# Nurturing Nature

by Marguerite Holloway, *staff writer*

They used to stretch for hundreds of miles as a tawny sea of saw grass. Metallic-looking plankton added a golden patina to the shallow, slowly moving water that flowed between hammocks of tall grasses and stands of white-barked, high-kneed cypress trees. Even now, at half their original size, the Everglades appear to stretch forever—gilded, green, punctuated by the white of an ibis or a pink roseate spoonbill. Nothing could seem more natural.

Yet the most important aspect of this unique ecosystem is anything but natural. Four great gates at the northern end of Everglades National Park and 1,400 miles of canals and levees determine the quantity of water that can enter the area. Sugarcane plantations and vegetable farms to the north and east use fertilizers and pesticides that determine the quality of that same water. Demands for agriculture, urban living and flood control have made the Everglades too wet in the wet season, too dry in the dry season, too rich in nutrient phosphorus and therefore too close to extinction.

Because control has undone the Everglades, it seems appropriate that chaos be their salvation. Biologists and engineers will try to recreate some of the irregularity of nature by, among other things, delivering water on an erratic schedule, putting uncontrolled, meandering curves into a straight canal and fostering botanic biodiversity rather than biomonotony. Thus, the formerly watery wilderness will be the locus of the largest and most expensive attempt at ecological restoration yet undertaken.

The fact that restoration is being attempted on such a grand scale is testament to the growing status and popularity of ecological restoration, a young field that already carries a heavy burden. Environmentalists, government officials and business managers increasingly perceive restoration as a way to undo ecological damage and to compensate for development. The practice encompasses such diverse efforts as

*Can we rebuild it? The field of ecological restoration is evaluating techniques to restore nature and is grappling with definitions of success*

removing nonindigenous plants, reintroducing endangered fauna, transforming canals that replaced rivers back into rivers and donning scuba gear to plant sea grass on the ocean floor. Converts have swelled the ranks of the Society for Ecological Restoration to 2,200; when it was established in 1989 the group had a mere 300 members. A peer-reviewed journal, *Restoration Ecology,* was launched last year.

Despite its newfound prominence, restoration remains controversial because it has raised profound and unresolved questions. The idea of restoration seems disarmingly simple at first, but the goals are elusive. If, for instance, scientists want to return an environment to its "natural" state, they need a full understanding of what that is, how the particular ecology is constantly changing and how human beings fit into it. No one has, or is likely to have, such insight. Given, then, that an exact reconstitution is not possible, should researchers—and society—be content with achieving a semblance? Should a restored system be self-sustaining, or should it be managed? Given such uncertainties, how is one to judge success?

These fundamental complexities are further complicated by political strategy and public policy. Some biologists believe the promise of restoration fuels destruction. They argue that such pledges encourage thoughtless development and exploitation: if people believe nature can be rebuilt, there is no harm in losing more of it. Other researchers see restoration as the only possible way society can respond to an already irreversibly impaired environment.

The Everglades will serve as the testing ground

***FLORIDA EVERGLADES** are drying up because they receive only about one fifth of the water that they did at the turn of the century. This unique ecosystem, which encompasses a saw-grass wilderness* (left) *as well as stands of cypress trees* (right), *will be the focus of perhaps the largest and most costly effort to restore an environment that has been attempted in the U.S.*

and battlefield where business leaders, government officials, biologists and the rest of the population address these questions on a vast scale. "The issue is so prominent, no one can afford not to have their name on it," comments Thomas V. Armentano, acting director of research at Everglades National Park. "If it works, it will be unprecedented."

## Just Add Water

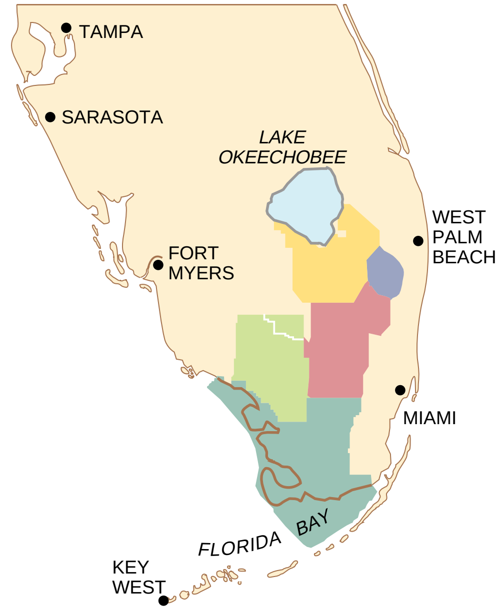
The starting point for restoration in southern Florida is water. As many conservationists working on the matter joke, the solution to the Everglades' problem is perceived as a *Field of Dreams* theme: if you water it, they will come. This sea-monkey, just-add-water approach derives from the hydrologic history of the region. Efforts at restoration began in the 1980s, when it became evident that the Everglades were drying up. Only one fifth of the water that used to reach the ecosystem at the turn of the century was getting there, often at the wrong times. Only 5 percent of the wading birds that used to nest in the wetlands were still doing so.

Development, which began in the early 1900s as areas were drained for farming in the peat-rich soil, has been, and continues to be, rapid and intense. Southern Florida has one of the fastest-growing populations in the country; domestic water consumption is also high at an average of 123 gallons per person per day. (The national average is 108 gallons per person per day.) The remaining two million acres of the Everglades are contained in the park, Big Cypress National Preserve, the Arthur R. Marshall Loxahatchee National Wildlife Refuge and several water conservation areas. Each site abuts residences or farms.

Most of the chaos that has been introduced into the ecosystem so far has been political, not scientific. In the years since the ecological threats became widely known, nearly every agency and special-interest group has been on one side or another of at least one lawsuit to promote or stall restoration. The largest case was brought in 1988 by the federal government against the state for failing to protect the water supply. Although the parties reached an agreement in 1991, sugar growers opposed it. A new compromise fell through in December 1993. (Ironically, because sugar is federally subsidized at between $1.4 billion and $3 billion a year, it appears that the federal government has paid many of the court costs against itself.)

Despite the haggling about who will pay and the unresolved, baroque questions about which agency will control what, several restoration projects are under way. The South Florida Water Management District, which regulates water use in the watershed and oversees the water conservation areas, has constructed a 3,700-acre wetland to remove nutrients from agricultural water.

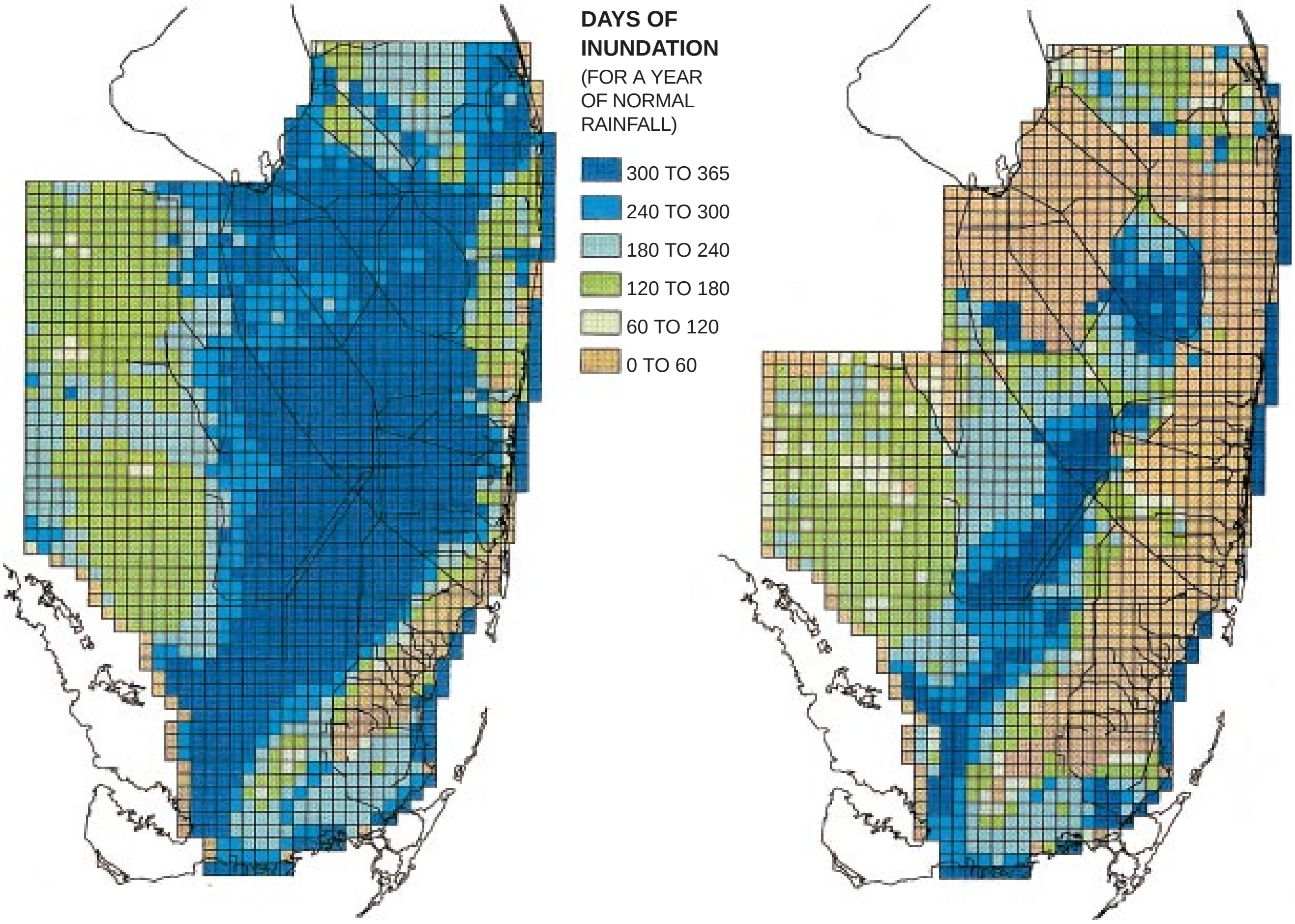
This runoff currently drains southeast into the wildlife refuge, where erect stands of cattails along the northern border attest to the influx of phosphorus. Although scientists debate the source of the mineral at some sites, the nutrient clearly fosters the growth of cattails. Cattails, in turn, replace saw grass and other indigenous plants, reducing floral diversity and habitat for waterfowl. The constructed marsh will turn cattails to advantage, using them to remove 75 percent of the phosphorus from incoming water.




The Everglades Nutrient Removal Project, as the marsh is called, constitutes the largest cleansing wetlands created in the U.S. Cattails and other plants used in the project are commonly employed in smaller-scale managed wetlands to purify water. Although conflicts in the approval process have held up the release of water, it is intended to serve as a demonstration. Similar facilities, covering a total of 40,000 acres, are also being planned to cleanse storm water.

Cleanup is not cheap. The cost of these efforts could reach $465 million or more, and it is this figure that makes many of the large sugar companies and farmers balk: under the most recent proposal, they would have been responsible for a total of between $232 million and $322 million over the next two decades. In January, however, Flo-Sun, Inc., reached an independent settlement and agreed to finance part of the cleanup. Given that many farms may not be around in several decades, the position of the holdouts makes some sense. Because growers keep the soil drier than it would normally be, the peat is being

**FOUR WATER-CONTROL GATES, including this one, punctuate the Tamiami Trail, which runs across southern Florida from east to west. The gates regulate the amount of water that flows south into Everglades National Park.**




**COMPUTER MODELS designed by the South Florida Water Management District will be used to plan water use in an effort to save the Everglades and simultaneously satisfy urban and agricultural needs. The natural system model (*left*) will illustrate how water moved in the region around 1900. The managed system model (*right*) shows how water flows now that the area is crossed by 1,400 miles of canals. The natural system model has not been fine-tuned, but the comparison of the two models in this simulation conveys the magnitude of development in the region and its effects on hydrology.**

oxidized and blown away at the rate of anywhere between one and three centimeters a year. Within a lifetime, many farmers may reach the limestone bedrock of southern Florida—at which point soil restoration may become the new focus of the region.

Scientists disagree on the relative importance of removing nutrients from the water or just getting the water back into the Everglades. Water formerly traveled over the area in a sheet that was sometimes as many as 60 miles wide and as much as a foot deep. Now it is ushered through a labyrinthine network of canals, pumping stations, locks and gates. Because the region's hydrology is so disturbed and there are so many demands for water, efforts to fix flow seem even more daunting than those designed to remove pollutants. Despite all the attention directed at the Everglades, the park only just recently received increased amounts of water. Armentano says the strategy is not working: the added water, which is coming into a slough from a canal to the east, is seeping right back out again.

Regional agencies have devised several long-term plans to address the hydrologic problems. Modelers at the South Florida Water Management District are writing computer programs to reconstruct how water traveled before the region was crosshatched by canals and levees. Once finished, this so-called natural system model will be superimposed on an existing model of how water currently flows. Researchers are also working to predict how hydrologic changes will affect vegetation.

Using these tools, experts hope ultimately to devise a politically acceptable and environmentally sound way to divide water in southern Florida, explains Jayantha T. B. Obeysekera, an engineer for the district. Such answers will not be available for a while. Models inevitably reveal the many gaps in data that have to be filled in by fieldwork. Furthermore, the graphic results must be viewed for what they are and with the same careful scrutiny that all the conflicting climatic change models garner. "It is like Disney World: it looks natural, but you go outside, and you realize it is not," Obeysekera cautions.

While modelers are trying to anticipate how the system could be manipulated, field engineers and biologists have been examining the feasibility of restoring the Kissimmee River. The Kissimmee was formerly a 103-mile-long rambling river that flowed south into Lake Okeechobee, which, in turn, sloshed into the Everglades. Together the river and the lake were responsible for the unique hydrology of the region. Like many rivers, the Kissimmee was unruly, inundating the wetlands adjacent to it, overflowing the lake after heavy rains, flooding farms, damaging property. So, between 1962 and 1972, the Army Corps of Engineers straightened it out. The Kissimmee is now a subdued, 56-mile canal called C-38.

Public opinion, however, proved less amenable to control. The army had only just completed its work when several groups, including the Fish and Wildlife Service and the Audubon Society—which had opposed the alignment in the first place—called for restoration. The conservationists, public and private, won their case, and the South Florida Water Management District was required to determine the feasibility of putting the curves back into the Kissimmee and water back onto its floodplains. The resulting study, as well as others, revealed that the loss of 30,000 acres of wetlands on either side of the river had diminished bird and fish habitat and had degraded water quality.

Between 1984 and 1989 the South Florida Water Management District conducted a demonstration project on 12 miles of the river to determine if restoration was indeed possible. "It would be the purest restoration project that I am aware of because it would eliminate any of man's interference in this area," yells Louis A. Toth, who directed the project. He and several colleagues are hovering above the project site in a helicopter, recording changes in vegetation that have taken place since they finished monitoring the project several years ago. A line of oaks a mile or so inland sketches the upper limit of the floodplain. The researchers see the succession they expected: in some sites, switchgrass is giving way to wax myrtle; willows are replacing woody species.

Toth is careful to emphasize that the project has not restored the floodplain—rather it shows that there is ecological benefit in trying to restore. As a pair of sandhill cranes dash through a marsh trying to escape the downdraft of the helicopter, Toth remarks that there was a 1,000 percent increase in the number of wading birds after reflooding: "It indicates that the species will return if there is further restoration." He also explains that it took nearly 20 years to develop a definitive goal for the project—a span that exceeds the lifetime of most restoration efforts and most political administrations.

The full-scale project, slated to begin next year, will bring back 26,500 acres of wetlands. To obviate demands for flood control, the district will also have to purchase farms. In total, restoration of the Kissimmee will cost at least $372 million. "It is the new environmental pork barrel," comments Daniel E. Willard of Indiana University. "It will cost 100 times as much to put the curves in as it did to take them out."

### Exorcists of Exotics

The last big piece of the restoration work in southern Florida has not received as much press as have pollutants and hydrology. Nevertheless, that element—the removal of nonindigenous plants, sometimes referred to as exotics—has become a pressing concern. According to a recent report by the Office of Technology Assessment, more than 2,000 plant species that came from somewhere else thrive in the U.S. today. Fifteen of them have caused over a half a billion dollars' worth of damage since 1906. But even committed restorationists are divided on the necessity of destroying them. Some feel any growth in a disturbed area is better than nothing. "In some places, we have phragmites, which are hated by everyone," Willard says, describing a marsh plant that can grow rife in areas outside its natural habitat. "But black night herons nest in phragmites. Is it a failure if we have them there?"

The exorcists of the exotics counter that native ecosystems and biodiversity

## Several Nonindigenous Pest Plants in Southern Florida

**MELALEUCA** (*Melaleuca quinquenervia*)—This Australian tree in the myrtle family was brought to southern Florida to drain the Everglades in 1906. It is now considered the region's most serious problem. The rapidly growing tree, which crowds out native vegetation and reduces habitat for animal life, can flower five times a year. It currently covers some 500,000 acres. Annual efforts to control its spread will cost about $1 million by 1995.

**WATER HYACINTH** (*Eichhornia crassipes*)—A fast-growing aquatic weed, water hyacinth originated in South America. It was introduced into Florida in the 1880s because of its beautiful purple flowers, and by the 1960s it covered 125,000 acres of public lakes and rivers. The plant blocks waterways, interferes with flood control and reduces biodiversity by preventing other species from growing. Possession of water hyacinth can lead to a $500 fine and 60 days in jail. Controlling this exotic weed costs about $3 million a year.

**BRAZILIAN PEPPER** (*Schinus terebinthifolius*)—This ornamental tree was brought to Florida in 1892 and is now rampant. After Hurricane Andrew, it spread into mangrove stands in Everglades National Park, where it has been difficult to remove. The pepper's seeds are mildly hallucinogenic, and some biologists report seeing birds so intoxicated on these seeds that they cannot fly.

**HYDRILLA** (*Hydrilla verticillata*)—This plant from Sri Lanka was introduced in the 1950s as vegetation for aquariums. More than 40 percent of Florida's public lakes and rivers are infested with hydrilla: a total of some 66,000 acres are covered with the exotic species. Hydrilla crowds out other plants and clogs waterways. It travels easily on boats and can produce millions of underground tubers that lie dormant for years. The state spent $48 million between 1980 and 1989 attempting to control the weed.

**AUSTRALIAN PINE** (*Casuarina*)—This tree, sometimes referred to as an oak, was brought to Florida in the late 1800s. It is replacing mangroves and other native vegetation, rendering habitats sterile because nothing thrives in its vicinity. It shades plants growing on dunes, thereby killing them and opening the dunes to erosion (the root system of *Casuarina* does not serve to stabilize the dunes).

*SOURCES: Dan Thayer, South Florida Water Management District; Greg Jubinsky and Jeff Schardt, Florida Department of Environmental Protection.*

cannot truly be restored as long as foreign species are present. “I am very anti–exotic species, even when they are not causing a problem,” says Peter White, director of the North Carolina Botanical Garden. “They are the most irreversible of all human effects: we can clean the air, we can clean the water, we can restore wetlands, but exotic species are difficult to get rid of.”

In the Everglades the most unwanted aliens are a Brazilian pepper plant and melaleuca, an Australian tree imported to help drain marshes. Both tend to grow in very dense stands, as do cattails, driving out other plants and reducing wildlife habitat. Keeping melaleuca controlled in the Everglades requires vigilance. Thick forests of the trees can be seen running along the canal bordering the eastern boundary; inside the saw-grass fields, hundreds of white corpses of the poisoned trees reveal the scope of the seek-and-destroy mission. In addition, two insect pests are being imported from Australia to control the pines.

At a site called the hole-in-the-doughnut, an even more dramatic campaign is being waged against the Brazilian pepper. Situated in the middle of the park, the hole-in-the-doughnut was farmed until the 1970s. It is now the location of the park’s hurricane-decimated research center. The soil the farmers had broken up and tilled for so many years proved to be ideal for the pepper plant. So park biologist Robert F. Doren, who started the Exotic Pest Plant Council 10 years ago, decided to remove the topsoil the farmers had worked. Doren found that the pepper plants did not return to areas from which the soil had been stripped. But what will take their place remains unclear—the results of the succession experiment will become evident only in the next few decades. In that time, $44 million will be invested in clearing 100 acres of topsoil each year for 15 or 20 years, at a cost of $16,500 an acre, while the hole-in-the-doughnut is rehabilitated. “One of the questions is, What do you actually get?” Armentano says.

Whether it is used by scientists to play gardener and weed out exotics or to play God and part the waters, information about the effects of restoration is in great demand in southern Florida—and elsewhere. Knowledge is inadequate in all areas of science, including the interaction between hurricanes, fire and nutrient recycling in the Everglades, the characteristics of the soil and its microbial communities, and the effects of sea-level rise on the ecosystem. In addition, basic components of the hydrology are not understood. What is the role of changed water patterns and drainage on bird nesting and feeding habits? Has reducing the flow of fresh water through the Everglades caused the demise of Florida Bay?

**JOY B. ZEDLER monitors a San Diego marsh that was built 10 years ago to compensate for the construction of a nearby highway. The new wetland still does not resemble a natural one.**

But because there is little precedent for restoration of this magnitude, many scientists are advocating a one-day-at-a-time approach. Such a strategy would allow experts to experiment and revise plans if a particular line of attack did not seem to be working. “We have to take an adaptive approach. We are not going to have the degree of predictability that we want,” explains Steven M. Davis of the South Florida Water Management District, an editor of the recent book *Everglades: The Ecosystem and its Restoration.* Davis thinks this concept is difficult for some researchers to accept. Many want to set targets for certain species: restoration is working if, say, the anhinga population increases by *x* percent. “We may have the illusion of control,” he notes. “But no matter what we do, we are not going to put the Everglades back to the way they were. There are going to be surprises.”

Indeed, many biologists argue that the flexible approach Davis champions should be the key element of restoration. Its absence is one of the biggest flaws in efforts to compensate for economic development, says Charles A. Simenstad of the University of Washington. Simenstad has done extensive work on the restoration of rivers and fish habitats in the Pacific Northwest. He found that when the failure of some aspect of a plan becomes apparent there is often little chance to correct the mistake. An inappropriate goal, dear to the agency granting the permit, is often the source of constraint.

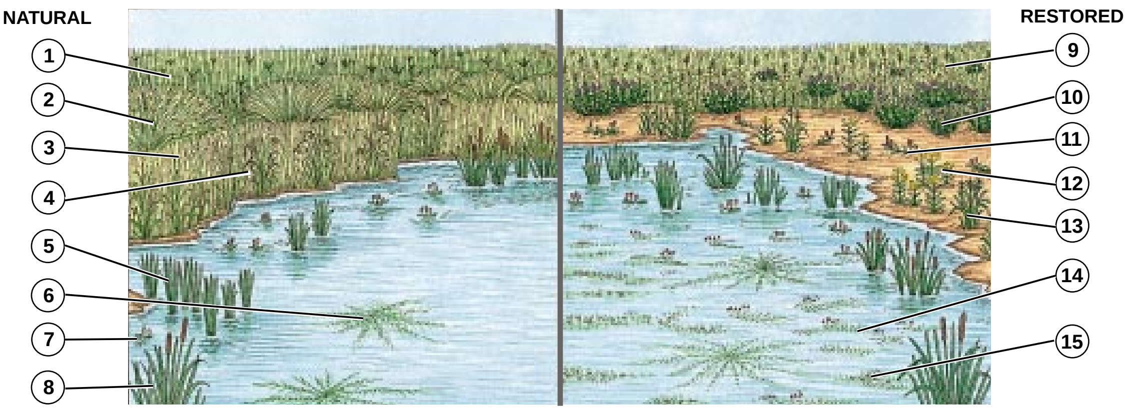
To make matters worse, many of these compensatory efforts do not yield information, because they are not framed in the context of experimentation and are not monitored. In an attempt to make projects more sound and more adaptive, Simenstad is encouraging multistage plans: try a few approaches, wait a few years, see which works best and then follow it.

Even though Simenstad, Davis and many other restorationists are trying to escape what may be a restricting emphasis on precise end points, this focus has arisen precisely because so many restoration projects have not had clearly defined goals. The adaptive strategy may make very good sense in places where engineers or scientists have a reasonable expectation that they can improve the functioning of an ecosystem. In those cases, perhaps rehabilitation is a better word: there is still a clear sense of what the original environment was, and getting back to it seems a somewhat reasonable feat. But a look at many past restoration projects suggests that such rehabilitation is not always possible, particularly where an entire ecosystem is being created. Furthermore, when the incentive for restoration is to compensate for development rather than to redeem an ecosystem, the lack of clearly defined goals for a project can conceal technical failure—or let a developer off the hook.

Joy B. Zedler of the Pacific Estuarine Research Laboratory at San Diego State University has conducted one of the most thorough dissections of one such restoration attempt. Since 1989 she has monitored a salt marsh that was built to mitigate the construction of a high-

## Restoration of Prairie Potholes

There is a widely held belief that prairie potholes, many of which were drained for agricultural purposes, are easy to restore: just return the water. But the ecosystems of these ponds, originally created by the surging of glaciers, may not be so amenable to quick rehabilitation, says Susan M. Galatowitsch of the University of Minnesota. The botanist examined records of more than 1,000 restorations conducted by the Fish and Wildlife Service and closely scrutinized 62 of them. She and others found that the longer the pothole had been dry, the less viable the seeds lying dormant in the soil proved to be. Certain types of plants also did not return, and as a result, few birds came back. "There is a whole suite of species that rely on sedge meadows," Galatowitsch notes. "Wrens, yellow-throats, bitterns and rails need dense vegetation. So they have not come in." She says it may be necessary to reseed areas to get the original vegetation to come in again. "The important thing is for people to be constantly improving restoration."




**1** BIG BLUESTEM GRASS *(Andropogon gerardi)*
**2** CORD GRASS *(Spartina pectinata)*
**3** BLUEJOINT GRASS *(Calamagrostis canadensis)*
**4** SEDGE *(Carex languinosa)*
**5** RIVER BULRUSH *(Scirpus fluviatilis)*
**6** GREATER BLADDERWORT *(Utricularia vulgaris)*
**7** AMPHIBIOUS SMARTWEED *(Polygonum amphibium)*
**8** SILVER CATTAIL *(Typha glauca)*
**9** SMOOTH BROME *(Bromus inermis)*
**10** ALFALFA *(Medicago sativa)*
**11** SMARTWEED *(Polygonum pensylvanicum)*
**12** BUR MARIGOLD *(Bidens cernua)*
**13** BARNYARD GRASS *(Echinochloa crusgalli)*
**14** SAGO PONDWEED *(Potamogeton pectinatus)*
**15** LEAFY PONDWEED *(Potamogeton foliosus)*

*SOURCES: Susan M. Galatowitsch and Diana Lobien, University ot Minnesota.*

way. The project was designed as a habitat for the endangered light-footed clapper rail. Ten years of salt-marsh building later, the rails still have not arrived. "I don't think we are ever going to get functional equivalency for the marsh," Zedler says.

Zedler also determined that for want of a bee, a marsh can be jeopardized. Some plants at the site were not setting enough seed, because pollinators were rare. The insects were not crossing the highway or making their way through urban areas to reach the wetland. "There are millions of pieces in an ecosystem, and we have looked only at a tiny fragment of them," Zedler cautions. "It is not as easy to restore these systems as developers would have us think. When you are trying to improve conditions, I think you can do a lot, but you can never get back what we lost."

This conclusion fits into a national pattern of restoration failures. Mary E. Kentula, director of the Environmental Protection Agency's Wetlands Research Program, and Jon A. Kusler, director of the Association of State Wetland Managers, edited a 1990 report on the status of the science of wetlands restoration. As Kentula notes, they determined that "the efficacy of restoration and creation methods remains uncertain. The technology is unproved for many types of wetlands, and the quality of completed projects is inconsistent."

Kentula also conducted a study of 150 young restoration projects in Oregon. She found that most of the new wetlands were very wet indeed. They were in fact about 90 percent open water. The natural sites they were meant to substitute were only 20 to 22 percent water; the rest was vegetation and wildlife habitat. The reason is that creating ponds is easier and cheaper than ensuring all the species that should be there are there, Kentula explains. But "wetlands are where we have the most experience in restoration, and we see the same mistakes being made over and over again." According to Kentula and Kusler, one of the hardest features of a project to get right is its hydrology.

Correct hydrology is precisely what Zedler ultimately found to be the most crucial missing element in the San Diego marsh. Zedler's observations have led her to be very outspoken about the dangers of mitigation—a position that has earned her the epithet "Joyless Zedler" among some of her colleagues. Zedler confines most of her concern to southern California. This region has lost more than 75 percent of its coastal wetlands—leaving only 31,700 acres of estuarine habitat, of which 18,600 is open water. Ninety-four animal and 187 plant species are endangered or threatened in the state. "California shows that if losses continue, you eventually get to a point where they cannot rebound if there is a catastrophic event," Zedler says. "Species have to come back from somewhere, and there is not enough habitat left so that they can recover."

Zedler and others believe science may not yet be up to the task of ecosystem duplication. The field is so young that it is lacking the quality control that it needs, states John Cairns, Jr., distinguished professor at the Virginia Polytechnic Institute and State University. Cairns chaired the committee that produced a 1992 National Research Council report on restoring aquatic ecosystems. Restoration needs "the kind of control in which ludicrous statements and publications are immediately pounced on and eliminated," he says. "The reason the new journal was founded was because of all the aggravation people in the field go through dealing with reviewers who do not know the existing literature, small as it is."

Other ecologists think these conclusions are unwarranted. They believe the shortcomings of many restoration projects are often perfectly explainable for several reasons. Regulations are one of the culprits. "For those projects that clearly failed, I would take the perspective that it is an agency's failure," argues Dennis M. King of the Center for Environmental and Estuarine Studies at the University of Maryland.

King makes a strong case. The surge in contemporary restoration activity was set in motion by changes in federal wetlands legislation in the 1980s. Before then, restoration in the U.S. had been largely nostalgic, such as the creation of a prairie because this symbol of the American landscape had disappeared, or practical, such as the prevention of erosion in a pit mine. Ten years or so ago mitigation was introduced. It is the process of last resort: compensating for development by creating, restoring or rehabilitating an ecosystem if destruction was unavoidable. If, for instance, a company wanted to build a mall on a marsh, it was unlikely to get a permit to do so from the Army Corps of Engineers unless it made a marsh elsewhere.

## Restoration of Mined Land

Mined lands are some of the major sites of restoration efforts, often conducted in an attempt to prevent topsoil erosion. Nine years ago Andre F. Clewell was hired to restore a 3.8-acre forest that had been wiped out by phosphorus mining southeast of Tampa, Fla. The American Cyanamid Company had been required to mitigate—that is, to compensate for the destruction wrought by mining the area (*top*). Clewell, who runs A. F. Clewell, Inc., in Quincy, Fla., says the Hall Branch Restoration Project has turned out to be one of his most successful. Because adjacent forests had not been disturbed, the botanist had good data for how the site was originally—something he needed because "the regulatory agencies had those presettlement forests as stars in their eyes." The most crucial aspect of the work was getting the elevation of the land right, which, in turn, ensured proper hydrology. "A matter of a few centimeters in elevation could cause drastic changes in the project," Clewell explains. After re-creating the original topography, he was able to foster the growth of reforested wetland, including the characteristic trees, shrubs and herbs (*bottom*). "We do not have to do any more to the system," Clewell notes. "We just have to make sure that the land is protected."

### A Mall for a Mud Puddle

In 1981 President Ronald Reagan's Task Force on Regulatory Relief pushed the Army Corps of Engineers to speed up the approval process. According to a 1990 study by William L. Kruczynski, then at the Environmental Protection Agency, the new rules limited the power of the EPA, the Fish and Wildlife Service and the National Marine Fisheries Service to review permits. The three agencies, charged with commenting on the environmental impact of development, increasingly recommended mitigation because it was clear that they could not influence the army's judgments.

But there were no mechanisms in place to monitor compliance. "The regulations had not been enforcing quality control," King explains. "And the market has been for low-cost permits, not high-quality restoration." One of King's favorite examples is a developer who chose a site on which to construct a wetland after receiving his permit to build a shopping center. He hit granite one foot below the surface at the site of the proposed marsh. Rather than go back through the permit process, the contractor blasted the granite and built a mud puddle that King says has no ecological value. The cost of the "restoration" was $1.5 million an acre.

With the right amount of money and follow-up, King says, anything is possible. "You see all those statistics on failure rates, and you talk to all the scientists and scratch below the surface and ask them why they failed, and they always know," he argues. "It is not a failure of science. The institutions are not holding the scientists' feet to the fire."

Mark S. Fonseca, a research ecologist at the National Marine Fisheries Service, agrees. He has been working on the restoration of sea-grass beds on the eastern seaboard for more than a decade. "The technical ability is there," Fonseca says. "It is more a problem of the scale of the losses." Fonseca explains that to be successful, restoration has to take place within the context of the preservation or rehabilitation of an entire ecosystem. He notes that he can restore an entire bay, even replant the entire seafloor with sea grass, but if the water column is not cleaned up and pollution persists, the grass will die all over again.

The importance of the Everglades plan derives from the fact that this vast wetlands provides such a context. The region is one focus of the attention of the National Biological Survey (NBS), a new agency established within the Department of the Interior to inventory all animal and plants as well as to study and identify areas at risk. The NBS will attempt to consider entire ecosystems rather than individual species, such as the northern spotted owl.

Because every gallon of water that flows through the Everglades is tracked by the South Florida Water Management District or the Army Corps of Engineers, the bureaucratic structure needed to monitor the region as a whole appears to be already in place. "Kusler and Kentula were looking at much smaller systems," Davis says. "You can set up end points when you have smaller areas. You have captive ecosystems: they are so highly managed they are like circuses. But the Everglades are huge. They will be less predictable in their responses."

The NBS approach, which embodies the prevailing ethic of sustainable development, resembles the perspective from which landscape architects and some western Europeans have traditionally viewed restoration. "They are used to looking at much larger systems than most ecologists are," Cairns says. "Most ecologists in the American and British mold try to find places where humans are not part of the system. The Europeans assumed that humans are always in the landscape. They are not running off to the Galápagos to find some untouched ecosystem."

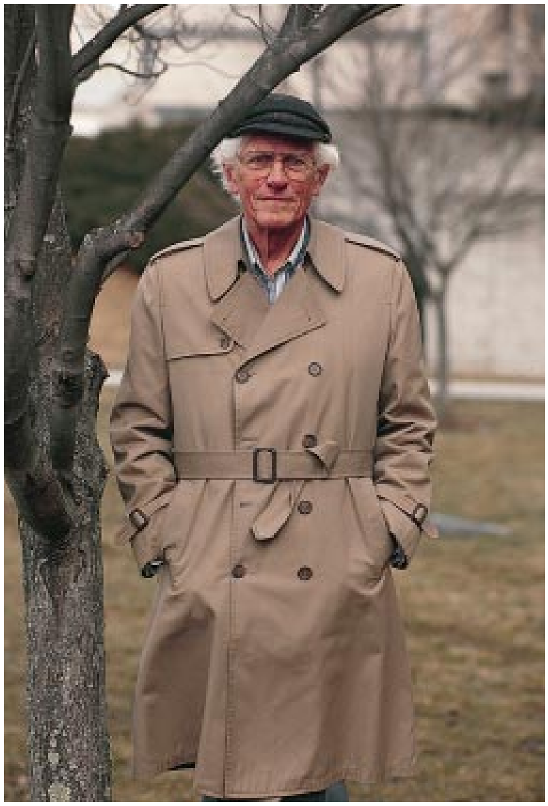
Achieving that kind of perspective at the level of the evolving science is also crucial. At the moment, the field appears to be missing the very quality that ecologists are demanding from restoration projects: integration. The discipline is by its nature broadly based: good restoration includes information on soil, microbes, botany, hydrology and population ecology, to name a few aspects of any ecosystem. But specialists rarely come together because of what Cairns describes as tribal language and an intellectual electric fence. At meetings, some scientists "want to talk about the number of bugs they had after using a certain fertilizer. It is almost like gardeners talking to each other," King laments. "The perspective has got to widen."

It is also clear that a degree of snobbishness exists on the part of people dealing with landscape-based projects toward those working on fragments of ecosystems. But doing one without taking the other into consideration may be useless, as the death of the pines in southern Florida attests. Barren pines, some with dead needles swinging from nearly naked branches, protrude from plush undergrowth on a 3.5-acre plot in Miami. Until Hurricane Andrew ripped through in 1992, this fragment was one of the last remnants of a coastal forest that covered southern Florida decades ago. Every tree on the site is now dead, as are most of the small pine forests in the region—only an 11,000-acre stand in the park remains.

No one knows what happened to the pines. Was it the force of the hurricane? Had the size of the forests made them vulnerable? Had municipal changes in water flow diminished the amount of sap the trees usually produced to push insect pests out of boreholes? "Everyone is watching the park, waiting to see what happens there," says George D. Gann-Matzen, president of EcoHorizons, a restoration firm, as he gazes at the dead trees. He was hired to remove an exotic Asian vine that had been smothering the pines, camouflaging them as great green druids, and to manage the tiny woods as if it were still wild, when the hurricane struck. Absent trees, Gann-Matzen is unsure whether to burn or plant seedlings.

Gann-Matzen's restoration and management problems appear isolated. But without this forest fragment in downtown Miami, the pines in Everglades National Park, just to the south of the city, could be in jeopardy. Ten of some 26 species of birds that inhabited the park's forest have not been seen in the past several years, or longer. And biologists speculate that the disappearance of the last few woods destroyed an arboreal corridor that these birds traveled southward along, down into the park.

So few large tracts of untouched land are left that restoration must work in tandem with preservation. Areas of conservation are needed to ensure that species can survive, particularly as the human population explodes and the pressures that regions such as southern Florida experience increase. There seems to be tacit agreement that most of nature is hardly natural anymore—the orchestration of water in the Everglades is but one example. Ultimately, the state of the science does not matter to the majority of restorationists. Their attitude is just do it, do something.



**JOHN CAIRNS, JR., chair of a National Research Council report on the restoration of aquatic ecosystems, is outspoken about the need for quality control and synthesis in the young field.**

FURTHER READING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