Mexican wolf. Photo by G. Andrejko, courtesy of Arizona Game and Fish Department.

"Green fire" returns to the Southwest: reintroduction of the Mexican wolf

David R. Parsons

"We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain. I was young then, and full of trigger-itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunters' paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view" (Leopold 1949:130).

The wolf referred to by Leopold in the opening quotation was a Mexican wolf (*Canis lupus baileyi*). Leopold killed it somewhere (no one knows exactly where) near the location where 11 reintroduced Mexican wolves were released on 29 March 1998 after having been extirpated from the wild in the United States 3 decades earlier. Leopold's granddaughter, Patricia Stevenson, helped carry one of those wolves to its acclimation pen in the Blue Range of the Apache National Forest in eastern Arizona. What follows is an overview of the program to restore Mexican wolves to suitable habitat within its historical range in the United States.

Taxonomy and historic range

The Mexican wolf is the southern-most occurring and most endangered subspecies of gray wolf (*Canis lupus*) in North America (Parsons and Nicholopoulos 1995). Confusion and disagreement exist over North American gray wolf taxonomy (Brewster and Fritts 1995), but available morphometric and molecular genetic data support the conclusion that the Mexican wolf is a distinct subspecies (Hall and Kelson 1959, Bogan and Mehlhop 1983, Wayne et al. 1992, Nowak 1995, García-Moreno et al. 1996).

Requirements of the Endangered Species Act of 1973 (ESA; 16 USC 1531-1544) underscore the importance of delineating, as accurately as possible, the original distribution of the Mexican wolf. Regula-

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tions for implementing the ESA state that "[t]he Secretary may designate as an experimental population a population of endangered or threatened species that has been or will be released into suitable natural habitat...within its probable historic range," [50 CFR 17.81 (a)].

Based upon a review of the taxonomic literature and the dispersal capability of gray wolves, Parsons (1996) defined the "probable historic range" of *C. l. baileyi* (Fig. 1). This range includes portions of central and northern Mexico, western Texas, southern New Mexico, and southeastern and central Arizona.

Life history

Little is known of the natural history of the Mexican wolf. Some data were obtained by trappers employed by the Predatory Animal and Rodent Control Service (PARCS). Numbers, weights, and details were often exaggerated (Brown 1983, Gipson 1995). Weights of wild Mexican wolves range from 25–45 kg (Young and Goldman 1944, Leopold 1959, McBride 1980). Adult Mexican wolves range from 140–170 cm in total length (nose to tip of tail), and 72–80 cm in shoulder height. The pelt of the Mexican wolf contains a mix of gray, black, brown, and rust colors in a characteristic pattern, with white underparts. Variation in pelage consists of light to dark versions of this pattern. Solid white or black Mexican wolves are not documented (Brown 1983).

Before the Mexican wolves were extirpated in the wild, they probably preyed primarily on white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*; Brown 1983). Elk (*Cervus elaphus*), pronghorn (*Antilocapra americana*), javelina (*Tayassu tajacu*), beaver (*Castor canadensis*), rabbits (*Sylvilagus* spp.), hares (*Lepus* spp.), and small mammals may have provided alternative prey, but use of these species as prey by Mexican wolves is not documented. Predation on livestock by Mexican wolves increased as the number of livestock in the American Southwest increased in the late 1800s and early 1900s (Brown 1983) and native ungulate populations concurrently declined through unregulated subsistence and market hunting (U.S. Fish and Wildl. Serv. 1987). Today, there are fewer livestock, and wild ungulate populations have been restored to many areas (U.S. Fish and Wildl. Serv. 1987).

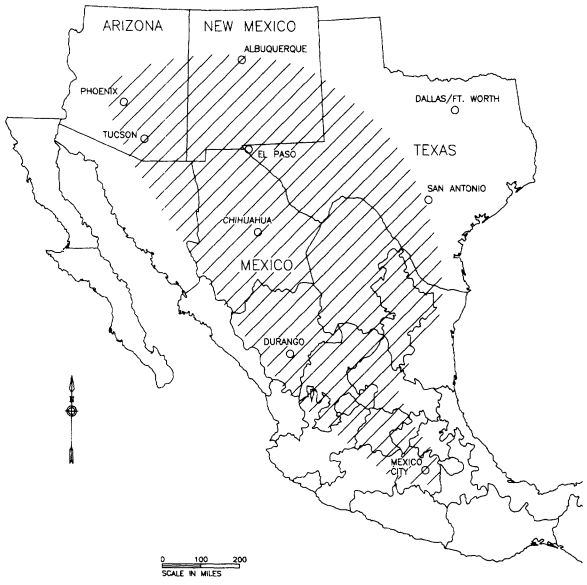

Fig. 1. Historic range of the Mexican wolf, from Parsons (1996).

Predation methods of Mexican wolves differ from those of other large predators in southwestern ecosystems. Wolves pursue their prey by chasing, sometimes over long distances, and often hunt in groups, while mountain lions (*Puma concolor*), for example, hunt singly and usually rely on ambush or opportunistic encounters with their prey (Young and Goldman 1946, Mech 1970). Thus, the evolutionary influence of Mexican wolves on their prey was probably important in southwestern ecosystems and was not replaced in their absence.

Bednarz (1988) suggested that Mexican wolves form small family groups of 2–8 members when not molested; however, data supporting this contention are lacking. Most information about free-ranging Mexican wolves was obtained from trappers, who often targeted lone wolves. Occasionally, groups of wolves were taken together, but intensive control activities undoubtedly affected the structure of wolf social units and eliminated the basis for scientific determination of pack size and social structure (Brown 1983).

McBride (1980) reported a mean litter size of 4.5 from 8 dens in Mexico. Mean litter size before parturition for 8 females was 6.8, indicating a degree of mortality during or after birth (McBride 1980). The size of 86 litters of Mexican wolves born in captivity ranged from 1 to 9 with a mean size of 4.6 (Siminski 1996). Captive females usually came into estrous between mid-February and mid-March. Gestation averaged 63 days, with parturition occurring in April and May.

Mexican wolves preferred wooded mountainous areas, presumably because of the favorable combination of cover, water, and prey availability. Most wolf collections have come from pine (*Pinus* spp.), oak (*Quercus* spp.), and pinyon (*Pinus edulis*)-juniper (*Juniperus* spp.) woodlands, and intervening or adjacent grasslands above 1,372 m in elevation (Brown 1983). Mexican wolves apparently avoided desert scrub and semidesert grasslands, which provided lit-

tle cover or water (Brown 1983). Wooded riparian corridors were probably used by Mexican wolves for traveling, dispersing, and hunting (Parsons 1996).

Population status in the wild

Wolves have inhabited the Southwest since the Pleistocene Epoch (Lindsay and Tessman 1974, Findley et al. 1975). Bednarz (1988) estimated historical wolf carrying capacity at 16.1 wolves/1,000 km^2, or about 1,500 animals within New Mexico.

Many methods were used to exterminate Mexican wolves, including trapping with snares and steel foothold traps, digging pups from dens, shooting, and poisoning. Public and private bounties provided an incentive to kill wolves. PARCS reported over 900 Mexican wolves killed in New Mexico and Arizona by government trappers or cooperators from 1915 to 1925, and it is believed that a greater number of wolves were killed for bounties from 1890 to 1915 (Brown 1983).

The Mexican wolf was extirpated from the wild in the United States by the mid-1900s (Brown 1983, Bednarz 1988). McBride (1980) estimated that fewer than 50 Mexican wolves existed in the states of Chihuahua and Durango, Mexico and speculated that ≤50 adult breeding pairs existed in Mexico in 1978. The present status of wild populations of the Mexican wolf in Mexico is unknown, but recent surveys in Mexico have not confirmed its presence (J. A. Carrera and J. F. Gonzales, Protección de la Fauna Mexicana A. C., Saltillo, Coahuila, Mex., unpubl. data). It appears unlikely that viable populations, if any wolves at all, remain in Mexico.

Legal status

The Mexican wolf was listed as endangered under provisions of the Endangered Species Act (ESA) in May 1976. In 1978, all North American gray wolves occurring south of the Canada-United States border were listed as endangered, except in northern Minnesota, where they were listed as threatened. Provisions of the ESA make it illegal to "take" any wolf without a permit unless a human life is threatened. The U.S. Fish and Wildlife Service (USFWS) has assigned a recovery priority of 3C to the endangered Mexican wolf, indicating that it is an endangered subspecies with a high degree of threat and recovery potential, whose recovery may conflict with some form of economic activity (Fed. Register, Vol. 84, No. 184, 1983: 43104). Section 4(f)(1) of the ESA requires the Secretary of the Interior to "develop and implement plans...for the conservation and survival of endangered species...unless he finds that such a plan will not promote the conservation of the species."

Results and discussion of recovery efforts

Recovery planning

The Mexican Wolf Recovery Team was formed by the USFWS in August 1979. The team prepared the Mexican Wolf Recovery Plan, which was approved and signed by the Director of the USFWS and the Director General of the Dirección General de la Fauna Silvestre (Mexico) on 15 September 1982. The plan contains the following objective: "To conserve and ensure the survival of *C. l. baileyi* by maintaining a captive breeding program and re-establishing a viable, self-sustaining population of at least 100 Mexican wolves in middle to high elevations of a 5,000 mi^2 (13,000 km^2) area within the Mexican wolf's historic range" (U.S. Fish and Wildl. Serv. 1982:23). Specific goals for down-listing to threatened status and de-listing the Mexican wolf will be established in a revised plan.

Given the natural and human-caused isolation of areas of suitable habitat for the Mexican wolf, a number of separate reintroductions likely will be required to ensure long-term conservation of the subspecies. Reestablishment efforts will most likely result in isolated populations (i.e., metapopulations) which may require active management to ensure adequate gene flow among these groups (Lande and Barrowclough 1987).

Captive breeding program

Between 1977 and 1980, 5 wolves (4 males and 1 pregnant female) were live-captured in Durango and Chihuahua, Mexico, to establish a captive population of Mexican wolves called the "certified" lineage. Reproduction in the certified lineage began at the Arizona-Sonora Desert Museum in Tucson, Arizona, with the birth of a litter of 5 pups by the wild-caught pregnant female in 1978. The only female pup in this litter died at the age of 4 days. In 1981 at the Wild Canid Survival and Research Center in Eureka, Missouri, the wild-caught female gave birth to her second litter in captivity (1 male and 3 female pups). All 4 of these pups survived and reproduced. By 1983, the captive breeding program was firmly established with the birth of 3 litters totaling 15 pups (Siminski 1996). Two of the wild-caught males eventually bred with the wild-caught female and produced offspring in captivity.

Based largely on the results of DNA studies, 2 additional lineages of captive Mexican wolves, 1 each in

the United States and Mexico, were certified for inclusion in the official breeding program for Mexican wolves in July 1995 (Hedrick et al. 1997).

As of March 1999, the captive population of Mexican wolves consisted of 178 individuals held in 40 zoos and wildlife sanctuaries in the United States and Mexico. This population is the result of captive breeding from the 3 officially accepted lineages of Mexican wolves. The first offspring from cross-lineage pairings were produced in 1997.

Management of the captive population follows a Species Survival Plan (SSP) developed and implemented by the American Zoo and Aquarium Association. The SSP objective is to establish and maintain a captive population of ≥240 animals with a minimum of 17 breeding pairs to conserve at least 75% of the gene diversity of the founding wolves for the next 50 years (Am. Zoo and Aquarium Assoc. 1994). With the assistance of computer programs (SPARKS, GENES, DEMOG, CAPACITY) the population is managed to minimize inbreeding and maximize retention of the genetic diversity of the 7 founders.

Some concern has been expressed over the limited genetic base of the captive population. With only 7 founders, some inbreeding cannot be avoided. However, no evidence of inbreeding depression has been detected in the population (Hedrick et al. 1997, Kalinowski et al. 1999). The recent inclusion of the 2 additional breeding lines will increase gene diversity and further reduce the likelihood of inbreeding depression in the population.

Recent analyses of allele frequencies at 10 nuclear microsatellite loci in Mexican wolves from the 3 different lineages, other gray wolves, red wolves, coyotes, and domestic dogs provide the most definitive information on the ancestry and genetic purity of the 3 captive wolf lineages (García-Moreno et al. 1996, Hedrick et al. 1997). From these and other studies, the Genetics Committee of the Mexican Wolf Recovery Team concluded that wolves in the 3 lineages are pure Mexican wolves with no indication of any past cross-breeding with coyotes, dogs, or northern gray wolves (Hedrick et al. 1997).

In late 1996, 5 pairs (1 M, 1 F) of "release-candidate" wolves were moved to a remote pre-release acclimation facility on the Sevilleta National Wildlife Refuge near Socorro, New Mexico. One year later, 5 additional release-candidate pairs were transferred to a similar facility constructed by the Turner Endangered Species Fund on the Ladder Ranch in southern New Mexico. An additional family of release-candidate wolves was held in a remote enclosure at Wolf Haven International in the state of Washington. At these facilities, contact between wolves and humans is minimized and wolves are introduced to road-killed carcasses of native prey species, mostly deer and elk, to supplement their routine diet of zoo canine food.

The reestablishment plan and description of recovery areas

Reintroduction of Mexican wolves to establish a wild population of ≥100 wolves was approved by the Secretary of the Interior in March 1997 (U. S. Fish and Wildl. Serv. 1997). Under the approved plan, genetically surplus, captive-raised Mexican wolves are being released into the Apache National Forest in eastern Arizona and allowed to recolonize the Blue Range Wolf Recovery Area in east-central Arizona and west-central New Mexico (Fig. 2). The White Sands Wolf Recovery Area will be used as an additional reintroduction area if the 100-wolf objective cannot be met on the Blue Range area. The plan calls for annual releases of about 3 family groups, totaling 10–15 wolves, for 3–5 years. Continued population growth will result from natural reproduction to achieve a final, self-sustaining population of 100 or more free-ranging, wild Mexican wolves in 8–10 years (U.S. Fish and Wildl. Serv. 1996).

Released wolves and their progeny were designated a "nonessential, experimental population" under provisions of section 10(j) of the ESA (Fed. Register, 12 January 1998:1752–1772). The USFWS believes that this designation provides adequate protection for recovery and appropriate management flexibility for addressing potential wolf–human conflicts, especially livestock depredation.

The Blue Range Wolf Recovery Area includes all of the Apache and Gila National Forests in east-central Arizona and west-central New Mexico, encompassing about 17,700 km^2 (Fig. 2). Elevations range from about 1,200 m in the semi-desert lowlands and along the San Francisco River to 3,350 m on Mount Baldy, Escudilla Mountain, and the Mogollon Mountains. Vegetation varies from grasses and shrubs in the lowest areas; pinyon, juniper, and evergreen oaks in the foothills at low to middle elevations; and mixed-conifer stands at higher elevations. Open grassy meadows occur throughout. Water is available in natural springs, streams, and rivers. Wild ungulate species include white-tailed deer, mule deer, elk, pronghorn, bighorn sheep (*Ovis canadensis*), and javelina. The area supports an estimated 57,000 deer and 16,000 elk. About 82,600 head of cattle were permitted to graze on 69% of the area in 1993. Other prevalent uses include forestry, mining, and outdoor recreation. About 4,500 km^2 (25%) is designated or managed as wilderness. This includes the 2,260-km^2 Gila Wilderness (the nation's first wilderness area), established through the efforts of Aldo Leopold. The entire area is open to public use (U.S. Fish and Wildl. Serv. 1996).

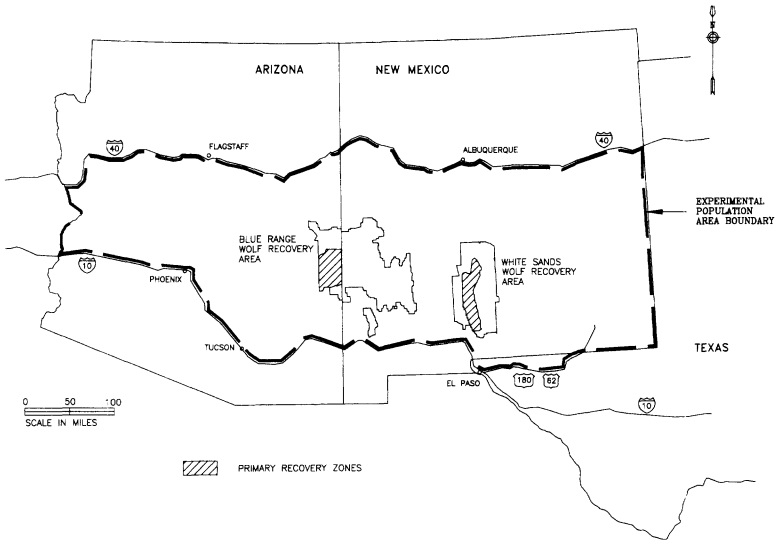

Fig. 2. Locations and boundaries of the Blue Range and White Sands wolf recovery areas and the Mexican wolf experimental population area. Wolf releases are authorized only in the hatched areas, from U.S. Fish and Wildlife Service (1996).

The White Sands Wolf Recovery Area includes all of the White Sands Missile Range, Holloman Air Force Base, White Sands National Monument, San Andres National Wildlife Refuge, Jornada Experimental Range, and a strip of primarily Bureau of Land Management and State of New Mexico lands west of the missile range (Fig. 2). This area encompasses the San Andres and Oscura Mountains and portions of the Tularosa Basin and the Jornada del Muerto. The White Sands Wolf Recovery Area contains about 10,400 km^2. Elevations range from around 1,200 m in the desert basins to 2,700 m in the San Andres Mountains. Vegetation varies from grasses and shrubs in the basins and lower foothills; pinyon and juniper above 1,830 m; to a small stand of ponderosa pine (*Pinus ponderosa*) on Salinas Peak in the San Andres Mountains. Water is present at several permanent and intermittent springs and artificial water sources. Native wild ungulate species present include mule deer, pronghorn, desert bighorn sheep (*Ovis canadensis mexicana*), and javelina. Feral horses (*Equus caballus*) and introduced gemsbok (*Oryx gazella*) are also present. The area supports an estimated 7,500 mule deer and 1,700 gemsbok; other ungulates occur in limited numbers. About 2,100 head of cattle graze on the area west of White Sands Missile Range. The missile range is not open to grazing by domestic livestock or to general public use. The most prevalent uses are military testing and training (U.S. Fish and Wildl. Serv. 1996).

Release of Mexican wolves

Eleven Mexican wolves representing 3 family groups were "soft released" after about 2 months of acclimation into the Apache National Forest on 29 March 1998. A soft release involves holding wolves in on-site pens prior to their release. This procedure allows the wolves to acclimate to and learn to recognize the release area and reduces tendencies to disperse following release (Fritts et al. 1997). While in the pens, wolves were fed carcasses of native prey species. Zoo canine food also was made available to the wolves for the first 2 weeks of the acclimation period. Supplemental feeding of carcasses continued for about 2 months following the wolves' release until sufficient killing of prey was confirmed. Supplemental feeding was also used as a management tool in specific situations to maintain wolf health and influence behavior. A qualitative assessment of reintroduction results for the first 7 months following the release of 11 wolves follows.

Three weeks following their release, 3 subadult members of 1 family group killed a mature cow elk, demonstrating that these captive-reared wolves retained basic hunting instincts. Advanced tooth wear indicated that this elk was very old. Additional kills of adult elk and elk calves by the 2 remaining family groups have been documented. All confirmed prey have been elk, though mule deer also occur in the areas occupied by the released wolves. Elk carcass remnants have not been fully analyzed, but field observations suggested most have been young of the year, old, or injured.

A dispersing yearling female attacked and injured a miniature horse colt which recovered following veterinary care. Field evidence suggested that another wolf probably killed a ranch dog. The Defenders of Wildlife organization compensated the animal's owners for both of these depredation incidents. Other wolves have been observed testing or pursuing livestock, but no killing of livestock by wolves has been confirmed.

Field evidence suggested that both alpha females remaining in the wild during the whelping season gave birth to pups in early May. Only 1 pup is known to have survived birth. The mother of this pup was illegally shot and killed on 7 August. Subsequent to its mother's death, the pup was observed with its father for 2 weeks and was last observed on 22 August 1998.

One adult male was shot and killed on 28 April by a camper who believed the wolf posed a threat to him and his family. Four wolves (1 adult female, 1 2-year-old female, and 2 yearling males) were illegally shot on

7 August, 18 October, 6 November, and 23 November, respectively. Persons responsible for these wolf killings have not been identified. Three wolves have been captured and returned to captivity: 1 lone, pregnant female whose mate was shot and 2 dispersing subadult females that frequented human settlements and harassed livestock. One adult female slipped out of her radiocollar after apparently getting her head stuck in a hollow log. She was last observed with her mate on 23 September and is now presumed dead.

Two adult females were placed in holding pens in or near the territories of the 2 remaining adult males on 16 November. The 2 males were captured on 18 and 23 November and placed in the pens with their new mates. These 2 pairs were released to the wild on 11 December 1998. One pair separated 3 days after their release. They were recaptured and returned to a pen within the male's home range, where they will be held through the breeding season and then released.

A family of 4 wolves (an adult pair and 2 female offspring) were soft released on 15 March 1999, bringing the number of free-ranging Mexican wolves to 6. An additional 11 wolves are planned to be released from April 1999 through May 1999. Six pairs could potentially reproduce in the wild in 1999.

Litigation

In April 1990 a coalition of regional and national environmental organizations filed suit against the departments of the Interior and Defense alleging the agencies failed to implement provisions of the ESA (Wolf Action Group, et al. vs. United States, Civil Action No. CIV-90-0390-HB, U.S. District Court, New Mexico). The plaintiffs claimed that the USFWS had failed to implement the Mexican Wolf Recovery Plan as required by section 4(f)(1) of the ESA, especially the plan's recommendation for the reestablishment of a wild population of Mexican wolves. The Department of Defense was charged with not "carrying out programs for the conservation of endangered species" as required of all federal agencies under section 7(a)(1) of the ESA.

The litigants negotiated a stipulated settlement agreement in 1993, wherein the USFWS agreed to implement the Mexican Wolf Recovery Plan as expeditiously as possible. The USFWS also agreed to expedite completion of the National Environmental Policy Act process for its proposal to reintroduce Mexican wolves to the wild, which would consider an array of reintroduction sites, including the WSMR.

In March 1998 the New Mexico Cattle Growers Association and 8 other groups supportive of the livestock industry filed suit in the Federal District Court of New Mexico to stop the reintroduction project (New Mexico Cattle Grower's Association et al. vs. United States, Civil Action No. CIV-98-0367-HB/LFG). This case is pending and has not been heard by the Court.

National Environmental Policy Act compliance

A "Preferred Alternative" (the approved plan described above), which incorporated a reintroduction plan proposed by the Arizona Game and Fish Department (Groebner et al. 1995) and 3 additional alternatives were described and analyzed in an Environmental Impact Statement (EIS). Potential impacts were identified and analyzed for the following topics: wild prey of wolves, hunting, livestock, predator control programs, governmental policies and plans, land use, military activities, recreation, and regional economies. Mitigation of potentially adverse effects is achieved primarily through the special rule (federal regulation) that established the nonessential, experimental population (Fed. Register, January 12, 1998: 1752–1772). The rule establishes geographic boundaries beyond which wolves will be captured and returned (Fig. 2); allows unavoidable, unintentional take; prohibits land use restrictions for wolf recovery on private and tribal lands; limits land-use restrictions on public lands to 1.6-km radius zones around release pens, dens, and rendezvous (pup-rearing) sites, when necessary; allows the taking of wolves that are attacking livestock on private lands; allows noninjurious harassing of wolves near people, livestock, pets, and buildings; allows for the removal of problem or nuisance wolves; allows for capture and removal of wolves that prey on livestock; allows agencies to manage wolves for purposes authorized by the USFWS; limits potentially lethal animal damage control activities in areas occupied by wolves; and prohibits intentional taking of Mexican wolves, except as authorized by the rule. Defenders of Wildlife, a national wildlife conservation organization, has agreed to reimburse livestock owners at fair market value for livestock killed by Mexican wolves.

The USFWS (1997) concluded that implementation of the Preferred Alternative set forth in the final EIS would not result in major adverse impacts.

Socio-political aspects

Public support for Mexican wolf recovery is strong and broad-based. A poll conducted in 1995 (M. D. Duda and K. C. Young, New Mexico residents' opinions toward Mexican wolf reintroduction, unpubl. contract rep. for League of Women Voters of New Mexico, Responsive Management, Harrisonburg, Virginia, 1995), showed that, statewide, about 60% of New Mexican residents supported reintroduction of

Mexican wolves, while 22–25% opposed it, depending on whether the reintroduction occurred in Arizona or New Mexico, respectively. In the 4 primarily rural counties in the proposed release areas, about 50% of residents polled supported reintroduction, and about 32% opposed it. Biggs (1988) found that 79% of New Mexican residents, statewide, supported Mexican wolf reintroduction into New Mexico; 79% of New Mexican ranchers opposed and 21% supported wolf reintroduction. Most statewide and rural Arizona residents supported reintroduction of Mexican wolves into its former forest and mountain habitats in Arizona (Johnson 1990). However, a survey of residents of Greenlee County, Arizona (most of which lies within the reintroduction area), found that 58% of respondents opposed and 22% supported wolf reintroduction (Schoenecker and Shaw 1997). Livestock-related concerns were the most frequently stated reason for opposition, followed by fears for human safety.

Despite demonstrated public support, most elected and appointed officials who have publicly stated their position oppose Mexican wolf reintroduction. This includes the governors of the states of New Mexico and Arizona, members of the New Mexico Game and Fish Commission, and the Director of the New Mexico Department of Game and Fish. The Arizona Game and Fish Department and Commission recommended a controlled experimental release on White Sands Missile Range in New Mexico prior to considering endorsing a release in Arizona. However, given the USFWS decision to reintroduce Mexican wolves to Arizona, the Commission has supported the project.

The USFWS has entered into agreements with the Arizona Game and Fish Department, the U.S. Department of Agriculture's Wildlife Services Division, and the New Mexico Department of Game and Fish to cooperatively implement the reintroduction project. Biologists from the 4 agencies constitute the field management team which implements the USFWS-approved Mexican Wolf Interagency Management Plan (U.S. Fish and Wildl. Serv. 1998). Field staff live in local communities within the reintroduction area. An Interagency Management Advisory Group, comprised of representatives from federal and state agencies and county and tribal governments, meets quarterly to review reintroduction progress and address emerging issues. A public interaction plan, developed with public participation, guides public outreach and information activities.

Conclusions

The Mexican gray wolf historically contributed to the overall biological diversity and ecological functioning of southwestern ecosystems and the continued evolution of species it preyed upon. Deliberate eradication efforts driven by public attitudes of the late 1800s and early 1900s nearly brought about extinction of the Mexican wolf. Increased public support for endangered species conservation and wolf recovery over the past 3 decades has created a socio-political climate that now favors wolf reintroductions.

State-of-the-art conservation biology principles and husbandry practices have been applied to resolve questions about taxonomic identity and genetic purity and to produce and maintain a healthy population of captive Mexican wolves. The cooperation of numerous zoos and wildlife sanctuaries throughout the United States and Mexico is critical to the success of the captive breeding effort.

Socio-political aspects of Mexican wolf recovery are complex and public opinion is strongly divided, with proponents of Mexican wolf recovery out-numbering opposers by about 2 to 1. However, positions of most elected officials run counter to the opinions of a majority of their constituents, suggesting influences by special interests or a lack of knowledge of constituent views.

The plan to restore Mexican wolves to the wild aspires to be responsive to the recovery needs of the Mexican wolf and the concerns of a diverse public, special interest organizations, elected officials, government agencies, and people who may be adversely affected by the wolf's return. Mitigation provisions reduce potentially adverse effects to the extent that no significant, adverse impacts are predicted to result from the reintroduction of Mexican wolves. However, localized effects could be severe, and it is important for the management team to work closely with area residents to prevent and resolve wolf-human conflicts.

Our understanding and execution of the technical and logistical aspects of captive propagation and release of Mexican wolves into the wild are believed to be sufficient to accomplish the recovery objectives for the Mexican wolf. Suitable, genetically surplus animals from the captive population are available for reintroduction and suitable reintroduction areas exist. The ultimate success of Mexican wolf reintroduction rests on the fates of released wolves and their offspring and human tolerance of their presence in the wild.

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The cost of managing the captive population is borne by the zoos and wildlife sanctuaries holding the animals and the American Zoo and Aquarium Association (AZA), which provides expertise in small population management. The AZA's Mexican Wolf Captive Management Group (P. Siminski, coordinator) oversees management of the captive population. Defenders of Wildlife compensates owners for livestock killed or injured by Mexican wolves. A. Armistead, V. Asher, D. Boyd-Heger, W. Brown, P. Frame, P. Morey, T. Peltier, N. Smith, and many volunteers monitored and managed Mexican wolves released into the wild. This effort was coordinated by W. Brown. C. Buchanan and J. Laufer managed and cared for these wolves prior to their release. P. Jenkins coordinated the preparation of the environmental impact statement. W. Brown developed and implemented outreach and public interaction plans. T. Johnson and D. Groebner guided the involvement of the Arizona Game and Fish Department. J. Bailey guided the involvement of the New Mexico Department of Game and Fish. N. Ames led the original Mexican Wolf Recovery Team, which prepared the Mexican Wolf Recovery Plan. The U.S. Forest Service provided valuable logistical and administrative support. Numerous conservation organizations, most notably Defenders of Wildlife, Lobo Restoration Fund, Mexican Wolf Coalition of New Mexico, Mexican Wolf Coalition of Texas, Preserve Arizona's Wolves, and White Sands Wolf Coalition, provided valuable educational and other support services. Most of these efforts are ongoing. Many others, too numerous to mention individually, made and continue to make significant contributions to the recovery of the Mexican wolf. W. Ballard, D. Boyd-Heger, W. Brown, and B. Hanson provided helpful reviews of this manuscript. I thank them all; and I especially thank my wife, Noralyn, for supporting my dedication to this project for the past 8 years.

Literature cited

American Zoo and Aquarium Association. 1994. The 1994 Mexican wolf SSP master plan. Compiled by D. P. Siminski, Arizona-Sonora Desert Museum, Tucson, Arizona.

Bednarz, J. A. 1988. The Mexican wolf: biology, history, and prospects for reestablishment in New Mexico. U.S. Fish and Wildlife Service, Albuquerque, New Mexico, Endangered Species Report 18.

Biggs, J. R. 1988. Reintroduction of the Mexican wolf into New Mexico—an attitude survey. Thesis, New Mexico State University, Las Cruces.

Bogan, M. A., and P. Mehlhop. 1983. Systematic relationships of gray wolves (*Canis lupus*) in southwestern North America. Occasional papers of the Museum of Southwestern Biology 1.

Brewster, W. G., and S. H. Fritts. 1995. Taxonomy and genetics of the gray wolf in western North America: a review. Pages 353-374 *in* L. N. Carbyn, S. H. Fritts, and D. R. Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Edmonton, Alberta, Occasional Publication 35.

Brown, D. E. 1983. The wolf in the southwest: the making of an endangered species. University of Arizona Press, Tucson.

Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque.

Fritts, S. H., E. E. Bangs, J. A. Fontaine, M. R. Johnson, M. K. Phillips, E. D. Koch, and J. R. Gunson. 1997. Planning and implementing a reintroduction of wolves to Yellowstone National Park and central Idaho. Restoration Ecology 5:7-27.

García-Moreno, J., M. D. Matocq, M. S. Roy, E. Geffen, and R. K. Wayne. 1996. Relationships and genetic purity of the endangered Mexican wolf based on analysis of microsatellite loci. Conservation Biology 10:376-389.

Gipson, P. 1995. Wolves and wolf literature: a credibility gap. Pages 345-353 *in* R. McIntyre, editor. The war against the wolf: America's campaign to exterminate the wolf. Voyager Press, Inc., Stillwater, Oklahoma.

Groebner, D. J., A. L. Girmendonk, and T. B. Johnson. 1995. A proposed cooperative reintroduction plan for the Mexican wolf in Arizona. Arizona Game and Fish Department, Phoenix, Technical Report 56.

Hall, R. E., and K. R. Kelson. 1959. The mammals of North America. The Ronald Press Company, New York, New York.

Hedrick, P., P. S. Miller, E. Geffen, and R. Wayne. 1997. Genetic evaluation of the three captive Mexican wolf lineages. Zoo Biology 16:47-69.

Johnson, T. B. 1990. Preliminary results of a public opinion survey of Arizona residents and interest groups about the Mexican wolf. Arizona Game and Fish Department, Phoenix.

Kalinowski, S. T., P. W. Hedrick, and P. S. Miller. 1999. No evidence for inbreeding depression in Mexican and red wolves. Conservation Biology 13:in press.

Lande, R., and G. F. Barrowclough. 1987. Effective population size, genetic variation, and their use in population management. Pages 87-123 *in* M. E. Soulé, editor. Viable populations for conservation. Cambridge University Press, New York, New York.

Leopold, A. 1949. A sand county almanac and sketches here and there. Oxford University Press, New York, New York.

Leopold, A. S. 1959. Wildlife of Mexico: the game birds and mammals. University of California Press, Berkeley.

Lindsay, E. H., and N. T. Tessman. 1974. Cenozoic vertebrate localities and faunas in Arizona. Journal of the Arizona Academy of Science 9:3-24.

McBride, R. T. 1980. The Mexican wolf (*Canis lupus baileyi*): A historical review and observations on its status and distribution. U.S. Fish and Wildlife Service, Albuquerque, New Mexico, Endangered Species Report 8.

Mech, L. D. 1970. The wolf: the ecology and behavior of an endangered species. Natural History Press. Doubleday Publishing Company, New York, New York.

Nowak, R. M. 1995. Another look at wolf taxonomy. Pages 375-397 *in* L. N. Carbyn, S. H. Fritts, and D. R. Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Edmonton, Alberta, Occasional Publication 35.

Parsons, D. R. 1996. Case study: the Mexican wolf. Pages 101-123 *in* E. A. Herrera and L. F. Huenneke, editors. New Mexico's natural heritage: biological diversity in the Land of Enchantment. New Mexico Journal of Science 36:101-123.

Parsons, D. R., and J. E. Nicholopoulos. 1995. The status of the Mexican gray wolf. Pages 141-146 *in* L. N. Carbyn, S. H. Fritts, and D. R. Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Edmonton, Alberta, Occasional Publication 35.

Schoenecker, K. A., and W. W. Shaw. 1997. Attitudes toward a proposed reintroduction of Mexican gray wolves in Arizona. Human Dimensions of Wildlife 2:42-55.

Siminski, D. P. 1996. International studbook for the Mexican gray wolf (*Canis lupus baileyi*). Arizona-Sonora Desert Museum, Tucson, Arizona.

U.S. Fish and Wildlife Service. 1982. Mexican wolf recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 1987. Restoring America's wildlife 1937-1987: the first 50 years of the Federal Aid in Wildlife Restoration (Pitman-Robertson) Act. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

U.S. Fish and Wildlife Service. 1996. The reintroduction of the Mexican wolf within its historic range in the United States. Final Environmental Impact Statement. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

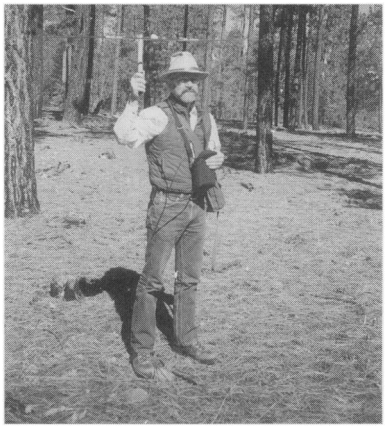
U.S. Fish and Wildlife Service. 1997. Notice of record of decision and statement of findings on the environmental impact statement on reintroduction of the Mexican gray wolf to its historic range in the southwestern United States. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 1998. 1998 Mexican wolf interagency management plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Wayne, R. K., N. Lehman, M. W. Allard, and R. L. Honeycutt. 1992. Mitochondrial DNA variability of the gray wolf: genetic consequences of population decline and habitat fragmentation. Conservation Biology 6:559-569.

Young, S. P., and E. A. Goldman. 1944. The wolves of North America. The American Wildlife Institute, Washington, D.C.

Young, S. P., and E. A. Goldman. 1946. The puma: mysterious American cat. Dover Publications, New York, New York.



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