

Hemmed In

Already endangered, Southwestern species struggle to survive in a landscape remade by fences, roads and border patrols.

BY JEFF WHEELWRIGHT
PHOTOGRAPHS BY WILL SEBERGER



Sonoran pronghorn (left) in the captive breeding program at Cabeza Prieta National Wildlife Refuge in Arizona, on the U.S.-Mexico border. The pronghorn is one of several endangered species whose habitat is severely impacted by human encroachment in the form of highways, access roads for increased border patrols, fences and other barriers.

We're deep in the desert with the engine off. No sooner do we start to drive again than the fastest animal in America, the pronghorn, bolts out of the brush. I had been hoping to see one. White- and chestnut-colored, deep-chested and springy, it runs directly across the rutted track in front of the truck — and in an instant, it is gone.

"Robust," is James Atkinson's first comment. "They don't stop and look back like a deer does. They keep going." Atkinson works for the U.S. Fish and Wildlife Service (FWS) at Cabeza Prieta National Wildlife Refuge in Arizona. He heads the recovery team for the endangered Sonoran pronghorn, which some call an antelope, though technically it is not. A subspecies of the widespread North American pronghorn, it was first listed as endangered in 1967.

Twelve years ago, the U.S. population of Sonoran pronghorn fell to just 21 animals. Thanks to a captive breeding program, which maintains some of the pronghorn in a 1-square-mile pen with periodic releases into the refuge, the number of pronghorn in the wild here has grown to about 200. A second population of 30 animals was recently established at the Kofa National Wildlife Refuge, about 90 miles north. Several hundred others live across the border in Mexico.

The buck we have flushed is probably still running; speeds of up to 60 mph have been recorded. Atkinson does not seem to be a romantic sort, but when he describes a herd of 20 or 30 pronghorn traveling through the desert, he gets a lilt in his voice. "Like bison, they're a range animal. When they have to move, they go. They go where they need to go, and they go as a group."

Unfortunately they cannot roam freely anymore. To the west, toward the Lower Colorado Valley, the terrain is extremely dry "and they prefer not to go there," says Atkinson, while in other directions "they're bracketed on three sides." Highways to the north and east, interstates 10 and 8, and Arizona Route 85, are barriers to migration, while the pronghorn are cut off from the herds to the south by the international border and another highway in Mexico. The pronghorn on Cabeza Prieta are confined to an island of cactus, mesquite and creosote bush. It's a large island, to be sure, about 1.6 million acres, but the habitat is so harsh that a successful recovery would be a herd of 300 animals.

For the pronghorn and 25 other endangered or threatened species, these are the hardest living conditions in the United States, and they are made worse by livestock grazing, recreational

and urban development, hunting and poaching, and the effects of climate change. The latest and most conspicuous environmental threat stems from the flux of illegal border crossings and the muscular response by the U.S. Department of Homeland Security (DHS). Since 2006, DHS has built hundreds of miles of steel fencing and roads in the strip of rough country between southern Arizona and the Mexican state of Sonora. A kind of border war is underway — with wildlife caught in the middle — as drug smugglers and illegal immigrants dodge the all-terrain vehicles of the Border Patrol, a DHS agency.

Whether the species is a pronghorn, a 200-pound jaguar or a pygmy owl, the fortifications and human activity cannot help but impede animals' movements and reproductive behavior. When breeding is curtailed, adverse genetic effects may occur. Therefore



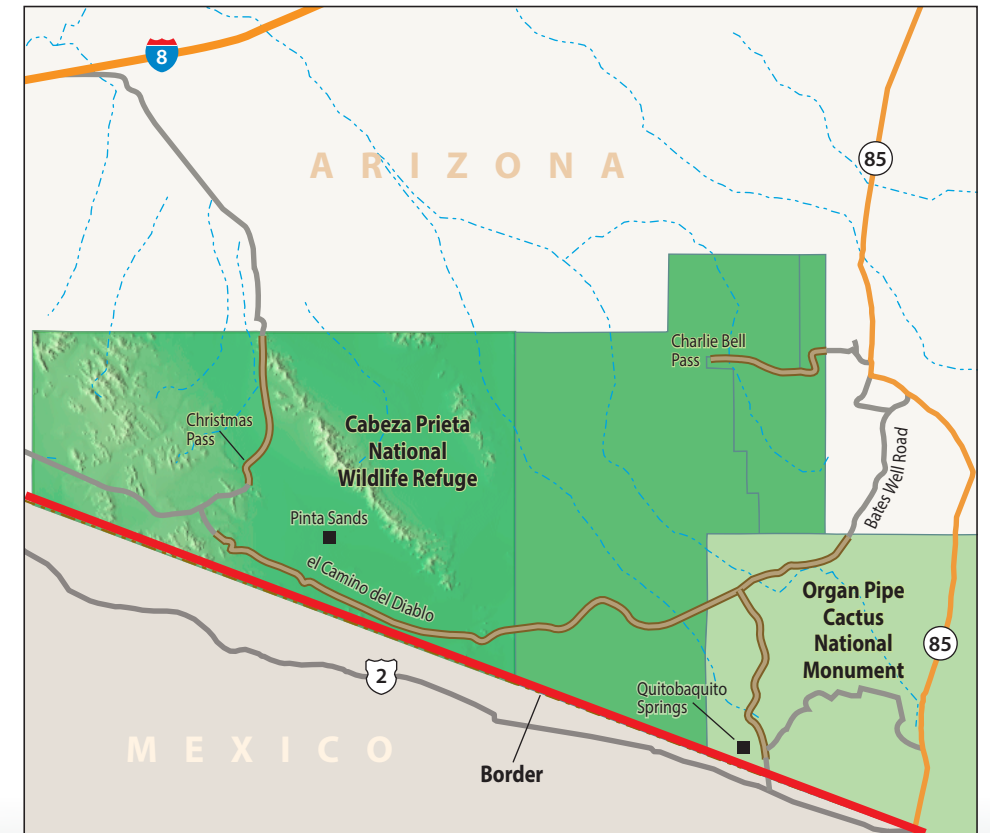
James Atkinson of Cabeza Prieta's breeding program and Mindi Avery of the U.S. Fish and Wildlife Service monitor the pronghorn breeding pen.

federal and state biologists are scrambling to assess the impacts, using funds largely provided by DHS. To reduce the issue to a word, they are studying "connectivity" — how do species respond when the geographical connections between the places they like to wander are blocked or degraded? Concerns about connectivity reach far beyond the border, since wild land is being broken up or broken down almost everywhere in the world.

The conditions here are favorable in one key respect. The border zone is fragmented in a positive way by the diversity of its natural features. As you move from west to east, from the low, scorching deserts of the Colorado River basin to the snow- and pine-topped mountains near the New Mexico border, a range of habitat unfolds. The prickly plains surrounding the isolated mountains are like seas that animals navigate when moving from one high sanctuary to another. Rich in large mammals, the borderlands of Arizona bring together North American species like bighorn sheep and black bears with rare Neotropical migrants like jaguars and ocelots. The area's



On the Border
Cabeza Prieta National Wildlife Refuge and the adjacent Organ Pipe Cactus National Monument sit right along the U.S.-Mexico border and Mexico's Highway 2. It's a high-traffic zone for illegal immigration and smuggling, leading to increased border patrols, Normandy-style vehicle barriers (above) and pedestrian fences that inhibit both human and animal passage.



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wetlands and streams, though taxed by drought and widely separated, are islands in their own right: an aquatic archipelago for rare fish, snails, plants and frogs.

HUMAN INCURSIONS

Back at the Cabeza Prieta refuge with Atkinson, it's May; not the best time to visit the pronghorn breeding operation, though not as viciously hot as it will get in June. The air conditioning of the truck gradually loses its battle with the 95-degree atmosphere. After showing me the captive breeding pen — its 75 skittish inhabitants all keeping out of sight today — the biologist takes me next to the Camino del Diablo in the southernmost part of the refuge. The Spanish explorers called this trail the Devil's Highway. Centuries of travel have cut banks two feet deep into the baked sand. Slithering when it's not jouncing, the truck pushes farther into the desert. A spur of low, brown mountains opens onto a flat valley, at the end of which an identical line of mountains partitions the passage to another flat valley. If the sun weren't holding steady, I would think we were driving in circles.

We pass a Border Patrol agent standing on the door mount of his green-and-white SUV. The agent is holding an antenna high in the air and swiveling it, evidently checking for intruders. Cabeza Prieta is constantly being surveyed, whether by unmanned drones overhead or distant radar towers. "We're probably being monitored by both sides," says Atkinson as we bump along, since the drug cartels are known to post spies on the rocky outcrops.

In a little while, we come to a Border Patrol encampment called Forward Operating Base No. 1, an otherworldly sight. Hummers and paddy wagons are parked inside a chain-link-fenced yard alongside fuel tanks and a boxy barracks. The American flag is streaming high while hot gusts blow a fierce dust onto the compound as if the desert were trying to expunge it. "It's a little city ... like dorms on Mars," Atkinson says drily. "There goes your wilderness experience."

Cabeza Prieta's wilderness saw very few human beings until the late 1990s. After a crackdown at the urban crossings in California, illegal traffic from Mexico and Central America shifted to the Arizona desert, a riskier environment. Migrants died in the heat — so many that the government permitted private groups to put out water stations. We pass one of the stations, marked by blue pennants. When the 9/11 attacks made homeland security a hot-button issue, enforcement intensified. In addition to new fencing, DHS has deployed 4,200 agents within the Tucson sector of the Border Patrol, three times as many as a decade earlier. Apprehensions of illegal migrants have gone down as a result, but they still number about 120,000 a year.

The legislation enabling the border fencing released DHS from environmental safeguards. If it needed to, the department could have ignored the Endangered Species Act. The project was completed in 2012, but DHS retains the right to invoke environmental waivers for project maintenance. Currently, the Border Patrol is required to notify Cabeza Prieta's manager



U.S. Border Patrol agent Vicente Paco examines Mexico-bound footprints (most likely drug smugglers) near the barrier fence on the Mexico border. A Department of Homeland Security employee (opposite page) repairs a portion of 12-foot-high pedestrian barrier along the border.

whenever its vehicles leave the Camino during an "incursion." Atkinson points out tire tracks going every which way in the flats. Though shallow, the tracks of the vehicles last for years in the crusty soil. Representatives of conservation groups, who periodically fly over the refuge and take photos, allege that American agents cause most of the damage on the refuge. After all, the barrier along the 56-mile-long border with Mexico has stopped most foreign vehicles, but was not designed to prevent foot traffic. "People are still coming — waves of drug smugglers," says Atkinson. "There's no sign of letting up."

Fifty miles west of the main road, Atkinson stops the truck, and we get out at a bleak place called Pinta Sands. Amid the dunes and outcrops of black, igneous rock stand a few scraggly saguaro cacti. We start walking south, accompanied by an armed ranger since we are not allowed to approach the border without protection.

After a mile or so, a dark fence appears, its beams made of weathered steel, its posts filled with concrete. Atkinson says that the pronghorn, if they want to, crawl under it. But we are at the edge of their island nonetheless, since in the near distance trucks are moving along Mexico's Highway 2, a busy, two-lane artery. People cross here but, without underpasses, the highway repels all but the most adventurous pronghorn. Connectivity for the species has been lost. Atkinson says that only one pioneering animal from the breeding program is known to have made it over. That buck now lives with a herd in Sonora.

GEOGRAPHICAL LIFELINES

The field of connectivity studies dates to the 1967 publication of *The Theory of Island Biogeography*, by R.H. MacArthur and E.O. Wilson. In this seminal work, which focused on islands in the sea, MacArthur and Wilson related the size of an island

and its distance from the mainland to the richness and resilience of the island's animals and birds, which were now natives. The idea was to understand the factors that either promoted or retarded the loss of island species. The authors considered such factors as the rate of new arrivals of a species, which bolstered the group both numerically and genetically. They also estimated the rate that alien species appeared on the island and set back the endemic populations. By weighing all the factors, positive and negative, island biogeography was able to model the probability and frequency of extinctions.

Next, biologists applied the models to virtual islands on continents. The tropical forests of the Amazon, for example,



were being fragmented by logging and burning, resulting in a patchwork of good and bad habitat. Scientists observed that animals came and went from such islands through safe corridors, skirting human settlements and degraded landscapes. In most instances, the creatures at risk on continental islands can be found in healthy, or at least adequate, numbers not too far away. So connectivity researchers try to identify the geographical lifelines between the robust and marginal populations. A corridor that is doing its job pushes back the probability of a local extinction — of island species winking out — just as trapped miners can be kept alive by tubes of air snaked from the surface.

But what if the rescue never comes? As wildlands are chopped into ever smaller chunks, migratory corridors are cut off. Healthy genetic exchanges between unrelated animals — the scientific term is gene flow — slow to a halt. At that point an inbred, isolated species, its numbers declining, is vulnerable to disease and to winking out. Bulldozers, chain saws and fences accelerate the process, but it's worth noting that connectivity between populations may also fade gradually, over an eon, as climatic conditions shift. That is what happened to the

Quitobaquito pupfish, which is the most vulnerable species on the border today.

The Quitobaquito pupfish is about the size of my thumb. Rather, of Izar Izaguirre's thumb, since he is a holding one in his meaty palm. Izaguirre, a Mexican biologist, works for the Pinacate Biosphere Reserve in northern Sonora, across the line from Cabeza Prieta. He has scooped a specimen from a shallow pool in the otherwise dry bed of the Sonoyta River. "It's so small," jokes Izaguirre, that "it's not a real fish." The dull color indicates either a female or a non-breeding male, since breeding males turn a jaunty blue during mating season.

This species lives in just two places: the Sonoyta River and

Quitobaquito Springs, islands that are only a mile apart with the border between. Quitobaquito Springs bubbles from the ground in Organ Pipe Cactus National Monument, a unit of the National Park Service just east of the Cabeza Prieta wildlife refuge, while the Sonoyta River flows intermittently through the Mexican city of the same name. Quitobaquito Springs is open on a limited basis during the springtime, when the park service brings tourists there under escort of armed guards. Ever since a park ranger was killed in a shootout with drug smugglers in 2002, the Border Patrol has played it tough in Organ Pipe. At present, some 500 agents are assigned to the park.

The Sonoyta River has its own set of problems. Izaguirre brings me to a normally reliable stretch called Agua Dulce (Soft Water). It is west of town in the flat scrub off Route 2. But when we get there, we find that Aqua Dulce has been reduced to a few slits of dark water. Awaiting the summer monsoon, the Sonoyta River is more stressed than ever since a nearby farming operation has started to pump the groundwater beneath it. The fish that we discover hiding in the pool is extremely hardy, though. A Quitobaquito pupfish can survive in a salty puddle in 100-degree temperatures; a bit of wet algae draped on its skin can keep it alive until the water returns.

Not only does an international border lie between the river and Quitobaquito Springs but so does a highway, four fences and, of course, the desiccated landscape. Although it appears that, for these two populations of pupfish, ne'er the twain shall meet, the reasons for their mutual isolation are geology and climate rather than man-made interference. At the end of the last ice age, when the climate was much wetter, an extended family of desert pupfish mingled in the streams and ponds of the Southwest. Flooding provided the corridors needed for migration and gene flow. As the climate dried, the fish retreated to small, separate refuges, where exchanges of DNA stopped. With time and distance, different species and subspecies of

pupfish emerged. According to a mineral analysis of the water, there was connectivity between the Sonoita River and Quitobaquito Springs when the area was rainy. But even before then, the Quitobaquito pupfish had broken from the main branch of desert pupfish because a volcanic eruption altered the drainage of the region and cut off the southern population from the rest.

The best proof of connectivity (or lack of it) comes from comparisons of DNA. In 1987, when the Quitobaquito pupfish was declared a distinct subspecies of the desert pupfish, it was largely on the basis of genetics. Here's how DNA and connectivity relate: When movements and mating across blocks of territory are taking place smoothly, gene flow is unrestricted, and scientists don't find a difference in DNA between the members of a species or subspecies. But where the flow has been interrupted or pinched, as with the pupfish, telltale patterns develop. The groups' DNA become less alike with each new generation. In 2000, after more detailed study, the Quitobaquito pupfish was named a species in its own right and put on a separate taxonomic rung from the desert pupfish. DNA trumps physical form, because the two species still look very much the same.

BORDERLINE SPECIES

A DNA lens is also being turned on the big animals of the border. For example, biologists have looked for evidence of connectivity in the genetics of black bears. In a 2011 report, a team led by Todd Atwood of the state Game and Fish Department compared the genetic markers of "mainland" bears living in the forested central part of Arizona with the bears in the mountains near the Mexican border. The latter are near the southern limits of their natural range and, in addition to being less abundant, they show less DNA diversity than the central population. The bears of southern Arizona can be genetically differentiated from the northern group, which may mean that movement between the highlands and border mountains is being constricted.

Extending the sample across the border, a University of Arizona team has established a high degree of connectivity between Arizona's and Mexico's black bears. Although the populations are closely related at present, Melanie Culver, the USGS geneticist who directed the work, points out that bears live a relatively long time, so the distinctions between the groups may show up in future generations. "The wall hasn't been there long enough to have demonstrated it yet," Culver argues. "There are bears alive that predate the wall, and they've had an opportunity to move from one side of the border to the other. It's not a complete barrier yet."

"Bears in Sonora are endangered," emphasizes Atwood, who has since moved to Alaska to work on polar bears. "It's highly probable that the fence is restricting gene flow where the fence is not permeable." Atwood concedes that the species is at the extreme margin of its range in Mexico, but if bears there are cut off and disappear, "it will be a loss, and you hate to see a



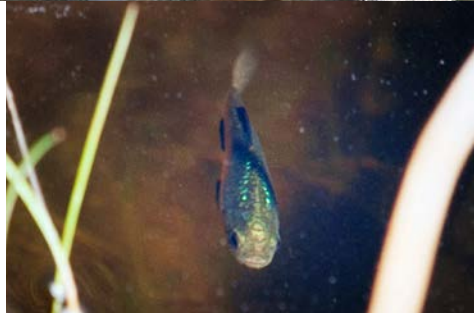
loss of range."

To mitigate the impacts of the fence and Border Patrol activity, the Department of Homeland Security has committed to spend \$50 million for environmental enhancement projects and field studies, but few projects have materialized. In

Cabeza Prieta, DHS has paid for water catchments for pronghorn — shallow troughs that capture rainwater for drinking — and has also contributed funds to the captive breeding program. Species along the border are, in effect, competing with one another for DHS funding, and the larger animals tend to do better than smaller ones in the competition. The jaguar, for example, which is popular with the public, has garnered more than \$2 million worth of "mitigation money." At least 10 studies of the big cat are underway.

A solitary hunter with skull-crushing jaws, the jaguar is the largest feline predator in the New World. Hounded for centuries, this endangered species no longer breeds in the southwestern United States. Indeed, the nearest healthy breeding population of jaguars is located 120 miles south of the line in Sonora. Yet because roaming males are occasionally sighted in Arizona, University of Arizona scientists, led by Culver, got \$800,000 to deploy motion-sensitive cameras in areas where the cats were most likely to venture across. Before biologists even think about managing a population, as with the pronghorn, a rough inventory must be taken. Meanwhile, responding to pressure from environmental groups, the FWS has listed some 760,000 acres of Arizona and New Mexico as critical habitat for the jaguar.

That millions of dollars are being spent on a species without



Clockwise: A ferruginous pygmy owl in the Sonoran desert of Mexico, across the border from Cabeza Prieta; a male jaguar is captured by a motion-sensitive camera, part of a University of Arizona survey; Sonoran pronghorn at the refuge at Cabeza Prieta; a Sonoran pupfish swims in a refugium at Cabeza Prieta's visitor center.



foothold in the U.S. bothers connectivity specialists such as Aaron Flesch. Flesch, a biologist at the School of Natural Resources and the Environment at the University of Arizona, has studied ferruginous pygmy owls, whose short, low flights might be crimped by high border walls. He would like to see more species in the mix being studied. "Not hummingbirds," he explains. "They can fly over the fence. But I'd select [species] on the basis of how fragmented their habitats are and their capacity for movement across the border."

Like others entering the field, Flesch has tried to fit his past research on animal movement behavior into the new conditions at the border. When he and five colleagues analyzed the harmful effects of the border fence on pygmy owls, bighorn sheep and other species in a 2010 paper, they dealt with hypotheticals. The real work simply didn't start soon enough. "The fence gained its political traction quickly — with no environmental assessments," says bear biologist Atwood. "We had no baseline. Everyone was caught flat-footed."

THREADS OF CONNECTION

One day in March, during very unusual weather on the border — a snowstorm — Flesch drives me to the small town of Naco, Ariz. The black branches of the mesquite bushes are about to leaf into green, but today they are blotched in white. We cross into Naco, Sonora. The *federales* on the Mexico side, cradling automatic rifles, have woolen masks on the lower half of their faces, ostensibly to guard against the wet snow but also so that bad guys cannot identify them.

We turn right out of town and drive west on a soggy, red dirt road. The rocky desert around Naco is badly overgrazed, worse on the Mexican side. We are next to a 12-foot-high pedestrian barrier, its mesh so heavy that the light from America passes through with difficulty. Flesch says human beings could get over if they had to. "Only wildlife can't cross."

He urges me to look at the big picture of fragmentation and extinction, a worldwide picture symbolized by the dark fence. "Populations wink off and on," he says. "Say you have a bad year for reproduction, and a population winks off. So for that species to reoccupy a territory, you need corridors. Movement is essential. It applies to a unicellular organism as well as to a jaguar. What matters is whether their habitat is continuous or fragmented. And with climate change, no patch is too big."

Flesch talks about the "meta-population" — a series of populations occupying a network of habitats, like beads strung on a necklace. Insofar as black bears, pronghorn or pygmy owls live in patches, they form meta-populations. The links between the patches make the strand of the necklace, without which the groups fall apart. Gesturing once more at the fence, Flesch says, "A patch could wink off and then you'll look at the impact of the wall. What if no animal can reoccupy?"

Except for Atkinson, whose desert pronghorn are on the rise, none of the American biologists I interviewed were particularly hopeful about the species they study. They see the changes at the border as just another piece chipped from the shrinking store of habitat. Species disappear in direct proportion to the expansion of the human meta-population. True, the number of *Homo sapiens* is projected to peak and go down before the end of the century, but by then the islands occupied by endangered creatures may be zoos, and gene flow will be provided by animals in shipping crates.

Across the border, Izaguirre is gloomy about the wildlife of Sonora. The general deterioration of aquatic habitat around the impoverished city of Sonoita makes the border barrier less of an issue for him. Besides the hazards of low water, exotic fish in the river are preying on pupfish. "We are working alone," he says of conservationists in Mexico. "It's not enough, what we do. The national interest is elsewhere." But before taking me back to the crossing to Arizona, the biologist wants to end the afternoon on a positive note, so he makes a detour to a local high school.

As we pull in, the girls and boys are just getting out of school. They're laughing and twiddling on their cell phones as kids do anywhere. There in the lawn of the courtyard is an artificial oasis. It's got marsh grass, native wildflowers, rocks and circulating water. I'm reminded that zoos, aquaria and other refuges for wildlife can be very pretty when they're done right. A population of Quitobaquito pupfish is thriving in the pool, connected only to the goodwill of children. ■

Jeff Wheelwright is a frequent Discover contributor and author of *The Wandering Gene* and *The Indian Princess: Race, Religion, and DNA*.