Bringing Back the Everglades

Amid great scientific and political uncertainty, ecosystem managers in Florida are pushing ahead with the boldest—and most expensive—restoration plan in history

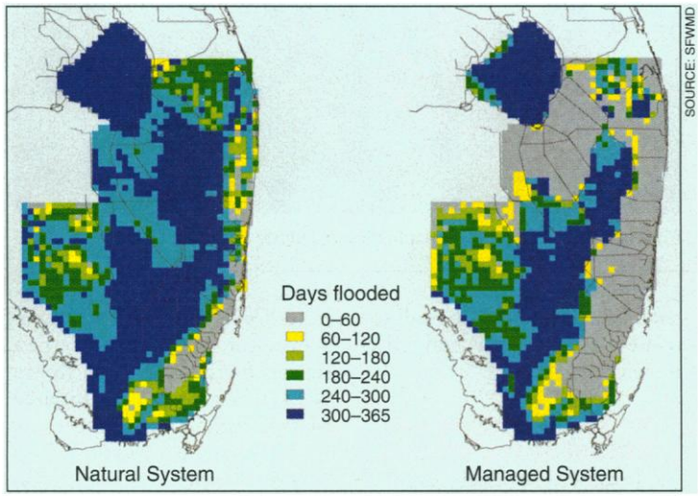
When steamships plied central Florida's Kissimmee River early in this century, passengers on ships traveling in opposite directions would spot each other across the marshes in the morning, then traverse the serpentine waterway for a full day before meeting. But in the 1960s, the U.S. Army Corps of Engineers straightened out the Kissimmee. In the name of efficiency and flood control, they dug 56 miles of straight canal to replace 103 miles of meanders—and destroyed at least 1.2 million square meters of wetlands in the process. The river was once home to flocks of white ibis; today it boasts the cattle egret, accompanying herds of cows grazing on the canal's linear banks.

But at one spot on the central Kissimmee, boats must again follow the twists and turns of the old river channel. The Corps is slowly putting the kinks back into the Kissimmee. By working with the state of Florida to restore the wetlands, they hope to bring back the invertebrates, fish, and, eventually, the wading birds that once nested here. With an estimated price tag of $370 million, this is the most ambitious river restoration in U.S. history.

It is, however, a mere drop in the watershed compared to plans for the rest of south Florida. Over the next 15 to 20 years, at a cost of roughly $2 billion, the Corps and state and other federal agencies plan to replumb the entire Florida Everglades ecosystem, including 14,000 square kilometers of wetlands and engineered waterways. It's an urgent task, planners say. For after decades of drainage, altered water flow, and pollution, the Everglades is dying, and as they go, so goes the region.

If wetlands that once replenished underground aquifers stay dry, cities may face future water shortages. Anoxic conditions threaten fish in Florida Bay, saltwater intrudes into marshes and drinking wells, and wildlife—including 55 endangered or threatened species—is at risk. "This is not rescuing an ecosystem at the last minute. This is restoring something that has gone over the edge," says George Frampton, assistant secretary of the Department of the Interior and chair of the federal interagency South Florida Ecosystem Restoration Task Force.

More than the ecology of southern Florida is at stake. Wetlands managers from Australia to Brazil are keeping a close eye on the project as they search for ways to restore their own ravaged regions. If planners can pull it off, the Everglades restoration will become a world model, says wetlands expert Joy Zedler of San Diego State University, who notes that most restorations "are the size of a postage stamp compared to the Everglades." James Webb, Florida regional director of the Wilderness Society and a member of the Governor's Commission for a Sustainable South Florida, puts it another way: "If we can't do it in the Everglades, we can't do it anywhere."



Remembrance of wetlands past. Before engineers redid its plumbing, more of the Everglades was flooded for more of the year *(left)*; the current situation *(right)* keeps cities and farms dry but hurts the natural ecosystem.

The overall goal of the restoration is to take engineered swampland riddled with canals and levees and transform it into natural wetlands that flood and drain in rhythm with rainfall. Planners hope the entire ecosystem—plants and animals—will blossom as a result. "Wet it and they will come" is the unofficial motto. But because no one understands all the complex ecology involved, planners must accept a hefty dose of scientific uncertainty. "We really don't know what we're going to get out there," says biologist John Ogden of Everglades National Park. And the Corps and the South Florida Water Management District (SFWMD), cosponsor of the restoration, still haven't come up with a final blueprint for the replumbing.

The other big unknown in the Everglades is political. Would-be rescuers represent a surprisingly broad coalition of interests and money, from federal and state agencies to environmentalists and urban developers, who want a steady water supply. But holding such a diverse coalition together over the planned life of the project will be tricky. Moreover, the steep price tag—of which one third is supposed to come from the federal budget—and extensive federal involvement run counter to Washington's current budget-cutting mood. Indeed, some of the agencies now contributing expertise and money, such as the National Oceanic and Atmospheric Administration, are high on the list of candidates for political extinction (*Science*, 19 May, p. 964). "We have the technical knowledge to do the restoration," says Ogden. "But I worry about sustaining the political will."

A river of grass

In the late 1800s, when fewer than 1000 people lived in what are now Dade, Broward, and Palm Beach counties, water spilled over the banks of Lake Okeechobee in the wet season and flowed lazily southward to Florida Bay. This was the "River of Grass," a swath of saw grass and algae-covered water 50 miles wide and only a foot or two deep. People found the vast swamp inhospitable—too wet and too many bugs—but its mosaic of wetland habitats supported a stunning diversity of animals and plants, including huge colonies of wading birds.

Then the human migration to Florida began. In order to make the River of Grass and adjacent marshlands suitable for cities and agriculture, about half of the Everglades was drained in successive waves of development starting early this century. The mammoth flood-control project, built by the Corps at the behest of the state of Florida, transformed the hydrology of both public and private lands. Today, water is channeled swiftly through 1600 kilometers of canals and 1600 kilometers of levees, stored in parks called "water conservation areas," and partitioned by countless water-control structures. The River of Grass is interrupted by the world's

largest zoned farming area, the Everglades Agricultural Area (EAA), south of Lake Okeechobee. To prevent flooding, "extra water" is diverted east and west to the Gulf of Mexico and the Atlantic Ocean. The whole system is completely artificial, says Lewis Hornung, a Corps engineer responsible for undoing much of the work of his predecessors on the Kissimmee.

The old Corps engineers recognized that their work would alter the natural world, says Hornung. But no one predicted the devastating effects. For example, hundreds of thousands of birds once nested around the headwaters of the Shark River in the southern Everglades. But as water was drained away further north, the marshes dried out more often, salinities rose—and the birds left. Throughout the Everglades, wading-bird populations are down by 90%. All other vertebrates, from deer to turtles, are down from 75% to 95%, says Ogden. "What we have out there is not the Everglades," he says. "It's a big wet area with spectacular sunsets, but functionally it's not working at all. The animal life in many places is no better than you'd see in roadside ditches in Florida in the summer."

The best laid plans

The good news is that hydrological damage may be reversible, explains ecologist Lance Gunderson of the University of Florida. "It's all there except the water. ... If we redo the hydrology, it will explode," says Richard Ring, superintendent of Everglades National Park.

But will the flora and fauna come back? Anecdotal reports from marshes in the northern part of the park suggest that the wetlands do indeed revive when fresh water returns, says Steve Davis, senior ecologist at the SFWMD. "And it's sort of common sense," adds Robert Johnson, chief hydrologist at the national park. "Wetlands need to be wet." Still, to date scientists can't cite the results of any large-scale reflooding study to prove this point. Says Ogden: "Hydrological restoration doesn't equal ecological restoration. This is a big uncertainty, and we need to design flexible plans to deal with it."

Plans are already shifting. In late 1994, the Corps released a preliminary study that outlined six alternatives for revamping the hydrology, although they didn't endorse any specific option. Planners now say none of the six is likely to be the solution, admits Stuart Appelbaum, who directs the Corps' Everglades planning process. There's simply no consensus yet on exactly how to increase water storage and flow while guarding against floods. Nor have restorers made tough decisions about which lands to acquire from private owners for water management. The Corps has gone back to its planning; Appelbaum says a coordinated restoration blueprint is due in 6 years.

Frampton and others want a plan sooner. But in the meantime, restorers point to three smaller, independent hydrological efforts that are already entering construction. One is the Kissimmee. A second project will funnel more water to Shark Slough in the northeastern part of Everglades National Park, and a third will create a buffer strip between wetlands and drained crop fields along the park's eastern border. "At least there are three projects you can point to that are more than just words or paper, where things are actually happening," says Colonel Terrence "Rock" Salt, executive director of the federal task force.

PHOTOS BY SFWMD

River test bed. Last year, as part of the Kissimmee River test restoration, high embankments were lowered *(left)*. By last month, the area (shown at right from a different angle) had been transformed back into a flood plain, and patches of wetland vegetation began to recolonize it.

These planners are using an approach they call "adaptive management," which basically means learning by doing. For example, as part of reflooding Shark Slough, Hornung's crew needs to move water from one water-conservation area to another. To do so, he could either build a canal—which models say is more efficient—or simply tear down the levee between the areas. He's experimenting by degrading part of the levee and watching what happens.

To researchers, such experiments are nothing out of the ordinary, but admitting that the outcome is unknown is a new idea for engineers accustomed to having a plan and sticking to it, says Salt. "In our legal system (and there have been many lawsuits over the Everglades already), uncertainty is an admission," says Davis of the SFWMD. "And now here we are starting off up front admitting and defining it."

Quality control

One thing ecologists do know is that water quality, as well as quantity, will be a crucial part of any restoration. Reflood the swamps with polluted water, and the historic system is unlikely to return. Says biologist Douglas Morrison of the National Audubon Society in Miami: "You can say, 'Wet it and it will grow'—but then the next question is what will grow?" In the Everglades, the answer is often cattails. These tall plants were once only a small part of Everglades vegetation, cropping up around high-nutrient areas like alligator holes. But today in some places, cattails nearly 4 meters tall completely blanket the wetlands, says ecologist Ronald Jones of Florida International University. "It's a massive conversion at the landscape level," agrees biologist Wiley Kitchens of the National Biological Service in Gainesville, Florida.

The culprit: phosphorus. The historic Everglades had extremely low concentrations of this nutrient, says Jones. Today, extra phosphorus enters the system from the EAA, where water used to irrigate fertilized sugarcane fields picks up a load of phosphorus, then is swiftly channeled to the water-conservation areas. There it spurs nutrient-loving vegetation like cattails and blue-green algae. Jones argues that to be true to the historic system, the Everglades needs very low levels of phosphorus—perhaps as low as 10 parts per billion. "The sugar growers say we want it cleaner than Perrier—and that's true, for phosphorus. That's just the character of the Everglades," he says.

Not surprisingly, the sugar growers are unconvinced. "Ten parts per billion—what's the basis for that? Parts of the Chesapeake Bay watershed are at around 400 ppb," says Peter Rosendahl, vice president of environmental communications at Flo Sun, one of the major sugar companies. He points out that no one really knows how much phosphorus the Everglades can handle; studies are under way now. "There's no real reason to believe that extra nutrients are the cause of the decline in the Everglades," he says.

A partial solution to the problem, one mandated by an act passed by the state legislature last year, calls for a ring of artificial marshes around the EAA to filter phosphorus from the water. A test marsh full of cattails is already up and running.

There are other thorny water quality issues, however. Chief among them is mercury, which is mysteriously contaminating fish and wildlife in the heart of the remote Everglades, to the point that fishers are advised not to eat their catch. So far, no one knows where the mercury is coming from or just how much damage it's causing, says Dan Scheidt, south Florida coordinator at the Environmental Protection Agency. But

whether the issue is phosphorus or mercury, it's increasingly clear that specific goals for water quality will have to be addressed in the coordinated restoration plan. "We have some movement on the hydrology," says Salt. "But we haven't yet looked at water-quality issues holistically—and we need to."

Supporting the swamp

The depth of the political backing for the plan also concerns planners. In the current political climate, it's hard to count on ongoing federal commitments. Webb of the Wilderness Society worries that popular support is "like the River of Grass itself—miles wide and only a few inches deep." There's also the small matter of aligning dozens of government agencies and interest groups, from sugar-cane growers to Indian tribes. For example, sugar-cane researcher Barry Glasz of the Department of Agriculture says he doesn't even like the word "restore," because to him it suggests turning the clock back to a time before agriculture. Indeed, many environmental groups would like nothing better than to reduce the sugar industry's presence in South Florida. "The EAA has about half a million acres of sugar. We'd like to see maybe one third of that taken out of production and become wetland or water-retention areas," says Ron Tipton of the World Wildlife Fund.

On the other hand, surveys have shown strong public support for saving the Everglades, says Davis of the SFWMD. And urban planners and utility officials—who want to guard the water supply—agree with environmentalists that some hydrological restoration is needed. In the historic system, wetlands cached rainfall for months and so recharged the ground water of the Biscayne Aquifer, which supplies the thirsty cities of Florida's southeast coast, explains Tom Teets, water supply planner for the SFWMD. Now much of the rainfall is shuttled out to sea long before it seeps into the ground. Water supplies are adequate for the 4.1 million people who lived in Florida's urban southeast coast in 1990, but Teets and others worry about the 6 million expected to live there by 2010. "We get 60 inches of rainfall, but we can't retain it because the water has been managed poorly," says Jorge Rodriguez, deputy director of the Miami-Dade Water and Sewer Department. "So we feel everyone can benefit from restoration."

Adjacent to the test fill in the central Kissimmee, water is once again flowing through the ancient oxbow turns. The area affected is too small to see a large influx of wildlife, says Louis Toth of the SFWMD, the Kissimmee's resident biology expert. But vegetation is slowly colonizing the filled-in canal, and game fish are spawning in the newly restored flood plain. Whether uncertain science and precarious political support can engineer a similar recovery for the whole Everglades, however, is still too far downstream to see clearly.

–Elizabeth Culotta

CENTRAL EUROPE

State Department Lifeline to Be Cut

BUDAPEST—Immediately after the collapse of the Iron Curtain, Western countries were quick to set up programs of collaborative research to aid scientists in the former Soviet bloc. Half a decade later, official enthusiasm for these efforts has cooled considerably: George Soros' International Science Foundation is finding it hard to recruit new donors and has been criticized by some factions in Russia, and the European Union's INTAS program has had its funds severely cut after being attacked by politicians for excessive bureaucracy. Now a program run by the U.S. State Department to finance cooperative research with scientists in Central Europe is in danger of being axed entirely.

That would be "a tremendous loss," says Mary Agocs, a former grantee of the program who now teaches epidemiology in Hungary, funded by Atlanta's Centers for Disease Control and Prevention. "The amount of money per grant is not that large ... compared to the amount that came out of it," she says.

The research programs were set up during 1989–90 after the United States signed joint science and technology agreements with Hungary, Poland, Slovenia, and the former Yugoslavia and Czechoslovakia. The program was imperiled last year and was cut from $4.3 million to $3.5 million. (These funds are matched by the Central European nations themselves.) But it now looks certain that the State Department will not ask for a continuation of the program in its fiscal 1997 budget proposal, which will go to Congress early next year. Three State Department officials contacted by *Science*, who asked not to be named, confirmed that the program would be dropped. A reprieve would come only if Congress restores the funds—an exceedingly unlikely event.

"The State Department was under a lot of budget pressure," says a department official familiar with the program. "There was a feeling among people not on the science side of things" that the program was dispensable, he says. American embassy officials here, who manage the program, are dismayed at the cuts, pointing out that it benefits U.S. researchers too. "It's very unfortunate. It's not a give-away program," says Steve Taylor, science attaché at the Budapest embassy.

"It will be a heavy loss for the Hungarian scientific community and research in general."

—András Székács

But it's a greater hardship for the Central European researchers who have benefited from the program. "It's very upsetting that it should happen now, when it is running so smoothly," says Dora Groo, program manager of the U.S.–Hungarian Science and Technology Joint Fund Secretariat in Budapest, which reviews applications and disburses the grants. Hungary and Poland have the biggest pieces of the program, this year receiving $1.25 million and $900,000, respectively. Research grants were distributed for studies in basic sciences, environmental protection, biomedical research and health, agriculture, engineering, and energy and natural resources. The fund's managers are scrambling for ways to keep the program alive, hoping that the U.S. government will reinstate the money in the future. One option is to solicit corporate sponsors for the project.

The planned cuts would hit Hungary particularly hard. Hungary has a strong reputation for science and innovation in Central Europe, particularly in atomic energy and medicine. Environmental scientist Géza Kovács of Hungary's Research Institute of Soil Science and Agrochemistry says the planned cut in the program comes at a crucial time in his research. Kovács and his American collaborator just completed a study simulating the reaction of crops to various environmental conditions, such as heat, humidity, and carbon dioxide levels. Kovács had planned to apply for a new grant to apply this basic research to real-life problems. "But of course, without support, it cannot go anywhere," he says.

Hungarian researchers say the program provided the first opportunity they had to conduct studies without the interference of the state. "That's quite important in a country where connections and hierarchy have been more important," says environmental researcher András Székács of the Plant Protection Institute. The impending program cuts "are more of an amputation," he says. "It will be a heavy loss for the Hungarian scientific community and research in general," he says.

–Susan Milligan

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