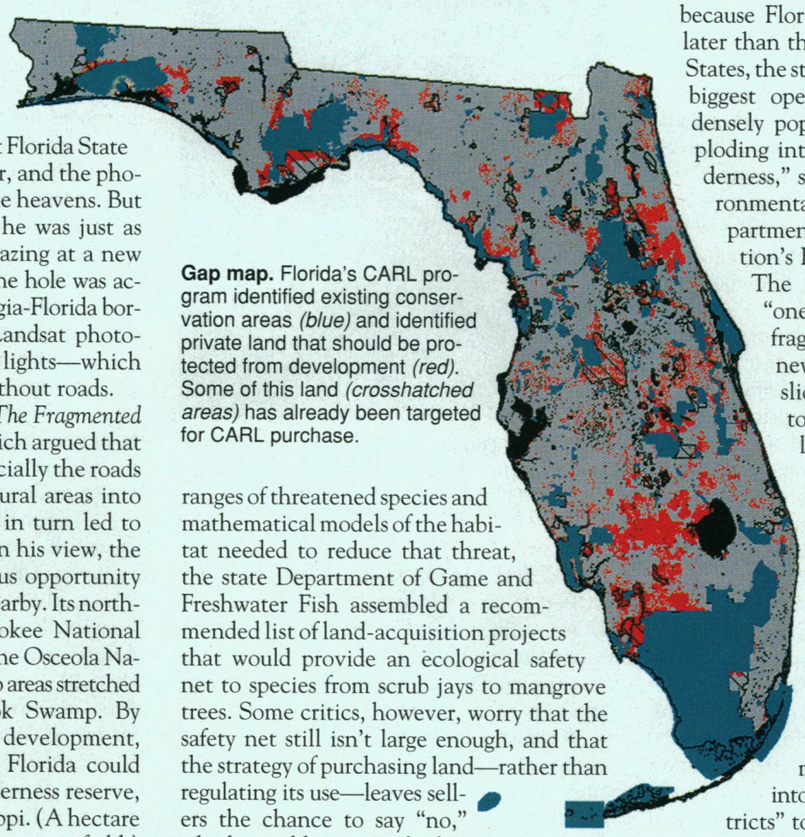
Filling In Florida's Gaps: Species Protection Done Right?

In the mid-1980s, while looking at some satellite photographs, Larry Harris discovered a "black hole." That's unusual—Harris is an ecologist at Florida State University, not an astronomer, and the photographs were of Earth, not the heavens. But on finding his "black hole," he was just as excited as an astrophysicist gazing at a new cosmological phenomenon. The hole was actually a huge area on the Georgia-Florida border, revealed by nighttime Landsat photographs to be nearly devoid of lights—which is to say that it was almost without roads.

Harris had just published *The Fragmented Forest*, an influential book which argued that human settlement—and especially the roads that accompany it—split natural areas into small, isolated pieces, which in turn led to ecological impoverishment. In his view, the "black hole" was a tremendous opportunity to keep this from happening nearby. Its northern portion was the Okefenokee National Wildlife Refuge; its southern, the Osceola National Forest. Between these two areas stretched the privately owned Pinhook Swamp. By protecting Pinhook from development, Harris realized, Georgia and Florida could create a 250,000-hectare wilderness reserve, the biggest east of the Mississippi. (A hectare is 2.47 acres, or the size of a soccer field.) With a coalition of environmentalists, he launched a campaign to put it together.

Ten years later, with a combination of state, federal, and private money, more than 50% of Pinhook's 28,000 hectares has been acquired. More important, the effort to save Pinhook has blossomed into the nation's largest—and arguably most successful—ecosystem-protection plan. Known as the Conservation and Recreation Lands (CARL) program, it has already purchased about 245,000 hectares in Florida. By the year 2000, its purchases may encompass 800,000 hectares, an area considerably larger than the state of Delaware. "There's nothing like CARL anywhere," says George Wilson, land-acquisition director in the Florida headquarters of The Nature Conservancy, the nation's biggest private land trust. "It may be the most ambitious land-conservation program in the nation, and maybe the world."

The program's ambitions extend beyond its huge scale. Since last year, CARL planners have been factoring in recommendations from one of the biggest and most complete ecological appraisals ever performed. By combining computerized maps of the ranges of threatened species and mathematical models of the habitat needed to reduce that threat, the state Department of Game and Freshwater Fish assembled a recommended list of land-acquisition projects that would provide an ecological safety net to species from scrub jays to mangrove trees. Some critics, however, worry that the safety net still isn't large enough, and that the strategy of purchasing land—rather than regulating its use—leaves sellers the chance to say "no," which could permit further habitat fragmentation.



Gap map. Florida's CARL program identified existing conservation areas *(blue)* and identified private land that should be protected from development *(red)*. Some of this land *(crosshatched areas)* has already been targeted for CARL purchase.

SOURCE: FLORIDA GAME AND FRESHWATER FISH COMMISSION

A background for success. The motivation for CARL is clear: Florida, an ecological treasure-trove, is under siege. Ecologists have long recognized that this low, sandy peninsula is a unique transition zone between tropical and temperate regions. Indeed, according to the Florida Natural Areas Inventory, a program run by The Nature Conservancy, the state contains 81 different types of natural communities, 13 of which are endemic—they occur nowhere else. Among them are coastal strand, a herbaceous community tied to sand dunes; tropical hardwood hammock, found only on limestone outcrops in extreme south Florida and home to some of the rarest plants and animals in the United States; and the remarkable freshwater marshes of the Everglades (*Science*, 23 June, p. 1688). These are home to 97 members of the federal endangered-species list, including manatees, Florida crocodiles, Southern black bears, red-cockaded woodpeckers, and the well-known Florida panther.

Florida was thinly populated until the 1930s, when the clearing of the Everglades began an era of rampant growth. Since the 1950s, its population has risen at an annual rate of about 4%—considerably faster than that of Bangladesh. And that doesn't include the 35 million tourists who now visit Florida every year, or the 7.4 kilometers of primary and interstate highways built every day to accommodate their millions of vehicles. Yet because Florida has developed so much later than the rest of the eastern United States, the state is also home to some of its biggest open areas. "You have really densely populated areas which are exploding into areas that are almost wilderness," says Mark Garland, an environmental specialist at the state Department of Environmental Protection's Bureau of Land Acquisition. The result, in Harris's view, is "one of the world's worst habitat-fragmentation problems," as new roads and communities slice the state's relatively untouched ecosystems into isolated patches—the prelude to a wave of extinctions.

Because, as Garland says, "everybody can see that things are disappearing here," Florida also has a tradition of conservation—it is the site of the nation's first wildlife refuge (Pelican Island) and the first eastern national forest (Ocala). In 1972, a series of environmental laws split the state into five "water management districts" to protect and maintain wetlands and ground-water supplies, mandated municipal and county growth-management plans, and created a state panel to evaluate all development projects with regional impact. Then, in 1979, it created CARL.

At first provided with an annual budget of $30 million to $40 million, CARL was designed to identify and protect from development land needed by "nongame wildlife"—endangered species. But as builders sought clearance from CARL about whether their plans would affect those species, Randy Kautz, director of habitat acquisition for Florida's Game and Freshwater Fish department, realized that the state had little idea of the species' home ranges. In a first step, Kautz's team used Landsat data to divide the state into 22 vegetation types, producing an approximate guide to the location of Florida's diverse ecosystems.

The next step was finding out who owned land needed for species survival. Kautz had seen work by J. Michael Scott of the Cooperative Fish and Wildlife Research Unit in Moscow, Idaho, who integrated data about plant and animal ranges with data on land ownership to identify species with unprotected habitats. "It occurred to me," Kautz

says, " 'Well, heck, we could do very similar types of stuff.' We could take range maps for endangered species and plug those into our vegetation map and create a habitat-based range map of where these species occur. With that, we could know ahead of time what was important, instead of only finding out after somebody had already invested millions of dollars in planning apartment units on the land."

At the same time, principal staff biologist and project co-director James Cox began creating what are known as population viability analyses (PVAs) for some Florida species. Based on conservation biology theories developed principally by Mark Shaffer, an ecologist who is now director of heritage programs at The Nature Conservancy, PVAs are computer simulations that estimate the chance that a given species will survive in particular circumstances, including genetic drift, inbreeding, environmental stochasticity (for instance, the chance that a big storm will wipe out most of the group), and demographic stochasticity (the chance that, say, a small population will randomly produce more offspring of one sex than the other, cutting the size of the next generation's breeding population).

By running such simulations repeatedly, conservation biologists try to estimate the minimum viable population for each species—the smallest number of individuals that would still have a good chance of survival. When this number is combined with natural-historical data such as the size of each breeding pair's home territory, the prevalence of its food sources, the dispersal ranges of juveniles, and the species's sensitivity to habitat disturbance, researchers can estimate the area needed to provide the minimum viable population with a reasonable chance of existence.

Although the technique is fraught with uncertainty—the life characteristics of few species are known with the necessary detail—PVAs are increasingly used by conservation planners. They are integral to large-scale conservation efforts like the Balcones Canyonlands Conservation Plan, which covers tens of thousands of hectares in central Texas, and the Natural Communities Conservation Planning program, which may cover more than a million hectares in southern California.

In Florida, Cox and his co-workers estimated the minimum area necessary to give ten 200-member populations of each species a 90% chance of survival for 2 centuries. This information was fed into Kautz's maps to determine whether that minimum area was already protected or, if not, where it could be purchased by CARL. "The whole system was intended to assess the security of endangered species on public land," Kautz says. "The question was, which ones need the most help and where?"

Saving the scrub jays. One in definite need is the Florida scrub jay (*Aphelocoma coerulescens coerulescens*), a unique, isolated population of a bird that is found in many parts of the United States. Marooned in the Lake Wales Ridge—the highlands of central Florida—when high seas drowned the rest of the peninsula a million years ago, this population developed more closely knit families than are seen among scrub jays in the rest of North America. Instead of flying away to find mates, juvenile birds hang around the parental nest, sometimes for several years, watching out for snakes and hawks and helping to feed the next generations of babies.

Today these intensely social birds—and the oak scrub ecosystem they live in—are marooned again, this time by a sea of retirement housing and agricultural development. Florida oak scrub is often described as

TAMI TOWNSEND/THE NATURE CONSERVANCY

Land for birds. Analysis of the scrub jay's current habitat and population dynamics indicated the birds needed another 4800 hectares to survive in central Florida.

one of the most threatened ecosystems in the United States.

Cox and Kautz found that only five existing conservation areas had enough remaining scrub to sustain populations of the bird. Poring over their PVAs and habitat maps, the researchers argued that setting aside another 4800 hectares of scrub in seven areas would provide a "minimum level of security" for the bird. The new land would also protect much of the remaining Florida oak scrub. According to Melba McPhee of The Nature Conservancy, CARL has purchased 3346 hectares of scrub in the highlands since 1990 at a cost of $12 million; ultimately, a CARL project will protect 13,378 hectares there.

By the time Cox and Kautz had finished establishing the bottom-line requirements for 30 threatened species of wildlife, 105 rare plants, and several particularly endangered ecosystems, they were suggesting the acquisition of 1.95 million hectares—about 13% of the state. In ecological terms, this was a minimum: According to the PVAs, it was just enough to leave the species alive. In political terms, though, it is a staggeringly large area. Between its creation in 1967 and last year, the federal Land and Water Conservation Fund, which buys wildlife habitat for the federal government, bought only 146,000 hectares, scrimping together the funds from a reluctant Congress. Cox and Kautz were proposing that Florida buy more than 10 times as much. Fortunately, they were in the state with the world's biggest land-acquisition program.

The great land purchase. The successful effort by Harris, Wilson, and others to convince then-Senator Lawton Chiles of Florida, a Democrat, to push for the purchase of Pinhook in the late 1980s induced the conservationists to approach then-Governor Bob Martinez, a Republican, with a bigger idea. In 1990, Martinez and the legislature approved Preservation 2000, a 10-year-long, $3.2 billion program for new parks, groundwater protection programs, environmental aid to local communities, and especially habitat purchases, which receive half the money.

Paid for by an annual bond issue, the CARL portion of Preservation 2000 is run by a six-member panel that represents five state agencies, including those covering forestry and environmental protection. Proposals come in from the agencies, counties, municipalities, developers, conservation groups, and individual landowners. Each agency ranks every parcel of land in terms of such criteria as its cost, relevance to the agency's mission, complexity (number of owners and simplicity of borders), and environmental importance, which increasingly means whether the land is part of the "strategic habitat conservation areas" identified by the Cox-Kautz analysis. "You end up comparing apples and oranges a lot," says Garland, a panel staff member. "But that's inevitable." The final recommendations, based on the average rankings, must be approved by Chiles, now governor, and his cabinet.

All sides agree that CARL is a political success—"How many times do you hear about people voluntarily taxing themselves year after year?" asks McPhee. That success, she and others suggest, is partly due to its practice of purchasing habitat outright from landowners, rather than controlling its use through strict environmental regulations. "Scientific criteria alone do not run the system," says Ed Kuester, chief of the Bureau of Land Acquisitions. "We try to factor in economics and politics. We've gone to great trouble to mitigate the impact on people." According to Kuester, the regulatory approach "never protects land from development. What's not permitted today gets a variance tomorrow. A vote this way or that way on a protected beach and you have a boardwalk, and the boardwalk ends up with a tiki hut, and then a dock, and then a marina, and it never stops." As Harris puts it, "You have to buy it. Otherwise, you're in a guessing game."

Moreover, Kuester says, regulation forces private landowners to "eat the cost" of pro-

viding habitat for endangered species—a cost that they often cannot escape, because the presence of the regulation makes the land worthless to buyers. By contrast, a purchase by CARL lets developers, in Kuester's words, "escape alive" from properties with wetlands or endangered-species problems. "With regulation, they're stuck. They can't do anything but fight. But if you offer to buy property on the CARL priority list, most of the time they'll talk with you."

The purchasing strategy does, of course, give landowners the option to say no. And that carries a risk of shutting the state out of vitally important land, Garland concedes. But so far it has not happened often. More important, in his view, buying rather than regulating prevents most complaints about the heavy hand of government intervention. "We've had several property-rights groups spring up in the state, with the two major ones in the panhandle and down by Naples," he says. "They feel that government should not be taking land off tax rolls, even if the sellers are willing. But mostly the opposition is muted."

How much is enough? Yet even CARL's most enthusiastic advocates admit that it will never have the estimated $5.7 billion needed to buy all the land recommended by the Cox-Kautz analysis. And some scientists think the program will have to do significantly more. Even the huge area CARL is currently going after may be an underestimate, according to PVA pioneer Shaffer, because the Florida team was "overly optimistic" about the likelihood of survival for small populations. And Reed Noss, editor of the journal *Conservation Biology*, argues that the project did not give enough weight to connecting individual conservation areas. "Even though they are talking about a huge increase in the amount of land protected," he says, "there's still a large amount of it that would be highly fragmented. If those areas ended up being surrounded by development, the conservation wouldn't work."

While conceding that "the connectivity issue" is a "very valid criticism," Kautz believes that guidelines from a study under way at the state Department of Environmental Protection should address that issue. And although specific plans for raising more money to purchase this land are not yet in evidence, Harris envisions a day not too far in the future when the Florida landscape contains an unbroken open strip that runs down the entire state. "What's happening here is exciting," he says. "I just came back from 6 weeks looking at preservation programs in Africa. And everywhere I went, people were asking me what we were doing in Florida."

–Charles C. Mann

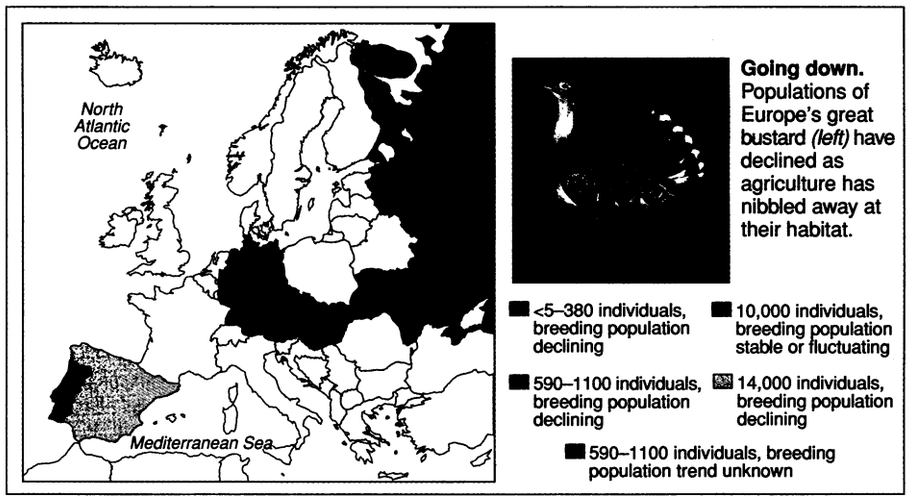
Charles C. Mann is the co-author, with Mark L. Plummer, of Noah's Choice: The Future of Endangered Species.

CONSERVATION II

Slow Start for Europe's New Habitat Protection Plan

Spain's conservationists and politicians are grappling with a vexing riddle about a bird and a road. Like the old puzzler about the chicken, this one deals with an existential question, but the bird at issue is the great bustard, a threatened species. And the question is not why the bird crossed a road, but whether a road will cross paths with the bird.

The bustard, once a common sight in the fields of Europe, has been in decline for the past 100 years as agriculture stripped away its habitat and food. In Spain, the birds' last remaining stronghold is the steppelike grassland in the central plains. This area has been identified by ecologists as a possible candidate for protection under the European Union's Habitats Directive, a bold conservation law containing a master list of threatened European habitat types. It calls on member nations to identify and protect those habitats.



Going down. Populations of Europe's great bustard *(left)* have declined as agriculture has nibbled away at their habitat.

PHOTO: CARLOS SANCHEZ

SOURCE: *BIRDS IN EUROPE: THEIR CONSERVATION STATUS* (BIRDLIFE INTERNATIONAL, 1994).

But the urge to conserve is not the only signal from Brussels these days. The European Union (EU) is also pushing—and funding, with $10 billion last year—ambitious regional development programs, including a massive new transportation infrastructure plan. And one of the proposed new roads crosses the great bustard's steppe stronghold—a development, biologists warn, that will send this bird population racing down the highway to extinction. "We're fighting this road proposal," says Juan Criado of SEO/Birdlife in Madrid, a key Spanish nature conservation organization.

They're fighting, however, without the help of the Habitats Directive. The law required Spain to list its proposed habitat sites this June, but like many of its European partners, the government hasn't complied—hardly an auspicious start for Europe's most prominent conservation effort.

The law has foundered because a lack of scientific data about local habitats and species distributions has prevented Spain and some southern European countries from figuring out which habitats to protect. Governments are also leery of programs that restrict use of large land areas, due to ever-present conflicts with development. Northern nations, with conservation programs already in place, are leery in a different way—reluctant to layer EU policy on their own. "Many politicians probably did not realize what they were signing up for," says John Lawton, director of the Centre for Population Biology at Imperial College, London. And in the face of this confusion and conflict, Lawton and some other observers are wondering how effective the new unionwide conservation policy will be.

Developing conservation. Although development has been the driving force behind the EU since its formation—last year, the EU spent more than half its budget on agriculture—the rising popularity of green issues, particularly in northern Europe, has forced conservation onto the pan-European agenda. Three years ago, concurrent with the worldwide environmental summit in Rio de Janeiro, the EU launched an ambitious plan to develop common conservation yardsticks along with an EU-wide network of protected conservation areas under the label Natura 2000. The tool for establishing that network is the Habitats Directive, focusing not just on individual threatened species—as does con-