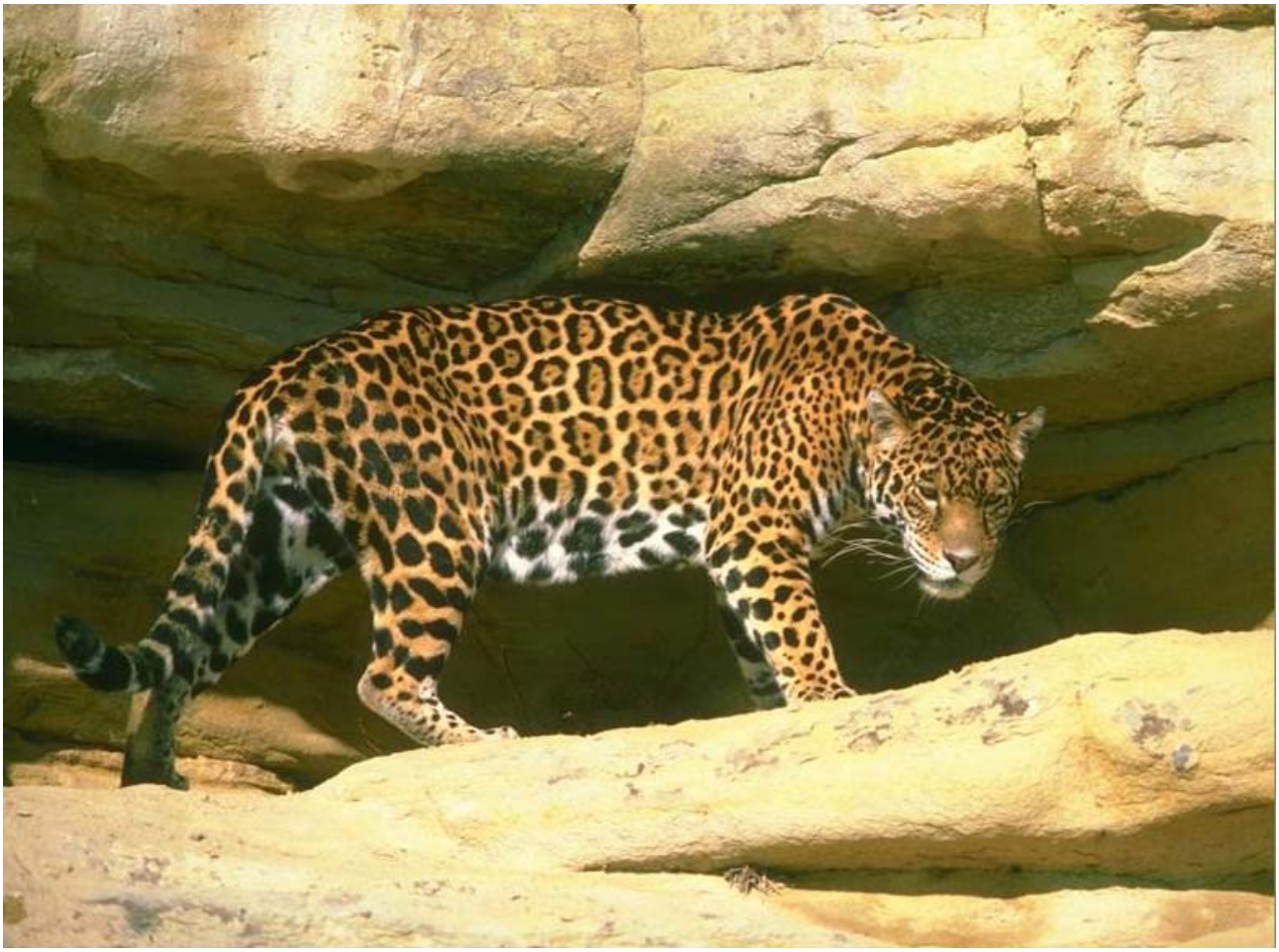
SUITABLE HABITAT FOR JAGUARS IN NEW MEXICO

By Michael J. Robinson, with maps by Curtis Bradley and Jeff Boyd



Credit: Animal Archive by timduru.org

Introduction.

This report utilizes criteria developed by the Habitat Subcommittee of the Jaguar Conservation Team to identify suitable jaguar habitat in New Mexico. The interagency Jaguar Conservation Team was established in 1997 pursuant to a "Conservation Assessment and Strategy for the Jaguar in Arizona and New Mexico," which was intended, among other aims, "to identify and eventually to coordinate protection of jaguar habitat."[1] According to this document, "Not later than 24 months after establishment of JAGCT, [ie. before April 1999] AGFD and NMGFD [*sic*] will produce state-specific maps delineating land ownership patterns overlaid with suitable jaguar habitat, insofar as such habitat can be delineated at that time."[2] In January 2003, the Arizona Game and Fish Department issued a report and accompanying maps that identified suitable habitat.[3]

In July 2003, the New Mexico Department of Game and Fish also issued a report on jaguar habitat, along with accompanying maps.[4] However, in an August 2004 meeting of the Habitat Subcommittee in Albuquerque, members who were present during the development of the habitat criteria between 1998 and 2000 reviewed the New Mexico report, concluded it was based on criteria different from those they had agreed to, further noted that it explicitly refrained from identifying suitable jaguar habitat, and decided not to forward it to the Jaguar Conservation Team as fulfilling the conservation assessment and strategy's intent. Charles L. Hayes of the New Mexico Department of Game and Fish then stated that the earliest the department could begin work to re-do its report would be July 2006.[5]

In light of the ongoing degradation of jaguar habitat in the United States, and the urgency represented by accelerating border infrastructure developments that may block jaguar migration corridors between the United States and Mexico – and considering the overall slowness of the process – the Center for Biological Diversity immediately offered to write the New Mexico habitat report and develop the necessary maps for the Habitat Subcommittee.[6] The Arizona Department of Game and Fish's Nongame Mammals Program Manager, William E. Van Pelt, chairman of the Habitat Subcommitee, accepted this offer in April 2005.[7] The present document is intended to complete the process of identifying suitable jaguar habitat in the two states preparatory to coordinating protection of those habitats.

---

[1] Johnson and Van Pelt, p. 1.

[2] Ibid, p. 17.

[3] Hatten, et al.

[4] Menke and Hayes.

[5] "Jaguar Habitat Subcommittee Meeting, August 30, 2004, Albuquerque, New Mexico. Final Summary Notes," pp. 2-4 (Microsoft word document attachment to Bill Van Pelt e-mail to meeting attendees, 11/17/2004.)

[6] Ibid, p. 4.

[7] Bill Van Pelt to Michael Robinson, e-mail, 4/12/2005.

Overview of the Jaguar in the United States.

The jaguar, *Panthera onca*, is the largest cat native to the New World, and is the third largest cat globally. Based on fossil remains, it is believed that the species developed from an evolutionary progenitor in North America, *Panthera onca augusta*. This larger predecessor feline began to colonize South America approximately 600,000 years ago, but then shrunk in size and lost its northernmost range - which originally extended to Washington, Nebraska and Maryland - sometime in the last 15,000 to 100,000 years. A possible instigator of its decline was competition with the larger lion, *Panthera atrox* (that later became extinct). Subsequent competition with the gray wolf, *Canis lupus*, may have prevented recolonization of former habitats.[8]

Fossil records indicate jaguars in Florida 7,000 to 8,000 years ago.[9] The species in historic times may have ranged as far east as the Appalachians, according to wildlife historian Peter Matthiessen, who cited reports of "Tygers" in the mountains of North Carolina in 1737 and even on the Atlantic coast of the Carolinas in 1711. But these may have been some of the last found in the eastern United States (although naturalist and artist John James Audubon cited reports, which he and subsequently Matthiessen both deemed unlikely, of jaguars east of the Mississippi River in the nineteenth century).[10]

Further west, records of jaguars are more complete and the species persisted longer. In the 1840s several jaguars were shot in the vicinity of San Antonio, Texas, according to a German naturalist, Dr. Ferdinand Roemer, who reported pelts for sale for $18 apiece and observed Comanches wearing jaguar skin quivers.[11] Audubon wrote of jaguar skins used for holster coverings, saddle cloths and caparisons on the prairies of Texas, in his 1854 work *Quadrapeds of North America*.[12] Five years later, Spencer F. Baird, Assistant Secretary of the Smithsonian Institution, who accompanied Lieutenant Colonel W. H. Emory's survey of the U.S.-Mexico boundary, recounted the "vast number of pumas and jaguars" subsisting on "the numerous herds of wild cattle, mustang, mules, and horses, besides plentiful other game in the fertile valleys and table lands of the Lower Rio Bravo, Nueces, and other Texan rivers."[13] Baird examined two jaguar remains from Texas, one from the Bravos River and one from the Rio Grande River at the

---

[8] Brown and Lopez Gonzales, pp. 30-32; Miller, et al. Such competition would have cut both ways. John James Audubon (p. 5) gives an account of Texas Rangers happening upon a jaguar feeding on a mustang, "surrounded by eight or ten hungry wolves, which dared not interfere or approach too near."

[9] Brown and Lopez Gonzales, p. 32.

[10] Matthiessen, pp. 41-42; Audubon, p. 10.

[11] Roemer, scientific appendix, #26.

[12] Audubon, p. 6.

[13] Baird, p. 6.

mouth of Las Moras Creek - the latter of which he mentioned because it was "The largest jaguar skin which I saw."[14]

It may have been the introduction of the horse and its use in hunting that doomed the jaguar in North America's grasslands. Though a "large tiger" was reported in 1853 as far north as the Canadian River in the Texas Panhandle west of Oklahoma,[15] the last jaguar on the Great Plains in Texas was killed in 1910, near the Llano River in Kimble County.[16] On the Gulf Coast of Texas the last two jaguars were killed in 1946 and 1948.[17]

Audubon also reported jaguars on the headwaters of the Rio Grande River, which originates in the San Juan Mountains of southern Colorado.[18] Explorer Rufus B. Sage reported that in December 1843 at the headwaters of the Platte River of Colorado "One of our party encountered a strange looking animal . . . of the leopard family." He added, "they are not infrequently met in some parts of the Cumanche country, and their skins furnish to the natives a favorite material for arrow-cases."[19]

Mammalogist Dr. C. Hart Merriam, the founder and chief for its first 25 years of the U.S. Bureau of Biological Survey (which in 1940 became the U.S. Fish and Wildlife Service), cited several nineteenth century travelogues that place jaguars in California as far north as the redwood country of Monterey Bay. One series of encounters, which Merriam judged "to admit of no question as to the identity of the animal," took place in the Tehachapi Mountains at the western edge of the Mojave Desert, and involved an adult "spotted animal, resembling a tiger in size and form, with two young ones."[20] Merriam interviewed "An old chief of the Kammei tribe" who reported that the "Tiger, - while rare, was well known" in the Cuyamaca Mountains of San Diego County.[21]

In Arizona and New Mexico extant jaguar reports are more numerous. Yet jaguars' very persistence and reoccurrence in these states throughout the 20th century raises the question of why the species was not even more ubiquitous than is suggested by the dozens of records that

---

[14] Ibid., p. 8.

[15] Foreman (1941), p. 77.

[16] Hensley, page unknown; "A Jaguar in Texas," page unknown. The 1967 Hensley article states the jaguar was killed in 1909, while the unsigned 1911 *Forest and Stream* article cites a photo of the carcass and quotes Vernon Bailey as saying it was killed "last spring;" the latter report seems more credible.

[17] Taylor, p. 66; "Tough Customer," p. 8.

[18] Audubon, p. 9.

[19] Sage, p. 347; naturalist Earnest Thomas Seton affirmed the likelihood that this was a jaguar.

[20] Merriam, p. 39.

[21] Merriam, p. 40.

remain. Matthiessen suggested that bounties offered by early Spanish authorities significantly reduced jaguar numbers.[22]

By the time the United States controlled the Southwest in the 1840s, and American explorers, ranchers and settlers began encountering and recording jaguars, the numbers may have reflected the efficacy of the Spanish bounty system. Jaguars would have been easier to spot in the relatively open habitats of northern Mexico, New Mexico and Arizona than in the rainforests of southern Mexico, and thus may have been disproportionately killed in northern habitats. Perhaps more importantly, open habitat was subject to heavier domestic livestock grazing, precipitating more frequent jaguar predation on stock and the concomitant efforts to kill jaguars. (High jaguar mortality in northern Mexico may have been offset by immigration from the more robust population in the proximate rainforests further south.)

In 1915, Congress passed a spending bill allocating $125,000 for use "on the National forests and the public domain in destroying wolves, coyotes, and other animals injurious to agriculture and animal husbandry" - the first of an annual appropriation that has continued to the present day for what was first termed eradication and in 1928 officially became "control."[23] Bureau of Biological Survey hunter Lee Parker killed the federal government's first jaguar, in December 1918 on or in the vicinity of Mt. Wrightson in the Santa Rita Mountains of Arizona.[24] By 1930, the Survey's Arizona district had an official policy that "All Lobo wolves and jaguars will be taken as fast as they enter this State from Mexico and New Mexico, as one hundred per cent of them live on livestock and game."[25]

The Arizona Game and Fish Department is aware of 84 known jaguar specimens, reported kills and credible other records from 1884 through 1996.[26] The department records 57 jaguar occurrences between 1901 and 2002, of which it classifies 30 as Class 1 or 2 sightings. (Class 1 sightings are those accompanied by verifiable physical evidence; Class 2 sightings are those by an experienced and reliable observer. In contrast, Class 3 sightings are those without physical evidence made by persons considered less reliable.[27]) In Arizona, jaguars have been recorded from as far north as the Grand Canyon, south through the Mogollon Rim, and throughout the Sky Islands – among other regions.[28]

---

[22] Matthiessen, p. 42.

[23] Robinson, pp. 79, 198.

[24] Stanley P. Young to Everett M. Mercer, 2/11/1953, Record Unit No. 7174, Stanley Paul Young Papers, Smithsonian Institution Manuscript Collections, p.2.

[25] "Objectives and Policies of the United States Biological Survey in Arizona," entered into the record of the Hearing before the Committee on Agriculture and Forestry of the U.S. Senate, in its consideration of S. 3483, May 8, 1930.

[26] Johnson & Van Pelt, p. 5.

[27] Van Pelt, p. 14.

[28] Hatten et al, p. 28; Brown & Lopez Gonzales pp.6-9.

Not all jaguars killed have made it into the Arizona Game and Fish Department's records. Bureau of Biological Survey scientists Dr. Albert K. Fisher and Dr. W. B. Bell reported in 1927 that "During the past two or three years at least five jaguars have been killed in Arizona," two of them females.[29] Between 1924 and 1927, the state agency's records indicate just four jaguars killed (two males and two of unknown sex). Clearly, the remaining records can give contemporary researchers an outline, but not a complete one, of jaguar occupancy of the southwestern United States.

Jaguars in New Mexico.

The historic record of jaguars in New Mexico begins with the first written account of what is today the United States. Pedro de Castañeda, who recorded the 1540-1542 expedition of conquistador Francisco Vasquez de Coronado, of which he was a part, mentions that "Gray lions and leopards were seen" somewhere in the vicinity of the upper Gila River.[30] New Mexico was a colony of Mexico until 1848, and records of jaguars have not been unearthed during this period. But during the three quarters of a century that New Mexico was a territory of the United States jaguars were reported from extensive regions.

Sometime in the late 1800s, according to an oral account by Watson E. Rich that U.S. Fish and Wildlife Service biologist A. F. Halloran published in a 1946 *Journal of Mammalogy* article, Bob Burch, a foreman on the Goldberg Ranch in the Caballo Mountains, killed a jaguar in that vicinity.[31] In both 1900 and in 1902, bounty hunter Nat Straw killed a jaguar in the Black Range of today's Gila National Forest, and another was later spotted in the same vicinity by fellow prospector (and future Forest Service ranger) Jack Stockbridge, but not known to have been killed.[32] Several other jaguars were reported to have been seen or killed in the same area, according to Biological Survey field researcher Vernon Bailey, one of the twentieth century's premier naturalists, citing a 1902 report by biologist C. Barber.[33]

Bailey wrote in his 1931 book *Mammals of New Mexico* that state game warden Page B. Otero reported a jaguar along Ute Creek in the grasslands of northeastern New Mexico in the winter of 1902/1903, and another somewhat further south the following summer. According to Bailey, Otero "had perfect confidence in these reports, as he knew the men who saw the animals." Otero also told Bailey of jaguars reported from the San Andres and Sacramento Mountains. [34] The game warden's brother, New Mexico Governor Miguel Antonio Otero,

---

[29] Fisher, A. K. and W. B. Bell, "Report of the Committee on Economic Mammalogy," American Society of Mammalogists, Museum of Vertebrate Zoology, University of California at Berkeley.

[30] Casteñeda, p. 52.

[31] Halloran, p. 160.

[32] Bailey, p. 282; McFarland, pp. 44, 46.

[33] Bailey, p. 282.

[34] Ibid, p. 283

showed Bailey "a beautiful skin of a jaguar, which had been killed the previous year [1902] in Otero County, made into a rug and presented him."[35]

Also in 1902, a Mrs. Manning "had been in the habit of putting out poison to kill the predatory animals about their ranch, 12 miles northwest of Datil, and among the victims of the poisoned baits was this jaguar," according to Bailey, who included in his book a photograph of the mounted pelt. The ranch was located at about 9,000 feet elevation, "in the pine and spruce timber of this exceedingly rough range of mountains." In 1905, another jaguar was reported at large in the same region.[36]

In 1903, a jaguar was shot by a rancher while feeding on a bull in Clanton Canyon in the Peloncillo Mountains of New Mexico's bootheel region, Bailey reported, citing his interview with local resident W. P. Burchfield. And in 1903 or 1904 another was "killed by a hunter named Morris on the west slope of Sierra de los Caballos," according to an account secured by Bailey's Biological Survey colleague Major Edward A. Goldman.[37]

By the time New Mexico achieved statehood in 1912, jaguar reports were significantly diminished. During Mexico's revolution and the accompanying border tensions, probably around 1916, U.S. troops were stationed near the Little Hatchet Mountains of New Mexico. One unnamed soldier, according to the account by itinerant prospector James A. McKenna, who was camping with the troops, "saw an animal which he thought was a black cougar." McKenna noted that "It is known as the Mexican jaguar and is seldom seen that far north," perhaps referring to the rarity of melanistic jaguars.[38]

Bailey reported in 1931 that "in recent years a few [jaguars] have been killed and many reported in the southern part of the state."[39] Several years prior to 1938, a jaguar was killed in the vicinity of Springer, a town on the plains of northeastern New Mexico and near the Cimarron River.[40] This is the last jaguar known to be killed in New Mexico for half a century. In 1937, a Biological Survey hunter named Bannerman pursued a jaguar in the San Andres range with his dogs, but could not get the animal to "tree," according to an account by biologist Halloran of his same agency.[41]

---

[35] Ibid, pp. 282-283.

[36] Ibid, p. 283 & plate 16a.

[37] Ibid, p. 283.

[38] McKenna, p. 255.

[39] Bailey, p. 282. Bailey was not uncritical of jaguar reports, and in reviewing an 1825 account of a jaguar driven by flood waters into a convent in Santa Fe, deemed the story "very improbable" and criticized the narrative's "artificial sound" – p. 283.

[40] Hill, p. 78. Hill headed a team of biologists from the American Museum of Natural History who spent two months on a survey of the mammalian fauna of the southern Sangre de Cristo Range, and adjacent high plains. The team was assisted during this period by local rancher Waite Phillips, who was in possession of the skin.

[41] Halloran, p. 160.

The modern era has shown the possibility of a resurgence for jaguars. Larry Link, proprietor of the Steins Ghost Town alongside Interstate 10 at the north end of the Peloncillos, reports having seen a jaguar north of the highway in 1990.[42] On April 19, 1995 jaguar tracks were photographed in the southern Peloncillos by Brian L. Starret.[43] On March 7, 1996, rancher and hunting outfitter Warner Glenn photographed a jaguar that his cougar hunting dogs had brought to bay in the Peloncillo Mountains alongside the New Mexico/Arizona border. He allowed the jaguar to escape.[44]

It may be that the animal observed by the felicitously named Larry Link was traveling a geographic link between the Peloncillos and the Gila National Forest further north.[45] On August 25, 1990, Gerald Z. Jacobi, Ph.D, a biology professor at Highlands University in Las Vegas, New Mexico, and his wife Donna Jacobi, Ph.D., observed a jaguar for around 30 seconds in the Black Range of the Gila National Forest. In fall 1998, Tom and Boe Duffy saw one cross a road near the San Francisco River of the Gila National Forest. On May 10, 1999, high school biology teacher John Trewern saw a large black cat cross the road in the Burro Mountains south of Silver City. The next morning he obtained a plaster cast of the animal's paw. The Jaguar Conservation Team rated each of these three sightings as Class 2 reports.[46]

Regulatory History.

In 1972, the U.S. Fish and Wildlife Service, successor agency to the Bureau of Biological Survey, listed the jaguar as an endangered species throughout its range outside of the United States, pursuant to such authority in the Threatened and Endangered Species Act of 1969. However, the agency continued to issue "hardship permits" to safari companies that had contracted with hunters previous to the listing – thus allowing the continued importation of jaguar pelts into the United States from populations to the south.[47]

---

[42] Larry Link telephone interview with Michael Robinson, 9/13/2004. Link says that shortly after the sighting he notified a New Mexico Department of Game and Fish official, who he didn't identify; Robinson notified Chuck Hayes of NMGF of Link's account and phone number by email, 9/13/2004, but no follow-up assessment of the sighting has yet appeared.

[43] Schmitt, p. 2.

[44] Glenn, pp. 1 - 21.

[45] Foreman, et al (2000), p. 147.

[46] Tim Snow, "Proposed Jaguar Sighting Report," 9/26/2000 (Jacobis); Tim Snow, "Proposed Jaguar Sighting Report," 8/15/2000 (Duffys); Bill Van Pelt to Michael Robinson, "Ranking for Burro mountain jaguar sighting," e-mail 8/8/2005 (Trewern) - all Jaguar Conservation Team forms and correspondence.

[47] "Endangered Species," Hearings before the Subcommittee on Fisheries and Wildlife Conservation and the Environment of the Committee on Merchant Marine and Fisheries, March 15, 26 & 27, 1973. House of Representatives, 93rd Congress, 1st Session. p. 308.

On July 25, 1979, the Fish and Wildlife Service published a Federal Register rule stating that through an "oversight" the jaguar was not listed as an endangered species in the United States when the list of foreign endangered species authorized under the Endangered Species Conservation Act of 1969 was used as a template in creation of the list authorized in the 1973 Endangered Species Act. The agency pledged to "take action as quickly as possible" to list the jaguar domestically,[48] and one year later, on July 25, 1980, issued a proposed rule to list jaguars in the United States as endangered. However, the agency did not finalize this rule, and withdrew it two years later.

On July 26, 1992, Anthony Povilitis, Ph.D., filed a technical petition seeking to list the jaguar as endangered in the United States. On July 13, 1994, in response to the petition, the Fish and Wildlife Service again proposed to list the jaguar as endangered. The agency did not finalize this listing proposal because on April 10, 1995 Congress enacted a moratorium prohibiting work on listing actions. The moratorium was lifted by presidential waiver on April 26, 1996. However, the Fish and Wildlife Service still did not finalize the listing proposal. In September 1996, the Southwest Center for Biological Diversity (predecessor to the Center for Biological Diversity) sued the Fish and Wildlife Service in federal court to require the listing. On March 14, 1997 the court ordered a listing within 120 days, and on July 22, 1997 the jaguar officially became an endangered species in the United States.[49]

Pursuant to that status, on June 22, 1999, the Fish and Wildlife Service issued a biological opinion on the USDA Wildlife Services predator control activities likely effects on jaguars. The opinion prohibited use of some predator killing devices in certain areas and authorized the inadvertent "take" (killing, injury or harassment) of one jaguar.

The Fish and Wildlife Service has not yet developed a recovery team or begun work on a recovery plan, nor designated critical habitat as required by the Endangered Species Act. In response to litigation by the Center for Biological Diversity and Defenders of Wildlife, in September 2004 the Fish and Wildlife Service agreed to issue a decision on designating critical habitat for jaguars by July 3, 2006.

Methodology.

On January 21, 1999, the Habitat Subcommittee of the Jaguar Conservation Team agreed on criteria to identify jaguar habitat in the United States, as follows:

> A. Area being considered must be within 50 miles of a documented jaguar occurrence. This would include an entire mountain range, if a portion of that range is within 50 miles of the occurrence.
>
> B. Based on Brown and Lowe (1980) habitat associations, the area must be in the Semi-desert Grassland, Plains and Great Basin Grassland, Subalpine Grassland, Interior

[48] 44 Fed. Reg. 43705.

[49] 62 Fed. Reg. 39148-39149.

Chaparral, Madrean Evergreen Woodland, Great Basin Conifer Woodland, Petran Montane Conifer Forest, Petran Subalpine Conifer Forest, Chihuahuan Desertscrub, Arizona Upland Sonoran Desertscrub, or Great Basin Desertscrub. Areas in the Lower Colorado River Sonoran Desertscrub, Mojave Desertscrub, and Alpine Tundra are not considered jaguar habitat.

C. Area must be within 10 miles of surface water, at least seasonally. Most areas within habitat associations listed in b. above have suitable water availability.

D. Areas with continuous row crop agriculture over an area greater than 1 square mile and any agricultural crop areas immediately adjacent to those areas are not considered adequate habitat. Areas with human residential development in excess of 1 house per 10 acres are not considered jaguar habitat. Areas developed for industrial purposes or a combination of industrial and residential development that create a footprint equal to or greater than 1 house per 10 acres are not suitable jaguar habitat.[50]

To locate documented jaguar occurrences in New Mexico, we used fifteen sightings from a 1998 database and associated general location map of jaguar sightings developed by the New Mexico Department of Game and Fish, omitting only an 1825 Santa Fe sighting which Bailey judged "very unlikely" and a 1905 sighting in the Datil Mountains reported by Bailey but with no information on his source.[51] We added the McKenna, Link, Duffy and Trewern sightings described above, for a total of eighteen occurrences. And we added six (un-numbered) occurrences within 50 miles of New Mexico that are mapped and discussed in the Arizona Department of Game and Fish jaguar habitat report;[52] these occurrences were also used to delineate suitable habitat in New Mexico. We mapped each occurrence as closely as possible to the geographic description and/or map available to us from the original source – although these varied in specificity.

The set of New Mexico sightings follows, with numbers corresponding to those in Figure 1:

---

[50] Meeting minutes, Habitat Subcommittee meeting, Douglass, Arizona, 1/21/1999. Three months after this meeting, and without approval by the subcommittee, the Arizona Department of Game and Fish submitted to the Jaguar Conservation Team's Scientific Advisory Group somewhat different criteria for approval, which were subsequently incorporated into the department's mapping effort; as far as effects on identification of habitats in New Mexico that would qualify as suitable for jaguars, the two sets of criteria do not diverge significantly (Meeting minutes, Habitat Subcomittee meeting, Albuquerque, New Mexico 8/30/2004).

[51] Schmitt, pp. 3-9. For the omitted sighting, see note 23.

[52] Hatten, et al, p. 21.

Location	Date	Observer & Details	Source
1. Peloncillo Mtns	around 1855	Observed by J. Weyss	Baird
2. Caballo Mountains	late 1800s	Killed by Bob Burch	Holloran
3. Black Range	May 1900	Killed by Nat Straw	Bailey
4. Datil Mtns.	1902	Poisoned by Mrs. Manning	Bailey
5. San Andres Mtns.	Before 1903	Unspecified; reported by Page Otero	Bailey
6. Sacramento Mtns.	Before 1903	Unspecified; reported by Page Otero	Bailey
7. Peloncillo Mtns.	1903	Killed by ranchers	Bailey
8. San Miguel Co, a few miles SW of Fulton, Cow Springs area	Summer 1903	Unspecified; reported by Page Otero	Bailey
9. Caballo Mountains	1904 or 1905	Killed by Morris	Bailey
10. near Little Hatchet Mtns.	around 1916	Observed by soldier	McKenna
11. near Springer	“some years” prior to 1938	Hill saw skin	Hill
12. San Andres Mtns.	1937	Bannerman chased with dogs	Holloran
13. Shakespeare, north of I-10	1990	Larry Link observed on property	Link
14. Black Range	8/25/1990	Observed by Gerald and Donna Jacobi	JCT, NMGF
15. Peloncillo Mtns.	4/19/1995	Tracks photographed by Brian Starret	AZGF
16. Peloncillo Mtns	3/7/1996	Chased by Warner Glenn’s dogs	Glenn

17. near San Francisco River	fall 1998	Observed by Tom & Boe Duffy	JCT
18. Hwy. 90 near Tyrone	5/10/1999	John Trewern saw crossing road, obtained plaster cast.	JCT

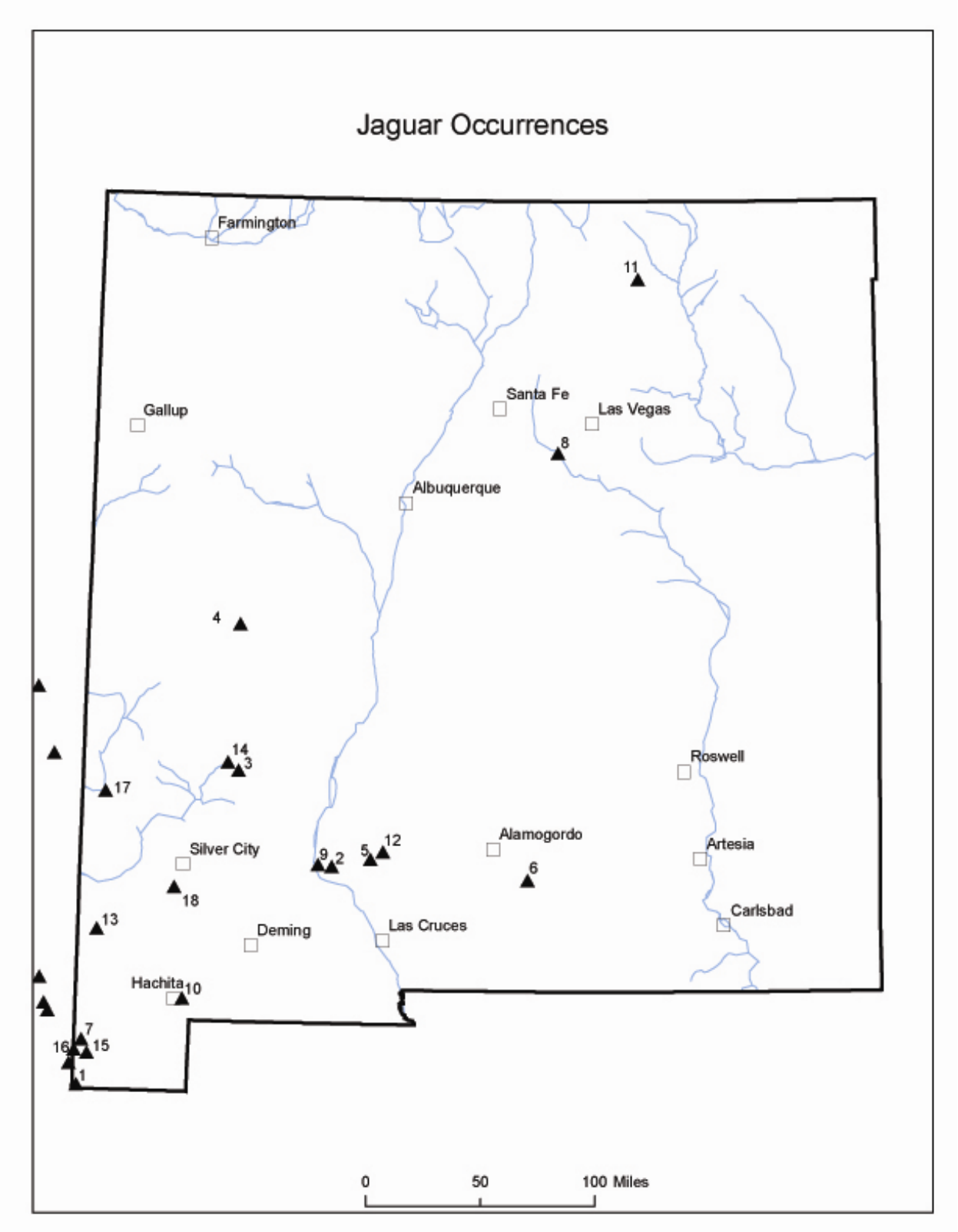


Figure 1.

Delineating mountain ranges is inherently subjective, since gradually sloping terrain and foothills make the outlines of a mountain range a matter of judgment. Thus, we used a terrain

ruggedness index to identify rugged areas as a surrogate for mountain ranges.

The terrain ruggedness index for the state of New Mexico was calculated by first aggregating a 30 meter digital elevation model of the state into 1 kilometer cells. Then the sum difference in elevations between each cell and its neighboring 8 cells was calculated. The calculated values for each cell were assigned a ruggedness classification according to their relative roughness. These classification values were based on Riley et al: level, nearly level, slightly rugged, intermediately rugged, moderately rugged, highly rugged, and extremely rugged. Areas in the four most rugged categories – intermediate, moderate, highly, and extremely rugged – were considered the surrogate for mountainous regions. [53]

This method comports with the purpose of using mountain ranges to delineate jaguar habitat. As evident from the occurrences of jaguars on open grasslands, the species is not limited to mountain ranges. But in the modern era mountains would serve to provide greater concealment (and thus protection) for jaguars and expedite their successful movement from one region to another. Such movements are particularly crucial in re-colonizing vacant habitat and finding mates, but are also important for any wide-ranging species to maintain genetic diversity. Movement corridors that provide places for concealment can be found even in rugged areas that do not constitute an entire mountain range. The Jaguar Conservation Team's Scientific Advisory Group recommended using a terrain ruggedness index to analyze connection potential, citing the lack of connectivity between habitats as a major threat to the jaguar in the United States.[54] So not only does the terrain ruggedness index serve to delineate mountain ranges, but it also functions as an indicator of the areas that would provide the greatest concealment for jaguars navigating the much-changed landscape of the twenty-first century.

To meet criterion A, we buffered each jaguar occurrence with a 50-miles diameter circle and added the adjacent, topographically rugged areas intersected by each circle. (See Figure 2.)

53 Riley et al.

54 Miller, et al, pp. 5, 6.

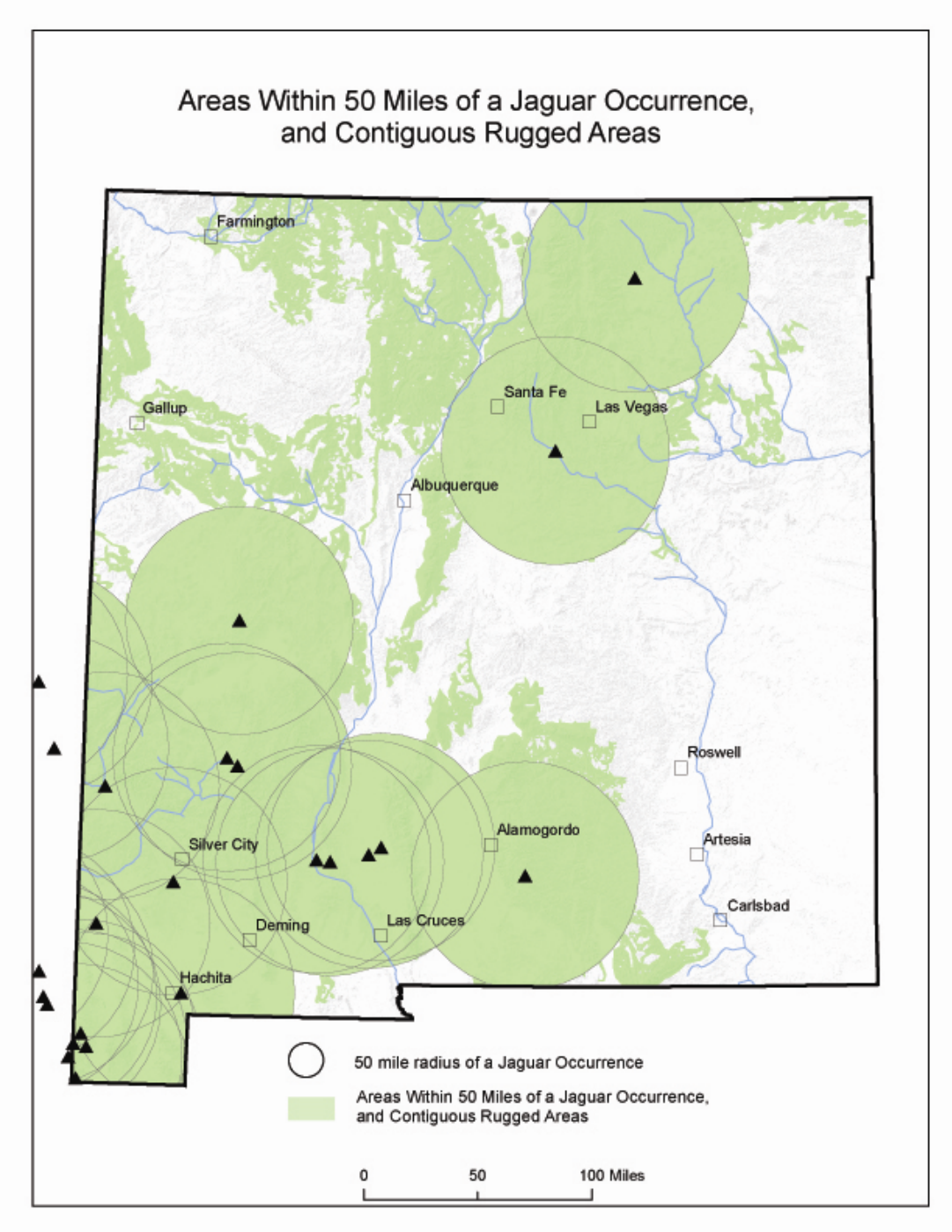


Figure 2.

Next, we applied the habitat associations listed in criterion B, but translating the Brown and Lowe criteria into the much more precise metric of GAP analysis, as follows.[55] (See Figure 3.)

[55] Brown and Lowe.

Jaguar Habitat	GAP Ecotypes	Brown & Lowe habitat equivalent
in	Subalpine Broadleaf Forest	PETRAN MONTANE CONIFER FOREST
in	Rocky Mountain Upper Montane Conifer Forest	PETRAN MONTANE CONIFER FOREST
in	Rocky Mountain Lower Montane Conifer Forest	PETRAN MONTANE CONIFER FOREST
in	Madrean Lower Montane Conifer Forest	MADREAN EVERGREEN WOODLAND
in	Rocky Mountain/Great Basin Closed Conifer Woodland	PETRAN MONTANE CONIFER FOREST
in	Rocky Mountain/Great Basin Open Conifer Woodland (Savanna)	PETRAN MONTANE CONIFER FOREST
in	Madrean Closed Conifer Woodland	MADREAN EVERGREEN WOODLAND
in	Madrean Open Oak Woodland (Encinal)	MADREAN EVERGREEN WOODLAND
in	Interior Chaparral	INTERIOR CHAPPARAL
in	Rocky Mountain Montane Deciduous Scrub	PETRAN MONTANE CONIFER FOREST
in	Broadleaf Evergreen Interior Chaparral	INTERIOR CHAPPARAL
in	Plains-Mesa Broadleaf Sand-Scrub	PLAINS AND GREAT BASIN GRASSLAND
in	Chihuahuan Desert Scrub	CHIHUAHUAN DESERTSCRUB
in	Chihuahuan Broadleaf Evergreen Desert Scrub	CHIHUAHUAN DESERTSCRUB
in	Chihuahuan Broadleaf Deciduous Desert Scrub	CHIHUAHUAN DESERTSCRUB
in	Short Grass Steppe	PLAINS AND GREAT BASIN GRASSLAND
in	Mid-Grass Prairie	PLAINS AND GREAT BASIN GRASSLAND
in	Tall Grass Prairie	PLAINS AND GREAT BASIN GRASSLAND
in	Great Basin Foothill-Piedmont Grassland	PLAINS AND GREAT BASIN GRASSLAND
in	Great Basin Lowland/Swale Grassland	PLAINS AND GREAT BASIN GRASSLAND
in	Chihuahuan Desert Grassland	SEMIDESERT GRASSLAND
in	Chihuahuan Foothill-Piedmont Desert Grassland	SEMIDESERT GRASSLAND
in	Chihuahuan Lowland/Swale Desert Grassland	SEMIDESERT GRASSLAND
in	Rocky Mountain Montane Forested/Shrub Wetlands	N/A
in	Southwest & Plains Forested/Shrub Wetland	N/A
in	Graminoid Wetlands	N/A
in	Rock Outcrop	N/A
in	Riverine/Lacustrine	N/A
in	Basin/Playa	PLAYA
out	Rocky Mountain Alpine Graminoid Tundra	ALPINE TUNDRAS
out	Rocky Mountain Alpine Forb Tundra	ALPINE TUNDRAS
in	Subalpine Conifer Forest	PETRAN SUBALPINE CONIFER FOREST
in	Upper Montane Open Conifer Woodland	PETRAN SUBALPINE CONIFER FOREST
in	Great Basin Microphyllous Desert Scrub	GREAT BASIN DESERTSCUB
in	Great Basin Broadleaf Deciduous Desert Scrub	GREAT BASIN DESERTSCUB
in	Rocky Mountain Subalpine and Montane Grassland	SUBALPINE GRASSLAND
out	Dryland Agriculture	N/A
out	Irrigated Agriculture	N/A
in	Barren	N/A
out	Mine/ Quarries	N/A
out	Urban	N/A
out	Urban Vegetated	N/A

Figure 3.

The area depicted in Figure 4 constitutes the qualifying vegetation. (See Figure 4.)

Figure 4

To apply criterion C, we delineated areas within ten miles of surface water. Again, despite its aridity, very little of New Mexico was beyond this distance from a water source. (See Figure 5.)

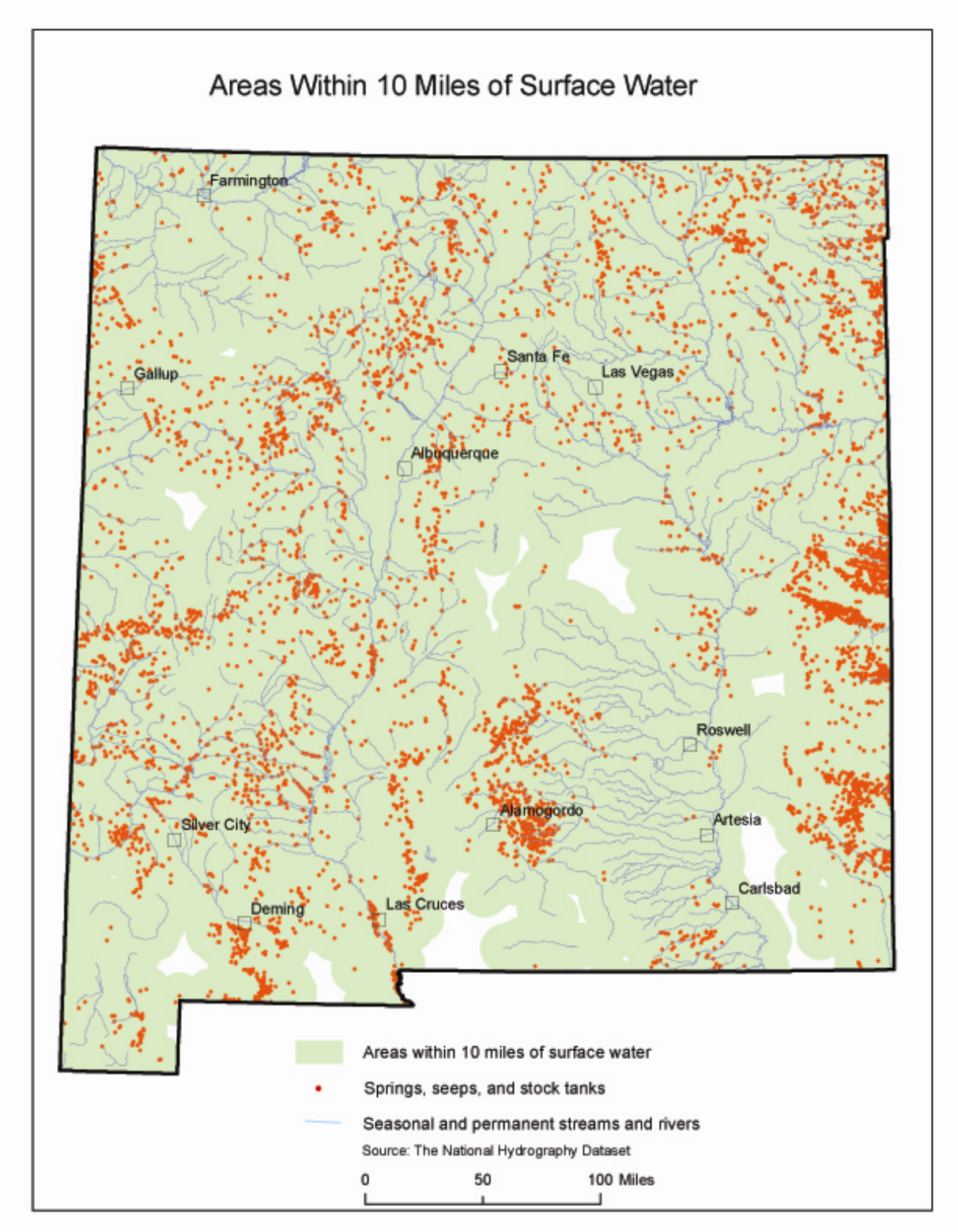


Figure 5.

To meet criterion D, we first identified and removed from further consideration areas with one house or more per ten acres, and areas developed for industry equivalent to or greater in extent than one house per ten acres. We downloaded Census Block data from the US 2000 Census merged for all New Mexico counties. The data were in spatial form, showing census block areas within each county of New Mexico, and in tabular form, with detailed demographic data for each census block. The two forms of data were combined to create a single file that allowed each census block to be located on a map and contain all the demographic data for that block.

The physical area of each census block was calculated and that number divided by the acreage of the block to give a density value for each block in units of households per acre. Blocks with a density of greater than 1 household per 10 acres were not considered jaguar habitat. (See Figure 6.)

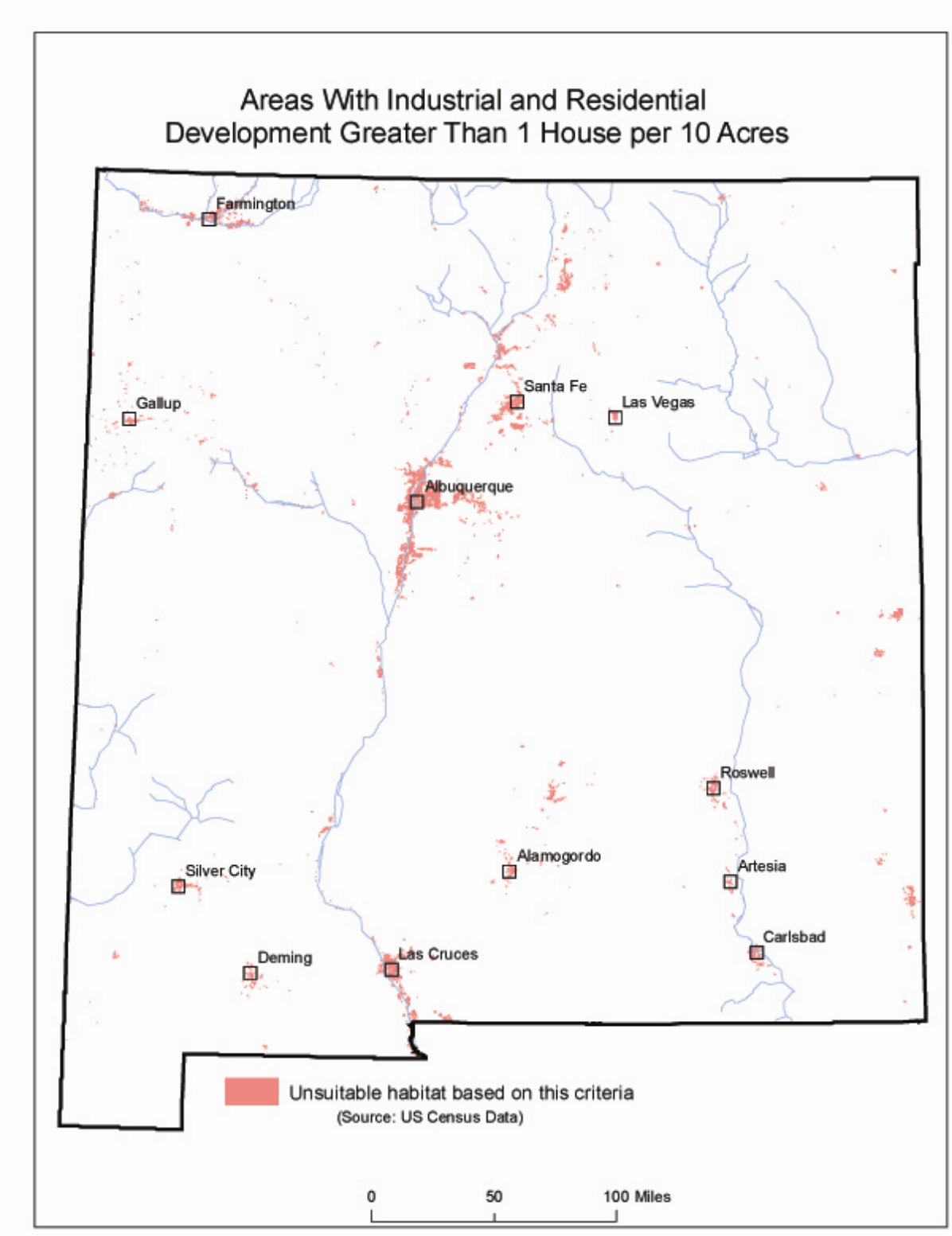


Figure 6.

To meet the rest of criterion D, we identified and removed from further consideration

areas classified as agricultural, mined areas, or developed (low, medium, and high intensity) in the latest version of GAP, the Southwest ReGAP.[56] (See Figure 7.)

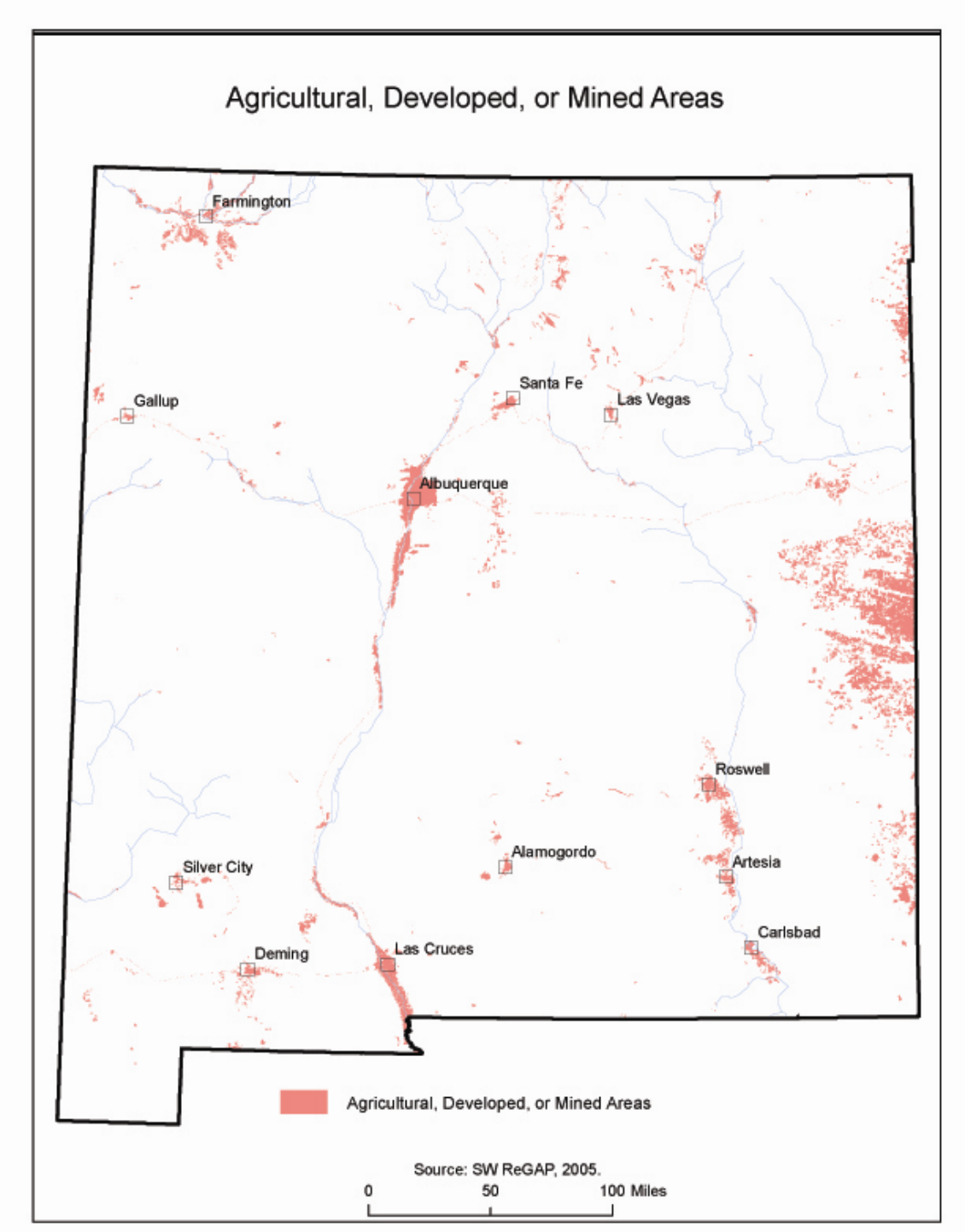


Figure 7.

56 http://fws-nmcfwru.nmsu.edu/swregap/

Suitable jaguar habitat consists of the overlap in areas depicted in Figures 2, 4 and 5, after removal of areas in Figure 6 and Figure 7. (See Figure 8.)

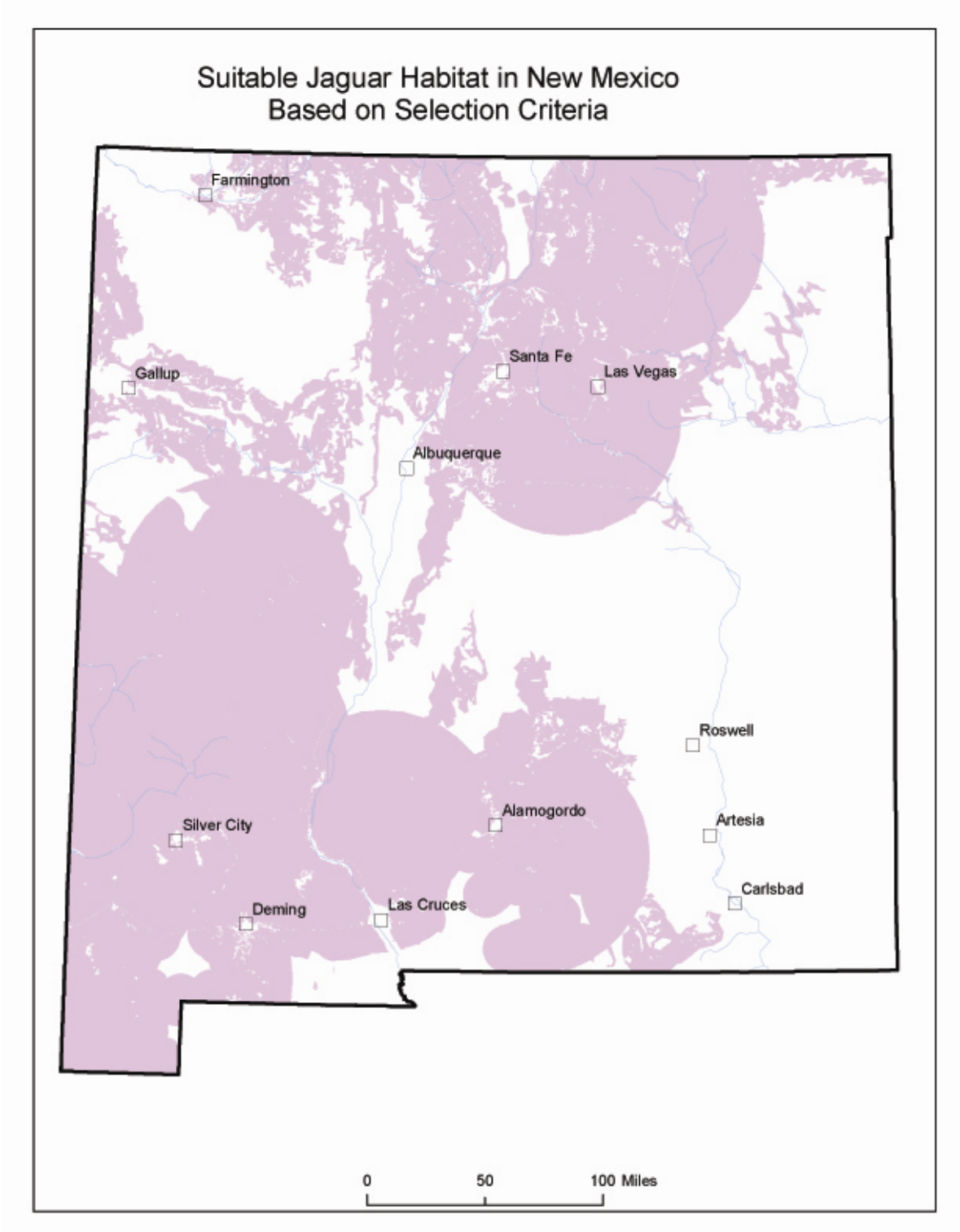


Figure 8.

Discussion and Conclusions.

It seems likely from the wide variety of biomes in which jaguars have been recorded in the United States, and considering the broad areas that still contain suitable habitat, that the principal constraint on jaguar population growth in New Mexico (and much of the rest of the southern tier of states) stems from the species' absence in most areas, and from their very low population density in other areas, rather than from habitat limitations.

Although density of prey species was omitted from the Jaguar Conservation Team's habitat model because prey can be increased through management actions (a course confirmed by the Jaguar Conservation Team's Scientific Advisory Group[57]), currently the U.S. portion of the jaguar's historic range enjoys advantages over northern Mexico's. In much of Mexico, poorly regulated subsistence hunting has resulted in significant depression of ungulate populations. In contrast – in the U.S., including New Mexico – ungulate populations are monitored and well-enforced bag limits serve to mitigate climatic causes of population declines (such as drought). Furthermore, the presence of elk (*Cervus elaphus*) in much of the jaguar's historic U.S. range adds variability to a potential jaguar population's prey base, and concomitant flexibility for jaguars to cope with any future oscillations in the numbers of other prey species.

Another criterion the Jaguar Conservation Team considered but ultimately omitted was road densities – again in recognition that at least on public lands these are also amenable to change based on management decisions. Nevertheless, it is clear that roadless areas can help protect jaguars from poachers. New Mexico and Arizona contain millions of acres of wilderness areas and wilderness study areas where vehicular intrusions are banned, most of which are within the regions identified as suitable jaguar habitat in this report and the Arizona habitat report. In this respect as well, the effective regulatory climate in the United States confers another potential advantage to some jaguar habitats here over those in northern Mexico.

The greatest threat to the integrity of jaguar habitat in the United States today is likely to be heavily-traveled, multiple-lane highways. Although a network of smaller highways and roads crisscrosses New Mexico (see Figure 9), only interstates 25, 10 and 40 are likely to cause significant levels of mortality from among jaguars attempting to cross it. It is noteworthy, however, that the 1990s records of jaguars north of I-10 seem to indicate that movement corridors had not been entirely severed at that time.

[57] Miller, et al, p. 5.

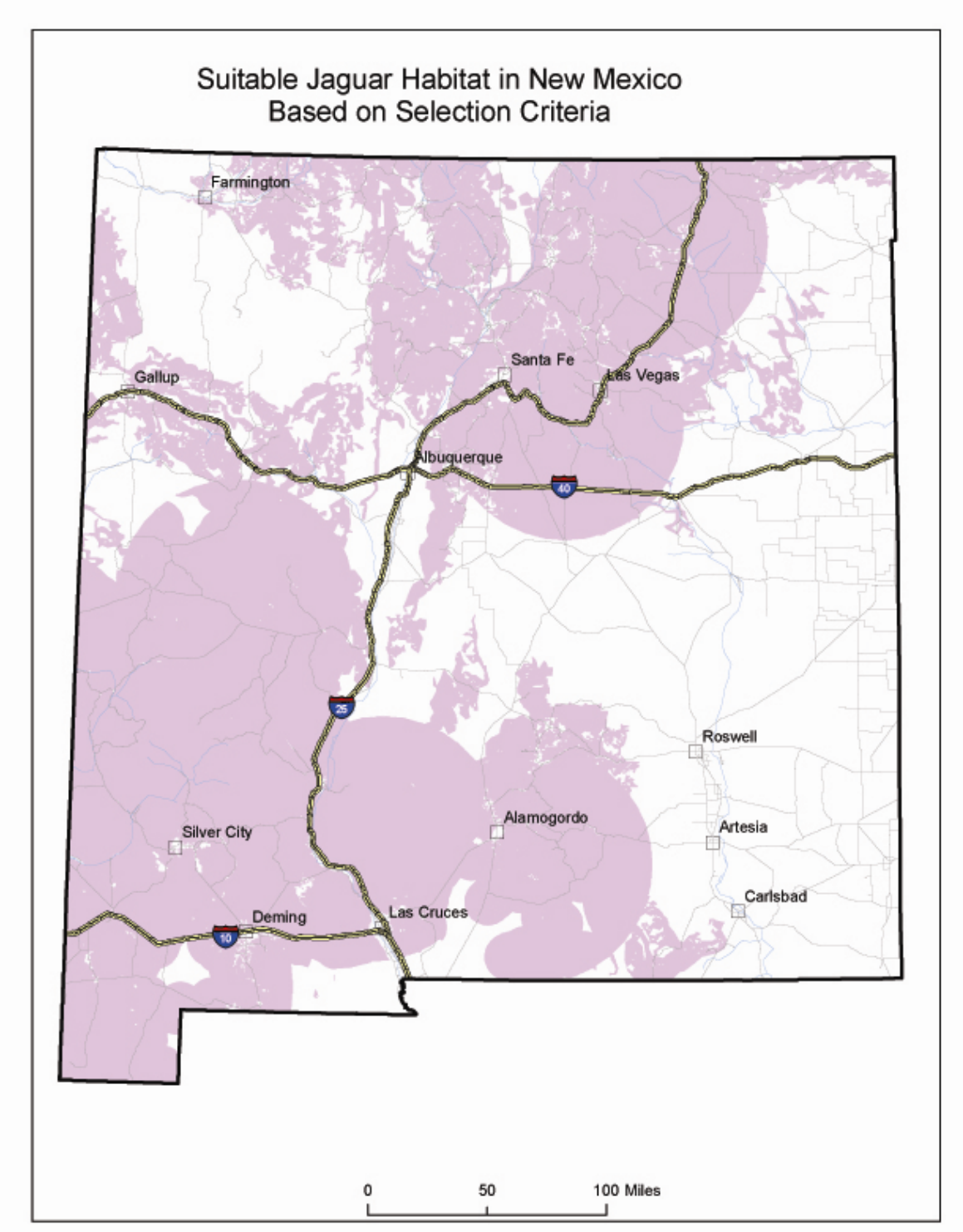


Figure 9.

A growing menace to possible jaguar re-colonization of New Mexico (and Arizona) is the ongoing development of physical barriers to movement along the United States border with Mexico for the purposes of stemming human movement. Proposals for additional barriers should be judged in part on their effects on jaguars.

Sources.

"A Jaguar in Texas," *Forest and Stream*, 1/7/1911. Volume & number unknown; anonymous.

Audubon, John James and John Bachman. *The Quadrupeds of North America*, Vol. III. New York. 1854. Edition unknown.

Bailey, Vernon. *The Mammals of New Mexico*. U. S. Department of. Agriculture, Bureau of Biological Survey, North American Fauna, No. 53. Washington, D.C.: Government Printing Office. 1931.

Baird, Spencer F. *Mammals of the Boundary*. Report of the United States and Mexican Boundary Survey, under the order of Lieut. Col. W. H. Emory, Major First Cavalry, and United States Commissioner. 1859.

Brown, David E. and Carlos A. Lopez Gonzales. *Borderland Jaguars*. Salt Lake City: University of Utah Press. 2001.

Brown, David E. and Charles H. Lowe. *Biotic Communities of the Southwest*. Salt Lake City: University of Utah Press. 1994 (map originally printed in 1980).

Castañeda, Pedro de, et al. *The Journey of Coronado*. Toronto: Dover. 1990.

Foreman, Dave, K. Daly, B. Dugelby, R. Hanson, R.E. Howard, J. Humphrey, L. Klyza Linck, R. List, K. Vacariu. *Sky Islands Wildlands Network Conservation Plan*. Richmond (Vermont): The Wildlands Project. 2000.

Foreman, Grant (editor). *A Pathfinder in the Southwest: The Itinerary of Lieutenant A. W. Whipple During His Explorations for a Railway Route from Fort Smith to Los Angeles in the Years 1853 & 1854*. Norman: The University of Oklahoma Press. 1941.

Glenn, Warner. *Eyes of Fire: Encounter with a Borderlands Jaguar*. El Paso: Printing Corner. 1996.

Hatten, J. R., A. Averill-Murray, and W. E. Van Pelt. "Characterizing and mapping potential jaguar habitat in Arizona." Nongame and Endangered Wildlife Program Technical Report 203. Phoenix: Arizona Game and Fish Department. January 2003.

Hensley, Emmett. "Hide Finally Brought Hunters $5.00: It's A Spotted Lion! No, It's A Jaguar!!" *The Junction* [Texas] *Eagle*. 5/25/1967. Page unknown. (From Landon Lockett, Austin, Texas, personal correspondence, June 2001.)

Halloran. Arthur. F. "The Carnivores of the San Andres Mountains, New Mexico." *Journal of Mammalogy*, vol. 27, no. 2, May 1946, pp. 154-161.

Hill, John E. "Notes on Mammals of Northeastern New Mexico." *Journal of Mammalogy*, vol. 23, no. 1, February 1942, pp. 75-82.

Johnson, Terry B. and William E. Van Pelt. "Conservation assessment and strategy for the Jaguar in Arizona and New Mexico." Nongame and Endangered Wildlife Program Technical Report 105. Phoenix: Arizona Game and Fish Department. 3/24/1997.

Matthiessen, Peter. *Wildlife in America*. New York: Viking. 1987.

McFarland, Elizabeth. *Wilderness of the Gila*. Albuquerque: The Publication Office, University of New Mexico. 1974.

McKenna, James A. *Black Range Tales*. Glorieta [New Mexico]: Rio Grande Press. 1991.

Menke, Kurt A. and Charles L. Hayes. "Evaluation of the Relative Suitability of Potential Jaguar Habitat in New Mexico." Santa Fe: New Mexico Department of Game and Fish. 7/31/2003.

Muldavin, E. "A Vegetation Classification and Land Cover Legend for Application to New Mexico Gap Analysis." Las Cruces: New Mexico Natural Heritage Program, New Mexico Cooperative Fish and Wildlife Research Unit, New Mexico State University. 1996.

Merriam, C. Hart. "Is the Jaguar Entitled to a Place in the California Fauna?" *Journal of Mammalogy*, vol.1, no. 1, November 1919, pp. 38-40.

Miller, Brian; Alan Rabinowitz; and Carlos Lopez. "Review of jaguar conservation strategy." Memo to Bill Van Pelt/Jaguar Conservation Team's habitat committee. 11/14/2000.

Riley, S.J., S.D. DeGloria and R. Elliot. A terrain ruggedness index that quantifies topographic heterogeneity. *Intermountain Journal of Sciences* 5:23-27. 1999.

Robinson, Michael J. *Predatory Bureaucracy: The Extermination of Wolves and the Transformation of the West*. Boulder: University Press of Colorado. 2005.

Roemer, Ferdinand. *Roemer's Texas*. Edition unknown. (Private translation by Helga H. von Schweinitz; documentation from Landon Lockett, Austin, Texas, personal correspondence, 6/2001.)

Sage, Rufus B. *Rocky Mountain Life; Or, Startling Scenes and Perilous Adventures in the Far West, During an Expedition of Three Years*. Boston: Wentworth & Co. 1858.

Schmitt, C. Gregory. "Jaguar (*Panthera onca*) Reports and Records from New Mexico." Unpublished report, New Mexico Department of Game and Fish. 1/15/1998.

Seton, Ernest Thompson. "The Jaguar in Colorado." *Journal of Mammalogy*. Nov. 1920, Vol. 1, No. 5, p. 241.

Taylor, Walter P. "Recent Record of the Jaguar in Texas," *Journal of Mammalogy*, February 1947. Vol. 28, No. 1, p. 66.

"Tough Customer: 121-Pound Jaguar Killed on Farm Near Kingsville," *Corpus Christi Caller Times*, 4/21/1948, p. 8; anonymous.

Van Pelt, William.E.. *Annual Report for the Jaguar Conservation Agreement for Arizona and New Mexico.* Nongame and Endangered Wildlife Program Technical Report 132. Phoenix: Arizona Game and Fish Department. July, 1998.