping managers make important restoration decisions.

## Task Force Has No Specific Planning Requirements

Under its charter the SCT has broad planning responsibilities to identify and fill gaps in science and to ensure the development of ecosystem indicators and coordinated monitoring plans to track the success of restoration. In particular, the charter requires the SCT to conduct several activities: identify key gaps in management information and propose coordinated research and other programs to address the gaps; coordinate scientific investigations to document long-term ecosystem effects of restoration; and identify future science needs and recommend priorities. Because of the inherent difficulties of coordinating the efforts of the many agencies with differing missions that conduct science activities, planning is critical to ensure that coordination of these activities occurs and that gaps in scientific information are filled. Furthermore, because the agencies and not the SCT have authority to fund science activities, the team must make recommendations to the Task Force and its Working Group to ensure that these groups have the information they need to make coordinated funding decisions about scientific activities among the agencies. A science plan would (1) facilitate coordination of the multiple agency science plans and programs; (2) identify key gaps in scientific information and tools; (3) prioritize scientific activities needed to fill such gaps; and (4) recommend agencies with expertise to fund and conduct work to fill these gaps. Such plans would complement the Task Force's strategic plan that addresses all restoration activities and is to be updated every 2 years to reflect the focus and direction of the restoration effort.

In part because the Task Force has not required it, the SCT has not developed a science plan to coordinate agencies' science activities and to report on progress in meeting restoration science needs. In 1996, the predecessor to the SCT—the Science Subgroup—issued a report with an extensive list of scientific information needs for restoration, but this list was never prioritized in a science plan that recommended specific scientific activities, responsible agencies, time frames, and funding needs. According to Task Force and SCT officials, no specific planning requirements were established because managers and scientists were focused on developing and getting approval of the Comprehensive Everglades Restoration Plan, which Congress authorized as a study in 1996 and finally approved, along with the State of Florida, as a plan in 2000.

Without requiring the SCT to develop and periodically update a science plan, the Task Force and Working Group have little assurance that the information needed to guide funding to priority activities is available or that scientific activities will fill significant gaps in information.

Another of the SCT's broad planning responsibilities is to ensure the coordination of a systemwide monitoring plan to support the evaluation of restoration activities. This plan would provide scientists with a key tool to implement adaptive management. The SCT, however, has not accomplished this task. According to the SCT and managers, the Corps' RECOVER program has developed indicators and a monitoring plan that will assist them in developing information needed to make adaptive management decisions to improve the hydrology and the wetland habitats in the ecosystem. The RECOVER plan does not, however, include indicators and monitoring needed to fully measure the achievement of the two remaining restoration goals—restoring, protecting, and preserving the natural system and fostering the compatibility of the built and natural systems. For example, the RECOVER monitoring plan excludes indicators for management actions related to reducing invasive species or recovering endangered species in upland areas. Without first developing indicators and a monitoring plan that encompass the ecosystem and management actions to restore the ecosystem, the Task Force and the Working Group have no means to determine whether ecosystem conditions are being restored and whether important goals of restoration are being or will be met.

## Task Force Has Not Established Effective Processes to Support SCT Planning and Reporting Responsibilities

The SCT is responsible for identifying and synthesizing scientific information needed for management decisions. Scientists and managers have noted the need for an effective process that allows the Task Force and the Working Group to identify significant management issues or questions related to the restoration that scientific activities need to address. Additionally, scientists and managers have noted that in order to assure that restoration is successfully implemented, scientists must be able to develop and report on issues that they believe need to be addressed through science activities. The SCT, as it was created by the Task Force, has no effective process to receive management input regarding management concerns related to planning for scientific activities or to allow scientists and managers to identify and prioritize scientific issues that the SCT needs to address. These processes are important in carrying out both the planning and synthesis responsibilities that the Task Force has given the SCT.

Management input into the SCT's planning effort is important because, as several scientists and managers emphasized, without this input, scientists cannot fully understand the information that managers need in order to make key restoration decisions and may omit some important management issues in their science planning. Some officials stated that the process of getting input is important because scientists and managers view restoration issues differently and ask different types of questions. For example, a manager may ask higher-level questions such as: "What is causing our water to have so much algae?" On the other hand, to answer such a question, a scientist would formulate more technical, detailed questions such as "How much phosphorus is present in the water, and what are the sources?"

Recognizing the need for management input into science planning, officials from the Department of the Interior, in 2002, initiated a planning process through which managers identified their questions related to management of the department's South Florida lands to Interior scientists. In turn, these scientists developed research questions to answer them.[18] The Task Force, Working Group, and SCT lack such a process for overall restoration science planning and therefore rely on the Working Group members of the SCT to convey a management view for planning. Thus far, this process has not been effective because Working Group members often do not attend SCT meetings. Without an effective process to get management input into science planning, the Task Force has less assurance that science activities are being conducted to address pressing management questions related to restoration.

To fulfill its responsibility to synthesize information for managers, the SCT needs to select the issues that it will address for the Task Force and Working Group. According to the National Academy of Sciences, synthesis of scientific information provides managers with an overview of scientists' understanding on different restoration issues and provides for the integration of many diverse scientific studies. A process used to select issues for synthesis reports needs to be transparent to members of the SCT, the Working Group, and the Task Force and needs to facilitate the provision of a credible list of issues that the SCT needs to address in synthesis reports. One way that other scientific groups that are part of restoration efforts approach the issue of transparency and credibility is to

[18]The Department of the Interior's science plan has yet to be completed as of February 2003; thus we did not evaluate the effectiveness of the department's planning process.

use an advisory board to provide an independent review of the scientific plans, reports, and issues being addressed by the scientific staff involved in the restoration efforts. For example, the Chesapeake Bay Program has a Scientific and Technical Advisory Committee that annually reviews the research plans of the scientific staff supporting the restoration.

The SCT, the Working Group, and the Task Force do not have an advisory group such as the Chesapeake Bay Program. Nor do these groups have any other process through which to gain agreement on the issues the SCT will address. As a result, some scientific issues have not been addressed. In 1999, the Task Force and Working Group rejected the SCT's offer to develop a report synthesizing available scientific information on a controversial area of land that some scientists and managers believed needed to be acquired for restoration purposes.[19] According to Task Force and Working Group officials, the lack of agreement on how to resolve issues confronting the area were political and economic, not scientific. However, according to scientists, a scientific analysis could have helped to clarify some of the factual information on the debate surrounding the land acquisition, such as the historical conditions of the land. Another reason that the groups disagree on issues for scientific review is that Task Force officials are concerned that the SCT scientists will advocate policy alternatives that reflect their agencies' concerns. Lacking a process through which they can agree on significant scientific issues that should be the subject of a synthesis report by the SCT, the Task Force and Working Group may overlook important information needed to make restoration decisions.

## Task Force Has Provided Few Resources for SCT Activities

Aside from providing the SCT with no specific planning and reporting requirements, the Task Force established the SCT with few resources. In particular, although the SCT has been able to develop and sponsor a few synthesis reports, it has done fewer reports than needed because its members have limited time to develop the reports or organize other groups to develop them. The SCT has identified a list of over 50 topics—such as water quality and the extent and condition of wetlands in the ecosystem—for which synthesis reports are needed. Yet, these reports, as well as several of the SCT's other responsibilities, have not been done in part because the SCT does not have full-time management staff to lead efforts

[19]This area of land is to the northeast of Everglades National Park and is called the "8.5 square mile area."

or full-time or part-time scientists to fulfill its primary responsibilities. Only two agencies—the Geological Survey and the South Florida Water Management District—have allocated some staff time for SCT duties. Furthermore, until recently, the SCT did not have any support staff.

Because the SCT must rely on volunteer efforts, most of its work has been accomplished by a few of its members. The SCT generally meets about four to six times per year, and SCT members stated that they have little or no time between meetings to devote to SCT tasks. SCT business has been conducted by a core group of people, who accept projects in addition to their workload at their respective agencies. SCT members and other scientists noted that voluntary efforts are increasingly limited by the growing number of meetings that scientists are expected to attend for restoration activities. In particular, scientists are expected to participate in individual project meetings for the Comprehensive Everglades Restoration Plan and other meetings to develop scientific information for restoration efforts. In contrast to the SCT's efforts, the RECOVER program, which has six subteams that are chaired and provided with full-time staff and $10 million to support monitoring efforts, has met multiple times a year since it was created in 2000 to develop the monitoring and assessment plan for the Comprehensive Everglades Restoration Plan—a task that also falls under the SCT's broad responsibilities.

With its available resources, the SCT has, over the last 6 years, conducted several science workshops to coordinate information and activities among scientists. These workshops highlighted several important restoration issues including some that identify gaps in scientific information, such as contaminants, agriculture, social sciences, and the habitat for the Cape Sable seaside sparrow, an endangered bird in and near Everglades National Park. The SCT also convened one science conference and one science forum to address overall ecosystem issues. A 1999 science forum focused on how to improve the interaction between scientists and managers and management issues that need to be addressed for restoration. However, in 2000, recognizing its inability to accomplish the other responsibilities in its charter given limited resources, the SCT reported to the Task Force that it could not accomplish most of its key responsibilities, such as science planning. Instead, the SCT identified the five priority activities and issues that it could address with available resources and presented these to the Working Group and the Task Force. These five were water quality, water flow, organization of science conferences, support of CROGEE, and evaluation of science related to the Comprehensive Everglades Restoration Plan.

In 2003, the Task Force partially addressed the SCT's request for resources. According to Task Force officials, it did not provide resources for the SCT when it was originally established in an effort to keep costs down. Recognizing the limits placed on the SCT's ability to plan for and coordinate scientific activities, 6 Working Group agencies have recently agreed to provide a total of $150,000 for fiscal year 2003 for one full-time and one or more part-time staff to provide administrative and logistical support to the SCT.[20] According to SCT members, such forms of assistance will help the SCT in accomplishing its tasks, but still do not provide management resources to allow the team to complete the broad responsibilities, laid out in the charter, that are needed to coordinate scientific activities for restoration. In addition, in recognition of the threat of invasive species to restoration success, the Task Force has assigned a full-time scientist to coordinate and plan related efforts for South Florida. To help coordinate invasive species activities, the Task Force also developed the Noxious Exotic Weeds Task Team and plans to create the Noxious Exotic Animal Task Team.

In comparison, leaders of other large ecosystem restoration efforts—the San Francisco Bay and Chesapeake Bay area efforts—have recognized that significant resources are required to coordinate science for such efforts. These scientists and managers stated that their coordination groups have full-time leadership (an executive director or chief scientist), several full-time staff to coordinate agencies' science efforts and develop plans and reports, and administrative staff to support functions. In addition, members of the Florida Bay restoration—which represents a part of the overall South Florida restoration initiative—noted that they could not have developed their science plan without a full-time executive director because, like SCT members, they have many restoration meetings to attend and full-time job responsibilities within their agencies to fulfill. Further, RECOVER program leaders stressed the importance of full-time scientists devoted to the development of their monitoring and assessment plan.

[20]As of February 2003, the agencies had each provided $25,000.

## Conclusions

The restoration of varied, important ecosystem functions is a complex undertaking that depends on the science activities of many federal and state agencies. Because no one agency conducts scientific work that supports all the restoration goals, coordination of the disparate science activities of the different agencies is necessary to ensure that gaps in information do not exist and that scientific information is synthesized and provided to managers. Furthermore, because the restoration of the ecosystem is expected to occur over several decades, coordination of scientific efforts and continuity in their orchestration are critical to ensure that information related to restoration efforts is updated and made available for restoration decisions and that indicators are monitored to determine progress toward restoration. Many agencies have already spent considerable funds to develop scientific information to support restoration decisions, a trend that is expected to continue. Yet, the SCT—the group created to coordinate scientific information for the restoration—is limited by a number of factors. First, the SCT is limited by the lack of clear direction on what it is to accomplish. Second, it has no processes to ensure (1) that the Task Force identifies key management issues that need to be addressed in science planning and (2) that the SCT, the Working Group, and the Task Force prioritize critical science issues requiring synthesis in order to provide input into restoration decisions. One such process used by other restoration initiatives utilizes an advisory group to review science plans and reports. Third, the SCT lacks resources to adequately carry out its responsibilities. While the Task Force's Working Group plans to provide administrative resources to the SCT, these resources would not sufficiently bolster the SCT to carry out its most important planning and reporting responsibilities. Until the factors limiting the SCT are addressed, coordination of scientific activities cannot be improved. As a result, opportunities to help ensure that (1) scientific gaps are filled, (2) progress toward restoration is monitored, and (3) adjustments to restoration projects are made where needed will be limited. Without effective coordination of scientific activities, the Task Force has scant assurance that the scientific information needed to make key restoration decisions will be available, decreasing the likelihood that restoration of the South Florida ecosystem will be successful.

## Recommendations for Executive Action

In order to improve the coordination of scientific activities for the South Florida ecosystem restoration initiative, we recommend that, as chair of the Task Force, the Secretary of the Interior

- specify the plans and documents—including a science plan focused on key information gaps, a comprehensive monitoring plan, and progress reports for each plan—that the SCT needs to complete and the time frames for completing them;
- establish a process that ensures the Task Force identifies key management issues that need to be addressed by science planning;
- establish a process, such as review by an advisory group, to ensure that the SCT, Working Group, and Task Force prioritize issues that require synthesis and are critical to restoration decisions; and
- evaluate the SCT's current staffing needs and allocate sufficient staff, including full-time management staff, to the SCT so that it can carry out its responsibilities.

## Agency Comments and Our Response

We provided a draft of our report to the Department of the Interior, whose secretary chairs the South Florida Ecosystem Restoration Task Force, for review and comment. Interior provided us with written comments, which are included in appendix III of this report. Overall, Interior agrees with the major premises of the report that improved coordination among the agencies is necessary and that the Task Force needs to clarify the responsibilities of the SCT and address our other recommendations. Although we did not get formal comments from the other Task Force agencies, we met with representatives of the agencies involved in the restoration effort and discussed our findings and recommendations with them, and Interior consulted them in preparing its written response. Interior noted, however, that the Task Force could not address these recommendations while the report was still in draft because doing so would have led to the premature disclosure of its contents. For this reason, Interior stated that the Task Force would, upon public release of the report, discuss the recommendations and make the ultimate decision on the role of the SCT and on the actions needed to meet our recommendations. Interior also provided several technical changes that we incorporated into the report, as appropriate.

Although Interior stated that it agrees with the premise of our report that scientific activities and information need to be better coordinated, it expressed reservations about our characterization of the role of the Task Force in the restoration. In particular, Interior emphasized that the Task Force has no legal authority to "manage" the restoration efforts and cautioned that the GAO report could be interpreted as indicating the Task Force can dictate executive action to its member agencies. We agree that the Task Force's role in relation to its member agencies is limited—and point this out in our report—and that its role is to coordinate and facilitate restoration activities. We believe that our report and recommendations are consistent with the authority given the Task Force to "coordinate the development of consistent policies, strategies, plans, programs, projects, activities, and priorities" for addressing the restoration of the South Florida ecosystem. The Task Force created the SCT specifically to coordinate scientific activities for the restoration, and our report identifies issues that prevent the SCT from carrying out its responsibilities. Precisely because the restoration will be the result of diverse agency programs, as Interior points out, we believe that the specific science documents that we recommended are necessary to coordinate consistent policies, programs, activities, and priorities among the multiple agencies conducting scientific activities in South Florida for restoration. Further, we believe that Interior underestimates the role that the Task Force has to act as a forum for coordination to further the cause of restoration. Namely, the Task Force and its Working Group—made up respectively of agency policy and decision makers—can and should use the forum to jointly focus on key restoration issues, including science, and to resolve differences that prevent progress in achieving restoration.

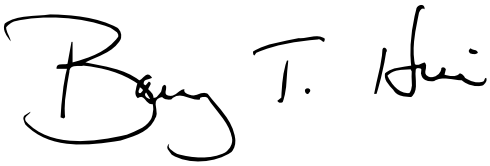
Concerning the coordination of scientific activities in particular, Interior said that the report does not adequately acknowledge existing processes that are being used to obtain scientific information for restoration decisions. For example, Interior pointed to mechanisms provided to help implement the Comprehensive Everglades Restoration Plan developed by the Corps of Engineers and the South Florida Water Management District. Specifically, Interior mentioned the Corps' pilot projects to investigate uncertain technologies and the adaptive management program described in the Corps' draft programmatic regulations for the plan. However, in discussing the several different groups that exist to coordinate or manage various aspects of science for restoration, we included a discussion of the RECOVER program that is the basis for the Corps' adaptive management program. In particular, we acknowledged that this program has developed a monitoring and assessment plan that will help determine if the water in the

ecosystem is being restored and whether wetlands are being restored. We also discussed the Project Delivery Teams that will help to coordinate scientific information for each of the 55 projects in the Comprehensive Everglades Restoration Plan. We clearly discussed these matters in the report while at the same time making our point that similar mechanisms have not been developed for programs other than the Comprehensive Everglades Restoration Plan, such as the Multi-Species Recovery Plan or the exotic plants plan. We did make one clarification in this section, based on technical comments from Interior, by adding a statement that RECOVER has developed the only systemwide monitoring and assessment plan for the restoration.

As a second example of the efforts to obtain scientific information, Interior pointed to its own, developing science plan for South Florida. Interior stated that its plan, if successful, may serve as a model for other Task Force agencies in managing their science programs. We agree that Interior's plan may serve as a model, if successful. In fact, we suggested in our report that Interior's approach to developing its science plan could serve as an example for the Task Force, Working Group, and SCT to follow in developing a science plan for the restoration. We also agree that the agencies should be encouraged to develop clear science plans related to restoration and their other activities. However, even with the development of agency science plans, the actions we recommend—such as a science plan to fill gaps, a comprehensive monitoring plan, and progress reports for each plan—continue to be needed for coordination of the diverse activities that are being and will continue to be pursued.

As arranged with your office, unless you publicly announce the contents earlier, we plan no further distribution of this report until 8 days after the date of this letter. At that time, we will send copies to interested congressional committees and members; the Secretary of the Interior; the Secretary of the Army; the Secretary of Commerce; the Secretary of Agriculture; the Administrator, EPA; and the Governor of Florida. We will make copies available to others upon request. This report will also be available at no charge on GAO's Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841. The key contributors to this report are listed in appendix IV.



Barry T. Hill
Director, Natural Resources and Environment

# Objectives, Scope, and Methodology

To determine the amounts and purposes of federal science funding for the South Florida ecosystem restoration, we collected funding information, for fiscal years 1993 through 2002, from headquarters and field officials of the key federal and state agencies involved in restoration science. The key agencies providing restoration science funding are the U.S. Army Corps of Engineers; the Department of Agriculture's Agricultural Research Service; the Department of Commerce's National Oceanic and Atmospheric Administration; the Department of the Interior's National Park Service, U.S. Geological Survey, Bureau of Indian Affairs, and Fish and Wildlife Service; the Environmental Protection Agency; and the South Florida Water Management District. We asked each agency to provide data on appropriations, obligations, and expenditures for the categories of restoration science—research, monitoring, and environmental assessments. We then converted the data to 2002 constant dollars. Some agencies provided estimates because they do not separate funding for (1) the three categories—research, monitoring, and environmental assessments—or (2) South Florida as opposed to mission-related science that may also benefit other restoration efforts as well. Although we did not independently verify the data's accuracy, we compared the data with other funding reports in an effort to identify inconsistencies. We also worked with the agencies while they prepared their data to increase reporting consistency among the agencies. We resolved all substantive inconsistencies with agency budget and program officials.

To determine what gaps in scientific information exist, we identified 10 important restoration projects and plans and interviewed key managers and scientists involved in them. We initially selected projects or plans that cost over $100 million and from that group selected projects that were underway or expected to be finished by 2005 in order to ensure that enough time has passed to identify and begin developing necessary scientific information. We also selected projects and plans from different locations (e.g., Florida Bay and Kissimmee River) in the ecosystem and some that affected the entire ecosystem (e.g., the exotic plants plan). This resulted in seven projects for our review. Finally, we added three projects to our list to ensure broad coverage of the Corps' pilot program approach and the Task Force's restoration goals, which otherwise would not have been included in our review: a pilot project and its related project under the Corps' Comprehensive Everglades Restoration Plan (Biscayne Bay Coastal Wetlands project and Wastewater Reuse Pilot project) and a project that supports the South Florida Ecosystem Restoration Task Force's third goal of restoration (Florida Keys Carrying Capacity Study). To identify information gaps based on the 10 projects and plans, we analyzed project

documents—such as those from the Corps of Engineers—to determine what information was being developed. We discussed the projects and information needs with project managers and key scientists involved with the projects. To identify information needs for restoration plans, we discussed the plans with appropriate agency officials and analyzed more detailed documents related to the plans. The 10 projects and plans we reviewed are a subset of the more than 200 restoration projects and the analysis is not meant to be generalized to the remaining projects.

To assess the process used to coordinate scientific activities and information for the restoration effort, we identified the groups that have responsibility for coordination. We reviewed and analyzed documents, such as charters and management plans that describe the purpose and goals for each of these groups. We interviewed the leaders of the different groups to discuss the coordination efforts undertaken by each group. In addition, we identified several similar restoration efforts and reviewed relevant documents and interviewed science managers for these groups to compare and contrast the organizations, abilities, resources, and staffing for all the efforts. The other restoration efforts we identified were the Florida Bay restoration effort, which is part of the overall South Florida restoration; the restoration of the Sacramento and San Joaquin Rivers and San Francisco Bay, called the CALFED restoration; and the restoration of the Chesapeake Bay, called the Chesapeake Bay Program.

We conducted our review from April 2002 through February 2003 in accordance with generally accepted government auditing standards.

# Expenditures for Federal and State Agencies for the South Florida Ecosystem Restoration

**Table 5: Expenditures for Federal and State Agencies for the South Florida Ecosystem Restoration Initiative, Fiscal Years 1993-2002**

Dollars in millions[a]

| | Expenditures | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agency** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **Total 1993-2002[c]** |
| **Department of Commerce** | | | | | | | | | | | |
| National Oceanic and Atmospheric Administration | 1.5 | 2.1 | 2.8 | 3.1 | 5.1 | 4.8 | 5.2 | 4.3 | 4.3 | 4.1 | **37.1** |
| **Department of Agriculture** | | | | | | | | | | | |
| Agriculture Research Service | 3.3 | 3.5 | 2.4 | 2.3 | 2.2 | 3.5 | 4.3 | 4.3 | 4.2 | 4.8 | **34.9** |
| **Department of Defense** | | | | | | | | | | | |
| Army Corps of Engineers | 0.0 | 1.7 | 2.8 | 0.0 | 6.1 | 2.1 | 3.5 | 4.4 | 5.5 | 11.2 | **37.5** |
| **Department of the Interior** | | | | | | | | | | | |
| U.S. Geological Survey | 2.2 | 2.9 | 7.5 | 11.7 | 9.4 | 9.2 | 9.0 | 8.4 | 8.4 | 8.5 | **77.2** |
| National Park Service | 0.0 | 0.0 | 0.0 | 0.0 | 6.8 | 10.1 | 6.1 | 11.2 | 8.5 | 5.3 | **48.1** |
| Fish and Wildlife Service | 0.4 | 0.7 | 0.8 | 0.9 | 1.2 | 1.1 | 1.1 | 1.3 | 1.1 | 1.2 | **10.0** |
| Bureau of Indian Affairs | 0.0 | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | **3.4** |
| **Environmental Protection Agency[b]** | 1.2 | 2.3 | 3.0 | 3.5 | 3.2 | 4.4 | 2.5 | 2.1 | 1.7 | 0.8 | **24.7** |
| **Federal Total[c]** | **8.7** | **13.2** | **19.9** | **21.8** | **34.4** | **35.6** | **32.1** | **36.5** | **34.2** | **36.4** | **272.8** |
| **State of Florida** | | | | | | | | | | | |
| South Florida Water Management District | 19.2 | 25.5 | 27.5 | 27.4 | 26.4 | 30.5 | 31.1 | 37.6 | 31.9 | 45.7 | **302.8** |
| **Total Federal and State Funding[c]** | **27.8** | **37.0** | **47.4** | **49.2** | **60.8** | **66.1** | **63.2** | **74.1** | **66.0** | **82.1** | **575.6** |

Source: Federal agencies (data), GAO (analysis).

[a]All dollars have been adjusted to constant fiscal year 2002 dollars.

[b]Not included under the Environmental Protection Agency's funding are its Clean Water Act grants and its Science to Achieve Results (STAR) grants, which total approximately $10 million and $13 million respectively. The agency's Clean Water Act grants are provided for research, monitoring, and assessments of water quality in South Florida. Some of the agency's STAR grants are provided for ecosystem research in South Florida.

[c]The sum of the agency dollars may not equal the totals due to rounding.

**Table 6: Expenditures by Federal and State Agencies for Research, Monitoring, and Assessment Activities, Fiscal Years 1993-2002**

Dollars in millions[a]

| | Expenditures | | | |
|---|---|---|---|---|
| **Agency** | **Research** | **Monitoring** | **Assessment** | **Total 1993-2002[c]** |
| **Department of Commerce** | | | | |
| National Oceanic and Atmospheric Administration | 31.5 | 5.6 | 0.0 | **37.1** |
| **Department of Agriculture** | | | | |
| Agriculture Research Service | 34.9 | 0.0 | 0.0 | **34.9** |
| **Department of Defense** | | | | |
| Army Corps of Engineers | 18.7 | 14.5 | 4.2 | **37.5** |
| **Department of the Interior** | | | | |
| U.S. Geological Survey | 45.9 | 8.1 | 23.1 | **77.2** |
| National Park Service | 26.3 | 9.3 | 12.5 | **48.1** |
| Fish and Wildlife Service | 0.0 | 10.0 | 0.0 | **10.0** |
| Bureau of Indian Affairs | 3.4 | 0.0 | 0.0 | **3.4** |
| **Environmental Protection Agency[b]** | 5.7 | 16.4 | 2.6 | **24.7** |
| **Federal Total[c]** | **166.4** | **63.9** | **42.4** | **272.8** |
| **State of Florida** | | | | |
| South Florida Water Management District | 80.6 | 141.3 | 80.9 | **302.8** |
| **Total Federal and State Funding[c]** | 247.0 | 205.2 | 123.3 | **575.6** |

Source: Federal agencies (data), GAO (analysis).

[a]All dollars have been adjusted to constant fiscal year 2002 dollars.

[b]Not included under the Environmental Protection Agency's funding are its Clean Water Act grants and its Science to Achieve Results (STAR) grants, which total approximately $10 million and $13 million respectively. The agency's Clean Water Act grants are provided for research, monitoring, and assessments of water quality in South Florida. Some of the agency's STAR grants are provided for ecosystem research in South Florida.

[c]The sum of the agency dollars may not equal the totals due to rounding.

# Comments from the Department of the Interior

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

FEB 19 2003

Mr. Barry T. Hill
Director, Natural Resources and Environment Team
U.S. General Accounting Office
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Hill:

The Department of the Interior appreciates the opportunity to review the General Accounting Office (GAO) draft report entitled *South Florida Ecosystem Restoration: Task Force Needs to Improve Science Coordination to Increase the Likelihood of Success* (GAO-03-345).

We appreciate the focus the report provides on Everglades science programs, which are integral to guiding the four-decade intergovernmental restoration effort to success. As steward of approximately one-half the remaining Everglades, the Department agrees with the GAO that improved coordination among multi-agency science programs is necessary. In doing so, agencies will maximize resources, avoid duplication of effort, share scientific expertise and ensure that the highest priority scientific needs are addressed in a timely fashion. Proper coordination of science programs will ensure that the best available science is incorporated into decision-making and that monitoring and assessment functions are based upon sound scientific principles.

Everglades restoration is a complex undertaking that will take place over the next four decades, with many factors contributing to the total effort. It is therefore not surprising that gaps remain in the scientific understanding of how certain projects should be designed, or work together, to achieve a restored Everglades ecosystem. As agencies move forward with implementing the many projects that collectively comprise the Everglades restoration effort, we agree with GAO that project-specific gaps need to be filled to ensure that projects perform as anticipated and contribute toward restoration.

Although we agree with the major premises in the report, we have some concerns that the report does not adequately acknowledge existing processes to obtain scientific information (and fill scientific gaps) for ongoing Everglades restoration projects. For example, the Comprehensive Everglades Restoration Plan (CERP) provides mechanisms to address gaps in scientific information. Although only recently authorized, CERP is based upon nearly two decades of scientific inquiry associated with understanding the natural hydrology of the Everglades. In large part, CERP is meant to improve the quantity, quality, timing and distribution of water for the Everglades natural system. This in turn is anticipated to result in improved ecological

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performance, thereby facilitating achievement of the three primary Everglades restoration goals, which are generally described in the report. Despite the scientific basis upon which CERP was developed, specific questions remain on the performance of certain CERP features, particularly aquifer storage and retrieval and wastewater reuse, and how best to implement individual CERP component features, both authorized and those requiring future authorization.

The Department anticipates that the Corps of Engineers' pilot projects, which will investigate uncertain technologies and planning processes, will address the gaps in information in an orderly way so that sufficient scientific information is available prior to finalizing project-specific designs, or before additional projects are submitted to the Congress for future authorization. Additionally, CERP implementation procedures, including an adaptive management program, are described in the Corps of Engineers' draft programmatic regulations, which were released to the public last summer and are anticipated to be finalized later this year. For example, the draft regulations specifically implement the requirements of the Water Resources Development Act of 2000 (P.L. 106-541), which requires processes to, among other things, *"ensure that new information resulting from changed or unforeseen circumstances, new scientific or technical information or information that is developed through the principles of adaptive management contained in the Plan, or future authorized changes to the Plan are integrated into the implementation of the Plan"* (emphasis added). The processes proposed by the programmatic regulations ensure that sufficient scientific information will be acquired and integrated into CERP decision-making, monitoring and assessment protocols will be established, and management actions will be based upon this information so that restoration is achieved.

To assist the Corps' efforts to implement CERP, as well as implement other ongoing projects to achieve Everglades restoration goals concerning habitat restoration and recovery of endangered species, we are improving the coordination of our own science programs through the development of a Department of the Interior Science Plan.

Our science plan is a direct result of improved coordination among Interior bureaus. Last year, the U.S. Geological Survey, the National Park Service, the Fish and Wildlife Service and the Department executed a Memorandum of Understanding to coordinate Everglades science programs. The Department's science plan will support the needs of the National Park Service and Fish and Wildlife Service - our land managing agencies - in implementing Everglades restoration programs, including CERP. The science plan is being developed under the leadership of the Geological Survey and will identify the issues that must be resolved through further scientific inquiry for each restoration project underway. Once the issues are identified, the plan will describe the adequacy of the scientific information gathered to date, any gaps that remain, and a strategy to acquire sufficient scientific knowledge so that agency decisions may be based upon sound science. As part of this effort, the Geological Survey will coordinate our science with our federal, tribal and state partners by establishing the Greater Everglades Science Coordination Council. The Council's first meeting is this month and we hope to have the science plan completed by the end of the first half of this year. If we are successful, our science plan may

serve as a model to other Task Force agencies who also manage science programs contributing to the restoration effort. Additionally, to improve coordination among Interior bureaus, the FY 2004 President's Budget proposes to consolidate our Everglades science program funding under the Geological Survey.

While we agree that improved coordination of scientific activities for the South Florida ecosystem restoration initiative is necessary, we also have some concerns with the report's characterization of the role of the Task Force. As you know, Section 528 of the Water Resources Development Act of 1996 (P.L. 104-303, "WRDA 1996") established the intergovernmental South Florida Ecosystem Restoration Task Force and its Florida-based Working Group to, among other things, coordinate consistent policies, strategies, plans and programs to address the restoration, preservation and protection of the South Florida ecosystem. The Secretary of the Interior is designated by statute as Task Force chair. Specifically, WRDA 1996 provides, in relevant part, that the Task Force:

> *(B) shall coordinate the development of consistent policies, strategies, plan, programs, projects, activities, and priorities for addressing the restoration, preservation, and protection of the South Florida ecosystem;*
>
> *(C) shall exchange information regarding programs, projects, and activities of the agencies and entities represented on the Task Force to promote ecosystem restoration and maintenance;*
>
> *(D) shall establish a Florida-based working group which shall include representatives of the agencies and entities represented on the Task force as well as other governmental entities as appropriate for the purpose of formulating, recommending, coordinating, and implementing the policies, strategies, plans, programs, projects, activities, and priorities of the Task Force;*
>
> ...
>
> *(G) shall coordinate scientific and other research associated with the restoration of the South Florida ecosystem;*

Although the Task Force plays a key coordination role, it does not have the legal authority to "manage" the restoration effort. Nor does it direct any specific programs, including scientific research. These are instead encompassed within the diverse agency programs that collectively contribute to a restored Everglades. Each Task Force member retains its authority to manage the programs for which it is responsible and brings its unique expertise and perspective to the entire group. This forum allows policy representatives to further collaboration among the federal, state and tribal parties to achieve common restoration goals. This distinction is important. We are concerned that the GAO draft report could be read as indicating the Task Force is "in charge" of the restoration effort or can dictate executive action to its member agencies.

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The draft GAO report recommends that the Task Force clarify the broad responsibilities of the Science Coordination Team or SCT, by specifying the plans and documents, including a science plan to focus on information gaps, a comprehensive monitoring plan, and progress reports for each plan, the SCT needs to complete. Additionally, the report recommends that the Task Force evaluate the SCT's staffing and personnel needs so that the SCT may carry out is responsibilities. Further, the draft report also recommends that the Task Force establish a process to ensure that key management issues requiring science planning are identified and that scientific issues are synthesized.

We agree that the responsibilities of the SCT can be clarified and that these issues should be addressed by the Task Force. However, we note that the ultimate decision on the role of the SCT, as well as the other recommendations for executive action contained in the report, must be made by the Task Force, rather than the Department of the Interior. We agree to raise these issues with the Task Force to determine how best to proceed.

Although our comments on the draft report are informed by the views of our South Florida Ecosystem Restoration Task Force (Task Force) colleagues, we are not responding on behalf of the Task Force. To do so would require the Task Force to disclose the contents of the draft report, which was not possible given the limits placed on its distribution. However, as soon as the report is publicly released, the Department looks forward to fully discussing the final report with the Task Force. We would appreciate the participation of GAO staff during that discussion so that the Task Force may fully address the report's recommendations for executive action and consider its response to the recommendations.

The Department appreciates the opportunity to provide comments on the GAO draft report. More specific comments are contained in the enclosure to this letter and certain technical comments have been provided directly to GAO staff. If you have any additional questions or need additional information, please contact Ann R. Klee, Counselor to the Secretary, at (202) 208-6182.

Sincerely,

Lynn Scarlett
Assistant Secretary
Policy, Management and Budget

Enclosure

# GAO Contact and Staff Acknowledgments

## GAO Contact

Chet Janik (202) 512-6508

## Acknowledgments

In addition to the person named above, Susan E. Iott, Jonathan McMurray, Beverly Peterson, Katherine Raheb, and Shelby D. Stephan made key contributions to this report.

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