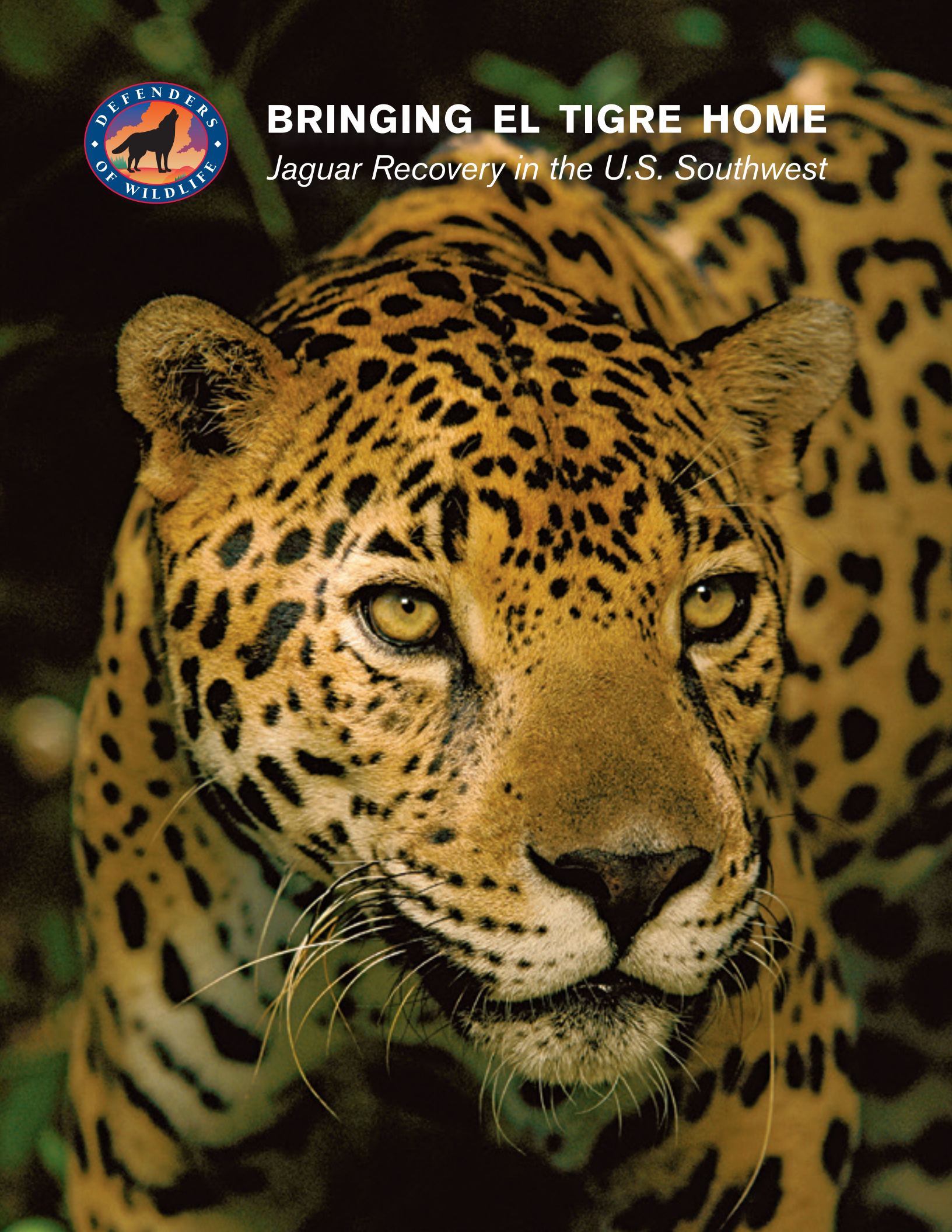


BRINGING EL TIGRE HOME

Jaguar Recovery in the U.S. Southwest





Defenders of Wildlife is a national, nonprofit membership organization dedicated to the protection of all native wild animals and plants in their natural communities.

Defenders has been working to conserve jaguars in Mexico and the United States for more than a decade. In Mexico, we played a major role in creating, supporting and guiding the Northern Jaguar Project, which works to sustain the most northern known breeding population of jaguars in the Americas. We also share the knowledge gained from years of coexistence work with our partners in Mexico. In the United States, we advocated or took legal action to compel FWS to list the U.S. population of jaguars as endangered, to designate jaguar critical habitat and to undertake recovery planning. We are also working to protect jaguar habitat and to maintain movement corridors. And we continue to oppose harmful development projects in critical jaguar habitat.

Author

Robert L. Peters, Ph.D.
Senior Southwest Representative, Defenders of Wildlife

Reviewers

Sergio Avila, *Arizona-Sonora Desert Museum*
Kim Fisher, *Wildlife Conservation Society, Bronx Zoo*
Carlos López González, *Universidad Autonoma de Queretaro, Biologia, Mexico*
Diana Hadley, *Northern Jaguar Project*
Craig Miller, *Defenders of Wildlife*
Chris McVie, *Tucson Audubon Society and Coalition for Sonoran Desert Protection*
Aletris Neils, *School of Natural Resources and the Environment, University of Arizona*
Tony Povilitis, *Life Net Nature*
Eric Sanderson, *Wildlife Conservation Society, Bronx Zoo*

Thanks to the following experts who provided additional information and insights:

Marit Alanen, Paul Beier, Ivonne Cassaigne, Matt Clark, Melanie Culver,
Brian Miller, Michael Robinson, Amy Rodrigues, Randy Seraglio

© 2017 Defenders of Wildlife
1130 17th Street, NW
Washington, D.C. 20036-4604
202.682.9400
www.defenders.org

Overview

Long considered extirpated in the United States, jaguars are reappearing. At least seven male jaguars, wanderers from Mexico, have returned to the mountains of southern Arizona and New Mexico since 1996. Two of these, dubbed Macho B and El Jefe, were photographed numerous times in Arizona during the past decade. In late 2016, two more jaguars appeared in the mountains of southern Arizona (Galvan 2016, Main 2017). Natural reappearances like these lend new urgency for actions to re-establish a reproducing population of jaguars that includes contiguous habitat in both the United States and Mexico.

Several habitat mapping projects, including one done for the Habitat Subcommittee of the interagency Jaguar Conservation Team, show that there is plenty of potential habitat in Arizona and New Mexico. There is also plenty to eat: Main jaguar prey species, deer and javelinas, are much more abundant now than they were 100 years ago.

Historically, the U.S. Fish and Wildlife Service (FWS) has not embraced jaguar recovery in the United States even though it has successfully brought back gray wolves and other imperiled predators with documented ecological, economic and aesthetic benefits. The re-establishment of jaguars in the United States could bring similar benefits, including improved ecosystem health through regulation of the abundance of prey species, protection of the many other species that share the designated critical habitat of this wide-ranging predator, and jaguar-centered tourism and other job-stimulating recreational opportunities. There is also the emotional, aesthetic and spiritual value people derive simply from knowing iconic creatures like jaguars persist in the wild. The fact that a video compiled from remote motion-sensing camera footage of jaguar El Jefe generated media attention worldwide and was viewed by more 100 million people attests to this existence value.

Yet it took being sued by conservation groups for FWS to list the U.S. population of jaguars as endangered, designate critical habitat and begin developing a recovery plan. FWS has also concluded that even huge development projects like the Rosemont open-pit copper mine planned for the home-range of El Jefe in the Santa Rita Mountains would not jeopardize the jaguar or adversely modify designated critical habitat. And the draft recovery plan FWS released in

December 2016 would do little to recover the jaguar in the United States.

The draft recovery plan correctly concludes that protecting the Mexican populations is essential, but it designates an insufficient U.S. recovery area and ignores the possibility of translocating jaguars from Mexico or elsewhere to the United States. Without biological justification, the draft recovery plan excludes large blocks of potential habitat north of the artificial boundary of Interstate 10 (I-10), and the population viability assessment based on this limited area not surprisingly concluded that there is insufficient U.S. habitat to support more than a handful of jaguars.

By contrast, jaguar habitat modeling that considered all of Arizona and New Mexico showed substantial amounts of suitable habitat north of I-10. In a few places, jaguars could safely travel across I-10 to this habitat using natural underpasses, like Davidson Canyon, but the draft recovery plan has no provision for protecting these potentially vital movement corridors.

FWS must develop a forward-looking plan that leads to population restoration within all suitable habitat in the jaguar's historical U.S. range and ensures connectivity with Mexico and within U.S. habitat blocks. Toward that end, we urge FWS, state wildlife agencies, conservation groups and citizens to work together to:

1. Fully commit to jaguar recovery in the United States.
2. Increase public awareness of U.S. jaguars.
3. Minimize opposition to recovery by educating livestock producers and implementing coexistence programs.
4. Base jaguar management plans and actions on a regional, ecological perspective.
5. Invest in and protect movement corridors.
6. Support the northern Mexico jaguar populations.
7. Ensure that female jaguars become established in the United States.
8. Dedicate funding to jaguar recovery.

Only with the unwavering commitment and support of all stakeholders will the cat commonly known as el tigre make it back to stay in the southwestern United States.

Introduction

Lost and Found

Jaguars were once widespread in the southwestern United States, ranging as far north as the Grand Canyon (Brown and López González 2001). They lived in New Mexico, Arizona and Texas, and some scientists believe they were present in other states, including California and Louisiana (Povilitis 2014, Brown and López González 2001). A resolution by the American Society of Mammologists (2007) placed jaguars “throughout the southern tier of the United States, from the west to the east coasts, and as far north as Monterey Bay, the Grand Canyon, and the southern Great Plains.” Rock art and other artifacts dating back to the Anasazi, Pueblo, Hopi and other native cultures of the Southwest support the presence of jaguars throughout the region (Pavlik 2003).

These U.S. jaguars were part of a greater, continuous population that ranged south across the border into Sonora and Tamaulipas, Mexico, and beyond (Brown and López González 2001; U.S. Fish and Wildlife Service [FWS] 2016a).

By the early 20th century, jaguars had been largely extirpated from the United States, systematically killed by

government predator-control agents, livestock producers and hunters (Bacon 2012). Despite persecution, occasional jaguars persisted in Arizona and New Mexico. Cubs were reported in Arizona into the 20th century, and a female was killed in the White Mountains of Arizona as recently as 1963 (Brown and López González 2001). In 1971, boys hunting ducks killed a male. In 1986, a hunter pursuing mountain lions with dogs in the Dos Cabezas Mountains of Arizona killed the last known male, and it looked like jaguars were gone from the states for good. Perhaps under the assumption that jaguars were extinct in the United States, FWS listed foreign jaguars as endangered under the Endangered Species Act (ESA) in 1975, but “through an oversight” omitted protection for U.S. jaguars (U.S. Fish and Wildlife Service [FWS] 2016a).

Then, in 1996, the hounds of another mountain lion hunter, rancher Warner Glenn, cornered a male jaguar on a rocky outcropping in the Peloncillo Mountains of Arizona, just west of the New Mexico state line. Glenn called off his dogs and took photos, which generated new excitement about jaguars in the United States. Later in 1996, a second jaguar was

A rancher hunting mountain lions took this photograph of a male jaguar in the Peloncillo Mountains of Arizona in 1996. His hounds cornered the cat on the rocky ledge and he called them off to capture the image, documenting the presence of a jaguar in the United States for the first time in many years and generating excitement about a U.S. comeback for the cat.



photographed by a rancher in the Baboquivari Mountains of Arizona, southwest of Tucson (Brown and López González 2001). In 1997, likely spurred by these sightings and pressure and litigation filed by nongovernmental organizations (NGOs), FWS made the long-overdue decision to list the jaguar as endangered in the United States (Brown and López González 2001). And in 2014, FWS designated critical habitat where federally permitted or funded projects must consider effects on jaguar habitat (U.S. Department of the Interior [DOI] 2014).

In addition to the two jaguars sighted in 1996, ranchers and scientists have since identified five more male jaguars, including two recorded by trail cameras in late 2016 in the mountains of southern Arizona (FWS 2016a; Galvan 2016, Main 2017). Two of these seven jaguars, Macho B and El Jefe, were detected repeatedly by motion-sensing cameras in Arizona, demonstrating that they were able to survive for years in good condition in the United States (FWS 2016a; Arizona Game and Fish Department [AGFD] 2009). Many biologists believe all these males traveled north from Mexico, likely from a well-known breeding population in Sonora, Mexico, some 100 miles south of the international border.

Trail cameras have recorded additional jaguars near the border on the Mexican side (Avila-Villegas and Lamberton-Moreno 2013). Both sides of the border have abundant prey and large amounts of open space, and individual jaguars could have territories that include habitat on both sides—so long as border walls and associated infrastructure do not prevent them from crossing. Tracks likely belonging to Macho B were discovered in northern Sonora in 2006, during the same period he was being photographed in southern Arizona (Avila-Villegas 2017).



El Jefe, the male jaguar who became an online video sensation, moves through the Santa Rita Mountains not far from Tucson. Remote camera footage of the jaguar taken in the area's scrub grasslands and sometimes snowy coniferous forests went viral and inspired the contest that gave him his name.

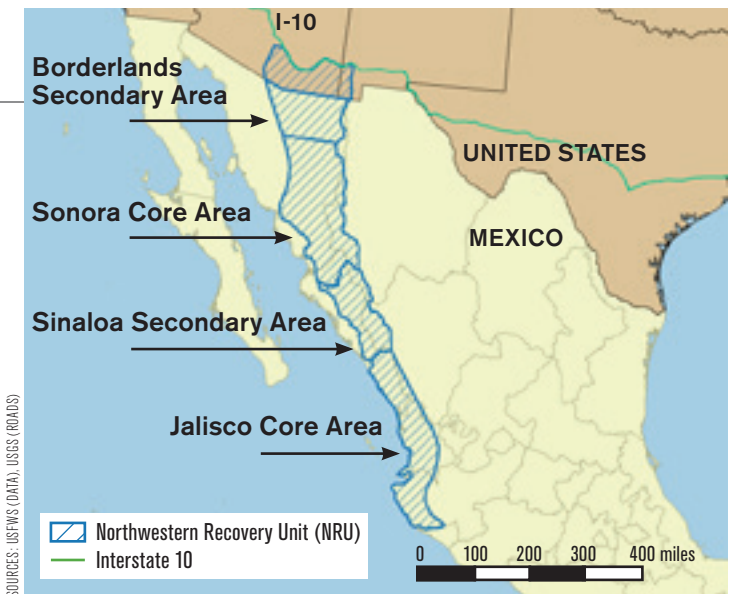


Figure 1. Northwestern Recovery Unit showing the Borderlands Secondary Area, where U.S. jaguars live, and the Sonora Core Area

The fact that all the animals identified recently in the United States are males is not surprising given that males range much more widely than females. Nonetheless, some scientists believe that undiscovered females could live in the United States or northern Sonora near the border (Avila-Villegas 2017). As Johnson et al. (2011) stated, “absence of evidence is not evidence of absence.”

In 2012, FWS divided all areas with jaguars in the Western Hemisphere into recovery units (FWS 2012), including the Northwestern Recovery Unit (NRU), which runs from Arizona and New Mexico south along the Sierra Madre Occidental system of mountain ranges through the Mexican states of Sonora, Sinaloa and Jalisco. The U.S. jaguars live in the northernmost division of the NRU called the Borderlands Secondary Area, which includes southern Arizona and northern Sonora, Mexico (Figure 1). South of the Borderlands Secondary Area are two “core areas,” one in Sonora—the probable source of the male jaguars arriving in the United States—and one in Jalisco. Jaguars are relatively numerous in these core areas and, as long as poaching and habitat loss can be controlled, relatively secure (FWS 2016a).

So how can the United States re-establish a population of jaguars? ESA protections and critical habitat designation came too late to prevent the virtual extirpation of jaguars in the United States. Males are making their way from Mexico, but in recent years no females have been detected, and without them real recovery is not possible.

This report describes a way forward for jaguar recovery in the United States. It reviews the potential benefits, inherent challenges and favorable conditions for recovery that exist today. Most important, it offers solutions for overcoming the obstacles to recovery and a vision for restoring el tigre, as the jaguar is widely known in Mexico, to our national fauna.

THE JAGUAR IN NATURAL AND CULTURAL HISTORY

Jaguars, like lions, tigers and leopards, belong to the feline subfamily *Pantherinae*—the only wild cats that can roar. Ancestral jaguars crossed into the Americas from Asia roughly two million years ago and became widespread (Seymour 1989). During the past 100 plus years jaguars lived in Arizona, New Mexico, Texas and possibly Louisiana and southern California (see Povilitis 2014, Brown and López González 2001). Although much reduced, the jaguar’s present range still includes parts of Arizona, New Mexico, Mexico, Central America and South America.

Jaguars are lone hunters with muscular, efficient bodies built to ambush and overpower prey. Their powerful jaws can easily puncture tortoise shells and kill large mammals with a single bite through the skull near the ears (Brown and López González 2001).

Borderland jaguars eat a wide variety of prey, including white-tailed deer, coatis, javelinas and desert tortoises. The stomach of the jaguar killed by duck hunters in Arizona in 1971 was reportedly “full of frogs,” a testament to the broad diet of the jaguar (Brown and López González 2001).

According to Brown and López González (2001), jaguars “readily take to killing livestock in areas where either the cats’ natural game has been depleted or where



ARIZONA HISTORICAL SOCIETY, LEE BROTHERS COLLECTION

A hunter poses with dogs and jaguar skins in this photo from the collection of an Arizona-based big-game guiding business that operated in the 1940s and 1950s.

calves and yearlings are pastured in rugged, brushy country.” Certainly, loss of livestock is a major reason people killed jaguars in their former U.S. territory and continue to kill them in Mexico where they persist.

In many Native American cultures, the jaguar was considered a symbol of physical, spiritual and religious power. Jaguar imagery appeared in temple carvings, rock art and sand paintings, and representations have been ascribed to Anasazi, Navajo, Tohono O’odam and others (Pavlik 2003). Elite Aztec warriors went into battle clothed in jaguar skins.

Other people in the Southwest have a long history with jaguars. Hispanic vaqueros wore silver-studded jaguar skins as chaps or decorated their saddles with pelts. In faded photographs from the early 1900s, Anglo homesteaders and ranchers pose proudly beside jaguars killed in the name of livestock protection. Hunters went to great efforts to find and kill these unique, powerful and beautiful animals whose skins were sought-after trophies. One hunter who killed a jaguar in Arizona in 1963—before state or ESA protection—said he turned down an offer of \$10,000 for the pelt (Davis 2013a).

Modern examples of embracing the jaguar as a symbol of power include the high-performance vehicle named for it and the Jacksonville Jaguars, a national football team.



ARIZONA HISTORICAL SOCIETY

A vaquero in San Bernardino, Sonora, Mexico, wears jaguar-hide chaps, circa 1908.

U.S. Jaguar Recovery

Benefits, Challenges and Reasons for Hope

Some have argued that jaguar recovery in the United States is not feasible because the cats are essentially gone (Davis 2013b). Others have said that the jaguar was never really a U.S. species and that the jaguars found here are simply wanderers from Mexico (see Johnson et al. 2011). Even some who do accept that there was once a U.S. breeding population may doubt the value of a peripheral population of jaguars on the northern edge of their range.

Brown and López González (2001) addressed the question of jaguar residency in the United States by reviewing 20th century records of jaguars in the Southwest. Excluding individuals whose sex was not certain, the list of occurrences they compiled included 16 males, seven females and three cubs—evidence that females were present and reproducing. As summarized by Povilitis (2014), contributions by other authors raised the total number of females on the list to nine, three of them with cubs. Given that females typically do not travel long distances, it is reasonable to assume that the females observed in the United States were likely born in or near the United States.

By the 20th century, jaguars had already been subject to substantial persecution, so the handful of females noted in the records reviewed are not likely indicative of pre-persecution numbers. The intentional extirpation of the species was effective. In Texas, for example, jaguars went from being described as “common” in 1859 to extirpated by 1927 (Brown and López González 2001).

The fact that borderland jaguars are on the edge of the species’ range does not necessarily make this peripheral population less important to conservation than the central population in Mexico. As reviewed in the Draft Jaguar Recovery Plan (FWS 2016a), opinions about the relative importance of peripheral populations vary, but some studies have suggested that they may be more important for the long-term survival of species than central populations. For example, Channell and Lomolino (2000) assessed 245 species that had lost large portions of their ranges, often due to human activity, and concluded that, overall, species at risk persist best in peripheral areas that may be less affected by people.

Arguments that restoring the jaguar to the southwestern United States is impossible are undermined by successful programs that have brought back other animals that were extirpated in the wild or nearly so. These include the black-footed ferret, bison, Mexican gray wolf, whooping crane and California condor.

Benefits

Successful jaguar recovery can bring ecological, economic and aesthetic benefits:

Ecological stability. The loss of jaguars from the Southwest left a tear in our ecological fabric. Like wolves and other apex predators, jaguars help regulate the abundance of prey species. Although analogous studies have not been carried out on jaguars, research has shown that reintroduction of wolves has a cascading effect on prey and other predators that improves the health of ecosystems where wolves had been missing. Benefits from wolf reintroduction include regrowth of streamside vegetation with concomitant increases in fish and bird abundance (Beschta and Ripple 2012, Baril et al. 2011).

Habitat preservation. Jaguars are an umbrella species, meaning that conserving land for these wide-ranging predators will also benefit numerous other species found in jaguar range. For example, the designation of critical habitat requires that federally funded or permitted development projects consider impacts on the jaguar (FWS 2015), and efforts to mitigate the effects of projects like open-pit mines may benefit other species as well.

Economic value. Typically, the economic benefits of wildlife accrue from tourism, hunting, fishing and creative conservation incentives for landowners who protect habitat and wildlife. For example, landowners near the Northern Jaguar Reserve in Sonora, Mexico, are compensated if jaguars are photographed on their land.

Jaguar-centered tourism and other recreational opportunities could stimulate jobs and income in the U.S. Southwest. Although the chances are small that a visitor would see a jaguar in the wild because they are stealthy, cryptic and relatively few in number, experience shows that people are drawn to places where jaguars live. For example, tourists visit the Cockscomb Basin Jaguar Preserve in Belize, even though they are told, “Please note that a visit to the Jaguar Preserve may likely provide you with signs of recent jaguar activity, but it is highly unlikely that an actual jaguar sighting will occur” (Belize National Parks 2016).

Economists have assigned dollar values to intangibles like ecological services and increased recreational opportunities from conservation. A handful of such

studies have been done for species like wolves and bighorn sheep, but not yet for jaguars (Industrial Economics 2013).

Existence value. Existence value, as it pertains to wildlife conservation, is the benefit that people derive simply from knowing that wild, iconic creatures like wolves or jaguars persist, even if the people receive no financial or other tangible benefit (National Research Council 2004). Emotional, aesthetic and spiritual appreciation is a major reason that people support the Endangered Species Act and donate to conservation organizations.

Challenges

Natural and man-made constraints and lack of support pose challenges to jaguar recovery in the United States. For example:

- The primary source population for natural recolonization is some 100 miles south of the U.S.-Mexico border.
- Although males have reached the United States, poaching, border fencing and high-speed roads—such as the east-west Mexican Highway 2, which is now being expanded—are significant barriers between the source population and potential U.S. habitat. The border wall, if completed, will likely be impenetrable by jaguars. In addition to the wall itself, associated infrastructure such as roads, helipads, generators, lights, operating bases and patrols by agents will deter jaguars.
- Neither FWS nor the states of Arizona and New Mexico are championing jaguar recovery.
- Funding for recovery efforts has been paltry.
- Many livestock producers resist recovery of large predators, including wolves and jaguars. In 2015, the New Mexico Farm and Livestock Bureau and others sued to undo FWS's designation of jaguar critical habitat. Defenders has intervened in the lawsuit to preserve the designation (Paterson 2015).

Reasons for hope

Despite the many challenges, there are good reasons and favorable conditions for pursuing jaguar recovery:

Public enthusiasm. Jaguars are beautiful, charismatic animals that speak to the human spirit. In 2016, when researchers released footage of a male jaguar following a stream in the Santa Rita Mountains (Conservation CATalyst 2016), an estimated minimum of 100 million

people viewed it (Serraglio 2016). The popular cat soon had a name, El Jefe (The Boss), the winning entry in a contest for middle-schoolers.

This enthusiasm for jaguars is reflected in local groups that have recruited and organized the many volunteers needed for maintaining trail cameras and collecting other noninvasive data on borderland jaguars and their habitat. For example, Sky Island Alliance and Patagonia Area Resource Alliance have placed and monitored cameras (Avila-Villegas and Lamberton-Moreno 2014). The Malpai Borderlands Group, a collaboration of ranchers in southeast Arizona and southwest New Mexico, instituted a program to compensate ranchers for livestock lost to jaguars after founding member Warner Glenn photographed a jaguar in the area in 1996 (Malpai Borderlands Group 2017).

Abundant prey. Prey is much more abundant now than it was in the last century when jaguars were still roaming Arizona, New Mexico and Texas. For example, the number of Coues white-tailed deer spotted in Arizona state surveys increased more than 2,000 percent from 1947 to 2014 (AGFD 2015). The count of javelinas, another important food, increased 659 percent from 1955 to 2013 (AGFD 2015). Although it is unknown how much of this apparent increase was due to changes in survey methodology, it is clear that food is plentiful.

Behavioral flexibility. Jaguars are habitat generalists that eat a wide variety of prey. They thrive in habitats as varied as tropical forests, swamps, thorn scrub and coniferous forests. In the United States, jaguars, including El Jefe, use conifer forests, a habitat quite different from the tropical forests most people associate with the cats. The female killed in the White Mountains of Arizona in 1963 was in conifer forest, as were 15 other U.S. jaguars on the list of 61 compiled by Brown and López González (2001). This adaptability means they can do well in many habitats provided they have adequate habitat connectivity and prey and people do not kill them.

Substantial suitable habitat. Looking at modeling done by the Center for Biological Diversity (CBD) using criteria developed by the Habitat Subcommittee of the Jaguar Conservation Team, a group of experts working in the early 2000s, it appears that roughly half of Arizona and New Mexico could still support jaguars (Figure 3). Other modelers have also predicted large amounts of habitat.

Improved habitat. During the last century, mesquite and other shrubs have colonized many Arizona grasslands that were once too open to provide security for jaguars. These areas are now suitable for the cats. Jaguar experts David Brown and Carlos López González wrote, “Ironically, this could be interpreted to mean that Arizona contains better jaguar habitat today than in 1900, when jaguars were presumably more numerous” (Brown and López González 2001).

Increased land protection. Significant jaguar habitat throughout the Southwest is in national wildlife refuges, monuments, parks and forests and wilderness and conservation areas. A growing number of private lands are also managed to complement conservation.

Designated critical habitat. In March 2014, FWS designated approximately 764,000 acres of critical habitat in Pima, Santa Cruz and Cochise counties in Arizona and Hidalgo County in New Mexico (DOI 2014). This is a good start, but the amount of critical habitat designated

is tiny compared to the jaguar’s historical range (Brown and López González 2001) and suitable habitat mapped by several researchers (Menke and Hayes 2003, Hatten, Averill-Murray and Van Pelt 2005, Robinson, Bradley and Boyd 2006, CBD 2010). It is not nearly large enough to sustain a viable U.S. population.

Synergy with other conservation efforts. Jaguar recovery in the United States will fail without a strong commitment from agencies, particularly FWS, the Forest Service, Bureau of Land Management (BLM) and state wildlife departments. Jaguars could benefit from conservation of Mexican gray wolf habitat and vice-versa. Figure 2 shows that areas of suitable habitat modeled by CBD (2010) coincide with areas of potential wolf habitat FWS identified in Arizona and New Mexico (FWS 2014). This is not surprising given that both predators do best in large areas without significant human disturbance. Protection of habitat and movement corridors between large habitat blocks would benefit jaguars, wolves, mountain lions and other wide-ranging species.

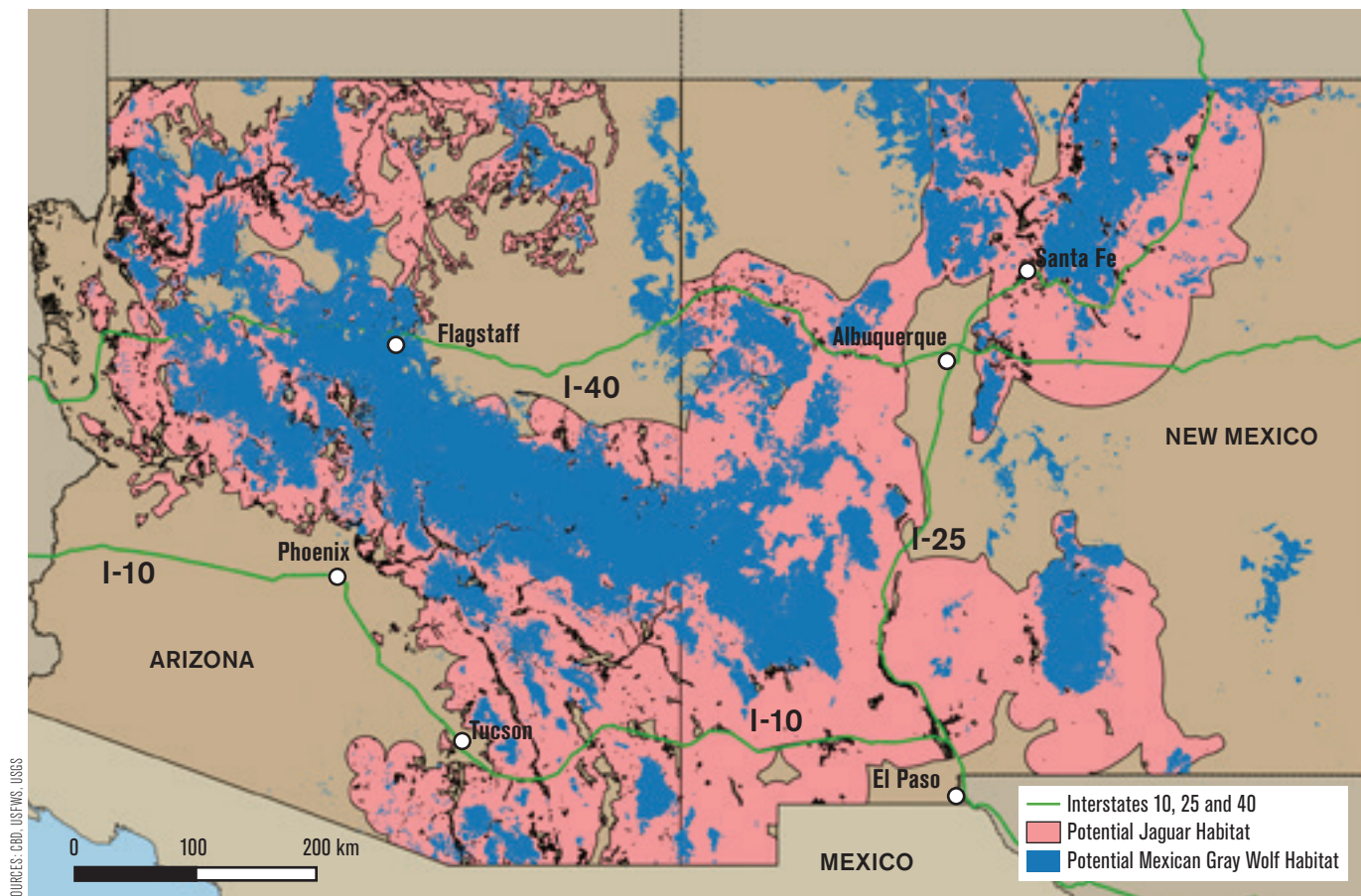


Figure 2. Suitable habitat for Mexican gray wolves and jaguars

Recovery Options

Natural Expansion and Translocation

Essentially, there are two ways that jaguars could repopulate their historic range in Arizona and New Mexico: natural expansion from Mexico and translocation—reintroduction by people.

Natural expansion

Allowing jaguars to naturally repopulate their range in the United States is the strategy of FWS. This scenario supposes that females will eventually follow males across the border, mate with them and establish a contiguous, interbreeding population extending from Arizona and New Mexico south to the source population in Sonora and possibly beyond.

For natural expansion into Arizona and New Mexico to succeed there would have to be 1) a surplus of jaguars in the northern Sonoran population to disperse to the United States; 2) low enough mortality along the route and in the United States that sufficient numbers survive to breed; and 3) females among the surviving, roaming jaguars.

There are significant, perhaps insurmountable, obstacles to this passive strategy. First, the closest probable source for U.S. jaguars is a small population in and around the Northern Jaguar Reserve in northeastern Sonora, 125 miles south of the border. The reserve is a sanctuary of more than 55,000 acres set up to protect the core of the northern Sonoran population, which probably numbers fewer than 100. Ensuring the long-term security and growth of this and other northern Mexican populations must be an important component of the natural expansion strategy.

A second obstacle is mortality along the route—enough dispersing individuals must safely reach potential habitat in the United States. If, as scientists believe, the males in the United States are emigrants from the Sonoran population, then some jaguars are clearly making it north. Nonetheless, the risks presented by poaching and roads and other development are great.

Poaching is a known problem for the Sonoran jaguar population. In 2014, a female named Corazón (heart), who was well known for having raised numerous cubs, was killed and her body intentionally burned even though she was wearing a tracking collar that alerted researchers to her death. Likewise, poaching could be a significant source of mortality for jaguars moving northward through the largely unprotected 100 plus miles to the U.S. border.

The routes by which jaguars can reach the United States from Mexico are limited. Kelly Stoner and colleagues identified just three such corridors (Stoner et al. 2015), any

of which could be restricted or made more dangerous by large development projects like mines or a border wall and associated infrastructure. Their study identified five highways near the border that would interfere with jaguar travel through these corridors, U.S. highways Interstate 19, state Route 82 and state Route 83, and Mexico Highway 2 and Highway 15. The Jaguar Draft Recovery Plan (2016) notes that “trans-border connectivity in the Borderlands Secondary Area is an important component of jaguar recovery in the NRU.”

A map developed by the Environmental Systems Research Institute (ESRI) shows how existing stretches of border wall transect the corridors jaguars are likely using to reach the United States (Figure 3). Although jaguars can still cross some sections of wall that were built to stop only vehicles, upgrades and new sections could prevent jaguars from ever reaching Arizona and New Mexico.

Finally, unlike males, females are not natural travelers and do not typically wander tens or hundreds of miles. Young females in the Sonoran population stick close to home, setting up territories adjacent to or even overlapping their mothers’. In 2013 biologist Peter Warshall (2013) estimated that it could take between 44 and 243 years for female jaguars from Mexico to reach the U.S. border, not including additional time to colonize habitat in the United States. The timing depends on assumptions about mortality, size of female territories, the direction in which females disperse, and jaguars’ ability to safely cross the border and east-west Mexican Highway 2. Warshall’s calculations underscore the improbability that jaguars could successfully re-establish a breeding population in the United States without assistance.

Translocation

A second possible method for re-establishing a viable population of jaguars in the United States is translocation: capturing wild jaguars in Mexico or elsewhere and releasing them in suitable habitat in Arizona and New Mexico.

Wildlife staff would have to plan translocation carefully to minimize harm to the source population and to the jaguars being moved. Jaguars and other cats have died from complications of capture, including respiratory and renal failure, cardiac arrest, seizures, falls from trees after being darted, hypothermia, wounds and broken teeth (Deem and Karesh 2005). Nonetheless, protocols exist for minimizing health risks and translocation is technically feasible. Jaguars, African lions, tigers, lynx, leopards and mountain lions have all been safely transferred to new locations, and there are cases

where individuals of each of these species are known to have established new home ranges (Bennett 2015). For example, 15 of 19 mountain lions released in Florida successfully established home ranges (Beldon and McCown 1996). In the Caura River Forest Reserve in Venezuela, a female jaguar and her cub were known to be alive eight months after being moved, while another female translocated to the Aguaro-Guariquito National Park in Venezuela was still in the park area five months later (Isasi-Catala 2010). A male jaguar that had been killing livestock in western Mexico was translocated to a more remote site in 2003 and photographed in the release area between 2003 and 2006 (Nuñez-Perez 2015).

Jaguars for translocation should be taken from populations robust enough to sustain periodic removal of some individuals. This strategy was identified in FWS's 2016 Recovery Plan for the Ocelot, which examined whether the ocelot population in Tamaulipas, Mexico, could sustainably provide individuals to bolster the Texas population. Translocated jaguars would likely survive best if taken from areas with similar habitat and prey, such as Sonora. Any removal of wild jaguars from Mexico should not happen without accompanying investment in habitat conservation or other measures to improve the overall size and health of the donor population (Bravo 2017).

Another approach would be to “rescue” jaguars that are in danger from human persecution or inadequate habitat by moving them, as was done for the jaguar preying on livestock in western Mexico mentioned above. Some conservationists might oppose removing problem jaguars for translocation rather than finding a solution that would allow them to remain on their territories, such as compensating livestock producers for loss or convincing livestock producers to use predator-friendly husbandry (Miller 2016).

Although captive breeding of jaguars for release is theoretically possible, it should be a last resort because of the substantial challenges of preparing animals for survival in the wild (Jule et al. 2008, Owen 2008). In general, captive breeding and release is most appropriate for species that have been completely or nearly extirpated in the wild such as the Iberian lynx (Wong 2014) and Amur leopard (Owen 2008).

Upgrades and additions to the border wall could prevent jaguars from reaching the United States, precluding natural expansion.



© MATT CLARK

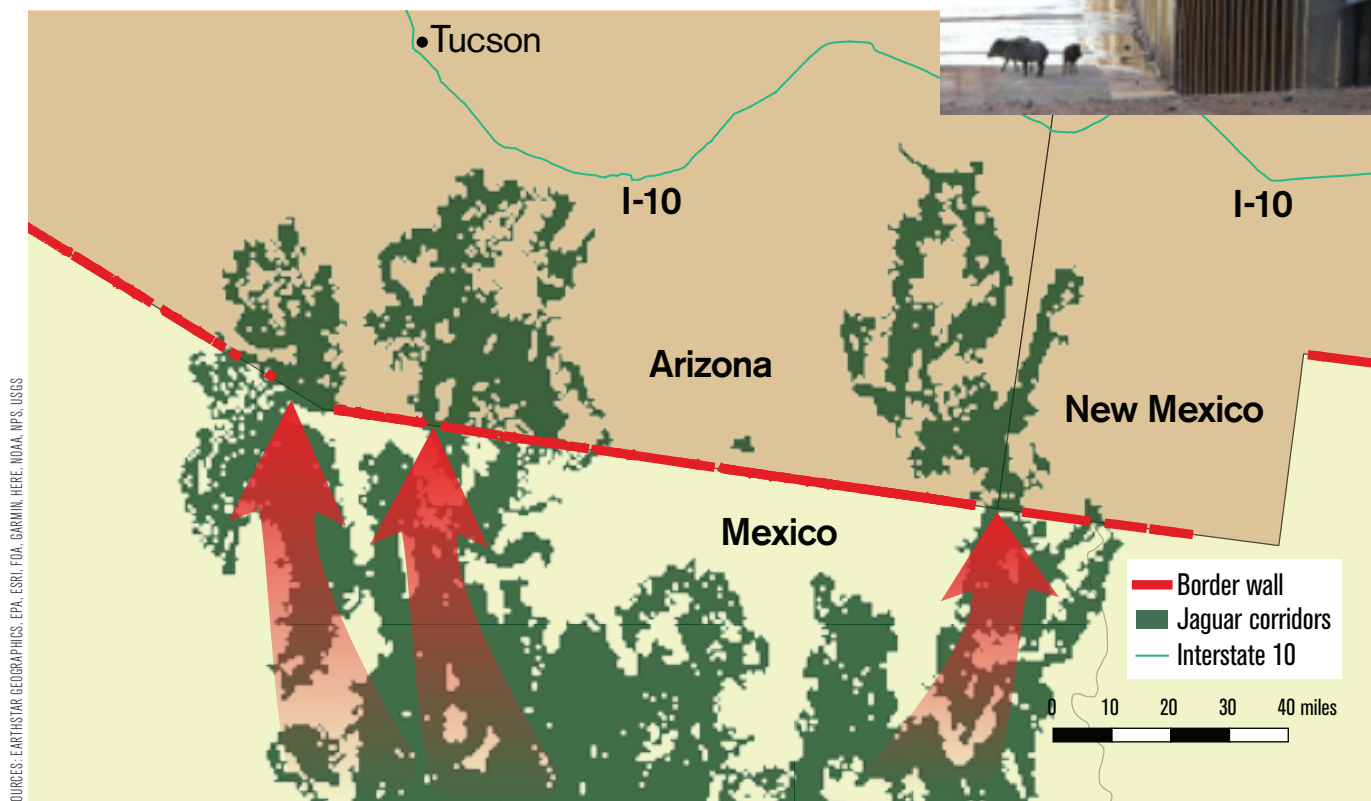


Figure 3. Existing border wall and jaguar movement corridors

Translocation of jaguars also presents challenges—politics, bureaucracy and international wildlife import regulations among them. Antagonism to recovery in the United States could result in illegal killings or political action constraining releases, as in the case of U.S. reintroductions of the Mexican gray wolf. Antipathy to predators is often high even when there are few livestock depredations compared to other causes of mortality.

For example, research in Brazil on jaguar-livestock conflict found that “livestock losses that were blamed on jaguars were shown, in reality, to be a result of disease, flooding, and theft. Exceptions occurred when the jaguars’ natural prey base

was scant and when livestock were allowed to roam freely throughout jaguar habitat” (Weber and Rabinowitz 1996).

Defenders of Wildlife has a long-standing, successful coexistence program that works with ranchers and others to prevent conflicts between predators and livestock. Some of the tools and techniques the program promotes could be useful in decreasing hostility toward jaguars. The Northern Jaguar Project, which runs the Northern Jaguar Reserve in Sonora, uses a variety of incentives and conducts educational outreach to reduce antagonism toward jaguars in and around the reserve (Northern Jaguar Project 2016).

NORTHERN JAGUAR RESERVE

The Northern Jaguar Reserve is more than 55,000 acres (86 square miles) of jaguar habitat in northern Sonora approximately 125 miles south of the U.S. border. Administered by the nonprofit Northern Jaguar Project and its Mexican counterpart, Naturalia, the reserve provides sanctuary to part of the largest breeding population of jaguars remaining in northern Sonora. This population is the likely source of the male jaguars that have found their way north across Mexico Highway 2 and the international border into the Sky Islands, the forested mountains rising from the deserts of the U.S. Southwest and northern Mexico. (Females are not known to have occupied territories in Arizona since the 1950s.)

Because the reserve itself is not large enough to sustain a viable population of jaguars, the Northern Jaguar Project

works with ranchers to protect jaguars in surrounding areas through a coexistence program. The program provides ranchers with financial rewards and conservation improvements, such as water tanks, when trail-camera photographs show that jaguars and other native cats are using their properties. The reserve is a center for the development of coexistence techniques and other research.

Situated in a biological diversity hotspot where northern and southern species overlap, the Northern Jaguar Reserve protects them all. What is believed to be the northernmost military macaw nesting site is on the reserve, as well as the southernmost bald eagle nesting site and the northernmost location where a breeding population of jaguars is found with mountain lions, bobcats and ocelots.



A Major Obstacle to Recovery Lack of Agency Support

Whether jaguars naturally expand into the United States or are translocated, the success of jaguar recovery will depend on agency resolve and adequate funding. At the moment, neither federal nor state agencies are championing or budgeting for recovery.

FWS, which has primary responsibility for planning and implementing jaguar recovery, has only done so when prompted by lawsuits. In 1975, FWS listed foreign jaguars under the ESA but overlooked the domestic population until pressured and sued by conservation NGOs, finally listing U.S. jaguars in 1997. In 2003, Defenders and CBD sued to force FWS to develop a formal recovery plan and designate critical habitat. In 2007, FWS stated that it would not develop a recovery plan (FWS 2007), and Defenders and CBD sued again, resulting in a federal judgment requiring FWS to reconsider a recovery plan and critical habitat. In 2014, 17 years after the jaguar was listed under the ESA, FWS finally

designated critical habitat but has not yet completed a final recovery plan.

In December 2016, FWS released a draft recovery plan that has little likelihood of restoring the jaguar to the United States. The plan says that “Mexico will be the primary contributor to recovery for the jaguar because over 95 percent of the species’ suitable habitat in the NRU [Northwestern Recovery Unit] exists within the borders of Mexico.” (Figure 4.)

This trivialization of the U.S. contribution is based on a significant underestimate of how much habitat exists in the United States. FWS arbitrarily restricted its analysis of U.S. habitat to a small area in Arizona and New Mexico south of Interstate 10 within at most 70 miles from the border—the U.S. section of the NRU.

Figure 4 compares the small U.S. area south of I-10 designated for jaguars in the draft recovery plan’s NRU with the potential habitat mapped by CBD for the Jaguar

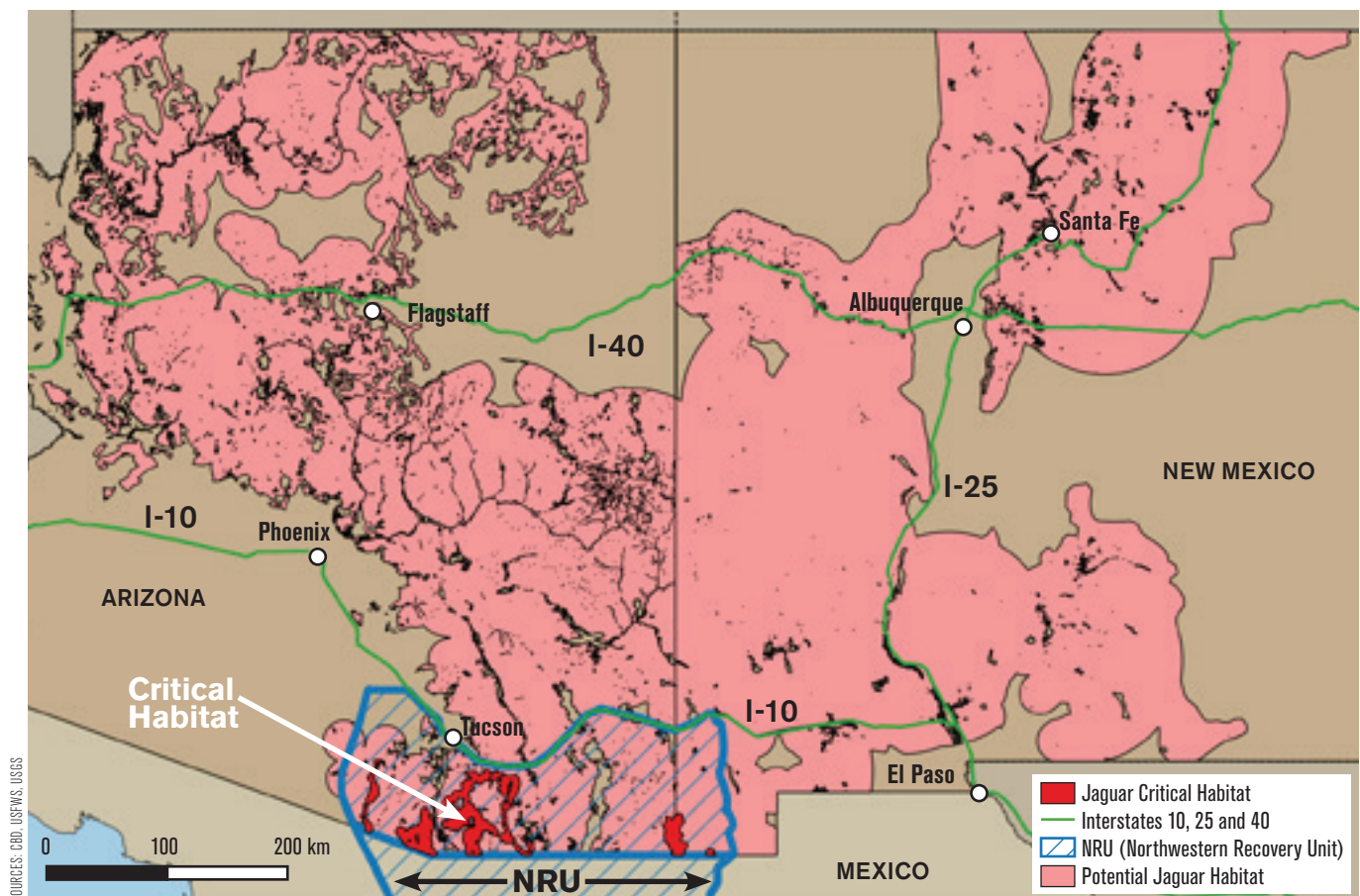


Figure 4. Potential U.S. jaguar habitat vs. Secondary Border Area of the Northwestern Recovery Unit and critical habitat

Conservation Team (CBD 2010), habitat that spans roughly half of Arizona and New Mexico. North of FWS's designated recovery area there are millions of acres of remote, suitable habitat in the Mogollon Rim-Apache Highlands of Arizona and New Mexico, including the area in the White Mountains where the last known U.S. female was killed in 1963 (Brown and López González 2001). Other habitat models for Arizona and New Mexico also identified large amounts of potential habitat (Menke and Hayes 2003, Hatten, Averill-Murray and Van Pelt 2005, Robinson, Bradley and Boyd 2006). A more recent study identified a large Mogollon Rim Cat Conservation Unit in Arizona and New Mexico north of the NRU (Grigione et al. 2009). These studies make different assumptions about topography, elevation, prey abundance, tree cover and other factors, but all show significant habitat north of I-10.

FWS's decision to restrict recovery to south of I-10 likewise restricted the amount of habitat considered in a population viability analysis the agency commissioned. Based only on the small amount of habitat within the NRU south of I-10, the report concluded that "conditions are not currently favorable" for recovering the jaguar in the United States (Miller 2013). This analysis predicted that the small amount of habitat designated for jaguars in the United States would support just two to four females, not enough for a viable population. However, if the assessment had included habitat north of I-10, that number would have been much higher. An estimate by Povilitis (2014) concluded that national forests in the Mogollon Rim and Sky Island areas of Arizona and New Mexico could together support 249 jaguars.



This natural passage beneath I-10 at Davidson Canyon in southern Arizona could allow jaguars to safely cross the busy highway to get to ample suitable habitat on the other side, but the jaguar recovery plan does not address protecting movement corridors across I-10.

Although I-10 does hamper northward dispersal, jaguars could cross the highway using natural underpasses such as Texas Canyon in the Dragoons Mountains, a crossing of the Peloncillos near the New Arizona-Mexico state line and Davidson Canyon, which connects the north-south Santa Rita and Rincon mountains. Additional natural drainages could be enhanced to facilitate travel. Jaguars could also be translocated north of the highway to, for example, the vast Mogollon Rim-Apache Highlands region described above.

The amount of suitable habitat FWS specified for recovery in the United States is not only small, it is also threatened by mining. In 2014, the U.S. Forest Service approved exploratory drilling for the proposed Sunnyside Mine in critical habitat for jaguars in the Patagonia Mountains. Defenders' legal action reversed the drilling decision (*Defenders of Wildlife v. U.S. Forest Service* 2015). In 2016, FWS signed a biological opinion that cleared the way for construction of the Rosemont open-pit copper mine (Figure 5) within jaguar critical habitat in the Santa Rita Mountains (FWS 2016b).

The Rosemont mine project would fence off more than a third of the much-watched El Jefe's territory. Lights, noise, roads and other human activity associated with the mine would affect a larger 228 square miles in and around critical habitat designated in 2014 and interrupt a vital north-south corridor (FWS 2016b). According to Chris McVie, an expert in Arizona wildlife corridors and land-use issues, "Rosemont would take a giant Pac-Man bite out of the single most viable north-south corridor in the southwestern United States, not just for jaguars but for ocelots, cougars and black bears" (McVie 2016).

FWS's justification in its biological opinion was that because there are jaguars in Mesoamerica and South America, the loss of El Jefe would not jeopardize the species (FWS 2016b). With FWS's go-ahead, the U.S. Forest Service—which manages much of the habitat that would be harmed by the Rosemont mine—is likely to approve the mine if the Army Corps of Engineers gives the project a Section 404 Clean Water Act permit.

The fact that the draft recovery plan does not consider translocating jaguars to the Mogollon Rim area or other potential U.S. habitat further increases the odds against jaguar recovery in the United States. As previously discussed, female jaguars do not disperse widely, and the possibility that any will reach the United States from Mexico diminishes with continued development of highways, housing and border wall infrastructure. Eventually, translocation may be the only way to establish a viable U.S. jaguar population. Translocation has worked for other U.S. endangered species in the Southwest, including Mexican gray wolf, Sonoran pronghorn, Gila

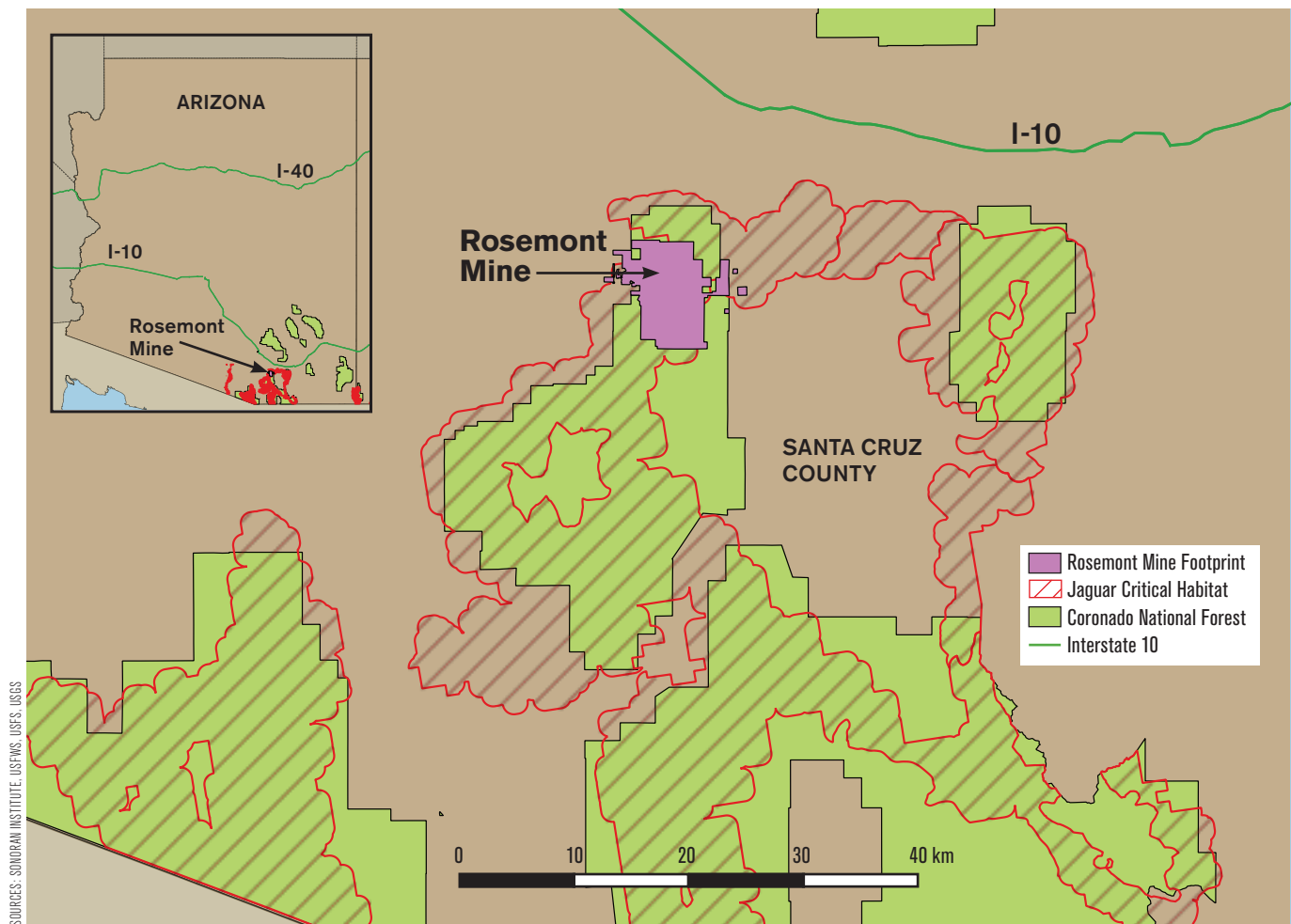


Figure 5. Rosemont mine footprint in critical jaguar habitat

topminnow and northern Aplomado falcon. It is also a central strategy in FWS's 2016 Recovery Plan for the Ocelot.

FWS's failure to proactively pursue jaguar recovery goes back years, starting with its initial failure to list the U.S. population. Only when forced to by litigation did FWS list U.S. jaguars, designate critical habitat and begin developing a recovery plan. Likewise, the states have failed to champion jaguar recovery. In 2013, Arizona's Department of Game and Fish formally opposed federal designation of critical habitat for jaguars (AGFD 2013).

The joint Arizona-New Mexico Jaguar Conservation Team, composed of state, federal and local government agencies, NGOs and private individuals, disbanded in 2009 after 12 years with little progress (Steller 2009). Members who wanted jaguars re-established in the United States and ranching interests who did not could not come together. The collaborative process was likely doomed in 2006 when 20 representatives of individual New Mexico Soil and Water Conservation Districts joined the team as voting members,

creating a large anti-jaguar block (Steller 2009).

States often oppose recovery of predators because of political pressure from livestock producers who fear predators will kill their animals. State agencies may also base policies on some hunters who believe apex predators compete for game species. Although many game department biologists are committed professionals who understand the ecological role of predators and support their restoration, political pressure from the top can make this difficult.

The Arizona Game and Fish Commission, which sets the policies and regulations for the department, currently includes businessmen, a lawyer, two members with law enforcement backgrounds and not a single biologist (AGFD 2016). By law, four of the five positions are reserved for "sportsmen" and livestock producers (Arizona Revised Statutes 2016). This deference to sportsmen over nonconsumptive users like wildlife watchers is entrenched in the history and philosophy of many state game agencies (Peterson and Nelson 2016).

The Way Forward

Goals and Recommendations

In the United States, the overall goal for jaguar recovery should be to restore the jaguar to suitable habitat within its historical range. To achieve it, FWS should identify all remaining U.S. habitat capable of supporting jaguars and take steps to restore jaguars to the areas identified—which would likely require translocating jaguars to areas, like the Mogollon Rim, that are geographically isolated or distant from source populations.

To succeed over the long term in re-establishing a viable U.S. population, jaguar recovery must also meet certain biological goals:

Representation. Restoration with representation requires maintaining the species in the mix of natural habitats found in its historical range. For the jaguar, this means ensuring its presence in the variety of U.S. habitat types where it was originally found. This includes the Sonoran Desert and the Apache Highlands of Arizona, the only place in the world where jaguars would have the opportunity to eat elk (Miller 2016).

Resilience. In the ecological sense, resilience is the ability of a species to bounce back from harmful events, including fluctuations in prey populations, disease, competition with other carnivores and human-caused mortality. One or two jaguars in the United States that are largely cut off from the jaguars in Sonora do not constitute a resilient population. Interbreeding and safe connections between the U.S. and Sonoran populations are likely necessary to sustain a resilient U.S. population large enough to maintain genetic diversity and recover from harmful events.

Redundancy. Ensuring the survival of endangered species requires redundancy—robust populations in multiple areas as a hedge against the catastrophic loss of any single population from factors like disease, severe weather events, fire or drought. This benefit can be seen in the “redundant” population of jaguars in Sonora that might be used to re-establish the U.S. population.

Connected Populations. When populations become too small and disconnected from other populations, there is a high probability they will disappear because of inbreeding or imbalanced sex ratios. Movement corridors are essential for healthy, connected populations, allowing dispersing

jaguars to colonize new areas and augment existing populations that are too small for genetic or demographic health. The corridors that keep populations connected would also let jaguars shift their ranges in response to climate change.

Ecosystem Effects. Jaguars and other top carnivores are “strongly interactive species” that have an outsize impact by preying on or competing with other species. The loss of such top carnivores can profoundly change ecosystem composition, structure and diversity (Beschta and Ripple 2012, Estes et al. 2011, Schmitz et al. 2000). To maintain or restore the natural characteristics of southwestern ecosystems, apex predators like jaguars and wolves should be maintained with large enough numbers and ranges.

Recommendations

To re-establish a sustainable, reproducing U.S. jaguar population that meets the biological goals of recovery, FWS should:

1. **Fully commit to jaguar recovery in the United States.** FWS’s goal should be a large breeding population in suitable habitat in the jaguar’s historical U.S. range—including the Mogollon Rim-Apache Highlands—that is connected with the northern Sonoran jaguar population.
2. **Increase public awareness.** The viral explosion of El Jefe’s image across the media world speaks to the charisma of jaguars and the public’s fascination with them. But many people still do not know that the jaguar is a U.S. species and part of our natural heritage. Government agencies, conservation groups and others need to capitalize on the jaguar’s public appeal and raise the profile of this endangered big cat.
3. **Minimize opposition to recovery by educating livestock producers and implementing coexistence programs.** As public awareness grows, jaguar proponents must counter misinformation about jaguars and communicate effectively with livestock producers and others with concerns about recovery. Coexistence programs that promote tools and techniques designed to keep livestock safe have been effective with wolves in the United States and jaguars in Mexico. Similar programs should be in place for jaguars in the United States.

4. Base management plans and actions on a regional, ecological perspective. Agencies and others should recognize that jaguars on both sides of the border form a single binational population that should be managed based not on politics, but on the species' requirements for safety, food, connectivity and room to move and reproduce.

5. Support the northern Mexico populations. Whether the strategy is natural expansion north from Mexico or translocation to establish a U.S. population, the United States should work with Mexican agencies, NGOs and scientists to protect and grow the northern Mexican populations, particularly in the Sonora Core Area and Borderlands Secondary Area. Federal resources should be expended on these populations as an investment in creating a viable U.S. population. This would require protecting more land in Mexico and supporting coexistence projects to encourage local landowners to be jaguar friendly, particularly in the corridors between the existing Sonora population and the U.S. border.

6. Ensure that both male and female jaguars become established in the United States. FWS and its partners must take a hard look at translocation. Although there are barriers and risks to translocation, the likelihood that natural expansion will fail means that translocation may be the only way to ensure a viable U.S. jaguar population. FWS should conduct an assessment—like the one it conducted for the recovery plan of the ocelot population in Tamaulipas, Mexico—to determine how many jaguars could be moved annually from the Sonora and Jalisco core areas without jeopardizing those populations.

An independent body, such as the Society for Conservation Biology or the National Academy of Sciences, should conduct a thorough analysis of the feasibility of translocation and develop a project plan. One analysis by Kelly and Silver (2009) concluded that, provided there is habitat, resources and community tolerance, “reintroduction of this most majestic of the New World felids may, in fact, be possible and worthwhile.” FWS should not prematurely reject this possibility.

7. Invest in and protect movement corridors. To re-establish a viable transborder population, jaguars need safe paths to travel from Sonora to Arizona and New Mexico and between habitat blocks in the United States.

Construction of any border infrastructure should be planned so that there are places that jaguars and other wildlife can cross the international border unhindered.

Complete obstruction of transborder corridors would make it impossible to restore the historical cross-border population and would prevent jaguars from establishing U.S. territories unless translocated.

Within the United States, the Davidson Canyon area and other natural highway underpasses should be protected and in some cases enhanced to ensure that jaguars and other large predators can safely cross I-10, I-19 and other highways. Such natural underpasses are scarce and protecting them should be a high priority. Future highway capital-improvement projects should incorporate joint wildlife planning with the Federal Highway Administration, state highway departments, federal and state wildlife agencies, municipalities and local and national NGOs as appropriate. It costs substantially less to incorporate wildlife-friendly features in the initial design and construction of highways than to retrofit (McVie 2016).

Connecting the tiny, isolated ribbons of critical habitat in Arizona and New Mexico (Figure 4, page 11) to each other will require, in part, maintaining crossing points on I-19, notably the 560-acre Cesare's Parcel Connection, as of yet not purchased for conservation. This Pima County Habitat Protection Priority parcel, which is directly across I-19 from Pima County's Canoa Ranch, would preserve a linkage between the Sierrita Mountains and Santa Rita Mountains (McVie 2016).

Industrial-scale development projects like the Rosemont, Hermosa and Sunnyside mines would impede habitat connectivity in the United States. Arizona Mining, a Canadian company, has approximately 20,545 acres of claims (Arizona Mining 2017) in jaguar critical habitat on national forest lands in the Patagonia Mountains, and, as of October 2016, had 14 drill rigs operating around the clock to extract mineral samples (Arizona Mining 2016).

8. Dedicate funding. FWS funds are already stretched thin for existing endangered species programs. For jaguars, additional funds will be needed for land purchase or easements on travel corridors and other habitat and for other conservation measures, including programs to decrease conflict between jaguars and livestock producers. The draft jaguar draft recovery plan estimates a cost of \$56 million for the first five years and \$605 million for 50 years, the estimated time to recovery. If translocation were to be carried out, there would be additional expense. Possible sources of funds include:

- **Cooperative Endangered Species Conservation Fund.** Funding for habitat purchase could come from this fund, which gives matching grants to states for purchasing endangered species habitat and for other recovery actions.
- **Environmental Quality Incentives Program.** Additional funds could be directed to restoring jaguar habitat under this Farm Bill's conservation programs. Among other things, this program pays private landowners to enhance their land to improve wildlife habitat (National Wildlife Federation 2016).
- **Competitive State Wildlife Grant Program.** Recovery efforts could also be funded from grants under this federal program, which awarded a total of \$8,456,617 divided between multiple states in 2016. Work on the

jaguar could be covered because it is identified as a Species of Greatest Conservation Need in the Arizona and New Mexico State Wildlife Action Plans (AGFD 2012; NMDGF 2016).

- **Wildlife Without Borders Initiative.** The relatively small grants available from the Mexico program within this FWS initiative (FWS 2016c) could be used to enhance the Sonoran population.
- **Wolf-Livestock Demonstration Project Grants.** Funding earmarked to help jaguars coexist with livestock producers might be modeled on these existing grants to states and tribes. The grants provide approximately \$900,000 annually to eight states for activities that reduce predation risk and compensate livestock producers for depredations (FWS 2016d).



JAGUAR, BRAZIL © BOB SHIPBAUGH

Grants from these federal sources would likely provide only a fraction of the money needed. Valuable contributions to corridors and core habitat can be made by NGOs and nonfederal governments. For example, the Jaguar Draft Recovery Plan discusses the possibility of raising money locally through fundraising projects like the Adopt-an-Ocelot program administered by Friends of the Atascosa National Wildlife Refuge in Texas. The county of Pima, Arizona, raised money from open-space conservation bonds to offset development by buying or leasing extensive mitigation lands, some of which contain jaguar critical habitat (Pima County 2016; Powell 2016). One purchase included portions of the Marley ranch in the Sierrita Mountains, which helps provide access for wildlife to a natural corridor under I-19 (McVie 2016).



Conclusion

Commit to Real Recovery

The jaguar is as much a part of our country's natural heritage as the bald eagle or the grizzly bear, but many people are not aware jaguars ever roamed the southwestern United States. Long ago driven south of the border by hunting and development, jaguars are venturing north. A handful of male jaguars have reclaimed their U.S. home, finding their way north from Mexico through a gauntlet of guns, vehicles, towns and border obstacles.

These stealthy survivors have been able to thrive within just miles of Tucson and smaller towns, crossing highways to move from mountain range to mountain range. If they can stay out of harm's way, conditions are suitable for them to stay in the United States and for other jaguars to follow. Today, populations of the jaguar's favored prey—deer and javelinas—are much more abundant than they were a hundred years ago when jaguars still mated and raised young in the United States. And the Endangered Species Act offers an added measure of a protection.

But agency support for jaguar recovery has been lacking and there are two other major challenges to overcome. First, enough jaguars of both sexes need to recolonize the United States to form a breeding population. Because females do not disperse long distances, and because growing cities, highways and other barriers thwart dispersal, recolonization is unlikely without human assistance, namely translocation. Second, jaguar mortality—including the direct mortality caused by guns and vehicles and the indirect mortality associated with mining and other activities that destroy habitat—must be prevented.

To overcome these challenge, federal and state agencies charged with jaguar protection must fully commit to re-establishing a U.S. population. As our nation's lead agency on endangered species, FWS must champion jaguar recovery in the United States, and all the federal and state agencies charged with safeguarding jaguars must make recovery a higher priority when considering projects that could harm the cats and their habitat.

Only with the unwavering commitment of these agencies and the support of NGOs, scientists and citizen advocates will el tigre make it back to stay in the USA.

References

- Arizona Game and Fish Department. 2009. "The Story of Macho B." Posted March 13, 2009. Accessed February 15, 2016. http://www.azgfd.gov/w_c/jaguar/MachoB.shtml
- _____. 2012. *Arizona's State Wildlife Action Plan: 2012-2022*. Accessed January 17, 2017. https://www.azgfd.com/PortalImages/files/wildlife/2012-2022_Arizona_State_Wildlife_Action_Plan.pdf
- _____. 2013. Public comment letter to U.S. Fish and Wildlife Service in response to proposed designation of critical habitat for jaguar. Accessed December 21, 2016. http://www.azgfd.gov/w_c/es/documents/130808.FWS.Jag.Critical.Habitat.Ltr.pdf
- _____. 2015. *Hunt Arizona: Survey, Harvest and Hunt Data for Big and Small Game*.
- _____. 2016. "Commission Members." Accessed October 24, 2016. <https://www.azgfd.com/agency/commission/members>
- American Forests, Association of Fish and Wildlife Agencies, Clean Water Action, Defenders of Wildlife, Friends of the Missouri Breaks Monument, Integrated Ocean Observing System Association, National Marine Sanctuary Foundation, National Estuarine Research Reserve Association, Natural Resources Defense Council, Ocean Conservancy, Oceana, Population Action International, Sea Grant, The Wilderness Society, World Wildlife Fund 2016. *Green Investments: How Budget Cuts Are Impacting Our Communities and the Environment: The Case for Reinvestment in FY17*.
- American Society of Mammologists. 2007. "Resolution of Jaguars: Conservation of Jaguars in North America." Accessed December 14, 2016. <http://www.mammalsociety.org/committees/resolutions/resolution-of-jaguars>
- Arizona Mining. 2017 "Investor Presentation, February 2017." Accessed February 17, 2017. https://arizonamining.com/_resources/presentations/Arizona-Mining-Corporate-Presentation.pdf
- _____. 2016. "Arizona Mining Continues Expansion of Taylor Deposit." Accessed February 16, 2017. https://www.arizonamining.com/_resources/news-releases/2016-10-05nraz.pdf
- Arizona Revised Statutes. 2016. Title 17, Chapter 2, Article 1, Section 17-202, *Arizona Revised Statutes*, Relating to the Arizona Game and Fish Commission Appointment Recommendation Board.
- Avila-Villegas, S. (Conservation Research Scientist, Arizona-Sonora Desert Museum). Email communication with author. January 10, 2017.
- Avila-Villegas, S. and J. Lamberton-Moreno 2013. "Wildlife Survey and Monitoring in the Sky Island Region with an Emphasis on Neotropical Felids." *USDA Forest Service Proceedings RMRS-P-67*: 441-447. Accessed January 9, 2017. https://www.fs.fed.us/rm/pubs/rmrs_p067/rmrs_p067_441_447.pdf
- Bacon, T. 2012. "The Implementation of the Animal Damage Control Act: A Comment on Wildlife Services's Methods of Predatory Animal Control." *Journal of the National Association of Administrative Law Judiciary* Vol 32, Issue 1, Article 6.
- Baril, L. M., A. J. Hansen, R. Renkin, and R. Lawrence. 2011. Songbird response to increased willow (*Salix* spp.) growth in Yellowstone's northern range. *Ecological Applications* 21:2283-2296.
- Beldon, R.C. and J. W. McCown. 1996. "Florida Panther Reintroduction Feasibility Study," *Final Report 7507*. Florida Game and Freshwater Fish Commission, Tallahassee.
- Belize National Parks. 2016. "Cockscomb Basin Wildlife Sanctuary and Jaguar Preserve." Accessed October 24, 2016. <http://ambergriscaye.com/pages/town/parkcockscomb.html>
- Bennett, L. 2015. "Conservation Evidence: Assessing Translocations and Reintroductions of Terrestrial Carnivores." Master's thesis, Nicholas School of the Environment, Duke University.
- Beschta, R. L., and W. J. Ripple. 2012. "The Role of Large Predators in Maintaining Riparian Plant Communities and River Morphology." *Geomorphology* 157-158: 88-98.
- Blue Ribbon Panel. 2016. *Final Report and Recommendations March 2016*. Blue Ribbon Panel on Sustaining America's Diverse Fish and Wildlife Resources.
- Bravo, J. C. (Director of Operations in Mexico, Wildlands Network). Phone interview by author. February 2, 2017.

- Brown, D. and C. López González. 2001. *Borderland Jaguars*, University of Utah Press
- Channel, R and M. V. Lomolino. 2000. "Dynamic Biogeography and Conservation of Endangered Species." *Nature* 403, no. 6: 84-86.
- Center for Biological Diversity (CBD) 2010. "Jaguar critical habitat comments in response to FR vol. 75, no. 8 (Jan. 13, 2010)." Accessed February 16, 2017. http://www.biologicaldiversity.org/species/mammals/jaguar/pdfs/Jaguar_critical_habitat_comments_3-2010.pdf
- Conservation CATalyst. 2016. Accessed December 14, 2016. <http://www.conservationcatalyst.com/>
- Davis, T., 2013a. '63 "Jaguar Killing Echoes Today in Habitat Debate." *Arizona Daily Star*, Jan 13, 2013. Accessed October 24, 2016. http://tucson.com/news/science/environment/jaguar-killing-echoes-today-in-habitat-debate/article_9048bb7d-0729-51f9-b544-653ac5b82450.html
- Davis, T. 2013b. "A Q&A with jaguar advocate—and jag critical habitat opponent—Alan Rabinowitz." *Arizona Daily Star*, March 19, 2013. Accessed January 11, 2017. http://tucson.com/news/blogs/desertblog/a-q-a-with-jaguar-advocate---and/article_aa2ac1fe-9109-11e2-8816-0019bb2963f4.html
- Deer Friendly 2016. "The Decline of Deer Populations." Accessed October 24, 2016. <http://www.deerfriendly.com/decline-of-deer-populations>
- Deem, S.L. and W. B. Karesh 2005. *Jaguar Health Program Manual: Field Veterinary Program*, June 2005 (Revised).
- Defenders of Wildlife v. U.S. Forest Service*. Order Granting Plaintiffs' Motion for Summary Judgment. ECF No. 39, Case No. 4:14-CV-02446 (D. Ariz. Sept. 15, 2015).
- Estes, J. A., J. Terborgh, J. S. Brashares, M. E. Power, J. Berger, W. J. Bond, S. R. Carpenter, T. E. Essington, R. D. Holt, J. B. C. Jackson, R. J. Marquis, L. Oksanen, T. Oksanen, R. T. Paine, E. K. Pikitch, W. J. Ripple, S. A. Sandin, M. Scheffer, T. W. Schoener, J. B. Shurin, A. R. E. Sinclair, M. E. Soulé, R. Virtanen, and D. A. Wardle. 2011. "Trophic Downgrading of Planet Earth." *Science* 333: 301-306.
- Galvan, A. 2016. "Wildlife officials: Video captures possible 2nd jaguar in US," *The Washington Post*, December 7, 2016. Accessed 12-13-2016. https://www.washingtonpost.com/national/energy-environment/wildlife-officials-video-captures-possible-2nd-jaguar-in-us/2016/12/07/d378a44a-bcca-11e6-ae79-bec72d34f8c9_story.html?utm_term=.e4b8a4e6592b
- Grigione, M. M., K. Menke, C. López-González, R. List, A. Banda, J. Carrera, R. Carrera, A. J. Giordano, J. Morrison, M. Sternberg, R. Thomas and B. Van Pelt. 2009. "Identifying potential conservation areas for felids in the USA and Mexico: integrating reliable knowledge across an international border." *Oryx* 43(1):78-86.
- Hatten, J.R., W.E. Averill-Murray and W.E. Van Pelt, 2005. "A Spatial Model of Potential Jaguar Habitat in Arizona." *The Journal of Wildlife Management* 69:1024-1033.
- Hoffmeister, D.F. 1986. *Mammals of Arizona*. University of Arizona Press, Tucson.
- Industrial Economics 2013. *Draft Economic Analysis of Critical Habitat Designation for the Jaguar*. Report prepared for U.S. Fish and Wildlife Service.
- Johnson, T. B., W. E. Van Pelt and J. N. Stuart. *Jaguar Conservation Assessment for Arizona, New Mexico and Northern Mexico*. Arizona Game and Fish Department and New Mexico Department of Game and Fish.
- Isasi-Catala, E. 2010. "Is Translocation of Problematic Jaguars (*Panthera Onca*) An Effective Strategy to Resolve Human-Predator Conflicts?" *Collaboration for Environmental Evidence Review* 08-108. Accessed February 18, 2017. <http://www.environmentalevidence.org/wp-content/uploads/2014/09/SR55.pdf>
- Jule, K. R., Leaver, L. A., and Lea, S. E. G. 2008. "The Effects of Captive Experience in Reintroduction Survival in Carnivores: a Review and Analysis." *Biological Conservation* 141(2): 355-363.
- Kelly, M. and S. Silver 2009. "The Suitability of the Jaguar (*Panthera onca*) for Reintroduction," in *Reintroduction of Top-Order Predators*, edited by M. Hayward and M. Sommers, 187-205. J. Wiley & Sons.

- Main, D. 2017. "Rare Jaguar Sighting in Arizona, 60 Miles North of Mexican Border." *Newsweek.com*. March 2, 2017. Accessed 3-14-2017. <http://www.newsweek.com/rare-jaguar-sighting-arizona-60-miles-north-mexican-border-563133>
- McVie, C. (Conservation Chair, Tucson Audubon Society; Advisory Board Chair, Coalition for Sonoran Desert Protection). Phone interview by author. January 10, 2017.
- Menke, K.A. and C.L. Hayes. 2003. "Evaluation of the Relative Suitability of Potential Jaguar Habitat in New Mexico." Report to New Mexico Department of Game and Fish, Santa Fe, New Mexico.
- Miller, P.S. 2013. *Population Viability Analysis for the Jaguar (Panthera onca) in the Northwestern Range*. Report in consultation with Technical Subgroup U.S. Fish and Wildlife Service Jaguar Recovery Team.
- Miller, C. (Senior Representative, Southwest Office, Defenders of Wildlife). Interview by author. December 12, 2016.
- National Research Council. 2004. "The Meaning of Value and Use of Economic Valuation in the Environmental Policy Decision-Making Process" in *Valuing Ecosystem Services: Toward Better Environmental Decision-Making*. Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems. National Academies Press. Accessed January 22, 2017. <https://www.nap.edu/read/11139/chapter/4#45>
- National Wildlife Federation 2016. "Background on the Farm Bill and Wildlife Connection." Accessed October 24, 2016. <http://www.nwf.org/What-We-Do/Protect-Habitat/Healthy-Forests-and-Farms/Farm-Bill/Farm-Bill-Background.aspx>
- New Mexico Department of Game and Fish (NMGF). 2006. *Comprehensive Wildlife Conservation Strategy for New Mexico*. New Mexico Department of Game and Fish. Santa Fe, New Mexico. Accessed December 21, 2016. <http://www.wildlife.state.nm.us/download/conservation/habitat-handbook/cwcs/Comprehensive-Wildlife-Conservation-Strategy.pdf>
- _____. 2016. *State Wildlife Action Plan for New Mexico*. Accessed 2-16-2017. http://www.wildlife.state.nm.us/download/conservation/swap/SWAP-November_2016-USFWS-approval-pending.pdf
- Northern Jaguar Project 2016. "Northern Jaguar Reserve: threats and opportunities." Accessed October 24, 2016. <https://www.northernjaguarproject.org/northern-jaguar-reserve/threats-and-opportunities>.
- Núñez-Perez, R. 2015. "Jaguar Translocation in Western Mexico." *Wild Felid Monitor*. Summer, 2015: 24-25.
- Owen, J. 2008. "Most Captive-Born Predators Die if Released." *National Geographic News*, January 23, 2008. Accessed October 24, 2016. <http://news.nationalgeographic.com/news/2008/01/080123-carnivores-wild.html>
- Paterson, K. 2015. "The Long and Winding Road of Jaguar Conservation." *FNS News* October 22, 2015. Accessed October 24, 2016. <https://fnsnews.nmsu.edu/the-long-and-winding-road-of-jaguar-conservation>
- Pavlik, S. 2003. "Rohonas and Spotted lions: the Historical and Cultural Occurrence of the Jaguar, *Panthera onca*, Among the Native Tribes of the American Southwest." *Wicazo Sa Review* 18(1): 157-175.
- Peterson, M. N. and M. P. Nelson. 2016. "Why the North American Model of Wildlife Conservation is Problematic for Modern Wildlife Management," *Human Dimensions of Wildlife*, 22(1):43-54.
- Pima County 2016. *Multi-species Conservation Plan for Pima County, Arizona: Final*. Submitted to the Arizona Ecological Services office of the U.S. Fish and Wildlife Service, Tucson, Arizona.
- Povilitis, T., 2014. "Recovering the Jaguar *Panthera onca* in Peripheral Range: a Challenge to Conservation Policy." *Oryx* 49(4): 626-631.
- Powell, B. (Program Coordinator, Pima County Office of Sustainability and Conservation). Phone interview by author. October 19, 2016.
- Robinson, M. J., C. Bradley, and J. Boyd. 2006. "Potential Habitat for Jaguars in New Mexico." Report to the Arizona Game and Fish Department from the Center for Biological Diversity.
- Sandlin, S. 2016. "Albuquerque Judge Temporarily Halts Wolf Releases." *Albuquerque Journal Friday*, June 10, 2016. Accessed October 24, 2016. <https://www.abqjournal.com/789815/abq-judge-temporarily-halts-wolf-releases.html>

- Serraglio, R. (Southwest Conservation Advocate, Center for Biological Diversity). Phone interview by author. August 3, 2016.
- Schmitz, O. J., P. Hambäck and A. P. Beckerman. 2000. "Trophic Cascades in Terrestrial Systems: a Review of the Effect of Top Predator Removals on Plants." *American Naturalist* 155: 141-153.
- Seymour, K.L. 1989. "*Panthera onca*." *Mammalian Species* No. 240:1-9.
- Soulé, M. E. 1985. "What is Conservation Biology?" *Bioscience* 35, 727-734.
- Steller, T., 2009. "Jaguar Team Ceases Work Amid Disputes, Big Cat's Death." *Arizona Daily Star*, October 18, 2009. Accessed October 24, 2016. http://tucson.com/news/local/wildfire/jaguar-team-ceases-work-amid-disputes-big-cat-s-death/article_7e3b5d4b-90df-50e6-bee1-2eb37b795a87.html
- Stoner, K. J., A. R. Hardy, K. Fisher, and E. W. Sanderson. 2015. *Jaguar Habitat Connectivity and Identification of Potential Road Mitigation Locations in the Northwestern Recovery Unit for the Jaguar*. Report to the U.S. Fish and Wildlife Service.
- U.S. District Court 2015. *Defenders of Wildlife et al. v. United States Forest Service et al.*, 4:14-cv-02446-RM, Document 39, U.S. District Court for the District of Arizona. 9-15-2015.
- U.S. Department of the Interior, Fish and Wildlife Service. Rules and Regulations. Final Rule. "Designation of Critical Habitat for Jaguar; Final Rule." *Federal Register* 79, no. 43 (March 5, 2014): 12572.
- U.S. Fish and Wildlife Service (FWS). 2007. "4(f)(1) Determination Regarding Recovery Planning for the Jaguar (*Panthera onca*)." Memorandum signed December 21, 2007.
- _____. 2012. "Recovery Outline for the Jaguar (*Panthera onca*)." Accessed December 21, 2016. <https://www.fws.gov/southwest/es/arizona/Documents/SpeciesDocs/Jaguar/049777%20-%20Jaguar%20Recovery%20Outline.pdf>
- _____. 2014. Draft Environmental Impact Statement for the Proposed Revision to the Nonessential Experimental Population of the Mexican Wolf (*Canis lupus baileyi*).
- _____. 2015. "Critical Habitat – What is it?" Last updated April 14, 2015. Accessed February 16, 2017. <https://www.fws.gov/Midwest/Endangered/saving/CriticalHabitatFactSheet.html>
- _____. 2016a. "Jaguar Draft Recovery Plan (*Panthera onca*)." Southwest Region, U.S. Fish and Wildlife Service, Albuquerque, NM. Accessed January 12, 2017. https://www.fws.gov/southwest/es/arizona/Documents/SpeciesDocs/Jaguar/Jaguar_Draft_Recovery_Plan_20_Dec_2016.pdf
- _____. 2016b. "Amended Final Reinitiated Biological and Conference Opinion for the Rosemont Copper Mine, Pima County, Arizona," April 28, 2016." AESO/SE 22410-2009-F-0389R1.
- _____. 2016c. Wildlife Without Borders. Accessed October 24, 2016. <https://www.fws.gov/international/wildlife-without-borders/>
- _____. 2016d. "U.S. Fish and Wildlife Service Announces \$900,000 in Wolf Livestock Demonstration Project Grants." Accessed February 16, 2016. [https://www.fws.gov/news/ShowNews.cfm?ref=u.s.-fish-and-wildlife-service-announces-\\$900000-in-wolf-livestock-&_ID=35907](https://www.fws.gov/news/ShowNews.cfm?ref=u.s.-fish-and-wildlife-service-announces-$900000-in-wolf-livestock-&_ID=35907)
- Warshall, P. 2013. "When Will Female Jaguars Cross the Border? Socio-Demographics of the Northern Jaguar." *USDA Forest Service Proceedings* RMRS-P-67: 87-90.
- Weber, W. and A. Rabinowitz. 1996. "A Global Perspective on Large Carnivore Conservation." *Conservation Biology* 10:1046-1054.
- Wong, S. 2014. "Iberian Lynx Beats Extinction as Cats Are Released to the Wild." *New Scientist: Daily News*, February 9, 2015. Accessed October 24, 2016. <https://www.newscientist.com/article/2076921-iberian-lynx-beats-extinction-as-cats-are-released-to-the-wild>
- Yu, L. Zhang, Y. P. 2005. "Phylogenetic Studies of Pantherine Cats (Felidae) Based on Multiple Genes, with Novel Application of Nuclear Beta-fibrinogen Intron 7 to Carnivores." *Molecular Phylogenetics and Evolution* 35 (2): 483–95.



DEFENDERS OF WILDLIFE
1130 17th Street, NW | Washington, D.C. 20036
www.defenders.org