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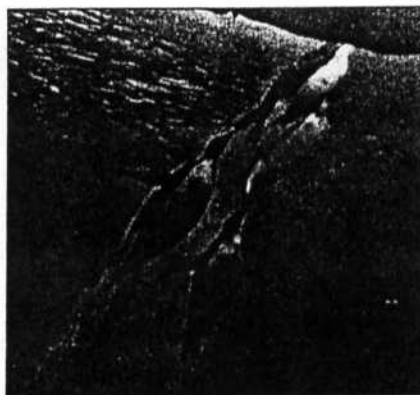


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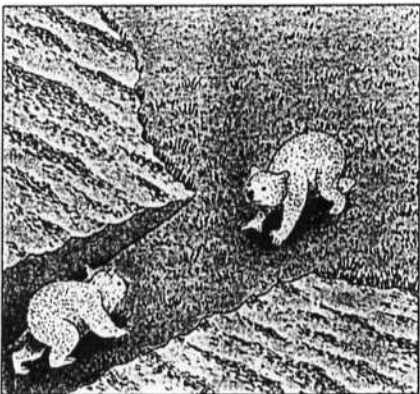
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FRONT COVER: In an unusual daytime feeding photograph by John Cancalosi, a koala in South Australia munches on eucalyptus leaves. To learn how koalas and other species benefit from corridors connecting habitat fragments, see page 30.

BACK COVER: For this portrait of a crowned crane at a feeding station in Kenya's Lake Nakuru National Park, Tim Davis positioned himself so that the rosy hue of an ornamental bougainvillea would suffuse the background.

SAFE PASSAGE

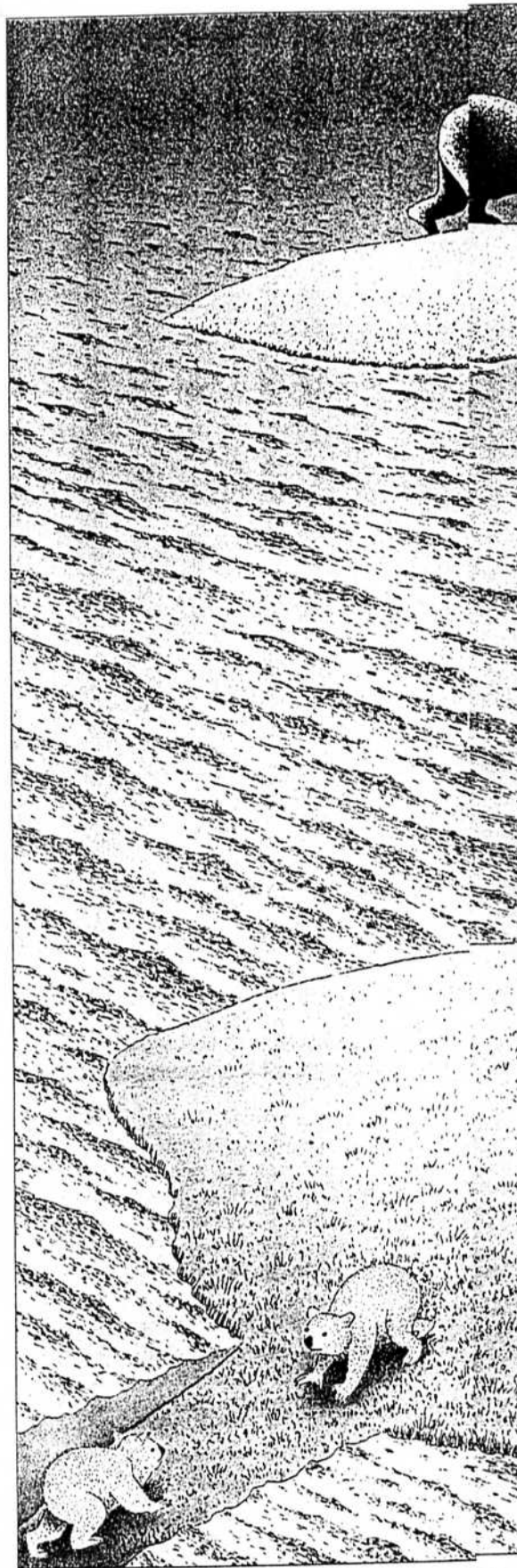
Strips of conserved habitat are turning out to be major wildlife conservation tools; will they be enough?

By Tim Thwaites

IMAGINE the shock last year during a scientific conference at the London Zoo when new maps revealed that once-vast tiger habitat had shrunk dramatically. Although there had been some concern that Project Tiger—a program launched by India in 1973 to conserve the big predator—was not working, the plan still seemed sound. After all, the biologists who designed the plan had been so confident of success that the tiger had become India's national symbol, and Prime Minister Indira Gandhi had become patron of the program.

The strategy was simple. The tiger was designated a protected species, and forest reserves were created for the species in which commercial activity was restricted and from which human residents were removed. These protected areas were to serve as refuges where tigers could live and breed without interference. It was assumed that surplus animals would then spill into the surrounding forests and move freely between the reserves.

But on the new maps, which were based on satellite data, the reserves appear as starkly isolated patches of forest in a sea of land developed to support a growing human population. "You can't hide from the satellite," says John Seidensticker, a curator of mammals with the Smithsonian Institution and



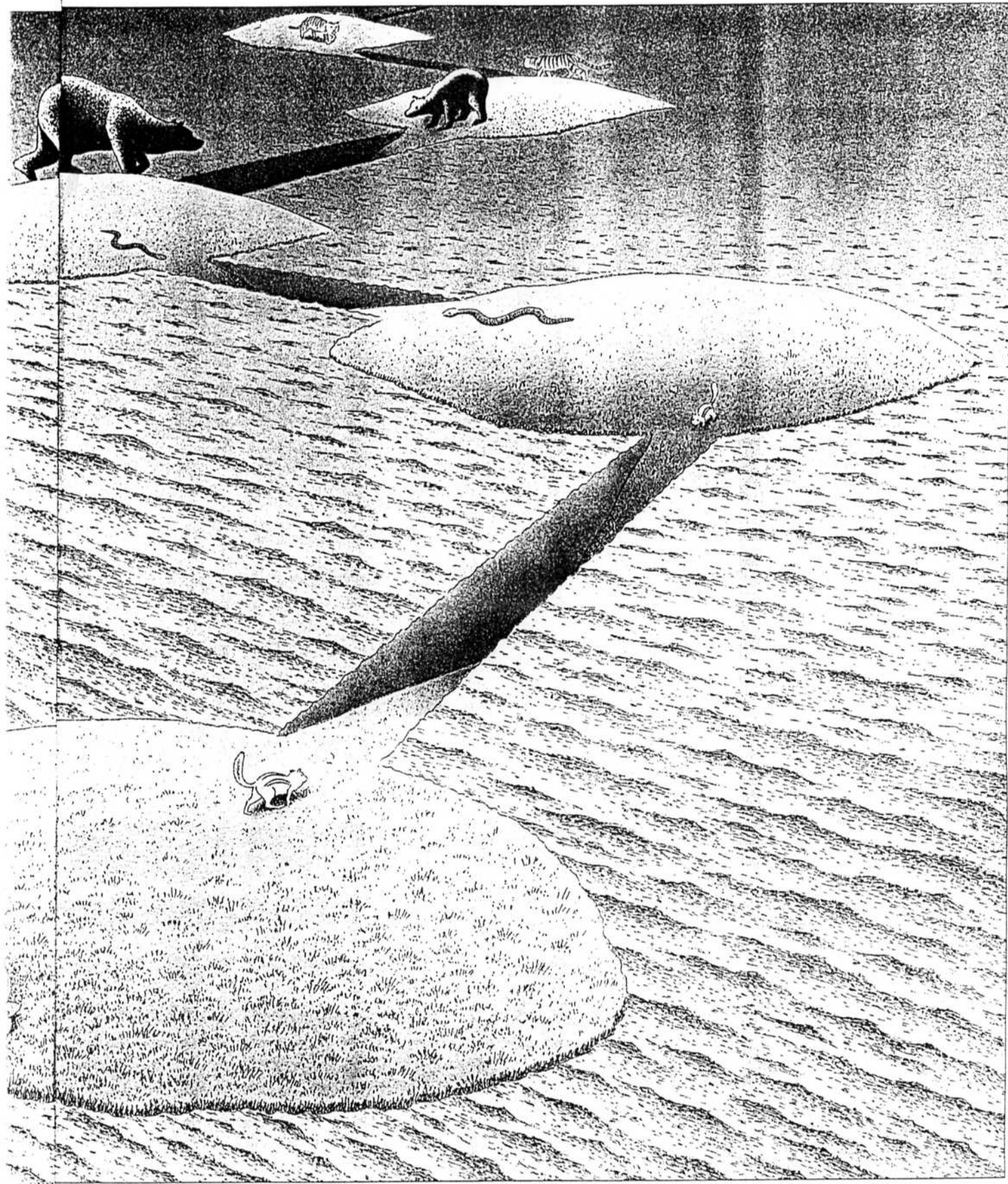


ILLUSTRATION BY GUY BILLOUT



chairman of the Save the Tiger Fund. "It's all out in the open." The main hope now for the species, he maintains, lies *between* the reserves—in the preservation or creation of corridors connecting the remaining fragments of habitat. In coming to that conclusion, he has had plenty of company. Conservation biologists worldwide are faced with rapid fragmentation of habitat for species ranging from koalas in Australia, to elephants in Asia, to grizzlies in North America. Everywhere, it seems, scientists are wrestling with the conservation answer of the wildlife corridor, usually thought of as a linear stretch of habitat connecting two much larger patches.

In Costa Rica, for example, a habitat corridor now links the Braulio Carrillo National Park to rain forest surrounding La Selva Biological Station. The land drops from an altitude of nearly 3,000 meters (almost 10,000 ft.) to sea level. Among the wildlife in the diverse habitat are more than 400 species of birds, jaguars, howler monkeys, vipers, sloths and thousands of species of insects. Already there are plans to add links to patches of privately owned rain forest. And the whole area eventually may connect with the The Way of the Panther Project—a scheme to link wildlife reserves from Mexico to Colombia.

Other cases abound. In Australia, one of many examples is the country's "coastal ribbon," which features prime habitat for koalas and other marsupials. Koalas in particular have specific needs; for the most part they consume only the leaves of a handful of the 650 native species of eucalyptus trees. As new homes sprout along the coast, conservationists are working to preserve corridors for the animals between critical patches of habitat.

The ideas behind wildlife corridors started 30 years ago, with research on islands by two ecologists, the late Robert MacArthur of Princeton and Edward O. Wilson of Harvard. They developed a theory to explain that the bigger an island and the closer it is to mainland that can supply wildlife, the more species it contains. Ecologists then noted that unlike islands in water, habitat "islands" in a landscape can be connected by strips of like habitat. They found ready examples in fencerows used by small mammals such as chipmunks, deer mice and voles to travel between woodlots. River valleys serve as flyways for many birds, and vegetation along riverbanks can connect patches of forest.

Such corridors, argued Wilson and colleague Edwin Willis in 1975, make it easier for animals to colonize patches of habitat—

and hence to boost the number of species a patch can carry. If the population in any one patch is wiped out by fire or disease, other animals can recolonize the patch through the corridor. Also, immigrants arriving through a wildlife corridor help reduce the levels of inbreeding in a given population.

That's the theory. But demonstrating that corridors actually function in such ways has proved difficult. To do adequate comparisons, researchers must find or create an environment where some habitat patches are connected together and others are not. Another problem is simply that it is hard to monitor and track animals actually using corridors.

One of the best studies to date involves a little creature called the mountain pygmy-possum—Australia's only truly alpine marsupial and only marsupial hibernator. Late last century, partially fossilized bones of a previously unknown mammal were collected in southern New South Wales. Then, more than 70 years after the bones were discovered, the species came to life. A small, friendly, unusual pygmy-possum was found living in a ski hut near Mount Hotham, about 200 kilometers (125 mi.) northeast of Melbourne.

Since then, several thriving populations of mountain pygmy-possums have been found. But with only about 1,800 breeding females, the species is still one of Australia's rarest mammals. In optimal habitat, outside the breeding season the sexes live apart. The females live higher up the alpine slopes in areas with the best-quality food and shelter. The males live lower down in more marginal areas and travel up rocky slopes to breed.

Since the 1960s, Mount Hotham has been developed as a popular ski area, and a road has come between the two habitats of one of the mountain pygmy-possum populations. In particular, government biologist Ian Mansergh found, the road prevented young males from leaving their mothers before autumn, as was usual. Females normally have no competition from males for forage outside breeding season. The result was that far fewer females survived winter to the next breeding season.

Mansergh and colleague David Scotts were able to solve the problem with a corridor and a rock-filled tunnel under the road, protected from predators. Not only did the mountain pygmy-possums use their corridor, but female survival rates immediately increased. And throughout the research, the scientists were able to compare the disrupted pygmy-possums with another, undisturbed population.



GAVRIEL JECAN (ART WOOLFE)

FEATURE OF THE TREES, a three-toed sloth (above) descends to the ground only to defecate, fertilizing the tree in the process. Even if patches of habitat (right) left standing in clear-cut rain forest were able to sustain sloths and other creatures, the animals would be cut off from other breeding populations and could die off easily within the fragments. One possible answer to such concerns is a major effort to link reserves from Mexico all the way to Colombia with a system of wildlife corridors.





Floodplain Management An NWF Priority

Lush with vegetation and food sources, waterways and their floodplains are natural passageways for wildlife, helping animals travel through an increasingly fragmented landscape of urban and agricultural development. The National Wildlife Federation is working to improve floodplain management with public education and lobbying for federal programs that encourage communities to promote greenways, recreation areas and open space along rivers and streams. "When properly managed," says NWF Resource Specialist David Conrad, "floodplains provide many of the essential corridors we will need in the future for fish and wildlife migration—and can also provide needed buffer zones to help maintain and improve water quality." To stay informed about NWF's efforts in floodplain management, write: NWF Floodplain Management Project, 1400 16th Street NW, Washington, DC 20036.

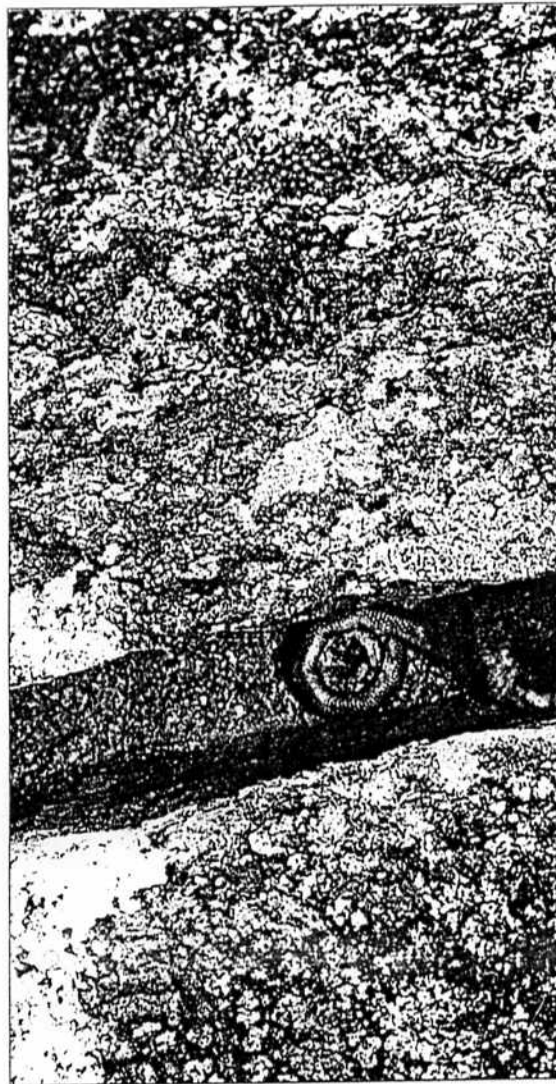
Another much-cited study that caught animals in the act of using corridors was conducted by conservation biologist Paul Beier of Northern Arizona University. Between 1988 and 1993, Beier spent night after night driving along rough dirt tracks through the Santa Ana Mountains south of Los Angeles following cougars tagged with radio collars. The mountains reach to within kilometers of two other large areas of cougar habitat, the Chino Hills at Coal Canyon and the Palomar Range at Pechanga.

Beier wanted to know if cougars would journey under or across freeways and along narrow strips of undeveloped land to reach these other pieces of habitat. Essentially, he was checking to see if the animals of all three patches were in contact, increasing the chances of outbreeding and genetic diversity. For two years he tracked only adult cougars. None moved outside the Santa Ana Mountains. Then he tagged nine adolescents about to leave their mothers for the first time. On that fateful night, the first of them crossed into the Chino Hills. Four others braved the freeways. Some crossed back and forth several times. A couple were killed making the journey.

The story does not end there. Local conservation groups are now using Beier's information to pressure the state, landowners and developers to preserve links at Coal Canyon and Pechanga. "The fact that so many people live in the area makes the cougar population all the more valuable," says Beier. "These are the local cats for 20 million people."

Some biologists are concerned that the money pumped into such links may be better spent adding to existing reserves. Foremost among the critics is Dan Simberloff of the University of Tennessee at Knoxville. "I'm dead against the assumption that by setting up a skinny piece of land between two fragments of habitat, you are necessarily achieving anything," he says. "The land for corridors is often very expensive to buy, and the corridors themselves are very hard and very costly to manage." It also irks him, he says, that resource companies can promote themselves as good environmental citizens just by leaving a few strips of habitat in the land they are exploiting.

Others have raised concerns that wildlife corridors could funnel prey into the clutches of waiting predators or become conduits for the spread of disease or fire. George Hess from the University of North Carolina, for example, cites the case of rinderpest, a deadly African disease of livestock. In the past the spread of this disease southward has been halted by removing wildlife from strategic



areas on the border between Tanzania, Zambia and Malawi. That has left no potential hosts for the virus that causes the disease.

But in a new analysis of all the scientific literature about wildlife corridors—now under review for publication in a scientific journal—cougar biologist Beier and Northern Arizona University biologist Reed F. Noss have found no such ill effects. "We conclude that there is no empirical evidence of negative impacts from corridors designed or preserved for conservation purposes," they write.

And many scientists maintain that corridors are still the best solution available for dwindling habitat—particularly if they are well designed. Says corridor proponent Andrew Bennett, a wildlife ecologist at Deakin University in Melbourne, Australia, "The real planning challenge for the next century is to get conservation agencies to think in terms of systems or networks of linked habitats on a landscape and regional scale."



JEAN PAUL FERRERO (MUSCOPUS) (CAPTIVE)

Meanwhile, habitat destruction around the world is forcing the issue. During the 1980s, for example, Brazil cleared an average of more than 2 million hectares (about 5 million acres) of forest a year. Australia is still clearing at the rate of half a million hectares (1.2 million acres) a year. Not only is it now more difficult for governments to lock land up in national parks, but the parks themselves are becoming increasingly isolated.

In the case of the tiger, habitat now is broken into about 160 pieces across Asia. That means the world's estimated remaining 5,000 tigers—most of which are in India—do not constitute one population. Rather, they are broken into small groups numbering on average about 30 individuals, although some are much larger. According to Seidensticker, self-sustaining populations of tigers may need to contain at least 50 breeding females. Small, isolated groups could be susceptible to extinction,

either by a chance catastrophe such as fire or perhaps by inbreeding in the long term.

For these already isolated groups, corridors will have to include people. Perhaps, envisions Seidensticker, reserves can be linked by multi-use zones that benefit both people and tigers. Such planning is far ahead of scientific research proving it will work. But as he and other conservationists see habitat break up before their eyes on satellite images, they may be able to take heart in the conclusions of Beier and Noss in their review of the research. "All else being equal, and in the absence of complete information," they write, "it is safe to assume that a connected landscape is preferable to a fragmented landscape." □

Free-lance science writer Tim Thwaites lives in Melbourne, Australia, where his garden has become a multi-use corridor for the local small-cat population.

A DEPT AT SQUEEZING through small spaces, a mountain pygmy-possum scampers along a rock passageway. The Australian marsupial is the subject of an oft-cited study of corridor use by wildlife. Outside the breeding season, males and females live apart, with the females claiming the best habitat. When a road threatened to permanently separate the two genders of one population, researchers used the opportunity to study the effects on the animals. The scientists also helped design, and then studied, a successful corridor in the form of a tunnel under the road.