in the scientific mainstream."

Brody, too, is a fan of greater inclusion. And he concedes that geography has become an essential element in the federal funding picture. "Five years ago, I'd have said that emerging institutions can do it on their own. Today there's a realization that the lack of geographic distribution undermines political support for all biomedical research," he says.

But Brody and others worry that BRIN may not be the best strategy. "It doesn't require states to make the necessary investment in their research infrastructure," he notes. "Look at some of the newer UC [University of California] campuses or the Florida system. State legislators there decided to put up the money, and those schools have become topflight research institutions."

Vaitukaitus says that NIH chose not to require states to ante up money for BRIN "because we didn't want to be unfair to those states that can't afford it. But they do need to show an institutional commitment to strengthening their research capacity." She says that "these people can be the best, too, given the resources and the wherewithal to carry out research."

The BRIN awards will provide each state with up to $2 million a year for 3 years, and some state officials are already hoping for a second round to allow sufficient time to collect data on the program's impact. Next month NIH will sponsor a workshop in Oklahoma City to discuss the evolution of both COBRE and BRIN. "From our perspective," says Taylor, "the best thing that could happen is for these states to graduate from the IDeA program."

However, EPSCoR's track record at NSF suggests that such an outcome is unlikely. All the original states are still eligible—and thus still at the back of the scientific pack. At the same time, NSF raised the bar a few years ago by shifting some of the funding to its research directorates, forcing applicants to hold their own against proposals from the rest of the country.

That's the sort of competition that NIH must foster, the advisory council told Kirschstein this summer. "Whatever you do, you need to rely on merit review and competition," says Brody. "Without that, you risk the loss of scientific quality."

–JEFFREY MERVIS

CONSERVATION BIOLOGY

Bold Corridor Project Confronts Political Reality

Eight countries have launched an ambitious effort to link protected areas, but critics say that the project's conservation goals have been diluted

EL NARANJO, THE PETÉN, GUATEMALA—From a motorboat plying the tranquil San Pedro River in this remote area, John Beaver surveys the jungle around him. To the north, a wetland teeming with birds and alligators fans out from Laguna del Tigre, a national park. To the south, verdant karst hills stretch off into the Sierra del Lacandón park. Beaver, a field staffer with The Nature Conservancy (TNC), hopes to provide safe passage for the animals by protecting a strip of land, or corridor, between the two parks. To do so, TNC will work with landowners to head off development. "For certain species, [the land link] is going to be key," says Beaver.

TNC's plans here are part of one of the largest, most ambitious conservation initiatives in the world. In an effort spanning eight countries, conservationists hope to establish scores of corridors that will one day connect a rosary of parks and managed lands running from Chiapas, Mexico, to Panama's Darien Gap. At a time when Central America's tropical forests outside parks are fast disappearing, these connections should enable genetic exchange and provide habitat for the isthmus's rich bounty of plants and animals.

That's the dream, at least, of the Mesoamerican Biological Corridor (MBC). First envisioned a decade ago by conservation biologists, the multinational effort is based on the idea that connecting protected areas is the only way to save dwindling populations of species. Creating the network over the next 40 years will require shoring up protected areas and managing agricultural land to harbor biodiversity. "This is perhaps the most advanced and the most pioneering attempt at corridors at this scale," says biodiversity expert Kenton Miller of the nonprofit think tank World Resources Institute (WRI) in Washington, D.C., an initiative partner. Since 1997 funders including the World Bank, the United Nations, the Global Environment Facility, and the Dutch and German governments have poured at least $100 million—and as much as $1 billion depending on what's counted—into the program.

Tropical link. A proposed wildlife corridor would help jaguars, scarlet macaws, monkeys, and other wildlife move between Sierra del Lacandón national park in Guatemala (above) and another park.

CREDIT: ANDY DRUMM/THE NATURE CONSERVANCY

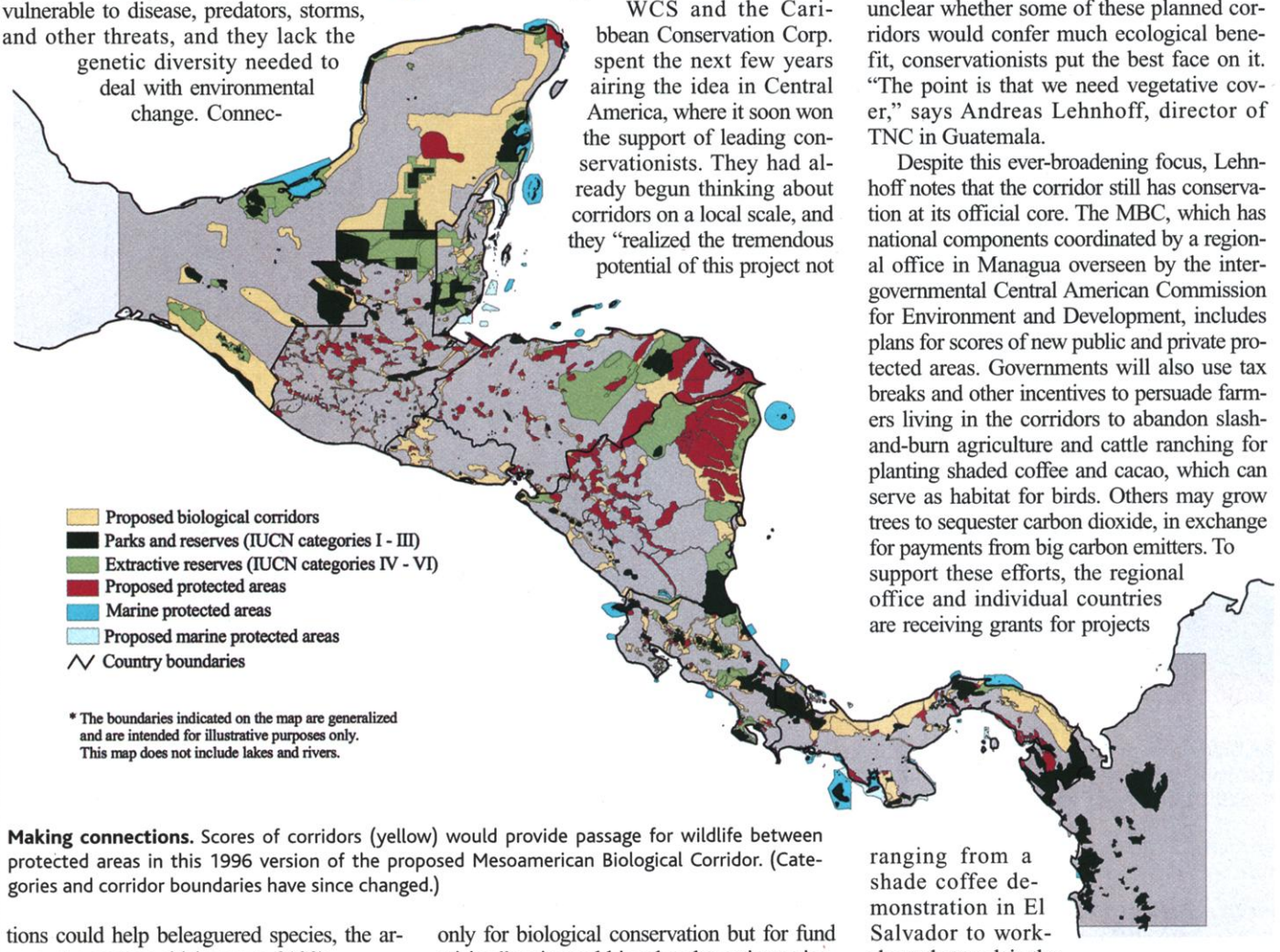
Some scientists and environmentalists are disappointed with the path Central America's ecocorridor has taken, noting that politicians have turned the original scientific concept into a catch-all for rural development projects, which they feel now overshadow conservation. "There is a concern that what started out as a science-based project has become populist-based and less guided by ecological principles," says Jim Barborak, a protected areas specialist with the Wildlife Conservation Society (WCS) in New York City. In only a few cases have countries actually begun to create corridors by setting aside land and working with farmers to change land use. And only a fraction of the funding is supporting the existing parks at the corridor's core.

But even skeptics say the corridor's underlying goal—creating a web of biological passages in densely populated countries struggling to overcome poverty—will serve as a test case for saving biodiversity in other places where walling off more forest isn't an option. "There's no place harder to deal with or more dramatic than Central America," says Katrina Brandon, a social scientist with Conservation International in Washington, D.C.

The MBC idea was hatched around 1990 by Archie Carr III, an estuarine ecologist at the WCS's office in Gainesville, Florida. WCS had a long history of working in Central America, whose mountains, tropical forests, and coral reefs hold 7% of the world's species, from howler monkeys to resplendent quetzals. In the late 1980s, as the region was emerging from several wars, countries were rapidly being deforested, and their parks—many of them fledgling

efforts—were becoming isolated patches, says Carr: "We were losing species, losing the battle. We needed something big and bold to counter those forces with."

Meanwhile, in the 1980s a growing number of conservation biologists had begun talking about wildlife corridors. The idea goes back to Harvard biologist E. O. Wilson's 1967 theory of island biogeography, which models how movement among islands—or patches of habitat—can either sustain or doom a population. Small, isolated populations are vulnerable to disease, predators, storms, and other threats, and they lack the genetic diversity needed to deal with environmental change. Connections could help beleaguered species, the argument goes (see sidebar on p. 2199).



Making connections. Scores of corridors (yellow) would provide passage for wildlife between protected areas in this 1996 version of the proposed Mesoamerican Biological Corridor. (Categories and corridor boundaries have since changed.)

CREDIT: ADAPTED BY WORLD RESOURCES INSTITUTE GIS LAB FROM CENTRAL AMERICAN COMMISSION FOR ENVIRONMENT AND DEVELOPMENT, UNDP, GEF (1996)

Ecologists Larry Harris and Reed Noss of the University of Florida had drawn up a plan in the mid-80s for corridors linking Florida parks. Asked by WCS to turn to Central America, mapping experts at the university applied the same concept on a much larger scale. The researchers entered data on the region's towns, preserves, and remaining unprotected forests into a geographic information systems (GIS) computer program. It found the best connection among them—a route mainly along the Atlantic Coast. The scientists dubbed it Paseo Pantera, or Path of the Panther, for the tawny mountain lion (*Felis concolor*) that ranges from Canada to Argentina.

As the biologists envisioned it, the Paseo Pantera would be a blend of existing parks, newly created protected areas, and buffer zones and corridors designed for "mixed use." In these corridors, farmers or ranchers continue their activities but in ways that do not threaten biodiversity. Paseo Pantera was a pioneering idea at the time, along with The Wildlands Project, a plan launched by Noss and others in 1991 to link wildlife reserves across the United States (*Science*, 25 June 1993, p. 1871).

WCS and the Caribbean Conservation Corp. spent the next few years airing the idea in Central America, where it soon won the support of leading conservationists. They had already begun thinking about corridors on a local scale, and they "realized the tremendous potential of this project not only for biological conservation but for fund raising," as it would involve the entire region, says biologist Mario Boza of WCS, who was then vice minister of the environment in Costa Rica. When governments endorsed the greenway plan in 1994, however, it provoked concerns from indigenous and peasant groups, who felt that they should benefit directly from the corridor.

So governments promised to add rural development to the corridor's mission. By the time the presidents from the seven Central American countries signed an agreement pledging to establish the MBC in 1997 (with Mexico joining soon after), it included concepts like natural disaster mitigation and leadership training for indigenous groups. Juan Carlos Godoy, vice minister of the environment of Guatemala, says this was the only way it could ever gain political support in the poverty-stricken region. "In Central America, where it's green and there's forest, there are people," he says, and any conservation strategy "has to respond to their needs."

As for the corridor blueprint, it's now more like a "braided network," Carr says: It includes hundreds of strips, many just 2 or 3 kilometers wide, connecting both big parks and tiny protected areas. Although it's unclear whether some of these planned corridors would confer much ecological benefit, conservationists put the best face on it. "The point is that we need vegetative cover," says Andreas Lehnhoff, director of TNC in Guatemala.

Despite this ever-broadening focus, Lehnhoff notes that the corridor still has conservation at its official core. The MBC, which has national components coordinated by a regional office in Managua overseen by the intergovernmental Central American Commission for Environment and Development, includes plans for scores of new public and private protected areas. Governments will also use tax breaks and other incentives to persuade farmers living in the corridors to abandon slash-and-burn agriculture and cattle ranching for planting shaded coffee and cacao, which can serve as habitat for birds. Others may grow trees to sequester carbon dioxide, in exchange for payments from big carbon emitters. To support these efforts, the regional office and individual countries are receiving grants for projects ranging from a shade coffee demonstration in El Salvador to workshops that explain the MBC to government officials.

But the corridors themselves, the heart of the initiative, are progressing slowly. Costa Rica, the model for conservation in the region with its famous parks system, is furthest along, with a formal plan to create 39 corridors and land-use projects under way in several of them. But the current Costa Rican government "has no interest in conservation," Boza says, and has declined to buy land for new protected areas or support innovative mechanisms such as a municipal water tax that would be used to pay landowners to reforest watersheds. Mexican scientists have planned a set of four large corridors in the

Building a Case for Biological Corridors

Although many of the problems in implementing the Mesoamerican Biological Corridor (MBC) are social and political (see main text), a fundamental scientific question remains: Do corridors actually work? In other words, will linking protected areas with strips of vegetation help preserve threatened wildlife populations? A growing pile of evidence supports the corridor concept, although some skeptics are not convinced.

At issue are basic questions such as whether species will use corridors to whether they do more harm than good by exposing wildlife to predators at their edges and spreading exotic species and disease. For some scientists, a 1998 review in *Conservation Biology* resolved the first question. Sifting through data from 32 corridor studies, ecologists Paul Beier of Northern Arizona University in Flagstaff and Reed Noss of the Conservation Biology Institute in Corvallis, Oregon, found evidence that species ranging from Australian marsupials to ocelots do, in fact, use corridors in wild landscapes.

Not only do populations move through corridors, but experimental studies suggest they can benefit from them. For example, to provide habitat for butterflies, Nick Haddad, an ecologist at North Carolina State University in Raleigh, and colleagues created openings, some linked by corridors, in a dense pine plantation in South Carolina. [The species studied, including the common buckeye (*Junonia coenia*), feed on plants that grow in open spaces.] Haddad reported in *Ecological Applications* in May 1999 that three butterfly species are more numerous in patches linked by corridors than in isolated patches.

Researchers are now looking for evidence that corridors promote desired genetic exchange between populations. One such study is reported this week in *Science* (p. 2246). Geneticist Marie Hale of the University of Newcastle in Newcastle-upon-Tyne, U.K., and colleagues examined how red squirrels use their fragmented habitat, which consists of tiny remnants of forest scattered across northern England and southern Scotland. To gain a historical perspective, the group analyzed DNA markers from 102 museum specimens of squirrels from the region collected over the past century.

The researchers showed that there are 11 distinct populations of squirrels spread over three areas. They then explored what happened after a new conifer forest planted in the 1920s matured, providing a solid corridor of trees between the north and south. The effects were dramatic: Since 1980 an English population of squirrels has merged with Scottish populations, and the squirrels have mixed genes across as many as 100 kilometers. "Changing the landscape can have a huge effect on populations," concludes Hale.

In Central America, indirect evidence suggests that the kind of corridors planned for the isthmus—patches, or "steppingstones," of preserves and forest connected by farmland managed so as to support biodiversity—would help imperiled bird species. In the early 1990s, researchers Robin Bjork of the Wildlife Conservation Society in New York City and George Powell of the World Wildlife Fund used radio telemetry to follow resplendent quetzals and three wattled bellbirds, which breed in mountain cloud forests and then spend several months at lower altitudes. The researchers found that both birds move along remnants of forest left in fields—but few remnants are left at middle altitudes. They suggest that preserving these remnants could be crucial to the birds' survival.

Frequent flyer. Altitudinal migrants like the quetzal could benefit from the corridor plan.

Despite such studies, some scientists remain skeptical. Ecologist Dan Simberloff of the University of Tennessee, Knoxville, maintains that corridors are "as likely [to] not do good as do good" and that the money used to create them might be better spent on expanding preserves. Supporters of the MBC acknowledge that it's unknown whether large mammals such as tapirs and jaguars will move through some corridors. But even if it only helps some species, the corridor plan will be an improvement over the deforested, abused land there now, says Juan Carlos Godoy, vice environment minister of Guatemala: "Is the cup half empty or half full?" **–J.K.**

country's south, and Belize has sketched out four as well; the government is now beginning discussions with local farmers.

The planned corridor that would link Guatemala's Sierra del Lacandón and Laguna del Tigre national parks illustrates some of the challenges. The San Pedro River, which runs through the proposed corridor to the Mexican border, is known as a route for illegal immigrants and drugs. The parks lie within the Maya Biosphere Reserve, the largest intact tropical forest north of South America, where endangered species such as scarlet macaws, spider monkeys, and pumas roam across jungle-covered Mayan ruins. But illegal logging is rampant there as well. Looming over the proposed corridor is a rumored plan by Mexico to pave a dirt road running through the proposed corridor; such a road would bring a huge new influx of traffic.

Working with a Guatemalan conservation group, Defensores de la Naturaleza, the TNC hopes to get landowners interested in eco-friendly endeavors like agroforestry and ecotourism. They are also talking with officials in the nearby town of El Naranjo about "orderly" development that won't sprawl over into the corridor, TNC's Beaver says. Other nongovernmental organizations have been giving poor, land-hungry farmers title to plots outside the parks so they will be less tempted to hack into protected areas. "The problems here aren't any lesser or greater than any of the other corridors. This gives you an idea of the range of things you have to deal with," Beaver says.

Aside from these few projects, Brandon and Barborak of WCS, among others, worry that too much funding is going into sustainable development and not to supporting the protected areas at its core. A report this month from WRI adds that the MBC is too top-down, suffers from conflicting agendas, and needs to gain wider public support if it is to succeed. The corridor "stands at a critical juncture between concept and reality," the report says. It suggests improving communication with local groups and emphasizing fundamental strategies, such as resolving land conflicts and passing laws like the proposed water tax in Costa Rica that would pay for ecosystem services.

The halting progress in Central America hasn't prevented the corridor idea from catching on in other parts of the world. Boza of the WCS is now promoting an ecological corridor that would run from the Yukon to Tierra del Fuego in Argentina, linking up for a while with the MBC and the proposed Wildlands Project. Other eco-networks are taking shape in Europe, western Australia, Bhutan's Himalayas, and Brazil's Amazon and Atlantic forests. "Most parks are too small to retain sufficient population sizes" of species, says Miller of WRI, who chairs the World Commission on Protected Areas. The only answer, he and others say, is to weave a larger web—and that means finding ways for people and wildlife to coexist. **–JOCELYN KAISER**

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