Mexican Wolf Blue Range Reintroduction Project 5-Year Review:

Technical Component

by

Interagency Field Team

Arizona Game and Fish Department
New Mexico Department of Game and Fish
U.S.D.A. – APHIS, Wildlife Services
U.S.D.A. Forest Service
U.S. Fish and Wildlife Service
White Mountain Apache Tribe

December 31, 2005

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Note: see the Administrative Component for a list of abbreviations, acronyms, and terms.

INTRODUCTION

The Mexican wolf (*Canis lupus baileyi*) was relentlessly pursued in the wild and eventually extirpated from the southwestern United States, in large part because of conflicts with livestock (Bailey 1907, Young and Goldman 1944, Brown 1983, Robinson 2005). Many techniques were used to eradicate them, including trapping, shooting, and poisoning with strychnine, arsenic, or sodium cyanide (Young and Goldman 1944, Parsons 1996, Brown 1983, Robinson 2005). Federal government trappers reported taking more than 900 wolves in Arizona and New Mexico from 1915 to 1925 (Brown 1983). How many more were killed there but not reported is unknown. Wolf removal efforts in Mexico in the early to mid-1900s were not completely successful, in that some wolves survived at least until the 1980s (McBride 1980).

Little is known about the Mexican wolf's natural history prior to reintroduction to the Blue Range Wolf Recovery Area (BRWRA) in Arizona and New Mexico in 1998. The Mexican wolf is the most genetically distinct (Garcia-Moreno et al. 1996) and southern-most occurring gray wolf subspecies in North America (Nowak 1995 and 2003). One obvious difference between Mexican wolves and other gray wolves is their smaller size. Historic weights of wild Mexican wolves ranged from 25-49 kg (54-99 lbs) (Young and Goldman 1944, Leopold 1959, McBride 1980), versus 36-55 kg (80-120 lbs) in more northern animals (Mech 1970).

Prior to reintroduction of Mexican wolves, biologists suggested their primary prey had been white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*) (Brown 1983, Parsons 1998); however, data collected on Mexican wolves since their reintroduction indicates their current wildlife prey are primarily elk (*Cervus elaphus*) (Reed 2004[1]). The dichotomy between the two perspectives is at least partially attributable to nonparallel frames of reference: historically-based perspectives (e.g. Brown 1983 and Parsons 1998) reflect the fact that deer were the prevalent wild ungulates in Mexican wolf range as it was known prior to the late 1990s (southern AZ and NM south into Mexico, where elk were virtually absent); in contrast, elk are common to locally abundant (sometimes even more so than mule or white-tailed deer) in the BRWRA, where Mexican wolf reintroduction is occurring.

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[1] In Reed (2004), opportunistic scat collection occurred in BRWRA from 1998-2001, where radio-collared wolves were present. Scats were actively collected from June-August 2000 and March-October 2001 within BRWRA. Relative abundance of wild ungulate prey and livestock in areas of wolf occurrence and scat deposition was not determined. Seasonal and area differences (e.g. winter-summer and AZ-NM) and conservative identification of scats as wolf (i.e. scats >28 mm) may have biased the results toward larger ungulates commonly found in larger scats. Also, note that wolf scats collected by a permittee reporting livestock depredations in the study area during this time were not made available to Reed.

Historically, Mexican wolves were distributed across a significant portion of the southwestern United States and northern and central Mexico. This range included eastern and central Arizona, southern New Mexico, and west Texas (Brown 1983, Parsons 1996). In addition, recent genetics work that looked at historic wolf specimens collected in 1916 and earlier (Leonard et al. 2004) suggests that Mexican wolves intergraded with more northern races well into Colorado. Mexican wolves were extirpated in New Mexico around 1942 (Bednarz 1988). Fewer than 50 Mexican wolves still existed in Chihuahua and Durango, Mexico by 1980 (McBride 1980). Subsequent surveys in Mexico have not confirmed presence of wolves in the wild (Carrera 1994), and it is unlikely that a viable population exists (Parsons 1996).

Five wolves (4 males and 1 pregnant female) were live-trapped in Mexico between 1977 and 1980 to establish a captive population known as the “Certified” (Parsons 1998) or “McBride” lineage. Two other lineages, both from captive facilities in the United States and Mexico, were also certified for the captive breeding population in 1995 (Hedrick et al. 1997). The latter wolves were referred to as the “Aragon” and “Ghost Ranch” lineages. There were a total of seven founders of the Mexican wolf Certified captive population: three from McBride, two from Aragon, and two from Ghost Ranch.

The Mexican wolf was listed as endangered under provisions of the Endangered Species Act (ESA) in 1976 (Parsons 1998). The Mexican Wolf Recovery Team was formed in 1979 and the Mexican Wolf Recovery Plan was approved and signed by the United States and Mexico in September of 1982 (U.S. Fish and Wildlife Service [USFWS] 1982). The main objectives of the Recovery Plan were to maintain a captive population and to re-establish a viable, self-sustaining wild population of Mexican wolves. Following approval of a Final Environmental Impact Statement (FEIS; USFWS 1996), the Secretary of the Interior approved the reintroduction of Mexican wolves to establish a population of at least 100 wolves in the BRWRA of Arizona and New Mexico in March 1997 (USFWS 1998). The USFWS classified wolves reestablished in this area as a “nonessential experimental population” under section 10(j) of the ESA (USFWS 1998). In 2003, the USFWS reclassified the gray wolf in North America creating three Distinct Population Segments (USFWS 2003). Under this reclassification wolves occupying the Southwestern Distinct Population Segment (SWDPS) including the current BRWRA population, were listed as endangered and a recovery team was convened to develop a new recovery plan for the SWDPS. Recovery planning for the Mexican wolf was put on hold, however, in January 2005 when an Oregon U.S. District Court judge enjoined and vacated the 2003 gray wolf reclassification rule (USFWS 2003), which also abolished the SWDPS. In December 2005, the USFWS decided not to appeal the Oregon Court ruling. This decision re-opened the door for the USFWS, Region 2 to once again move forward with Mexican wolf recovery planning in the Southwest. Target deadlines for Recovery Plan development and completion will be identified once the Recovery Team resumes meeting. In the meantime, the Mexican wolf in the BRWRA will continue to be managed as part of a Nonessential Experimental Population for reintroduction purposes.

Mexican wolves were first reintroduced to the BRWRA in March 1998 when 11 animals were initial-released into the primary recovery zone (Parson 1998). Additional individuals and family groups of Mexican wolves have been released or translocated into various parts of the BRWRA each year through 2003. Interagency Field Team (IFT) members have monitored the reintroduced population for reproduction, food habits including livestock depredation, and other biological traits of Mexican wolves. Predictions in the FEIS estimated that by the sixth year of the reintroduction, the number of wolves in the wild would be about 55 (USFWS 1996). In 2003, the IFT estimated the Mexican wolf population in the BRWRA to be approximately 50 to 60 wolves, indicating population numbers were on track with FEIS (1996) predictions (Arizona Game and Fish Department [AGFD] 2004) in regards to this population parameter.

Herein, we: (1) provide a 5-Year Review of the Mexican wolf reintroduction pursuant to the Mexican wolf Final Rule (USFWS 1998), and (2) highlight additional analyses that provide valuable information to the current reintroduction effort. In addition, we identify home range and dispersal patterns; analyze release success; document reproduction, population growth, causes of mortality, survival and removal rates; assess prey numbers; investigate livestock depredation patterns, and classify human/wolf encounters in the BRWRA.

STUDY AREA / REINTRODUCTION AREA

The BRWRA includes all of the Apache and Gila National Forests (NF) in east-central Arizona and west-central New Mexico, encompassing 17,775 km^2 (6,845 mi^2) (USFWS 1996). In addition, the White Mountain Apache Tribe (WMAT) has developed a management plan for wolves that adds 6,475 km^2 (2,500 mi^2) for wolves to recolonize. Elevations ranged from <1,220 m (4,000 ft) in the semi-desert lowlands along the San Francisco River to 3,353 m (11,000 ft) on Mount Baldy, Escudilla Mountain, and the Mogollon Mountains (USFWS 1996). The BRWRA has four distinct seasons including autumn (Sep-Nov), winter (Dec-Feb), spring (Mar-May), and summer (Jun-Aug). The BRWRA has relatively mild weather with cool summers and moderate to cold winters over most of the higher elevations, and warm year-round temperatures in the lower elevations (USFWS 1996). Average temperatures ranged from 43 to 65 ^{o}F in the higher elevations and lower elevations, respectively (USFWS 1996). Yearly precipitation ranged from 30.5 cm (12 in) in the southern woodlands to 94.0 cm (37 in) in the mixed conifer forests (USFWS 1996). Snow typically occurred at higher elevations from December to March, however snow is also possible in the BRWRA as early as October and as late as June. Mixed conifer forests in the higher elevations and semi-desert grasslands in the lower elevations characterized the area, with ponderosa pine (*Pinus ponderosa*) forests dominating the area in between (USFWS 1996). Potential native prey of Mexican wolves included elk, white-tailed and mule deer, and to a lesser extent, pronghorn (*Antilocapra americana*), javelina (*Tayassu tajacu*), and Rocky Mountain bighorn sheep (*Ovis canadensis*) (Parsons 1996). Elk populations were estimated in the FEIS at 15,800 (3.7/km^2) (USFWS 1996). Both species of deer were estimated at 57,170 total (average density 13.36/ km^2) (USFWS 1996). Approximately 82,600 cattle and 7,000 sheep were permitted to graze roughly 69% of the BRWRA, and 50% of the allotments were grazed year-round when the Reintroduction Project began (USFWS 1996). The actual numbers of cattle and sheep varied each year relative to environmental factors, and were generally lower because of drought conditions (see also Section 3.2 of the Socioeconomic Component of the 5-Year Review). Other domestic animals in the BRWRA that wolves might encounter include cats, dogs, poultry, goats, horses, and mules. Other large predators in the

BRWRA included coyotes (*Canis latrans*), cougars (*Puma concolor*), and black bears (*Ursus americanus*) (USFWS 1996).

METHODS

All adult wolves released from captivity or trapped in the wild were radiocollared (models 400 and 500, Telonics, Inc., Mesa, Arizona). Wolves were radiotracked periodically from the ground (i.e. triangulation) and a minimum of once a week from the air (White and Garrot 1990). Location data (i.e. date, UTM location, wolf identification number, sex, age, number of wolves, behavior, and weather) were entered into the Reintroduction Project's database, along with reports for specific incidents (e.g. depredations, wolf/human conflicts, aversive conditioning, captures, mortalities, translocations, initial releases, predation). The cut-off date for data analysis for the Technical Component of the 5-Year Review was December 31, 2003. However, data from subsequent years (i.e. 2004 and 2005) were used when available and appropriate.

Home Ranges

Aerial locations of wolves were used to estimate home ranges (White and Garrott 1990). Annual home range polygons were based on locations from January through December each year that were evenly distributed across summer and winter seasons for wolves from a given pack (Mladenoff et al. 1995, Wydeven et al. 1995). Some packs maintained home ranges for several years; thus, we used each pack year as an independent home range sample. In order to maximize sample independence, only individual locations of radiomarked wolves that were spatially or temporally separated from other radiomarked pack members were used. This approach minimizes pseudoreplication (Garton et al. 2001) among locations.

Wolf home range size in some areas reaches an asymptote at around 30 locations. In such cases increasing the number of locations beyond this level has little effect in increasing estimated home range size (Carbyn 1983, Fuller and Snow 1988). Thus, we elected to use ≥30 locations per year as a threshold for analyzing home ranges. Alternatively, some authors have suggested that in recolonizing wolf populations, a larger number of locations (≥80) may be required for home range size to reach its asymptote (Fritts and Mech 1981). To account for this potential sampling bias, we used the fixed kernel (FK) method to estimate wolf home ranges due to its low bias when sample sizes are small (Kernohan et al. 2001). In contrast, previous wolf home range analyses have relied largely on the less stable and less accurate minimum convex polygon (MCP) method (e.g. Carbyn 1983, Fuller and Snow 1988, Burch 2001). Fixed kernel home ranges derived from smaller samples typically yield more accurate home range size estimates than estimates more dependent on increased sample size to develop accurate home ranges (Seaman et al. 1999, Powell 2000, Kernohan et al. 2001). Thus, we used a 95% FK approach to describe home range sizes due to its improved performance relative to other home range estimators.

Polygons were generated using the FK method (Worton 1989) at the 95% (home range use) and 50% probability levels (core use areas) (White and Garrott 1990), with least-squares cross-validation as the smoothing option in the animal movement extension in the program Arcview (Hooge et al. 1999; Environmental Systems Research Institute 2000). Home range polygons were only created for wolves that localized and established an exclusive use area. Home range sizes were compared with each other and with those in the literature (e.g. Fuller and Murray 1998, Fuller et al. 2003).

Releases and Translocations

We defined "initial releases" as wolves released directly from captivity, with no previous free-ranging experience, into the Primary Recovery Zone (Fig. 1). "Translocations" were defined as free-ranging wolves (either captive reared or wild born) captured in the wild and moved from one area to another. This included wolves temporarily (<24 hrs to 24 months) placed in captivity after being free-ranging. Candidate release wolves were acclimated prior to release in USFWS approved facilities, where contact between wolves and humans was minimized and carcasses of road-killed deer and elk supplemented their routine diet of processed canine food. Information on captive facilities, genetic lineages of Mexican wolves, and individual wolves chosen for release is discussed elsewhere by García-Moreno et al. (1996), Parsons (1996, 1998), Hedrick et al. (1997), and Brown and Parsons (2001).

Three initial release or translocation methodologies were employed: (1) hard releases in which a wolf or wolves were released directly from a crate to the wild (Fritts et al. 2001), (2) soft releases in which a wolf or wolves were held in a chain link enclosure for one to six months until acclimated to the area (Fritts et al. 2001), and (3) modified soft releases in which a wolf or wolves were held in a mesh enclosure until they self-released by tearing through the mesh after ≤1 day to 2 weeks of acclimation. We considered a successful initial release or translocation to be any wolf that ultimately bred and produced pups in the wild (breeding season data from 2004 for wolves released in 2003 was included in the analysis). We excluded wolves whose fate was unknown (e.g. uncollared released pups, or missing collared animals) from this analysis. We considered each time an animal was released to be an independent sample. The number of successful and unsuccessful-released wolves was compared using a chi-square analysis to limit the number of variables subsequently used in a logistic regression analysis (Hosmer and Lemeshow 2000). We used likelihood-based methods (i.e. ΔAIC_c and w_i) as a means to quantify the strength of models explaining release success patterns (Burnham and Anderson 1998). The dependent variable was a binomial (whether a release was successful or not), while independent variables included: (1) year of release, (2) type of release (i.e. initial release or translocation), (3) method of release, (4) season of release (autumn, winter, spring, and summer), (5) number of adults in the group, (6) if the group was released with pups or not, (7) status of the wolf (i.e. breeder, subadult, or pup), (8) sex, (9) age, (10) time spent in captivity, (11) time spent in wild, (12) proportion of wolf's life spent in the wild , (13) time spent in the acclimation pen, and (14) State (i.e. New Mexico or Arizona). Logistic regression provides poor confidence intervals when there are empty cells. Thus, models with overdispersed data were removed from further consideration (Hosmer and Lemeshow 2000).

Reproduction and Population Growth

Population estimates were determined through the use of howling surveys (Harrington and Mech 1982, Fuller and Sampson 1988), tracks, and visual observations during aerial and ground radiotelemetry (White and Garrot 1990). A "breeding pair" was defined as an adult male and adult female wolf that produced at least two pups during the previous breeding season that survived until December 31 of the year of their birth (USFWS 1998). "Pack" was defined as two or more wolves traveling together. Thus, minimum population estimates incorporated the total number of collared wolves, uncollared wolves, and pups, documented as close to December of the year of interest as possible. We attempted to maintain at least two radiocollared wolves in each pack within the BRWRA and investigated (i.e. looked for sign, howling surveys) reports in areas where packs were not known to exist.

Pups were born from early April to May within the wild population and were counted post-emergence from the den whenever opportunity allowed. Counts of pups, failed radiocollars, and uncollared wolves were based on the latest date in the year in which verification was available. This period for pups was prior to October because they become less distinguishable from uncollared subadult and adult wolves after that. The period following 28 weeks of age in a pup cycle is generally referred to as the slow growth rate (Mech 1970, Kreeger 2003). Although wolves continue to grow until 12 to 14 months of age, relatively little mass is gained by either sex from 28 to 51 weeks of age (Kreeger 2003). Further, pups tended to be closely associated with collared animals prior to October, at den or rendezvous sites. After October, pups occasionally disperse or travel separately from the breeding pair, either alone or with other uncollared members of the pack.

Finally, average pack size for free-ranging Mexican wolves, and average litter size for reproducing packs were calculated and compared with other gray wolf populations. In this case, litter size represented the earliest documented count of the pups in a given pack. These observations do not represent the number born in a given year as some mortality likely occurs before initial counts.

Mortality

Wolf mortalities were identified via telemetry and reports received from the public. We investigated mortality signals within 12 hours of detection to determine the status of the wolf. Carcasses were investigated by law enforcement agents and later necropsied to determine proximate cause of death. We summarized causes for all known deaths. For radiocollared wolves, we calculated mortality, missing, and removal rates using methods presented in Heisey and Fuller (1985).

We calculated overall cause-specific mortality rates (i.e. human-caused versus natural mortality), however, similar to other studies (e.g. Fritts and Mech 1981, Fuller 1989, Pletscher et al. 1997, Bangs et al. 1998), mortality was primarily human-caused. Thus, there was not enough consistent variability in cause of death to justify additional breakdown of mortality rates, or to warrant calculation of yearly cause-specific mortality rates. However, management removals may have an equivalent effect as mortality on the free-ranging population of Mexican wolves (see Paquet et al. 2001). Thus, we also calculated yearly cause-specific removal rates for radiocollared wolves because sufficient sample sizes existed for these classifications. Later in recovery, these removals may actually be deaths, as wolves will be increasingly removed through lethal control (Bangs et al. 1998). Wolves were removed from the population for four primary causes: (1) dispersal outside the BRWRA, (2) cattle depredations, (3) nuisance to humans, and (4) other (principally to pair with other wolves, or move to a better area without any of the other causes occurring first). Each time a wolf was moved to a new location was considered a removal, regardless of animal status later in the year (e.g. if the wolf was translocated or held in captivity). We calculated an overall failure rate of wolves in the wild by combining mortality, missing, and removal rates to represent the overall yearly rate of wolves that were affected (i.e. managed, dead, or missing) in a given year. Mortality, missing, and removal rates were then compared with predictions in the FEIS (USFWS 1996) and in other wolf populations (Fuller et al. 2003).

In addition, we developed single variable models using Cox's proportional hazards model (Cox and Oakes 1984) to identify possible important covariates that influenced wolf survival. We developed one model for mortality and one model for removals. The dependent variable was hazard rate (i.e. the mortality or removal rate), while independent variables included: (1) year, (2) status of the wolf (i.e. breeder, subadult, or pup), (3) sex, (4) age, (5) time spent in captivity, (6) time spent in the wild, (7) proportion of the wolf's life spent in the wild, and (8) state (i.e. New Mexico or Arizona).

We generated rates inside of 1:24,000 quadrangle maps to determine how mortality, missing, and removal rates varied across the landscape. Spatially explicit survival models needed for each quadrangle were based on: (1) aerial locations, (2) mortalities, (3) missing animals, and (4) removals. Time between aerial locations averaged 6.25 $\pm$ 5.75 (SD) days (n = 4,909). Thus, we calculated the number of radio days by multiplying the number of locations in a given quadrangle by 6.25 days. Quadrangles that contained <5 aerial locations or <30 radio days were areas where data were insufficient for full evaluation. We calculated monthly mortality, missing, and removal rates within a cell and considered monthly failure rates (see above) >3% (34% yearly) as a sink area. In this case, a sink area would be considered any quadrangle where mortality, missing, and removal create an area in which the growth rate of Mexican wolves is <1.0. We identified 34% yearly failure rate as the equivalent to a 1.0 growth rate in a regression equation developed from other wolf populations (Fuller 2003). Further, we identified quadrangles with monthly failure rates between 4 and 6% as weak sinks. We also identified the last location of wolves that disappeared, to examine the possibility that these wolves were killed in that area. In the scope of these analyses, we attempted to answer the following questions: (1) is wolf mortality substantially higher than projected in the FEIS, (2) have any sinks been identified, and (3) are any sources of mortality significantly higher than expected?

Dispersal

To evaluate the self-sustaining potential of the Mexican wolf population, we investigated dispersal and movement patterns of individual wolves on the landscape. Wolf dispersal was defined as the time when a wolf permanently left its' natal home range (Boyd and Pletscher 1999). To account for wolves that functioned as individual animals following release or translocation, we defined these as movements rather than classic dispersals. Distance and direction of travel, age and sex of the wolf, and result of the movement (i.e. the ultimate fate of the animal) were recorded for each event. We calculated travel distance and direction using Arcview (Environmental Systems Research Institute 2000), either between the central point of successive home ranges, or the distance and direction from the original home range or release site, to the point where individual wolves died or were captured. Movements were considered successful if the animal ultimately produced pups. The purpose of this analysis was to evaluate the effects of dispersal and movements on population growth within the BRWRA.

Predation

We opportunistically searched for wolf-killed and scavenged native ungulate carcasses throughout the year. After wolves abandoned a carcass, IFT members attempted to determine the proximate cause of death (Roy and Dorrance 1976, Fritts and Mech 1981, Mech et al. 1998, Mech et al. 2001). Kills were classified as confirmed, probable, or possible based upon standardized criteria (Roy and Dorrance 1976) and the preponderance of evidence. Only confirmed or probable kills were used for analysis purposes. Data on species, age (calf/fawn, or adult), sex, and amount consumed were recorded for each carcass. In addition, bone marrow and mandibles were collected as an indicator of overall health (i.e. percent fat) and for aging, respectively.

We also recorded the location of each kill relative to a specific state game management unit. Each kill was referenced to population estimates of deer and elk within each management unit and year in which the kill occurred. This represented prey availability. For Arizona, data on population estimates for individual management units were based upon deer and elk management summaries for 2003 (AGFD unpublished data). In New Mexico, we used the most recent aerial population survey relative to when the predation event occurred (New Mexico Department of Game and Fish [NMDGF] unpublished data). Thus, each kill had a specific reference to the population of elk and deer, and the male: female, and female: calf or fawn ratios. Ungulate estimates were then averaged across all years and game management units to represent available prey. We then compared documented wolf kills to the available prey estimate (AGFD unpublished data, and NMDGF unpublished data) and ratios using chi-square analysis (Sokal and Rohlf 1981). The available ungulate estimates differed between states (i.e. methods and accuracy). However, we believe the data were sufficient to give relative proportions of deer versus elk, male: female, and female: calf or fawn ratios for comparisons with wolf kills. We did not extend the data to suggest what the estimated numbers of elk or deer were within the BRWRA.

We located select packs from fixed-wing aircraft daily during a one month period (March 2003) to determine the feasibility of a winter study to document kill rates (Peterson 1977; Ballard et al. 1987, 1997; Mech et al. 2001; Smith et al. 2004). Ground tracking was done on days we were unable to fly. Kills discovered during this study were included in analyses. Except for this pilot study, we expected data collected on ungulate kills would be biased toward larger ungulates (e.g. large elk are more likely to be discovered than elk calves or deer). Thus, selection patterns were only valid if selection occurred for smaller animals, or alternatively against larger animals.

Prey density estimates were not available for the entire BRWRA; therefore, we were unable to use this parameter to estimate the number of wolves the BRWRA could support (Keith 1983, Fuller 1989). However, we compared the mass change during repetitive examinations of captive adult (≥2 years) Mexican wolves with the mass gain or loss in repetitive captures of wild adult Mexican wolves to evaluate the ability of wild wolves to find or kill enough food to maintain their mass. The hypothesis that mass gain or loss was equivalent between wild and captive wolves was tested with a two-sample t-test. Starvation in adults is indicative of food limitation (e.g. prey availability or inability of a wolf to capture adequate prey such as might occur when a "naive" wolf is initially-released) in wild wolf populations (Fritts and Mech 1981, Ballard et al. 1997). Thus, any significant deviation from 0 weight loss between captures would indicate food limitation.

Depredations

Personnel from the U.S.D.A.-APHIS Wildlife Services (WS), or other members of the IFT if WS personnel were unavailable, examined dead or injured cattle, sheep, horses, and dogs to determine cause of death. Domestic animal depredations were classified as confirmed, probable, or possible wolf kills, non-wolf, or unknown, in adherence with standardized criteria (Roy and Dorrance 1976, Fritts 1982). We compared depredations with projections in the FEIS and other population of wolves (Bangs et al. 1998, USFWS et al. 2003). These comparisons were normalized to represent the number of wolf-caused mortalities relative to 100 wolves within the population.

The effectiveness of the wolf depredation investigation program (i.e. livestock and other domestic animals) was evaluated based on: (1) response time from reported to arrival of personnel, (2) number of documented confirmed or probable livestock kills compared with that predicted in the FEIS (USFWS 1996), (3) trend in confirmed depredations per 100 wolves, (4) number of wolves removed per livestock depredation, and (5) recurrence of depredations by wolves translocated due to previous depredations. We considered a response time of <24 hours, documented confirmed or probable kills less than or equal to estimates identified in the FEIS (1996), and a decreased or stable trend per 100 wolves as a sign of an effective depredation program. Although, we recognize that not all livestock kills from wolves or other causes are documented (Fritts 1982, Bangs et al. 1998, Oakleaf et al. 2003), the most valid analysis must be based on the best available data, which currently are depredation investigations, versus unknown livestock loss figures. However, Project personnel and ranchers spent a considerable amount of time monitoring wolves and/or livestock, looking for possible depredations. Further, biases (i.e. not all livestock kills are found) should be similar to other areas in the United States, making comparisons between Mexican wolves and other wolf populations reasonable.

Human/Wolf Interactions

We summarized human-wolf encounters based on categories described by McNay (2002). Three categories applied to Mexican wolves: investigative search, investigative approach, and aggressive charge. We considered wolf behavior an investigative search when the wolf ignored humans or human activity. An investigative approach described wolves that moved toward people in an inquisitive, non-threatening manner. In an aggressive charge, wolves moved toward people rapidly. Because every documented aggressive charge by a Mexican wolf occurred when a dog was present, we did not feel that any of the other terms used by McNay (2002) were appropriate (e.g. agonism, predation, prey testing, self-defense, and rabies). Encounters triggered by a dog were considered provoked, while other cases were considered non-provoked (McNay 2002). We also identified whether the interaction was related to food conditioning (i.e. associating food with people). Further, we identified wolves that appeared habituated (i.e. close proximity to humans and habitations with an apparent lack of fear or concern for human presence) to people (Appendix I).

We also identified cases where aversive conditioning (e.g. hazing with cracker shells or rubber bullets, translocations) was applied. We determined what proportion of the wolves was removed for nuisance behavior and the general trend of wolf/human interactions.

Genetics

All animals released to the wild in the BRWRA were genetically redundant to the captive Mexican wolf population. Data from microsatellite analysis show that all three lineages (i.e. McBride, Ghost Ranch, and Aragon) can definitively be differentiated from northern gray wolves, coyotes, and dogs (Hedrick et al. 1997). Prior to releasing Mexican wolves from captivity, we pulled blood from each animal for genetic analysis and storage at the National Forensics Laboratory in Ashland, Oregon. In addition, we pulled blood from every wild wolf captured to determine if it was a pure Mexican wolf. This allowed us to determine the parentage and pack affiliation of each animal. This also allowed us to monitor for possible introgression of coyote, dog, or wolf-dog hybrid genes into the Mexican wolf population. Finally, blood was also collected and banked from any non-target canids (i.e. feral dogs, coyotes, wolf-dog hybrids) that were captured in order to monitor for possible introgression of Mexican wolf genes into coyote or dog populations.

RESULTS

Home Ranges

Home ranges (95% FK probability contour) were determined for 19 packs totaling 39 pack years (Fig. 2) and averaged 462 ± 63 km^2 (SE) (182 ± 24 mi^2). Core use areas (50% FK probability contour) averaged 59 ± 9 km^2 (23 ± 4 mi^2). During a pack's first year of home range establishment, their home range (log transformed to normalize) was smaller than packs which had been in the wild greater than one year or for packs that formed naturally in the wild (t = 3.310, P = 0.002, n = 39; and t = 2.610, P = 0.013, n = 39 for home ranges and core use areas, respectively). Home ranges were primarily contained within the BRWRA (partly as a function of the Final Rule (Fig. 1). However, 28% (n = 11 out of 39) of pack annual home ranges had at least small portions (approximately 20%) outside of the reintroduction boundary (Fig. 2). The total area occupied by established wolf packs has continued to increase during each successive year of the Project, primarily due to an increase in the number of colonizing packs (Table 1).

Releases

Ninety wolves were released 130 separate times including 51 translocations (n = 11 translocated wolves were wild born), and 79 initial releases from captivity. Overall, wolves were successful (i.e. produced pups in the wild) 26% of known fate releases (i.e. dead, produced pups in the wild, or removed). Success was 18% for known-fate animals initial-released from captivity (n = 60), while known-fate translocated wolves (n = 46) were twice as successful (37%; χ^2 = 4.646, P = 0.031, df = 1). Wolves released in New Mexico (translocations; 47% success) were more successful than those released in Arizona (initial releases and translocations; 22%; n = 106, χ^2 = 5.229, P = 0.022, df = 1). Not surprisingly, adult wolves were more successful (38% success), than subadults (16%) or pups (10%; n = 106, χ^2 = 7.767, P = 0.021, df = 2).

Temporal effects also influenced release success, with 2002 (67% success) the best year for releases, followed by 2000, 2003, 1998, 1999, and 2001 (32, 29, 13, 12.5, and 11%, respectively [n = 106, χ^2 = 15.486, P = 0.008, df = 5]). Fall (75% success) and summer (35% success) were more successful periods for release than winter (22%) or spring (18%; n = 106, χ^2 = 8.221, P = 0.042, df = 3). Further, successful releases consisted of wolves that spent a greater proportion of their lives in the wild prior to release (0.236 ± 0.323 [SD]; unsuccessful released wolves 0.117 ± 0.214; n = 106, t = -2.186, P = 0.031), and a greater number of months in the wild (6.679 ± 8.474 [SD] months; and unsuccessful released wolves 3.088 ± 6.2225; n = 106, t = -2.369 P = 0.020). Successful wolves were older at the time of release (3.111 ± 1.765 years) than unsuccessful animals (2.217 ± 1.739, n = 106, t = -2.35, P = 0.022). Similarly, successful wolves spent more time in captivity (2.731 ± 1.660 years) relative to unsuccessful (1.991 ± 1.706, n = 106, t = -2.35, P = 0.022). However, the last result is likely because years in captivity and age were highly correlated (r = 0.956) and age was believed to be an overriding influence. All other significant variables were not highly correlated (r < 0.70), and thus only years in captivity was removed from the model-building process. All other variables had no significant effect on the successful release of Mexican wolves and were excluded from the model-building process (all P > 0.10).

Logistic regression analysis determined the top candidate model included status of the wolf, the proportion of the released wolf's life spent in the wild, and year of release as dependent variables (Table 2). There was also support for models with state, season of release, and age dependent variables (Table 2). The top candidate model described the data (R^2 = 0.223), and predicted unsuccessful released animals well (specificity = 0.804). However, the model did not predict successfully released animals as well (sensitivity = 0.454).

Reproduction and Population Growth

We estimated the Mexican wolf population within the BRWRA grew from 4 in 1998 to 55 in 2003 (Table 3). Initially (1998-2001), this growth came primarily through reintroductions. From 2002-2003, reproduction has been the primary factor influencing growth (Table 3). At the end of 2003, 25 radiocollared wolves were free-ranging within the BRWRA. There were also approximately 12 uncollared subadult wolves and ≥20 pups documented by the end of September (Table 3). During 2003, the population consisted of 13 packs (i.e. two or more wolves traveling together), and five lone collared wolves. In 2003, seven packs (i.e. Hawks Nest, Cienega, Saddle, Bluestem, Bonito Creek, Gapiwi, and Luna) produced wild conceived and wild born litters. The number of uncollared subadults observed during a given year generally tracked the number of pups observed the previous year (e.g. the total number of pups in the wild prior to 2003 was 37, while the sum of subadults observed was 22 [Table 3]). This trend indicated that a large proportion of pups that survived until late October were likely to survive late into the following year.

The number of breeding pairs (e.g. n = 4 versus 10 in 2003) and pups produced (e.g. n = 20 versus 40 in 2003) were below the level predicted in the FEIS (Figs. 3a-3b; USFWS 1996), while the number of released, removed, and population estimates were generally at or above predicted levels (Figs. 3c-3e; USFWS 1996).

Compared with other reintroduced or recolonizing wolf populations in the United States, the rate of Mexican wolf population growth was intermediate (Fig. 4a). Similarly, the number of Mexican wolf breeding pairs lay between other expanding wolf populations (Fig. 4b). Average litter size for wild conceived and wild born pups was 2.1 pups/litter (n = 16, range 1-5); far less than the average litter size of 4.2 -6.9 observed elsewhere (Fuller et al. 2003). The average number of wolves per pack (packs that had been in the wild for at least one year) was 4.8 (n = 16, range 2-11) based on autumn estimates.

Mortality

Causes of death for Mexican wolves in the wild from 1998-2003 were largely human-related (i.e. vehicle collision [8], illegal gunshot [19], self defense [1], lethal control [1], and capture complications [1]). Other causes of death included (one each) death by dehydration, brain tumor, infection, cougar attack, and unknown. Three of the preceding deaths were documented from uncollared wolves. An adult male from the Lupine Pack was bitten by a rattlesnake. As a consequence of the bite, his neck became swollen, which likely led to asphyxiation from the radiocollar. Canine bite marks on his head were likely caused by other pack members reacting to his aberrant behavior. In addition, 5 pups died (i.e. three parvovirus, two distemper) in a captive facility following capture and removal from the wild. Out of 31 radiocollared wolves that were classified as mortalities from 1998-2003 (Table 4), 26 were human-caused, four were natural mortalities, and one was unknown cause of death. This resulted in an overall mortality rate of 0.21 (Table 4) and rates of 0.18 and 0.03 for human-caused and natural mortalities, respectively.

Loss rates (i.e. mortality and missing wolves) were predicted at 25% in the FEIS (USFWS 1996). We added mortality and missing rates to compare with this prediction, resulting in a 25% overall loss rate (Table 4). Loss rates were below the 25% level during three years (i.e. 1999, 2000, and 2002). Although loss rates were similar to the 25% loss rate predicted within the FEIS, removal rates were higher than the 10% removal rate predicted within the FEIS (Table 4; USFWS 1996). Thus, the overall mortality/removal rate was also much higher than that predicted in the FEIS (Table 4; USFWS 1996). However, the FEIS also anticipated that 5 of the 15 wolves released each year (1998-2002) were expected to die or be removed relatively quickly and did not incorporate these removals/deaths into the overall estimate. By including these 5 removals in the overall removal rate (as we did in Fig. 3d), the overall annual removal rate was 22%. Thus, for comparison with our data (we included data on removal and survival regardless of the timing of the event relative to releases), the removal/mortality level predicted in the FEIS was 47% (USFWS 1996). The removal/mortality level observed in the wolf population was higher (64%) than that predicted by the FEIS (Table 4; USFWS 1996).

The greatest single cause of removal was wolves moving outside the recovery area (Fig. 1, Table 5). Further, this is the only removal cause that did not decrease over time (Table 5). Predictably, nuisance and other removals (e.g. generally to pair with a new mate) decreased over time (Table 5).

Cox's proportional hazard models (Cox and Oakes 1984) (*n* = 185 observations, 33 failures, and 33,415 radio days) identified three variables that may be important in predicting which wolves become mortalities: year, months in the wild, and proportion of the wolf's life spent in the wild. Year differences were a result of high mortality during 1998. All other years appeared similar and reduced the hazard rate relative to 1998 (1999: 0.237, -1.71, 0.087, 0.046-1.230 [hazard ratio, *z*, *P*, 95% confidence ratio]; 2000: 0.268, -1.95, 0.051, 0.071-1.005; 2001: 0.285, -2.11, 0.035, 0.089-0.914; 2002: 0.116, -2.89, 0.004, 0.027-0.500; 2003: 0.352, -1.86, 0.062, 0.118-1.05). The greater amount of time spent in the wild (0.964, -1.76, 0.078, 0.926-1.004 [hazard ratio, *z*, *P*, 95% confidence ratio]) and the greater proportion of a wolf's life spent in the wild (0.301, -1.87, 0.061, 0.086-1.057) also reduced the hazard rate in univariate model building analysis. All other variables did not affect the hazard rate (all $P > 0.15$).

Similarly, Cox's proportional hazard models (Cox and Oakes 1984) (*n* = 185 observations, 58 failures, and 33,415 radio days) identified the same three variables that may be important in predicting which wolves succumb to removal. Year differences were a result of high removal during 1998, 1999, and 2000. Thus, the hazard rates relative to 1998 were: (1) 1999: 0.714, -0.58, 0.561, 0.230-2.222 [hazard ratio, *z*, *P*, 95% confidence ratio]; (2) 2000: 1.197, 0.38, 0.702, 0.477-3.004; (3) 2001: 0.398, -1.73, 0.084, 0.140-1.131; (4) 2002: 0.307, -2.11, 0.035, 0.102-0.919; (5) 2003: 0.409, -1.74, 0.081, 0.150-1.117). The greater amount of time in the wild (0.962, -2.41, 0.016, 0.933-0.993 [hazard ratio, *z*, *P*, 95% confidence ratio]) and the greater proportion of a wolf's life spent in the wild (0.478, -1.70, 0.089, 0.205-1.118) also reduced the hazard rate in univariate model building analysis. All other variables did not affect the hazard rate (All $P > 0.24$).

Depicting survival rates across the landscape ultimately produced a checkered pattern of source-sink areas within and outside the reintroduction boundary (Fig. 5). A total of 218 1:24,000 quadrangles (quads) contained a minimum of one aerial location from 1998-2003. The majority (77%, *n* = 168) of these quads were sources, however, 65% (*n* = 109) of these source quads were based on data insufficient for full evaluation (radio days <30). The remainder of quads (*n* = 50) were considered sinks due to various causes (Fig. 5). However, a proportion of sink quads were also based on data insufficient for full evaluation (*n* = 22).

Dispersal

Collared wolves (*n* = 45) functioned in the wild as individual wolves either immediately following release (*n* = 32) or through natural dispersal (*n* = 13). Only 8 (5 following release and 3 natural dispersal) of these animals were ultimately successful (i.e. bred and produced pups in the wild). The majority of single wolves (60%) died (*n* = 12), or were removed for being outside the boundary (*n* = 15). Other fates of single wolves included removal for nuisance (*n* = 5) and cattle depredations (*n* = 1), wolves still alive but had not bred (*n* = 2), and missing wolves (*n* = 2). Three of the successful dispersing animals were ultimately removed. The majority of single wolves (68%) were outside the boundary for at least one location (*n* = 31 out of 45), even if they were not necessarily removed for this cause. Movement distances were similar between natural dispersal and movements following release ($t = 1.211$, $P = 0.233$), thus these two groups were pooled to analyze movements. Movement distances for lone wolves averaged 87 ± 10 km (54 ± 6 mi). Movement distances were similar between male and female wolves ($t = -0.951$, $P = 0.347$, $n = 44$). Neither sex was more prone to display lone movements relative to the released population ($\chi^2 = 0.207$, $P = 0.649$, $df = 1$). Wolves primarily dispersed in a northwest or southeast direction (51%), which was the same direction as the mountain ranges in the BRWRA (Fig. 6). Not surprisingly, yearlings were more prone to disperse than adults relative to the released population ($\chi^2 = 8.391$, $P = 0.004$, $df = 1$).

Predation

From 1998-2003, the IFT documented 72 confirmed or probable native ungulate kills made by wolves. In addition, wolves were documented to feed or scavenge on 28 native ungulates killed by other predators, hunters, vehicles, or natural causes. Of the 72 confirmed or probable kills, 90% (*n* = 65) were elk, indicating a strong preference for elk relative to ungulate species available (32% elk, and 68% deer [$\chi^2 = 116.192$, $P < 0.001$, $df = 1$]). Mexican wolves also killed mule deer (*n* = 4), white-tailed deer (*n* = 1), and bighorn sheep (*n* = 2). However, it was unknown if this preference for elk was simply a function of prey size (e.g. larger elk being easier for the IFT to find than deer due to consumption rates), or alternatively a 'true' selection. Further, areas used by wolves appeared to be in high-density elk areas on a state game management unit scale. Prey availabilities on a local scale were not available.

Wolves selected for calf elk within the population (39% and 23% of kills and population, respectively), and selected against cow elk (47% and 60% of kills and population, respectively), while bulls were selected similar to availability (14% and 17% of kills and population, respectively; $\chi^2 = 5.098$, $P = 0.078$, $df = 2$). This trend would likely be more significant if systematic locations of ungulate kills were more prevalent during the study because wolves appear to be selecting for smaller prey (e.g. calves that are presumably harder to locate) and against larger prey (e.g. cow elk). The preference for elk relative to deer was supported by a recent scat study (Reed 2004).

Adult wolves lost mass between subsequent captures in the wild ($\bar{x} = -1.025$ kg [-2.260 lbs], $n = 40$). This pattern was significantly different from the pattern observed in captivity where wolves gained weight ($\bar{x} = 0.519$ kg [1.146 lbs], $t = -2.647$, $P = 0.009$, $n = 139$). However, weight loss between captures of wild wolves was not significantly different from 0 ($t = -1.705$, $P = 0.096$, $n = 40$). Both of these results were influenced by two wolves (M190, F189) from the same pack that lost 15.9 kg (35 lbs) and 8.39 kg (18.5 lbs) soon after release. After removal of these outliers, the difference between wild and captive wolves weight change was not significant (t = -1.599, P = 0.112, n = 129). Further, when these two wolves were removed from the sample the difference from 0 for weight loss of wild wolves was further obscured (t = -0.994, P = 0.327, n = 38).

Depredations

There were 89 reported incidents within the WS database between 1998 and 2003. Average response time to investigate complaints was 23 hours (12 hrs min, 120 hrs max). Cattle killed (i.e. confirmed, probable, possible) by wolves from 1998-2003, consisted of one bull, 12 cows, and 24 calves (Table 6). Also, 6 dogs, 4 horses, and 5 cattle were confirmed injured by wolves, and 3 additional cattle possibly injured by wolves. Twenty two wolves were removed or translocated as a result of livestock depredations. Thus, 1 wolf was removed for every 1.18 confirmed depredations.

WS personnel also investigated livestock kills not related to wolf depredation. These included nine accidents, six feral dogs, three black bears, five coyotes, one domestic hybrid wolf, two cougars, and one unknown causes not related to wolves. Depredation rates (per 100 wolves) on cattle varied from year to year, but were always within the 1-34 range predicted in the FEIS (Table 7; USFWS 1996). There was no clear trend in the data, but 2003 had one of the lowest depredation rates observed during the six years (Table 7). Five of 18 wolves translocated following depredations (not necessarily removed for depredations, but had previously depredated) ultimately depredated again before the end of 2003. In contrast, 39 of 83 (47%; released and radiocollared in the wild and never translocated) wolves caused at least one confirmed depredation (injury or kill). Further, 9 of 17 known-fate wolves (53%) translocated following depredations ultimately bred and reproduced in the wild. This rate exceeded the overall release success of 26%, as well as translocation success rate (37%).

Human/Wolf Interactions

We documented wolves displaying limited fear of humans on 33 occasions. The majority of these were considered investigative searches (64%) in which wolves did not approach people, but simply ignored their presence (Appendix I). Most other cases were considered investigative approaches (27%) where the wolf approached a human in a non-threatening manner. Three charge incidents (9%) occurred where wolves were more aggressive. In all of the charge incidents and most of the investigative approaches (5 out of 9), dogs were involved, and these cases were considered provoked. Similarly, most of the investigative search cases involved dogs (12 of 21) and were considered provoked. Of the 12 non-provoked incidents where wolves displayed a lack of fear of humans, six involved wolves or a wolf considered habituated (Appendix I). One involved a carcass hanging in a deer camp that the wolves fed on, and another was an unknown large canid (a wolf or large dog). Two other incidents involved people encountering wolves while riding horses, followed by a brief interaction.

Overall, nine wolves were removed due to human nuisance behavior on 11 occasions. Human-nuisance removal rates declined after 2000 (Table 5). Further, 23 of the 33 known wolf incidents occurred within three months of initial release or translocation of the animal, including all of the aggressive charges, and all of the non-provoked cases. Of the remaining nine cases, seven involved domestic dogs, one was unknown if dogs were present, and two were the result of unverified wolf reports.

In 20 of the 33 cases, aversive conditioning and/or removal was applied in an attempt to prevent recurrence of the behavior. On several occasions ($n = 6$) aversive conditioning may have contributed to the ultimate success of the wolves with minimal future problems (See Appendix I).

Genetics

Two Mexican wolf hybrid litters totaling 13 pups ($n = 7$ and $n = 6$) have been confirmed since the onset of reintroduction. Both litters resulted from a female Mexican wolf breeding with a male dog. The first wolf (628) was born in the wild and the second (613) was born in captivity. The first incident occurred in 2002 and involved 628 which had been traveling with a male wolf. The second incident occurred in 2005 (although this incident occurred outside the scope of the 5-Year Review, it is included because of its relevance to the discussion) and involved lone 613 which bred with a feral dog. Both hybrid litters were promptly discovered while the pups were still den-bound and were humanely euthanized. Genetic testing verified hybridization had occurred in both litters.

DISCUSSION

Home Ranges

Wolf home range size differences 1across their geographic range appear to be principally related to prey abundance or biomass (Keith 1983, Fuller 1989, Fuller et al. 1992, Fuller et al. 2003). Specifically, home range size and area/wolf likely relate to the amount of vulnerable prey biomass available to wolves, and thus are also possibly related to prey species (Fuller et al. 2003). Eighteen Mexican wolf packs established territories between 1998 and 2003, totaling 39 pack years, and averaging 462 ± 63 km^2 (SE), or 182 ± 24 mi^2. The average home range size of Mexican wolves most closely resembled moose (*Alces alces*) dependent gray wolf packs studied in the north (see table 6.3 in Fuller et al. 2003, and table 1 in Fuller and Murray 1998). However, home range size was smaller than that of other reintroduced populations that principally preyed on elk in central Idaho, and the Greater Yellowstone Area (Oakleaf 2002). The large territories in these areas and in the Mexican wolf population may reflect wolf populations that are not subject to density-dependent constraints, or alternatively a general pattern for wolf packs relying primarily on elk (Oakleaf 2002). Further, the spatial distribution of elk may require wolves to maintain a larger home range to encompass sufficient summer and winter ranges of elk. More importantly, however, Mexican wolves have successfully established and maintained home ranges, regardless of size, within the BRWRA.

Releases

Release success was limited with our population (26% success), particularly for wolves released directly from captivity (18%). These success rates were similar for red wolves (*Canis rufus*) (21%; Phillips et al. 2003), but less than those for gray wolves in Idaho (68%) and Yellowstone (77%; Fritts et al. 2001). Similar to Fritts et al. (2001) and Phillips et al. (2003), release success did not depend on the type of release (i.e. hard release, soft release, or modified soft release). However, similar to other studies, hard releases tended to produce more movement and less pack cohesiveness relative to soft release strategies (Bangs et al. 1998, Fritts et al. 2001).

Our model-building efforts identified 3 primary variables that predicted successful and unsuccessful release efforts: (1) status of the animal (breeder, subadult, or pup), (2) proportion of the released wolf's life spent in the wild, and (3) year of the release). Red wolves also had reduced success among pups released (Phillips et al. 2003).

Perhaps most importantly, the proportion of the wolf's life spent in the wild influenced success, with wolves with a greater proportion of time in the wild being more likely to survive and reproduce. Again, this result was similar to that observed in red wolves (Phillips et al. 2003). This result likely also influenced the increased success of translocated wolves relative to initial released wolves, and the increased success of wolves released in New Mexico (only translocated animals) relative to Arizona (translocated and initial released wolves). This variable might also relate to the increased success of released wolves in Yellowstone and Idaho relative to red wolves and Mexican wolves. Other variables not modeled that might relate to the increased success of wolves in Yellowstone and Idaho include differences in cattle numbers and grazing patterns, road density, and the lack of a boundary rule. Because all wolves released in Yellowstone and Idaho were captured in the wild in Canada (Bangs and Fritts 1996, Bangs et al. 1998, Fritts et al. 2001), it was likely that these latter wolves were more adept initially to adaptation in the wild. Brown (1983) suggested use of captive stock is the biggest impediment to successful Mexican wolf reintroduction, and that wild wolves from Yellowstone or Canada would be more successful in Arizona and New Mexico. However, we agree with Phillips et al. (2003) that captive wolves can contribute to establishment of a viable wild population, and as such are an appropriate source stock to reestablish wolf populations. In regard to the Mexican wolf, there is no other option; all known extant animals are of captive origin.

Reproduction and Population Growth

Population growth within the BRWRA more closely resembled patterns observed in northwestern Montana and Wisconsin than those observed in the released population in Idaho and Yellowstone. Mexican wolf pack sizes averaged 4.8 wolves, which was less than populations in other areas of North America that principally preyed on deer (5.6 wolves/pack), elk (10.2 wolves/pack), moose (6.5 wolves/pack), and caribou (*Rangifer tarandus*) (9.05 wolves/pack [see table 6.1 in Fuller et al. 2003]). Similarly, litter size was small for Mexican wolves, averaging 2.1 pups/litter, relative to other populations of gray wolves (see table 6.4 in Fuller et al. 2003). However, litter size was similar to the 2.8 pups/litter observed in red wolf populations (Phillips et al. 2003, calculated from Table 11.4).

Several competing hypotheses can be developed from these data. First, there is a strong correlation between litter size and ungulate biomass available for wolves (Fuller et al. 2003). Thus, one hypothesis is that wolves in the BRWRA may be limited by the amount of vulnerable prey. Generally, winter snow is ephemeral in the BRWRA, and elk can escape snow pack by changing elevations (USFWS 1996). Other areas where wolves have been studied are much further north where snow is more consistent and deeper across the range, and thus may have more profound effects on prey vulnerability to wolf predation (Nelson and Mech 1986, Mech and Peterson 2003, Smith et al. 2004). Thus, one would predict less vulnerable prey in winter for wolves simply as a result of weather differences between the BRWRA and other areas in North America where wolves have been studied. However, based on ungulate biomass indexes, Paquet et al. (2001) found that the BRWRA could support about 213 wolves, based solely on elk populations, and in theory up to 468 wolves, based on all ungulates. Thus, it would appear there are enough ungulates available to support more wolves than currently exist. However, it is not just prey numbers that wolves respond to, but rather vulnerable prey biomass (Packard and Mech 1980, Fuller et al. 2003).

A second hypothesis is that pack size and pup production are a result of historical adaptation within the environment. For example, Bednarz (1988) suggested Mexican wolves historically occurred in small family groups of 2-8 individuals. However, McBride (1980) reported mean litter size of 4.5 pups and a mean litter size before parturition of 6.8 pups. Further, the captive population of Mexican wolves has a mean litter size of 4.6 pups (Siminski 2003). Also, female Mexican wolves captured in the wild and returned to captivity while pregnant or shortly after whelping had a mean litter size of 4.6 ($n = 6$). Thus, it is likely that more pups are born than are observed in the wild.

The final hypothesis is that wolves released from captivity may be initially less capable of exploiting vulnerable prey, and thus have fewer surviving pups when counts are conducted. This is illustrated by the fact that Mexican wolf and red wolf populations (Phillips et al. 2003) appear to have relatively low litter sizes in the wild. In theory, we would expect to be able to test this hypothesis in the future as more wild born wolves pair and produce pups. Further, frequent management (see below) of these populations may influence the ability of these wolves to fully exploit their home range. Indeed, the two Mexican wolf packs that produced the greatest number of pups in the wild ($n = 5$) were within their respective territories for approximately 3 years prior to achieving this litter size. Data should be collected to evaluate all three hypotheses, especially the first, because of lack of information addressing these issues.

These competing hypotheses, however, do not change the overriding fact that Mexican wolves have successfully reproduced in the wild within the BRWRA. Further, the wild population of Mexican wolves has continued to increase as a result of releases, translocations, and, more recently, natural reproduction in a fashion consistent with predictions in the FEIS (USFWS 1996).

Mortality

Mortality rates of Mexican wolves were among the lowest observed relative to other wolf populations across North America (Fuller et al. 2003). However, the level of mortality that eventually leads to a declining population is likely related to the level of reproduction in the population, and whether breeding wolves are killed (Fuller 1989; Ballard et al. 1987 and 1997; Fuller et al. 2003). We found low levels of reproduction, and no differential mortality rates among age or status classes. In other words, the Mexican wolf population may still decline at lower mortality rates relative to other, more fecund, wolf populations. Further, this population is essentially a closed population with presumably no opportunity for recovery via immigration except for additional releases from captivity. Nevertheless, loss rates observed in the wild were similar to levels identified in the FEIS (USFWS 1996), and the population is increasing.

The absolute number of removals and removal rates were above levels identified in the FEIS (USFWS 1996). Further, removal rates were consistently higher than mortality rates. Thus, the dominant factor influencing an individual wolfs' persistence on the landscape was not mortality, but rather removal. Some forms of removal (e.g. those caused by livestock depredations) will likely remain near current levels or vary yearly with environmental factors (Bangs et al. 1998, Mech et al. 1988), as they are a necessary part of any successful wolf-recovery program. Nuisance-related removals are declining, and likely will continue to decline as initial releases from captivity are reduced in the BRWRA (see below). Similarly, other removals (e.g. removals to pair animals, or move wolves to better locations) have dropped since the first few years of the Project, with no such removals in the last two years. Despite some removal rates dropping following the recommendations of the 3-Year Review (Paquet et al. 2001), the elevated trend in boundary-related removals (36% of all removals) remains a concern.

We agree with Paquet et al. (2001) and Phillips et al. (2003) that removal of wolves for no other cause than being outside the BRWRA: 1) increases the cost of the overall recovery program and requires that field personnel be increasingly allocated to trap individual wide-ranging wolves, 2) fosters the erroneous perception that all wolves can be contained within artificial boundaries, 3) is in direct conflict with management philosophies employed by the USFWS on other projects (USFWS 1994a, 1995), 4) excludes habitat that could enhance recovery efforts, and 5) artificially restricts natural dispersal. Dispersal behavior is vital to establishing long-term population viability through colonization of new areas (Boyd and Pletscher 1999, see below).

Cox-proportional-hazard models (Cox and Oakes 1984) identified three covariates (year, proportion of the individual wolf's life spent in the wild and absolute number of months spent in the wild) that were potentially important in reducing wolf mortality and removal rates. Two covariates (i.e. year and proportion of the individual wolf's life spent in the wild) were also retained in the release success model discussed above.

Source and sink habitat was distributed inside and outside the BRWRA. Many cases of suspect data occurred within individual 1:24,000 quadrangle areas due to the random distribution of wolf locations and therefore the number of radio days per cell was similarly uncertain. The number of suspect data cells may suggest that either: 1) we analyze the data using a larger grid size (e.g.

1:100,000 quadrangles), or 2) we interpret the current data and continue to track the changes as data accumulate within individual cells. We chose the latter option, as this is a long-term study with consistent data collection through time. Overall, there appear to be two primary sink areas; the northwest corner of the BRWRA, and the northeastern side of the BRWRA (Fig. 5). The overall pattern of source-sink dynamics within the BRWRA suggest that a large area may be required to maintain a viable population of wolves within the southwestern United States (e.g. the more sink areas identified, the larger the area needed to maintain a viable population).

Dispersal

Movement distances for lone wolves averaged 87 ± 10 km (54 ± 6 mi [SE]), with a maximum distance of 271 km (168 miles), and two other lone wolves moving >200 km across the landscape. This mean movement distance was similar to other studies conducted on colonizing wolves (see Table 6 in Boyd and Pletscher 1999). These long distance dispersers crossed interstate highways and the non-essential experimental population boundary, and persisted in various habitat types ranging from the New Mexico-Mexico border (e.g. desert habitat) to north of Flagstaff, Arizona (Fig. 6). The number of dispersals appear to be increasing (Fig. 6).

Under the Final Rule (which requires that all wolves remain within the BRWRA), few "legal" dispersals could occur. For example, if a wolf moved the average lone-movement distance (i.e. 87 km) from the geographic center of the BRWRA and the FAIR in a random direction, it would end outside the BRWRA 66% of the time. Thus, the average dispersing wolf in the ideal spot (i.e. the geographic center of the area that wolves can occupy) would still use areas outside the BRWRA 66% of the time. Indeed, single wolf movements resulted in the majority spending some time outside the BRWRA (68%).

Currently, we are documenting more dispersal by wild born wolves, as would be expected with increased pup production in recent years. Generally, wolves disperse between 1-2 years of age (Fuller 1989, Fritts and Mech 1981), although there is some variation depending on prey abundance and wolf densities (see Ballard et al. 1987 and 1997; pages 116-119 in Mech et al.; and Table 6 in Boyd and Pletscher 1999). However, as wild born wolves (i.e. the segment of the population with a decreased chance of mortality and removal) approach dispersal age, it is increasingly likely that many will ultimately disperse outside the BRWRA and will need to be removed if current rules and regulations remain unchanged.

Predation

Without human management and mortality, wolf population densities are principally related to vulnerable prey densities (Keith 1983, Fuller 1989, Ballard et al. 1997, Fuller et al. 2003). Wolves tend to kill less fit prey that is predisposed to predation in some form (Mech and Peterson 2003). Documented kills by Mexican wolves were principally elk, with calf elk preferred prey. Mexican wolf selection for calf elk was similar to other studied wolf populations (Smith et al. 2004, Husseman 2002). Selection for elk may be related to prey distribution, such that deer are more scattered across the landscape, relative to the more predictable and larger elk herds (Huggard 1993, Mech and Peterson 2003). Current research investigating winter (through daily aerial flights, and GPS collars), and summer (through GPS collars) kill rates should allow a better evaluation of predation patterns in the future and help elucidate the overall impact of wolves on ungulates. To date, however, no detectable changes have occurred to big game populations as a result of wolf reintroduction.

Although the number of pups produced per litter is of concern (see discussion above), the majority of adult wolves maintained their weight in the wild, with two notable exceptions. There were no wolf mortalities from intraspecific strife, and we found no Mexican wolves dead from starvation. High levels of intraspecific strife or any indication of starvation would be indicative of a food-stressed environment (Fritts and Mech 1981, Ballard et al. 1997). The lack of evidence that these indicators occurred combined with a suggested wolf population level that ungulates in the area could support (Paquet et al. 2001), leads to the conclusion that there was ample vulnerable prey in the area to support wolves.

Depredations

Healthy populations of native ungulates throughout the United States have allowed wolf recovery to occur. As a consequence, the proportion of livestock lost to wolves is generally low in most areas where wolves and livestock coexist in North America, (Bjorge and Gunson 1985, Fritts et al. 1992, Bangs et al. 1998, Fritts et al. 2003, Oakleaf et al. 2003).

Fritts et al. (2003) noted that most livestock losses in previously studied areas were killed during the summer grazing season. At this time of year, wolves and livestock were often located in remote forest grazing areas (Oakleaf et al. 2003). The pattern was markedly different in the BRWRA, with many of the remote areas year-round forest grazing operations (i.e. cattle calved, raised their young, and were present in remote areas year-round), compared with summer operations in northern areas. Newborn livestock and younger calves in remote locations may be the most vulnerable segment of the cattle population (Oakleaf et al. 2003).

One hypothesis regarding the question of why wolves do not kill more livestock given the availability of relatively vulnerable animals has been that wolves react differently to livestock than to wild prey due to limited exposure of wolves to livestock (e.g. livestock are only present during a portion of the year in more northerly latitudes [Fritts et al. 2003]). If this hypothesis were correct, one would expect that where wolves and livestock coexist year-round, depredations would be greater and the number of vulnerable livestock in the area would be greater. However, confirmed depredations are currently occurring at only a slightly higher rate in the BRWRA, despite 3-4 times greater time for cattle and wolves to interact (Table 8). Thus, confirmed depredations by wolves have remained within levels identified within the FEIS (USFWS 1996).

Another pattern that is markedly different than that observed in other wolf recovery areas (see Bangs et al. 1998) is the relative success of translocating previously depredating wolves. We found that these wolves contributed to recovery and caused fewer depredations than average for the entire population. Fritts et al. (2003) suggested that typically when wolves depredate on cattle, they do not depredate again for several weeks, if at all. Even in the northern Rockies recovery area, the pattern of wolves translocated for depredations and ultimately depredating again, was generally only observed in northwestern Montana (Bangs et al. 1998), with translocated wolves in Idaho showing far fewer repeat depredations. This pattern may relate to the ability, both in Idaho and the BRWRA, to translocate wolves into unoccupied wolf habitat free of livestock.

Human/Wolf Interactions

Overall, Mexican wolves were involved in 30 incidents of apparently fearless behavior. However, the majority of these incidents (79%) involved wolves that had recently been released and had spent limited time in the wild, with the remainder of the cases involving dogs. Similar to other areas where wolves and humans interact, aggressive behavior by wolves in the Southwest toward humans with dogs were the most frequent occurrence (McNay 2002, Fritts et al. 2003). Wolves have been documented to kill domestic dogs virtually everywhere the two coexist (Bangs et al. 1998, Fritts et al. 2003), including the BRWRA. Wolf attacks on dogs may sometimes result in a temporary loss of flight response to humans (McNay 2002, Fritts et al. 2003). In the three cases that a Mexican wolf or wolves appeared aggressive and charged toward humans, dogs were in the area and the aggression appeared to be focused on the dogs rather than the people.

As of December 2005, this Reintroduction Project has not documented, nor have there been reported, any instances in which wolves have come into physical contact with humans. However, wolves released from captivity may be more prone to initial fearless behavior toward humans, despite minimizing human contact in captivity and developing appropriate standards for selecting individual wolves to release (see Parsons 1998, Brown and Parsons 2001). Aversive conditioning and/or removal resolved all problems reasonably quickly. The paucity of documented wolf attacks in North America suggests that wolves rarely attack people there (McNay 2002). However, as the Adaptive Management Oversight Committee (AMOC) was completing the 5-Year Review, an event occurred in Canada that might be relevant to the subject of human-wolf interactions in North America. On November 8, 2005, a pack of wolves or wild dogs may have attacked and killed a man. These animals may have become habituated to humans due to a proliferation of garbage dumps associated with mines and mining exploration activities. This incident is currently under investigation and an official coroner's report is expected in January 2006. However, wolves in protected populations generally are less fearful of humans than those in exploited populations (McNay 2002). Thus, managers should continue to closely monitor initial released wolves and initiate aggressive aversive conditioning, or removal if appropriate, when wolves are near humans.

Genetics

There is no genetic evidence to date that suggests introgression with dogs or any other canids is occurring in the free-ranging Mexican wolf population. While there have been two documented hybrid incidents in the BRWRA, each litter was detected and removed from the wild before any of the offspring could potentially reproduce in the wild. Where hybridization has been known to occur (i.e. Europe), hybrid survival was typically poor and had no detectable impacts on wolf population viability or genetics (Mengel 1971, Vila and Wayne 1999). Differences in seasonality of female estrus and male fertility between wild and domestic species may also shed light on the apparent lack of effect of isolated hybrid events. While domestic dogs of both sexes are known to breed year-round, wolf-dog hybrids retain the annual breeding cycle of their wild wolf parent; however, the timing is shifted so that the wolf-dog hybrid breeds approximately three months earlier (Mengel 1971). Mengel (1971) concluded that the phase shift in the breeding season of wolf-dog hybrids served as an effective block to introgression of dog genes into wolf populations. Therefore, even had the two litters not been detected, there likely would have been no negative impacts to the free-ranging Mexican wolf population.

We promptly discovered both hybrid litters as a result of ongoing management and monitoring. In the first incident, an entire wolf pack was in the process of being removed from the wild for depredating on cattle. Upon locating the den and removing the pups, we noticed that one pup had markings (i.e. whitish with spots) that were inconsistent with typical Mexican wolf pups, which immediately prompted genetic testing of the entire litter. When the tests determined the litter was a wolf-dog mix, the pups were humanely euthanized. In the second incident, female 613 was translocated as a single wolf near another pack's home range in January 2005, just prior to the breeding season. The pack's breeding female had previously been killed. The intent of this translocation was to create a new pair by augmenting the population with 613, a genetically important female. Although 613 was located within 3 miles of the breeding male, the two wolves were never documented together. Subsequently, 613 was seen on several occasions in an area with numerous feral dogs. When she exhibited localized denning behavior in the spring, the IFT closely monitored the den and discovered the pups had obvious dog markings. The litter was humanely euthanized.

The Final Rule identified the potential for hybridization between Mexican wolves and dogs. We will continue to monitor the genetic purity of the Mexican wolf population by genetically testing all captured wild wolves, dogs, and coyotes. In this way, we will continue to investigate genetic data and determine if introgression of either domestic dog or coyote genes has occurred in the Mexican wolf population or vice versa.

MANAGEMENT IMPLICATIONS

Many of the goals and projections described in the FEIS (USFWS 1996) have been met or exceeded. Most notably, population counts are at projected levels, with mortality lower than estimated in the FEIS (USFWS 1996). Thus, the overall Reintroduction Project is functioning at least as well as projected and should continue with some modifications. This is consistent with Recommendation 3 in the Recommendations Component of the 5-Year Review.

First, both the number of released, and the number of removed wolves have exceeded levels projected within the FEIS (USFWS 1996). These higher levels are largely a result of guidelines in the Final Rule for the BRWRA that require wolves to be removed if they establish a home range wholly outside the recovery area, or at the request of private landowners for wolves on their lands outside the recovery area (USFWS 1996). These policies conflict with normal wolf movements (see Table 6 in Boyd and Pletscher 1999), and differ from management of wolves elsewhere in the United States (USFWS 1994a, 1995). Accordingly, we recommend the USFWS modify the Final Rule to allow wolves to expand into adjacent areas of the Mexican Wolf Experimental Population Area (Fig. 1). This step alone would greatly reduce the number of removals due to boundary violations and bring removal rates more in line with predictions in the FEIS (USFWS 1996). This is consistent with Recommendations 5, 7, and 9 in the Recommendations Component of the 5-Year Review.

Data suggest that animals living in the wild for a greater proportion of their life are more likely to be successful, and are less likely to succumb to mortality or removal. Thus, our second recommendation is that wolves with wild experience continue to be translocated after their first removal event, except in extreme situations (i.e. lethal control or permanent removal from the wild following three depredations in a one year period). This is consistent with Recommendation 9 in the Recommendations Component of the 5-Year Review.

Our third recommendation is that greater effort be placed on appropriate centralized databases. There is a need to continue improving the efficiency, reliability, and accessibility of the Project's databases. This is consistent with Recommendation 15 in the Recommendations Component of the 5-Year Review.

Finally, the Blue Range Wolf Reintroduction Project differs socially, biologically, and environmentally from other wolf recovery programs. Ample research opportunities exist to collect and compare data with more northerly and better-studied wolf populations. As such, we recommend that more research opportunities be explored and funded to provide insight into overall Mexican wolf biology and Reintroduction Project effectiveness. This is consistent with Recommendation 16 in the Recommendations Component of the 5-Year Review.

Table 1. Average 95% fixed kernel home range and 50% core use areas documented for Mexican wolves in the Blue Range Wolf Reintroduction Area, Arizona and New Mexico, 1998-2003.

Year	No. packs	$\bar{x}$ home range size (km^2)[a]	$\bar{x}$ core use size (km^2)[b]	Total area occupied by packs (km^2)
1998	2	150	19	301
1999	5	118	21	590
2000	5	575	71	2,872
2001	6	479	52	2,876
2002	9	299	37	2,691
2003	12	725	92	8,700

[a] $\bar{x}$ home range size was based on 95% fixed kernel estimators.
[b] $\bar{x}$ core use size was based on 50% fixed kernel estimators.

Table 2. Models supported within the analysis for successful Mexican wolf releases in the Blue Range Wolf Recovery Area, Arizona and New Mexico, 1998-2003. The dependent variable was based on 28 successes (i.e. wolves that bred and produced pups in the wild) and 78 failures (i.e. wolves that did not successfully breed and produce pups in the wild).

Model	AIC_c	ΔAIC	w_i
Status[a] + Wild/Life[b] + Year	113.71	0.00	0.334
Status + Wild/Life	114.64	0.93	0.210
Status + Season[c] + State[d]	115.67	1.96	0.125
Age + Wild/Life + Year	116.69	2.98	0.075
Year + Status	116.84	3.13	0.242
Age + Wild/Life	117.02	3.31	0.064
Status + Season	117.49	3.78	0.050
Translocation[e] + Status	119.25	5.54	0.021
Status + Months in the Wild	119.98	6.27	0.015
Age + Season	119.99	6.28	0.014
Season + State	120.49	6.78	0.011
Year	120.73	7.02	0.010

[a] Status of the wolf (breeder, subadult, or pup).

[b] The proportion of the wolf's life spent in the wild at the time of the release.

[c] Season of release for the wolf (autumn, winter, spring, or summer).

[d] State of release of the wolf (New Mexico or Arizona).

[e] Either translocation or initial release.

Table 3. Minimum population estimates of Mexican wolves in the Blue Range Wolf Recovery Area, Arizona and New Mexico, 1998-2003, based on visual counts, removals, and releases.

Year	Released[a]	Removed[b]	Mortalities	Pups[c]	Collared	Uncollared[d]	Estimate[e]
1998	16	6	5	0	4	0	4
1999	23	12	2	8[f]	7	0	15
2000	31	23	4	5	15	2[f]	22
2001	21	10	9	3	18	5	26
2002	16	7	3	21	25	3	42
2003	23	14	13	20	23	12	55
Total	130	58	36	57		22	

[a] Based on the number of initial releases and translocations of Mexican wolves. Any animal that was captured and moved was considered a new translocation. Thus, a single wolf may have been released several times in a given year.

[b] Wolves captured and moved. We considered it removal regardless of whether the animal was re-released or not. These estimates include wolves that were removed and died in captivity (not included in mortalities), animals that were lethally removed (1 in 2003, included in mortalities), and animals that died during capture (1 in 2002, included in mortalities).

[c] Based on the number of pups observed in the wild as close as possible to the end of the year. Radiocollared pups (n= 7) were also included in the collared end-of-year count for 2002.

[d] Uncollared subadult wolves (not pups of the year) documented by this Project as close to the end of the year as possible. These numbers do not include missing wolves.

[e] Minimum population estimate for the end of the year. These numbers represented the cumulative of pups, collared, and uncollared animals observed near the end of the year for any given year.

[f] Six of these pups were removed in 2000 and not counted as subadults in 2000.

Table 4. Mortality, removal, and missing rates of collared Mexican wolves in the Blue Range Wolf Recovery Area, Arizona and New Mexico, 1998-2003. The table also includes failure rate (i.e. dead, removed or missing) of wolves in the wild. All rates were calculated using the program Micromort (Heisey and Fuller 1985). The numbers in parentheses represent the number of radiocollared wolves that were removed, missing, or died during a given time frame by cause.

Year	N[a]	Removal Rate	Mortality Rate	Missing Rate	Failure Rate
1998	13	0.46 (6)	0.39 (5)	0.08 (1)	0.93 (12)
1999	14	0.49 (6)	0.16 (2)	0 (0)	0.65 (8)
2000	30	0.65 (19)	0.14 (4)	0.07 (2)	0.86 (25)
2001	31	0.28 (9) [b]	0.22 (7)	0.06 (2)	0.56 (18)
2002	34	0.26 (7)	0.11 (3)	0.04 (1)	0.41 (11)
2003	37	0.30 (11) [b]	0.27 (10)	0 (0)	0.58 (21)
Total[c]	75	0.39 (58) [b]	0.21 (31)	0.04 (6)	0.64 (95)

[a] N represents the total number of collared wolves in the population during the full year. Some wolves had more radio days than other wolves.

[b] Includes one wolf that died while being removed outside the BRWRA (2001), and one wolf that was lethally removed for cattle depredations (2003). These wolves were exclusively classified as a removal rather than both a removal and mortality. This treatment of animals is consistent with Heisey and Fuller (1985), in that individuals can only be uniquely classified as to one fate.

[c] Total represents the summation of all mortality or removal events divided by the radio days and raised to the 365 power, to describe the average yearly mortality, removal, and failure rates.

Table 5. Removal rates (Heisey and Fuller 1985) of Mexican wolves within the Blue Range Wolf Recovery Area, Arizona and New Mexico, 1998-2003, by cause. Values in parentheses represent the number of radiocollared wolves that were removed during a given time frame by cause. Some wolves were translocated immediately following removal, while others were placed in captivity, or translocated at a later date.

Year	N[a]	Removal Rate	Boundary[b]	Nuisance[c]	Cattle[d]	Other[e]
1998	13	0.46 (6)	0.08 (1)	0.15 (2)	0 (0)	0.23 (3)
1999	14	0.49 (6)	0 (0)	0 (0)	0.245 (3)	0.245 (3)
2000	31	0.65 (19)	0.17 (5)	0.17 (5)	0.14 (4)	0.17 (5)
2001	30	0.28 (9)	0.13 (4)	0.06 (2)	0.06 (2)	0.03 (1)
2002	34	0.26 (7)	0.15 (4)	0.04 (1)	0.07 (2)	0 (0)
2003	37	0.30 (11)	0.19 (7)	0.03 (1)	0.08 (3)	0 (0)
Total	75	0.39 (58)	0.14 (21)	0.07 (11)	0.10 (14)	0.08 (12)

[a] N represents the total number of collared wolves in the population during the full year. Some wolves had more radio days than other wolves.

[b] The removal rate of wolves that moved outside of the Blue Range Wolf Recovery Area (see Fig. 1).

[c] The removal rate of wolves that displayed poor behavioral characteristics and were located close to humans.

[d] The removal rate of wolves that depredated repeatedly on livestock

[e] Wolves removed to pair with other wolves or to relocate to a better area prior to other causes of removals being initiated.

Table 6. Number of livestock and dogs confirmed (Conf.), probable (Prob.), or possible (Poss.) killed by Mexican wolves in the Blue Range Wolf Recovery Area, Arizona and New Mexico, 1998-2003. Information from the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services database.

	Cattle			Dog	Sheep	Horse
Year	Conf.	Prob.	Poss.	Conf.	Conf.	Poss.
1998	0	0	0	1	0	0
1999	5	0	4	0	0	0
2000	1	0	2	0	1	0
2001	5	0	3	0	0	0
2002	9	0	0	1	0	0
2003	3	4	1	0	1	1
Total	23	4	10	2	2	1

Table 7. Number of cattle confirmed killed by wolves, wolf population estimates, and number of cattle killed per 100 wolves in 5 states. Data represent the years 2000-2002 for all states except Arizona/New Mexico, which includes 1998-2003. We used USDA-APHIS, Wildlife Services annual reports from each state to determine the number of cattle killed by wolves. Kills were verified by specialists trained in field necropsies to determine cause of death and do not reflect those animals that were determined to be probable or possible kills.

State/year	Cattle killed	Wolf population	Cattle killed/wolf population x 100
Montana 2000	14	97	14
Montana 2001	12	123	10
Montana 2002	20	183	11
Montana Mean	15.33	134.33	11
Wyoming 2000	3	159	2
Wyoming 2001	18	189	10
Wyoming2002	23	217	11
Wyoming Mean	14.67	188.33	8
Idaho 2000	15	187	8
Idaho 2001	10	251	4
Idaho 2002	9	263	3
Idaho Mean	11.33	233.67	5
AZ/NM 1998	0	4	0
AZ/NM 1999	5	15	33
AZ/NM 2000	1	22	5
AZ/NM 2001	5	26	19
AZ/NM 2002	9	42	21
AZ/NM 2003	3	55	5
AZ/NM Mean	3.83	27.33	13.83

Figure 1. The Mexican wolf Blue Range Wolf Recovery Area (comprised of the primary and secondary recovery zones) and non-essential experimental population area, Arizona and New Mexico.

Figure 1. The Mexican Wolf Blue Range Wolf Recovery Area in Arizona and New Mexico.

Figure 2. Mexican wolf home ranges established from 1998-2003 in Arizona and New Mexico. Numbers represent individual packs (≥2 wolves traveling together) that had enough locations (>30) and movement characteristics consistent with a home range (See text on following page for description of the packs).

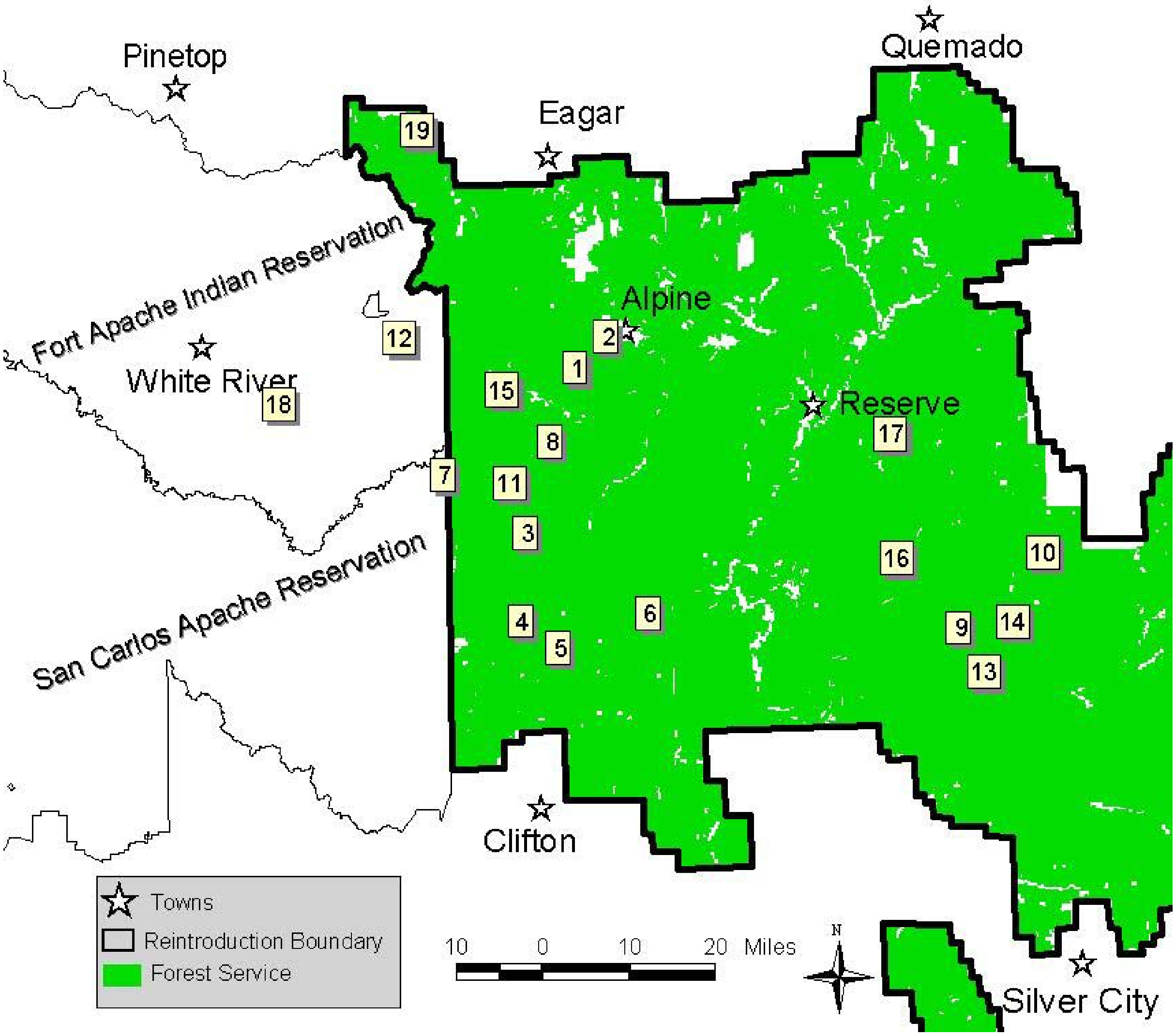


Figure 2, Continued.

No.	Pack name	Release year(s)[a]	Home range year(s)	Breeding pair year(s)[b]	No. wolves map in 2003
1	Hawks Nest	1998 IR, 1998 TR	1998-2003	1999, 2002-2003	4
2	Campbell Blue	1998 IR	1998	N/A	0
3	Campbell Blue II	1998 TR, 2000 TR	1999-2000	N/A	0
4	Mule	1999 IR	1999	1999	0
5	Pipestem	1999 IR	1999	N/A	0
6	Gavilan	1999 IR	1999	1999	0
7	Francisco	2000 IR	2000-2003A	2000-2002	0
8	Cienega	2000 IR	2000-2003	2002	5
9	Mule II	2000 TR	2000	N/A	0
10	Pipestem II	2000 TR	2001-2002	N/A	0
11	Saddle	2001 IR	2001-2003	2003	8
12	Bonito Creek	2001 NP	2001-2003	2003	N/A[c]
13	Luna	2002 TR	2002-2003	2002	4
14	Gapiwi	2002 TR	2002-2003	N/A	4
15	Bluestem	2002 IR	2002-2003	2002-2003	7
16	729 and 799	2003 NP	2003	N/A	2
17	Francisco II	2003 TR	2003	N/A	1
18	Hon-Dah	2003 TR	2003	N/A	N/A[c]
19	Cerro	2003 NP	2003	N/A	0

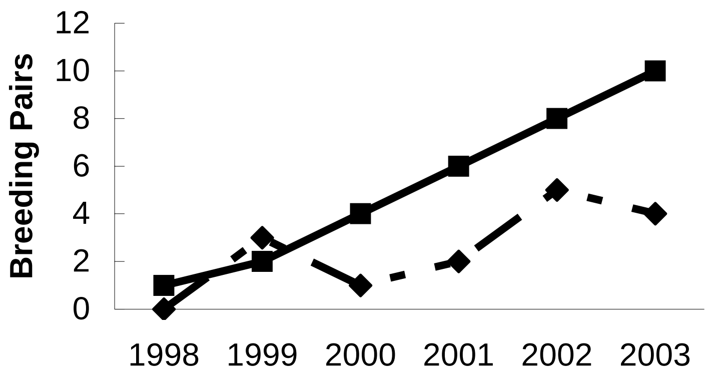
[a] Represents the year that the pack was initially released from captivity (IR), translocated (TR), or naturally paired in the wild (NP).

[b] Represents individual years that a pack had an adult female, an adult male and at least two pups that survived until December 31 of the year.

[c] Numbers of wolves on Fort Apache Indian Reservation are not provided, at the request of the White Mountain Apache Tribe.

Figure 3. Observed (dashed line) and predicted (USFWS 1996; solid lines) Mexican wolf population trends in the FEIS (USFWS 1996).

A:



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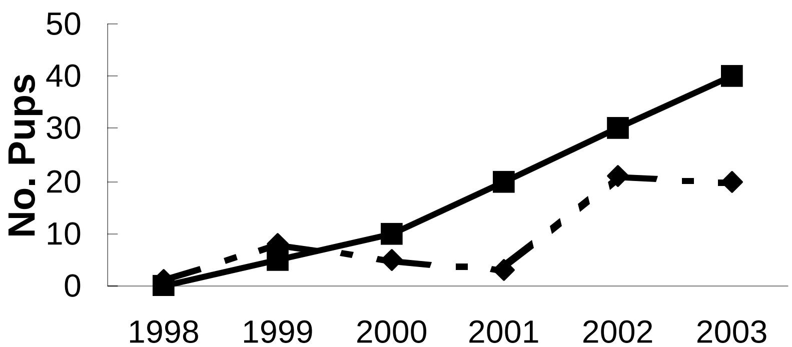
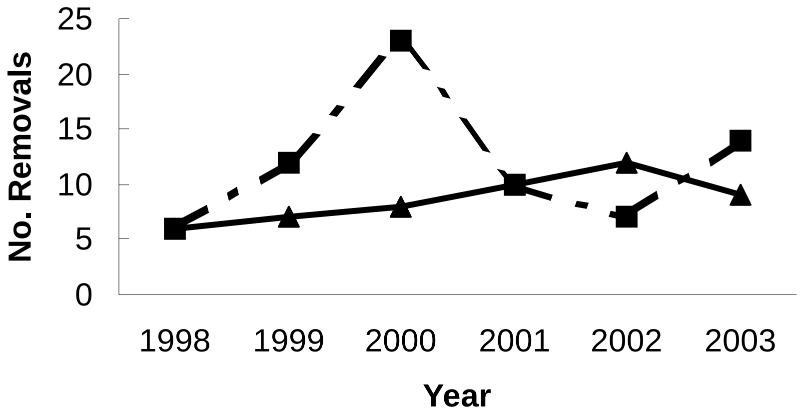


Figure 3, Continued.

C:



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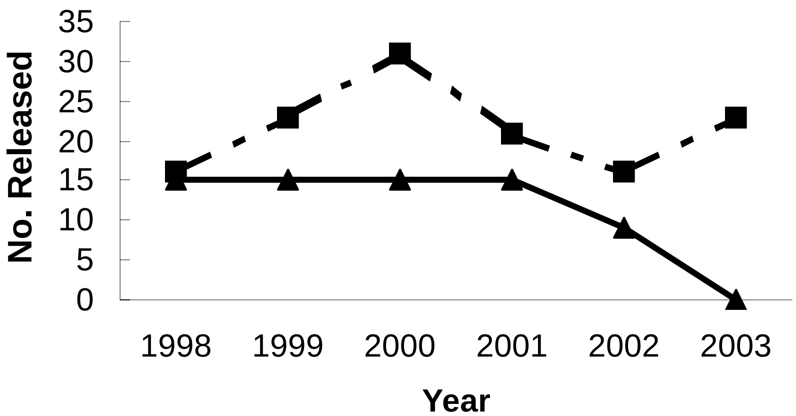


Figure 3, Continued.

E:

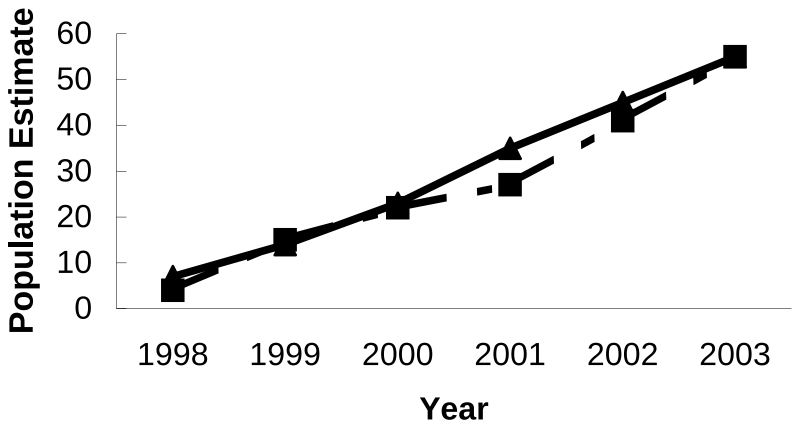
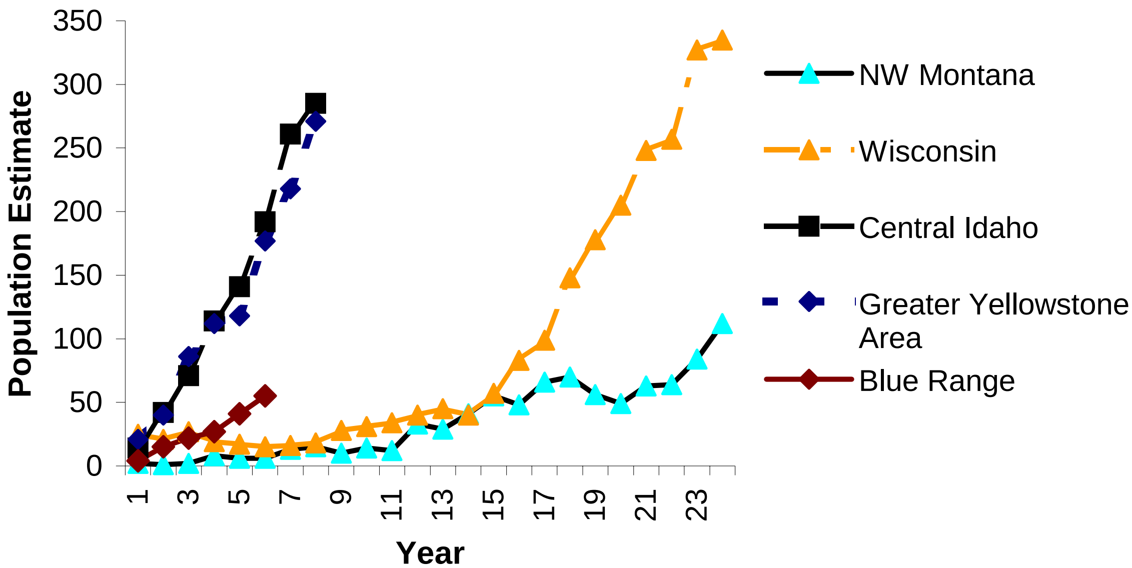


Figure 4. Population trends observed with Mexican wolf and other reintroduced or recolonizing gray wolf populations in the United States.

A:



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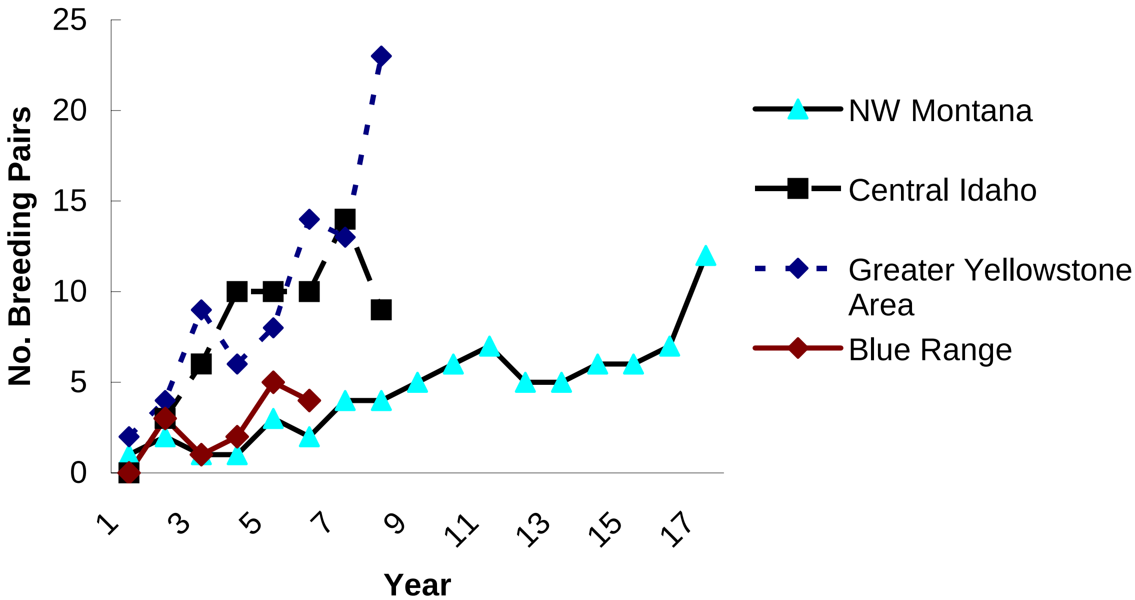


Figure 5. Source-sink dynamics of Mexican wolves in the Blue Range Wolf Recovery Area, Arizona and New Mexico, 1998-2003. Inset figures identify areas with multiple causes for sinks (see the legend in the bottom left corner).

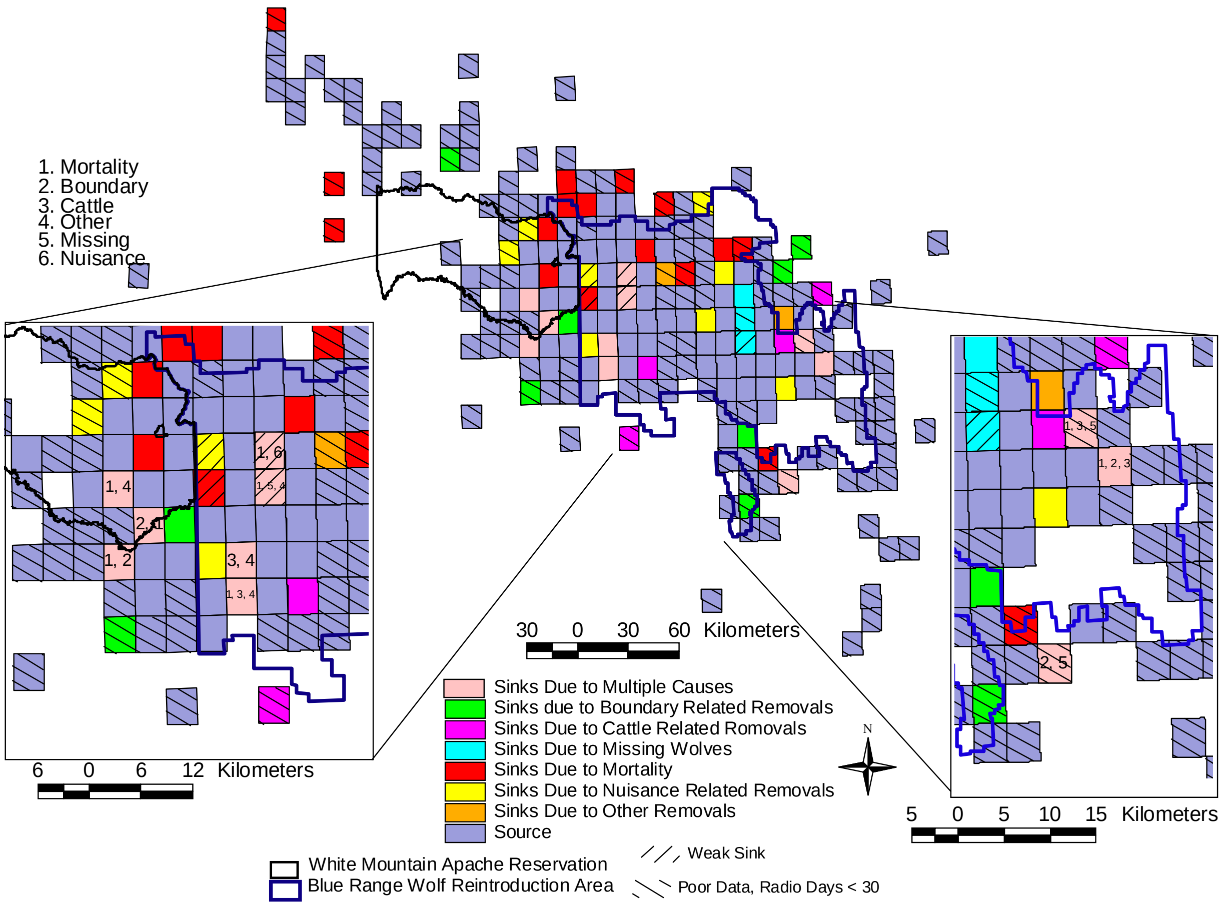
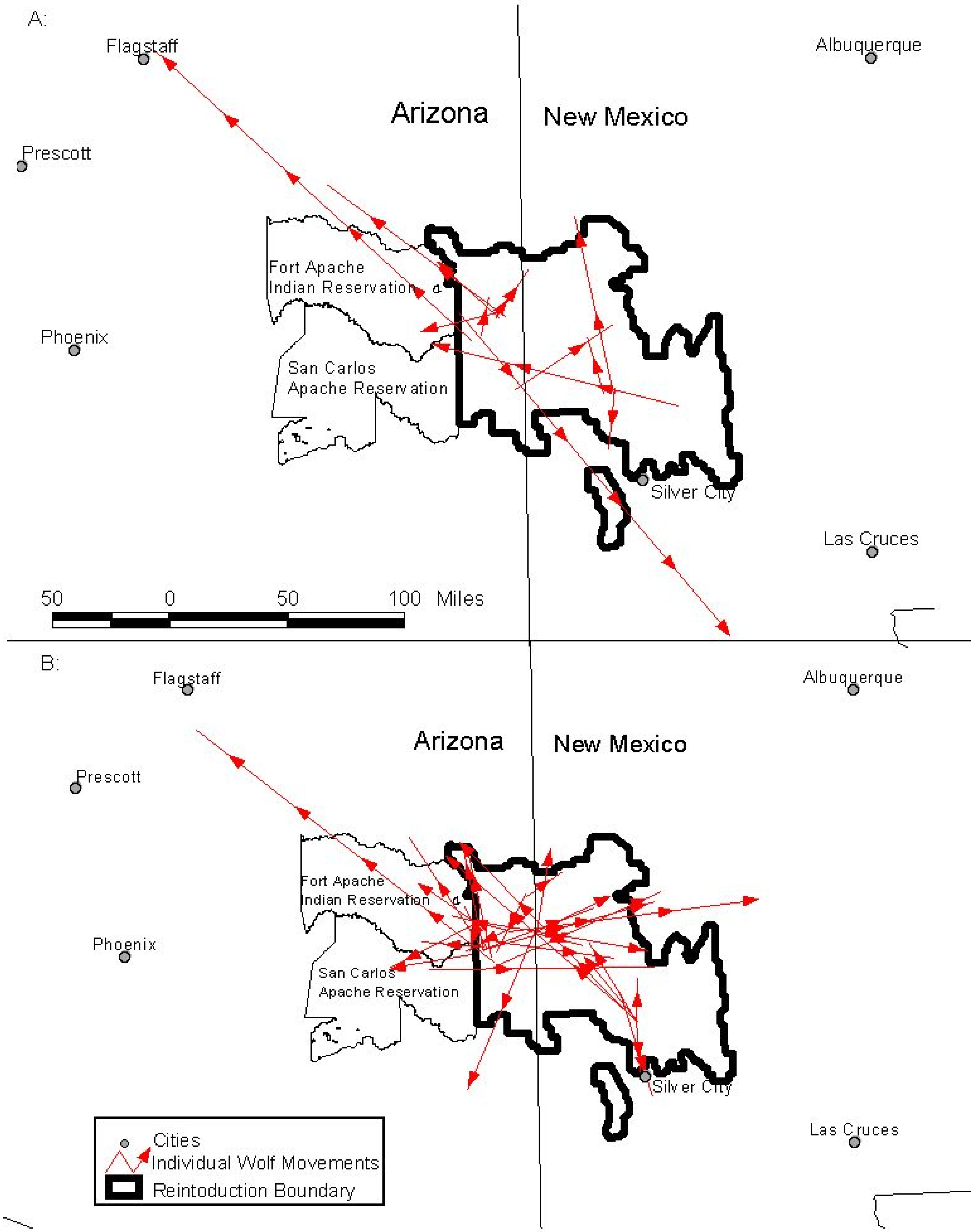


Figure 6. Movement patterns of individual Mexican wolves in the Blue Range Wolf Recovery Area from 1998-2000 (A), and 2001-2003 (B). Each line represents one dispersal/movement of a lone wolf.



APPENDIX I—Wolf/Human Interactions in the Blue Range Wolf Recovery Area, Arizona and New Mexico, 1998-2003

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT actions)	Memo
1	April 28, 1998	156	Yes	Charge/ Investigative approach, Dead	Wolf 156 was shot by a camper who feared for his family's safety when the wolf was in the area of their camp and attacked their dog
2	May 8, 1998	494		Investigative search, **Aversive conditioning** Habituated, **Removed**	Wolf 494 became a nuisance by frequenting the town of Alpine, Arizona, from May 8 to 28, 1998 and was permanently removed from the wild.
3	May 1999 to August 1999	191, 208, 562,	Yes	Investigative approach, **Aversive conditioning** Removed for livestock depredation	191 (alpha female), 208, and 562 (all recently released) approached ranch house with loose dogs, dogs chased wolves, wolves chased dogs, dog was bitten. Owner ran wolves off, one wolf M208 followed owner back toward house. F191 subsequently denned and several more encounters with dogs ensued near the house. Attempts at aversive conditioning were mostly unsuccessful. All wolves removed in August due to livestock depredation.
4	January 6, 1999	166, 482		Investigative search, Food conditioning	Campbell Blue pair pulled down a deer carcass hanging in a hunter's camp
5	January 5, 2000	522	Yes	Investigative search, **Removed**	Female 522 hung around hunter's camp and interacted with dogs. Trapped and put in acclimation pen to hold through hunting season.
6	February 6, 2000	522	Yes	Investigative search, **Removed**	Interacted with dogs at a ranch house immediately post-release.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT actions)	Memo
7	April 14, 2000	166, 518	Yes	Charge, **Removed**	Permittee reported an aggressive encounter with Campbell Blue pair when the female (518) bumped his horse and passed under it. Wolves also attacked one of his dogs. They followed him to a cabin and he stayed in it until the wolves left.
8	May 16, 2000	191, 208,	Yes	Investigative approach, Removed for livestock depredation	A female was jogging with 2 dogs when 2 wolves approached. According to the jogger, the wolves were clearly interested in her dogs and she was able to scare them away.
9	June 1, 2000	624		Investigative search. **Removed**	Frequented a ranch house
10	July 16, 2000	624	Yes	Investigative search. **Removed**	Frequented a ranch and exhibited playful behavior with a dog.
11	August 20, 2000	509, 511, 587, 590	Yes	Aggressive charge, Habituated, **Aversive conditioning**	Camper and his cocker spaniel were in the middle of a meadow behind his trailer when 4 wolves (most likely Francisco) came running out of the woods toward them. Camper fired one shot in front of the wolves but they kept coming. He fired a second shot as they got closer and they turned away. He was upset at the situation and felt that the wolves were a danger to people and animals/pets. Later that week, people camped nearby observed several wolves and pups resting in the shade under and around the camper's trailer. At the time he was inside with his dog, unaware wolves were outside. He was upset when he learned of the incident, stating that this was not the behavior of wild animals and was concerned about what would have happened had he or his dog come out of the trailer.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT actions)	Memo
12	August 24, 2000	511, 509, 587, 590		Investigative approach, Habituated, **Aversive conditioning**	Camper observed Francisco and Cienega packs on multiple occasions camping at Double Cienega. Sometimes they came through camp, <5 ft of him taking pictures, although the pups seemed more skittish. He saw them other times farther away within the campground or out in the meadow.
13	Sept. 25, 2000	590		Investigative search, Habituated, **Aversive conditioning**	Yearling male 590 frequented Double Cienega Campground most of one day.
14	Sept. 29, 2000	509, 511, 587, 590		Investigative approach Food conditioning, Habituated, **Aversive conditioning**	5-6 people camped in Double Cienega from about August 21 to 30, 2000. They had interactions with Francisco Pack throughout the week. On multiple occasions campers howled them in, chased them on ATVs, left food out, and shot blunt arrows at them. The wolves also chased their horses, mules, and people on ATVs. The IFT informed them this behavior was not acceptable, and explained that what they were doing could have negative effects on the wolves' behavior. On August 30, 2100, while speaking with the hunters, an IFT member observed the wolves chasing the mules. He then hazed the wolves by running at them and throwing rocks. The wolves did not respond. We first spoke with the group on about August 23, 2000. IFT personnel informed them about the Mexican Wolf Reintroduction Project, the presence of wolves in the area, and proper behavior with respect to wolves (e.g. do not leave food out; keep an eye on mules/horses; if you see wolves, yell and throw rocks at them). We also asked them to let us know if they had any interactions with the wolves.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT actions)	Memo
15	October 1, 2000	Unknown		Investigative search, Food conditioning	At about 0440 hrs, the homeowner went out the front door on the porch and observed an animal in the driveway. At first he thought it was a German shepherd, then by the color and size he realized it was a wolf. He scared it away and it headed west down the road. He tried to follow it in his truck but lost track of it. When he got back to the house it was by the back door eating out of the dog dish. He scared it away again and it ran behind the house between the animal pens and the barn. He checked the dog dish and it was empty. He was not sure if there had been food in it or not. IFT personnel responded to the call made by the landowner's sister. The IFT observed large canid tracks in the driveway and yard. (track size = 5 x 3 ½", in the sand and gravel). No other tracks were found in area. IFT personnel returned on October 2, 2000 at about 0500 hrs.
16	November 2001	M580; Wildcat	Yes	Investigative search, **Removed**	Point of Pines, San Carlos Apache Reservation. Wolf frequented a residential area. There were many domestic and feral dogs in the area. The wolf was captured by helicopter.
17	Summer 2002	Bluestem		Investigative search, Habituated	Vicinity of PS Knoll, Apache National Forest, Arizona. Permittee was on horseback and encountered a wolf while monitoring cattle. The permittee shouted at the wolf, however the animal made no response. The wolf eventually left the area. The wolf did not approach the permittee, therefore, most likely was displaying curious behavior. Unknown if a dog was with permittee or not.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT actions)	Memo
18	Summer 2002	Bluestem	Yes	Investigative search, Habituated	Vicinity of PS Knoll, Apache National Forest, Arizona. Permittee on horseback encountered a wolf while monitoring cattle; dog present. Shouted at wolf; wolf vacated area. Wolf most likely displaying curious behavior, possibly due to the presence of the dog.
19	Summer 2002	637; Bluestem		Investigative search, Habituated, **Aversive conditioning**	U.S. Forest Service reported a wolf walking down the Big Lake campground road, in Apache National Forest, Arizona. Project personnel located wolf f637 150 yards south of active campsites. Project personnel responded that same day and fired/hit the wolf with a rubber bullet. Wolf vacated area.
20	Summer 2002	637; Bluestem	Yes	Investigative search, Habituated, **Removed**	White River, Fort Apache Indian Reservation, Arizona. Project personnel located f637 around White River for several days. The wolf was seen traveling adjacent to residential area. Project personnel attempted to haze the wolf from these areas. Many domestic and feral dogs in area. Wolf observed interacting with resident's dog about 8 miles to the north of White River in the yard of a private residence. Wolf was captured and returned to captivity.
21	Summer 2002	Bluestem	Yes	Investigative search, **Aversive conditioning**	Sprucedale Ranch, Apache National Forest, Arizona. No direct interaction between wolves and humans, but wolves were observed from the ranch headquarters. A female domestic dog with pups was present which was killed by the wolves after she attempt to chase them away from area. Project personnel intensively monitored wolves, and aversively conditioned them when located in area. Wolves eventually stayed away from ranch.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT actions)	Memo
22	Summer 2002	Bluestem	Yes	Investigative search, Habituated, **Aversive conditioning**	Beaver Creek Ranch, Apache National Forest, Arizona. On several occasions the wolves were in the vicinity of the ranch headquarters and cabins. No direct interaction between wolves and humans. Several dogs and horses at residence. The IFT intensively monitored and aversively conditioned wolves when located in area. Wolves eventually stayed away from ranch.
23	August 23, 2002	Francisco	Yes	Investigative search	Four Drag allotment, Apache National Forest. Permittee was checking cattle along Malay pasture fence line with his working dogs. Permittee encountered WS and was told he could ride into the area with the dogs based on a wolf radio signal in a different direction. The dogs were released and began barking while working cattle. When a dog squealed, the permittee saw a wolf holding it by the back of the neck and shaking. The rancher yelled and the wolf let go. The rancher left with his dogs.
24	Summer 2002	Francisco	Yes	Investigative search	Four Drag Cattle allotment, Apache National Forest hunter encountered wolves while hunting cougar in a remote area. Hunter was on horseback with a pack of hounds. The dogs got in a fight with the wolves; one of the dogs suffered extensive injuries. Hunter heard the fight, rode his horse toward the wolves, and fired a shot in the air. However, one wolf would not let go of the one hound. The other three wolves were about 50 yards away when he approached. He fired two more shots and scared the wolf away at about 10 yards. Hunter reported being in fear for the dogs but did not feel threatened himself. The wolves had a kill nearby and may have had pups in the area.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT action)	Memo
25	October 19, 2002	584, 624; Gapiwi	Yes	Investigative approach	Chicken Coop Canyon, Gila Wilderness, New Mexico. Hunters saw two wolves near camp. Later wolves followed outfitter (on horseback) and her dogs. Hound ran at wolves, brief fight, hound came back and wolves left.
26	October 21, 2002	584, 624; Gapiwi	Yes	Investigative approach	On October 21, 2002, two wolves came by outfitter's camp. Meat from three elk was near camp. There were also dogs in the camp. Hunters ran out to take pictures and the wolves left. Adult pair of wolves had a rendezvous site nearby with one pup.
27	May 1, 2003	648 (?); Sycamore		Investigative approach, **Aversive conditioning**	Near Little Turkey Creek, Gila Wilderness, New Mexico. Hunter saw a wolf on trail during middle of the day. Wolf moved toward hunter, and he threw a rock at the wolf, causing it to leave.
28	May 2003	592, 648; Sycamore		Investigative search, Removed	Seventy-Four Draw, Gila National Forest, New Mexico. Young female on horseback encountered 2 wolves. Closest wolf was approximately 10 yards away, second wolf was further off and moving away from. Gun fired to scare wolf off. Wolf showed limited fear of person and gunshot, but eventually moved away. Incident lasted approximately 10 minutes.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT action)	Memo
29	May 2003	592, 648; Sycamore		Investigative search, **Removed**	Seventy-Four Draw, Gila National Forest, New Mexico. Wolves followed armed rancher six miles. He was on foot driving cattle down a canyon toward home. The wolves had been observed trying to kill calves in that group and the rancher chose to move them onto private land. He drove the herd of cows and was followed by the wolves for an hour. Rancher stated, "The wolves followed right behind me and kept getting closer and closer, I yelled at them and threw rocks at them, and it didn't work. When they got within 40 feet of me at that point I thought wild animals don't act like this, and because I felt threatened, I fired one round from my 30-30 over them. Their reaction was to skulk off the road and go around me and get in front of the cows again, they still showed no signs of leaving. They seemed to try and hold the cows up, just like when we originally saw them. From that point on I had trouble driving the cows and had to throw rocks over the cows trying to scare the wolves off, this continued until the vehicle the IFT member was driving came into earshot then the wolves moved up on the side of the canyon wall but still didn't leave. The IFT person was informed the wolves were right there with me and he confirmed that."
30	Spring 2003	Unknown; Cienega Pack home range	Yes	Investigative approach	Foote Creek trail area, Apache National Forest, Arizona. Cougar hunters had wolf a follow them for approximately one mile. The hunters had several hounds with them. The wolf never approached the hunters or dogs and eventually left the area.

Event	Date	Wolves involved	Dog presence (provoked)	Classification (bolded items indicate IFT action)	Memo
31	July 1, 2003 -July 31, 2003	613; Red Rock		Investigative search, **Aversive conditioning** Habituated, **Removed**	Occurred around Aragon and Cruzville, New Mexico. Wolf near residences at Cruzville, hit with one rubber bullet, and moved to Aragon area. Sighted repeatedly near residences, no direct threats; F613 would leave area or hide when observed. Caught near residence east of Aragon after killing a turkey. Wolf caught and returned to captivity.
32	Fall 2003	729; Red Rock	Yes	Investigative search	Sheep Basin, Gila National Forest, New Mexico. Hunters pulled into camp at night and saw M729 confronting their two dogs, that were tied to a tree. Hunters got out of vehicle and yelled at the wolf. The wolf stared at the hunters and eventually fled from the area. No threat to human safety. Wolf was drawn into area by presence of dogs.
33	Fall 2003	Unknown		Investigative approach, **Aversive conditioning**	Dry Prong, San Carlos Apache Reservation. Based on a second hand report from a San Carlos Apache Tribe representative. A wolf approached a tribal hunting camp within 50 yards and was hanging around near the camp and was unafraid of people. The hunters tried to scare the wolf away by yelling and throwing things in the direction of the wolf, but it wouldn’t leave. The hunters did not feel safe and moved their camp.

APPENDIX II—Assessment of Blue Range Wolf Recovery Area Project Evaluation Questions Identified in the 1998 Mexican Wolf Interagency Management Plan (Parsons 1998)

The 1998 Mexican Wolf Interagency Management Plan identified nine questions to serve as the foundation for the 3-Year and 5-Year Reviews. Each question was analyzed in a scientific manner and discussed in the body of the Technical Component of the 5-Year Review. However, for ease in evaluating the nine questions, they are also addressed separately, below. Note that two of the questions (i.e. Is effective cooperation with other agencies occurring? Are combined agency funds adequate?) are addressed in the Administrative Component of the 5-Year Review. Two additional questions (i.e. Have sinks been identified? Have any sources of mortality been higher than expected?) identified by an AMOC cooperator have been added to this section.

1. Have wolves successfully established home ranges within the designated wolf reintroduction area?

   Response: The data show that many home ranges have been established and maintained within the designated reintroduction area. Overall, 19 packs established home ranges in 39 cumulative pack years (see Table 1, and Fig. 2). However, many of these packs had a small portion of their individual home ranges outside the current reintroduction boundary.

2. Have reintroduced wolves reproduced successfully in the wild?

   Response: Reintroduced wolves have successfully produced pups in the wild. Most of the successful reproduction from 1998-2003 was documented in 2002 and 2003. Overall, 16 packs produced wild-conceived and wild-born pups. Average litter size, however, was below that observed in other wolf populations in the United States and the projections in the FEIS (USFWS 1996) (Fig. 3).

3. Is wolf mortality substantially higher than projected in the FEIS?

   Response: Wolf loss rates (i.e. mortality plus missing rates) were similar to estimates identified in the FEIS (USFWS 2003). However, removal rates were higher than mortality rates and were the dominating processes influencing the population (see Tables 4 and 5). Combining removal, missing, and mortality rates to form a failure rate (e.g. wolves that did not persist on the landscape) indicated that overall levels were higher than predicted in the FEIS (see Tables 4 and 5).

4. Is population growth substantially lower than projected in the FEIS?

   Response: Projected population growth and current population are very similar (Fig. 3). However, releases are also higher than projected in the FEIS (USFWS 1996) (Fig. 3), thus the population is likely artificially high.

5. Are numbers and vulnerability of prey adequate to support wolves?

   Response: This is a difficult question to analyze because of the difficulties in quantifying levels of vulnerable prey within the overall prey populations. Different measurements produce different results. For instance, the small number of pups per litter suggest that prey might be limiting within the population (see the Reproduction and Population Growth section of the Discussion). Other matrices indicate the level of available and vulnerable prey is adequate (e.g. number of wolves predicted by Ungulate Biomass Index, weight loss indexes, and the level of intraspecific strife). Overall, it appears there is an adequate natural prey base for Mexican wolves within the BRWRA.

6. Is the livestock depredation control program adequate? *(*include evaluation of the number of depredations vs. number projected vs. other wolf programs vs. the first 3 years of reintroduction).

   Response: Each of the five measures used to define a successful depredation control program indicate current methods are adequate. The number of confirmed wolf-killed cattle was within projections in the FEIS (USFWS 1996), although higher than that observed in other populations of gray wolves. This higher number of killed cattle within the BRWRA relative to other wolf populations likely relates to differing grazing regimens between areas (i.e. the BRWRA has year-round grazing, whereas other wolf occupied areas in the United States do not).

7. Have documented cases of threats to human safety occurred?

   Response: No cases of physical contact between a Mexican wolf and a human have occurred during the six years of data analyzed. On three occasions, wolves behaved aggressively toward humans or the dogs that accompanied them (see Appendix I). In all three cases, wolves were within three months of initial release and dogs were present.

8. Have any sinks been identified?

   Response: Sinks were scattered inside and outside the BRWRA (see Fig. 5). Two clusters of sinks occurred within the BRWRA, one each in the northwestern and northeastern corners of the BRWRA.

9. Have any sources of mortality been significantly higher than expected?

   Response: Sources of mortalities are consistent with other studied populations, and were principally human-caused (e.g. illegal shootings or vehicle collisions). See also Question 3, above.

APPENDIX III—Evaluation of the Biological and Technical Recommendations Identified in the 3-Year Review Paquet Report (Paquet et al. 2001)

The following is an evaluation of the biological and technical recommendations from the 3-Year Review Paquet Report (Paquet et al. 2001), indicating the status of each recommendation as either completed, not completed, or not considered necessary to complete, and the appropriate assessments and findings.

1. Continue to develop appropriate opportunities to release (and re-release) wolves for at least 2 years to ensure the restoration of a self-sustaining population

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: Releases and translocations continue to be used as management actions to ensure the restoration of a self-sustaining wolf population. Adaptive management will facilitate the continuation of these management practices as needed in the future.

   Finding: This is consistent with Recommendation 3 in the Recommendations Component of the 5-Year Review.

2. Begin developing population estimation techniques that are not based exclusively on telemetric monitoring.

   Status (Time Frame): Not completed (initial stages; time frame for completion unspecified)

   Assessment: Staff and funding have not been available to fully implement this Recommendation. Currently, the IFT uses howling surveys, track counts, and observational data, in association with trapping/collaring, and telemetric monitoring, to obtain population estimates. A standardized system for determining population estimates still needs to be developed, and additional techniques need to be implemented or refined.

   Finding: This is consistent with Recommendation 17 in the Recommendations Component of the 5-Year Review.

3. Develop data collection forms and data collection and management procedures similar to those used by the red wolf restoration program in North Carolina.

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: New forms and procedures have been incorporated into Project Standard Operating Procedures (SOPs) and other procedural documents, based in part on examples from wolf projects in Minnesota, North Carolina, and the Northern Rockies.

   Finding: Continues to be adaptively implemented as needs for new forms and procedures are identified.

4. Require biologists to promptly and carefully enter field data into a computer program for storage, proofing, and analysis.

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: The IFT has developed, enhanced, and maintained Project databases for all essential field data, including but not limited to wolf locations, mortalities, survivorship, incident reports, depredation investigations, releases, and predation/carcass analysis. In addition, a comprehensive database documenting the chronological history for all wolves past and present, both in the wild and in acclimation facilities, has been created, and is regularly maintained for accuracy and completeness.

   Finding: This is consistent with Recommendation 15 in the Recommendations Component of the 5-Year Review.

5. Make all data available for research and peer review.

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: Project data for research and peer review are available to individuals and entities with appropriate research proposals. Data have been made available to a graduate-level scat study, the 3-Year Review, a depredation study, an undergraduate summer intern study, and an ongoing graduate-level study on Mexican wolf predation patterns.

   Finding: This is consistent with Recommendation 16 in the Recommendations Component of the 5-Year Review.

6. Carefully consider using a modified #3 soft-catch trap for capturing Mexican wolves rather than the McBride #7

   Status (Time Frame): Being implemented

   Assessment: The IFT considered, but decided against, using modified #3 soft-catch traps because the amount of injuries caused using McBride #7 traps was minimal, and the concern that too many wolves would be able to pull out of the #3 traps. The IFT documented wolves pulling out of McBride #7 and Newhouse #4 traps.

   Finding: The question of efficacy of #3 soft-catch traps for capturing Mexican wolves has not been satisfactorily answered and will be pursued further. This is consistent with Recommendation 21 in the Recommendations Component of the 5-Year Review.

7. Encourage research that will help inform future program evaluations and adjustments.

   Status (Time Frame): Completed/being implemented (initial stages; ongoing)

Assessment: The Reintroduction Project is implementing a cattle depredation study and a preliminary winter predation study in the BRWRA. In addition, a graduate-level study on wolf predation patterns was initiated in fall 2004.

Finding: This is consistent with Recommendation 16 in the Recommendations Component of the 5-Year Review.

8. Develop a contemporary definition of a biologically successful wolf reintroduction and the criteria needed to measure success.

   Status (Time Frame): Not completed

   Assessment: Recovery planning for the Mexican wolf was put on hold in February 2005, after an Oregon U.S. District Court judge enjoined and vacated the 2003 gray wolf reclassification rule (USFWS 2003). In December 2005, USFWS decided not to appeal the Oregon ruling. This decision re-opened the door for USFWS Region 2 to once again move forward with Mexican wolf recovery planning in the Southwest. Target deadlines for Recovery Plan development and completion will be identified once the Recovery Team resumes meeting. Criteria to measure reintroduction and recovery success will be developed in the Recovery Plan. After recovery goals have been established, the BRWRA can be evaluated relative to those goals.

   Finding: This is consistent with Recommendation 33 in the Recommendations Component of the 5-Year Review.

APPENDIX IV—Evaluation of the Recommendations from the Six Working Groups of the 3-Year Review Stakeholder Workshop

The following is an evaluation of recommendations generated by the six Working Groups of the 3-Year Review Stakeholders Workshop (Kelly et al. 2001), indicating the status as either completed, not completed, or not considered necessary to complete, and the appropriate assessments and findings.

1. Create maps and reports that reflect population levels of prey base, their spatial and temporal distribution, and current and projected management objectives and direction for New Mexico, Arizona, and Mexico.

   Status (Time Frame): Not completed (time frame for completion unspecified)

   Assessment: Detailed information on spatial, temporal, and density distribution of prey species would be helpful, but funding and personnel restraints in all three AMOC-member Game and Fish agencies (i.e. AGFD, NMDGF, WMAT) preclude such detailed surveys. Current management objectives for ungulates within the BRWRA can be obtained from the appropriate management agency (AGFD, NMDGF, or White Mountain Apache Outdoor and Recreation Department). Projected game management objectives cannot be described at this time, because of the many variables that affect future management strategies. In Mexico, wildlife management is much more complex and less structured, due to the large amount of private land and limited financial ability of government agencies to carry out these activities. Also, neither the Recovery Program nor the Reintroduction Project has authority or jurisdiction in Mexico.

   Finding: AMOC and the IFT will continue to seek innovative approaches to support and encourage the referenced State and Tribal wildlife agencies in improving the quality of prey base surveys. In addition, they will continue to use existing data sets to adaptively describe prey bases across the BRWRA in a manner that is consistent with data quality.

2. Identify wild ungulate prey base habitat enhancements to be accomplished through private property incentives programs and federal, state, tribal, and county, land management agency planning processes.

   Status (Time Frame): Not completed (time frame for completion unspecified)

   Assessment: This activity has not been pursued due to other higher priority management activities and a lack of planning, funding, and personnel to address this issue.

   Finding: Developing a list of prey base habitat enhancements that can be employed at some time in the future, when planning, funding, and personnel permit, is consistent with Recommendation 26 in the Recommendations Component of the 5-Year Review.

3. Predation losses to be determined by cooperators and stakeholders on game species and develop definitive statements on anticipated allocations of wild ungulates to wolves and hunters.

   Status (Time Frame): Not completed (partially implemented; time frame for completion unspecified)

   Assessment: Intensive winter monitoring has provided minimum food consumption rates and characteristics of prey being fed on by wolves. Supporting information is gathered through the analysis of other wolf kills found opportunistically throughout the year. An ongoing graduate study on Mexican wolf predation patterns should provide further insight toward food habits of wolves. However, losses to predation will be localized and difficult to determine, without additional research focused on ungulate population dynamics. Allocating wild ungulates to predators is not currently, or planned as, a management strategy in Arizona, New Mexico, or on FAIR.

   Finding: This is consistent with Recommendation 11.c. in the Recommendations Component of the 5-Year Review.

4. When livestock depredation is suspected, utilize partnerships between stakeholders to assist with increased monitoring of vulnerable livestock and local populations of wolves in order to determine if and when depredation occurs.

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: When wolves are in close proximity to livestock, the IFT informs ranchers and other livestock owners of the wolf locations. In addition, when wolf territories overlap with active livestock pastures, and depredations are confirmed or suspected, livestock managers may be provided telemetry equipment to assist with monitoring of vulnerable livestock. Under these circumstances, the IFT intensifies monitoring efforts.

   Finding: Additional assistance (i.e. riders, ranch-hands, monetary compensation etc.) can be acquired through Defenders proactive carnivore conservation fund.

5. Notify livestock operators when wolves are likely to den in livestock pastures and consider modifying livestock grazing use to minimize opportunities for depredation.

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: This Recommendation has been implemented, with successful results, through partnerships between the IFT, livestock permittees, U.S. Forest Service, and Defenders.

   Finding: The IFT, AMOC lead agencies, and cooperating organizations continue to seek innovative approaches to notifying affected livestock owners and to minimize wolf-livestock conflicts.

6. Inform livestock operators of procedures to preserve evidence of depredation and contact points to have kills confirmed.

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: This information is provided to livestock operators that have wolf/livestock conflicts through personal communication.

   Finding: A flyer has been developed with this information and has been distributed. The flyer needs to be revised to incorporate information contained in recently completed SOP 10.0: Incident Reporting by Other Agencies and SOP 11.0: Depredation on Domestic Livestock and Pets.

7. When wolves are confirmed to be involved in livestock depredation, apply direct control measures in an attempt to curtail depredation and monitor effects to determine if depredation reoccurs

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: Intensive monitoring and direct control measures are implemented after depredations are confirmed or suspected, in accordance with protocols.

   Finding: Direct control measures and circumstances for their use are described in the recently completed SOP 13.0: Control of Mexican Wolves.

8. If wolves are observed chasing/harassing livestock, utilize aggressive aversive conditioning in an effort to curtail the behavior and if these attempts fail take direct control actions to curtail the behavior or remove the offending animal or animals.

   Status (Time Frame): Completed/being implemented (ongoing)

   Assessment: Aggressive aversive conditioning may be successful in temporarily deterring wolves from livestock in some cases. Direct control measures may be needed but other less drastic options need to be implemented before direct control (removal) of the wolves will occur.

   Finding: These management responses are conducted in accordance with SOP 13: Control of Mexican Wolves. This is consistent with Recommendation 10 in the Recommendations Component of the 5-Year Review.

9. Review and refine the criteria for release site selection and timing, including: potential conflicts with previously released wolves, potential conflicts with land uses; potential conflicts with humans; potential conflicts with management priorities for other species of wildlife; desired impacts on other species (i.e. reducing populations of other predators), den-

site potential; wild ungulate prey base abundance and availability; post-release movements and dispersal potential; any other relevant biological factors; logistical feasibility; cost of field monitoring; and field project staffing needs.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: A comprehensive analysis of release site areas should increase chances of wolf survival and reproduction, and lessen impacts to current land uses and local residents.

Finding: Through adaptive management and information gained from previous releases, the release site selection process has become more refined and is likely to have increased success in the future. In addition, SOPs 5.0: Initial Wolf Releases and 6.0: Wolf Translocations address these.

10. Create a review team that includes stakeholders to identify and prioritize potential release sites within the reintroduction area (includes timing, prey base, land ownership).

    Status (Time Frame): Not completed/being implemented (initial stages; time frame for completion unspecified)

    Assessment: AMOC did this for the spring 2004 release proposal, through AMWG and Greenlee County AZ. This Recommendation was considered not completed because a new review team was not created to accomplish this task. In Arizona, this was done initially to identify the eight original release sites within the primary recovery area, and also on FAIR through the White WMAT planning process. Similarly, New Mexico completed this task for four initial sites selected within the Gila wilderness.

    Finding: The IFT, on an ongoing basis, will continue to evaluate and propose potential release sites as identified in SOP 5.0: Initial Wolf Releases and SOP 6: Wolf Translocations.

11. Develop criteria for class of wolves to be released (individual vs. pack; male vs. female; pregnant female; old vs. young; etc.).

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Analysis of previously released wolves to determine the most successful characteristics has helped make subsequent releases more successful. However, adherence to strict criteria may not be possible, given the relatively small number of genetically surplus wolves that can be released, and other field considerations.

    Finding: The IFT will use criteria developed in SOP 5.0: Initial Wolf Releases and SOP 6.0: Wolf Translocations.

12. Develop a formal supplemental feeding protocol.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: Supplemental feeding is dictated by factors such as: 1) use of food caches 2) wild experience of released wolves 3) release site fidelity 4) natural prey use, etc. Flexibility must be maintained to allow for adaptive management under dynamic situations.

Finding: The IFT will follow the supplemental feeding protocol in SOP 8.0: Supplemental Feeding.

13. Review and refine all depredation management procedures and guidelines on public and on private lands.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Depredation management procedures and guidelines were reviewed and refined.

    Finding: Three SOPs related to this Recommendation were approved in 2005: SOP 13.0: Control of Mexican Wolves, SOP 11.0: Depredation on Domestic Livestock and Pets, and SOP 10.0: Incident Reporting by Other Agencies.

14. Review and refine all procedures and guidelines for detecting and monitoring released wolves, radiotracking and recapture practices in proximity to livestock and elsewhere.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Procedures and guidelines for detecting, monitoring, and capturing wolves were reviewed and refined.

    Finding: Nine SOPs related to this Recommendation were approved in 2005: SOP 11.0: Depredation on Domestic Livestock and Pets, SOP 13.0: Control of Mexican Wolves, SOP 15.0: Helicopter Capture and Aerial Gunning, SOP 16.0: Howling Surveys, SOP 17.0: Ground Telemetry, SOP 18.0: Aerial Telemetry, SOP 21.0: Handling, Immobilization, and Processing Live Mexican Wolves, SOP 22.0: Chemical Darting, and SOP 23.0: Blood Collection, Handling and Storage.

15. Review and refine all procedures and guidelines for translocation.

    Status (Time Frame): Completed/being implemented.

    Assessment: Translocation procedures and guidelines were reviewed and refined.

    Finding: SOP 5.0: Initial Wolf Releases and SOP 6.0: Wolf Translocations were revied, revised, and approved in 2005.

16. Review and refine all criteria, procedures, and guidelines for temporary and/or permanent removal from the wild of released wolves.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Criteria, procedures, and guidelines for removal of wolves were reviewed and refined.

    Finding: SOP 11.0: Depredation on Domestic Livestock and Pets and SOP 13.0: Control of Mexican Wolves were approved in 2005. Relocating wolves previously removed from the wild is recommended by the IFT, and approved by the respective agency where the release site is located. Relocating wolves is based on cause of removal, genetic profile of population, population density, and amount of breeding pairs in the wild.

17. Review and refine all procedures and guidelines for preventing, managing, or monitoring dispersal.

    Status (Time Frame): Not completed (time frame for completion unspecified)

    Assessment: Analysis of previously released wolves to determine the age class of most common dispersers, pack size with highest dispersal rates, and other circumstances of dispersal has allowed the IFT to better prevent, manage, and monitor dispersal. Routine aerial and ground telemetry monitoring has allowed the IFT to track dispersing wolves.

    Finding: Formal procedures or guidelines have not been developed specifically for dispersal, but portions of this Recommendation are covered in various other Project documents such as: the FEIS, the nonessential experimental rule, and various SOPs (i.e. SOP 5.0: Initial Wolf Releases, SOP 6.0: Wolf Translocations, and SOP 13.0: Control of Mexican wolves). However, dispersal is a natural and desirable behavior of wolves, which facilitates natural pair formation, reproduction, and recolonization. Therefore, it is impossible to prevent and is extremely time consuming to manage dispersal behavior.

18. Review and refine all procedures and guidelines for detecting or monitoring prey use.

    Status (Time Frame): Completed

    Assessment: Various IFT activities are designed to document prey use (i.e. winter study, depredation study, and ongoing graduate research). In addition, wolves are intensively monitored after direct releases from captivity or when in close proximity to cattle, to determine prey use.

    Finding: SOP 19.0: Intensive Winter Monitoring and Ungulate Mortality Collection outlines specific guidelines for detecting and monitoring prey use, through intensive aerial and ground monitoring.

19. Review and refine all procedures and guidelines for detecting and monitoring selection and use of den sites.

    Status (Time Frame): Not completed (not considered necessary)

    Assessment: Routine monitoring has detected the selection and use of most den sites; therefore, formal procedures or guidelines have not been deemed necessary by the IFT. Some den sites have been analyzed for their physical and biological characteristics.

    Finding: Current procedures appear adequate for detecting and monitoring den sites and additional formal guidelines are not deemed necessary at this time.

20. Review and refine all procedures and guidelines for detecting and monitoring reproduction.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: The IFT initially documents reproduction through monitoring, observational data, localized movements during denning season, and later determines successful reproduction through den site analysis, howling for pups, and observations. The current field practices of the IFT have been very successful at determining reproduction.

    Finding: Current procedures appear adequate for detecting and monitoring reproduction, but the IFT continues to look for opportunities to adaptively improve methodology.

21. Review and refine all procedures and guidelines for detecting and monitoring pup recruitment (survival past one year).

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: The IFT documents recruitment through collaring pups and tracking survival. Supplemental information is obtained by acquiring pack size and pup counts through observational reports, howling surveys, and track counts. Collaring or ear tagging pups with remote transmitters is the best way to accurately determine pup recruitment (survival past one year).

    Finding: Monitoring pup recruitment is difficult, but current procedures appear adequate at this time. The IFT continues to assess and evaluate opportunities to adaptively improve methodology, however.

22. Review and refine all procedures and guidelines for detecting and monitoring availability and use of water.

    Status (Time Frame): Not considered necessary to complete/implement

Assessment: Implementing this Recommendation would require intensive monitoring and research efforts beyond the current scope of the IFT. Prior to releasing wolves, the IFT considers the proximity of a release site to perennial water sources, as part of the release site selection criteria.

Finding: Creating procedures and guidelines for detecting and monitoring water availability and use has no application for the Reintroduction Project, and therefore, is deemed unnecessary.

23. Review and refine all procedures and guidelines for identifying and addressing conflicts with land uses and land users.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Conflicts with land uses and users are identified and addressed through AMOC and AMWG.

    Finding: SOP 13.0: Control of Mexican Wolves was approved in 2005 and addresses approaches to mediating conflicts with land uses and users.

24. Develop procedures and guidelines for minimizing undesired and maximizing desired impacts on other species of wildlife.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Concerns over minimizing undesired and maximizing desired impacts of wolves are addressed through AMOC and AMWG.

    Finding: Provisions to address this topic were incorporated into the FEIS, Final Rule, and SOP 13.0: Control of Mexican Wolves. Additional procedures and guidelines will be developed when issues arise.

25. Review the protocol for husbandry of captive pre-release wolves in on-site acclimation pens to ensure it is adequate to maximize post-release survival and breeding success.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: A husbandry protocol for captive wolves in on-site acclimation pens was developed in 1998, prior to the first release of Mexican wolves. Since the inaugural release of Mexican wolves in 1998, Project personnel have been refining methodologies used for releases to maximize post-release survival and breeding success.

    Finding: This is consistent with Recommendation 27 in the Recommendations Component of the 5-Year Review.

26. Develop guidelines to ensure that Project staff solicit and consider information from all available knowledge bases (including published and unpublished sources, locally knowledgeable individuals, natural historians, academicians, agency staff, and historical as well as recent information) during Project planning and implementation.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: During development of SOPs and other Project guidelines, IFT members solicited and considered information from professionals and specialists within the field of wolf research/management, review published and unpublished documents, and research archived data within each of the respective agencies. AMOC and AMWG provide opportunities to use all available knowledge bases in other planning and implementation stages, including public/stakeholder input.

    Finding: This Recommendation is consistent with Recommendations 13 and 16 in the Recommendations Component of the 5-Year Review.

27. Compile data to ensure availability of data

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Data are collected and compiled on all facets of the Reintroduction Project, including but not limited to: wolf locations, mortalities, incident reports, observation reports, depredation investigations, predation/carcass analysis, releases/translocations, acclimation facilities, and the captive breeding program. Project personnel assimilate archived data to disseminate internally among the cooperating agencies, the public, and academic entities. Information dissemination occurs through status reports, monthly updates, briefings, recommendations, proposals, and technical, professional, and general presentations. In addition, data were made available for the 3-Year Review and are gradually being released to academia for research purposes.

    Finding: This is consistent with Recommendation 15 in the Recommendations Component of the 5-Year Review.

28. Develop the 5-Year Review criteria

    Status (Time Frame): Completed

    Assessment: Criteria were developed by AMOC.

    Finding: 5-Year Review criteria are completed as supported in this document.

29. Develop the 5-Year Review process

Status (Time Frame): Completed

Assessment: The 5-Year Review process was developed by AMOC.

Finding: Development of the 5-Year Review process is completed as supported in this document.

30. Provide technical training opportunities for field staff in the broader recovery zone and other wolf projects (including Mexico) in order to standardize methods and provide quality control.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Several Reintroduction Project employees previously participated in the red wolf recovery program, the northern Rockies wolf recovery project, and the northeastern wolf recovery project. Frequent discussions with other projects and familiarity with the literature has helped ensure standardized methods and quality control. Continuing education for staff will help staff retention and make the Project more effective and efficient. Mexican interns have worked on the Mexican wolf Reintroduction Project, acquiring technical skills and exposure to policies and procedures, and developing a partnership with their United States counterpart.

    Finding: This is consistent with Recommendation 28 in the Recommendations Component of the 5-Year Review.

31. Ensure that Project staff have competency in data gathering, storage, retrieval, and analysis.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Appropriate Project staff are trained and evaluated in data gathering, storage, retrieval, and analysis. On-the-job training and fulfillment of employee professional development plans provides Project personnel with opportunities to enhance and refine their ability to accomplish the aforementioned objectives. However, agencies need to provide their staff with more opportunities to acquire skills and appropriate knowledge required to perform these tasks using current scientific methodologies. Agencies should identify deficiencies through regular job performance appraisals.

    Finding: This is consistent with Recommendation 28 in the Recommendations Component of the 5-Year Review.

32. Ensure that Project staff have competency in verbal and written communication skills

    Status (Time Frame): Completed/being implemented (ongoing)

Assessment: Training and evaluation of all appropriate staff in verbal and written communication skills is an ongoing process.

Finding: This is consistent with Recommendation 28 in the Recommendations Component of the 5-Year Review.

33. Agency personnel should attend at least two communication training sessions annually.

Status (Time Frame): Not considered necessary to complete/implement

Assessment: Project personnel attend regular training as part of their respective professional development plans, and are also continually involved with on the job training opportunities.

Finding: Given time and funding constraints, it is considered excessive for staff to attend two communication-training sessions annually. Opportunities for in-house and on-line training will be explored.

34. Develop mechanisms to communicate and inform stakeholders, especially for local communities

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: AMOC and AMWG provide opportunities for local communities and other stakeholders to communicate directly with Project managers quarterly, within or near the BRWRA. In addition, monthly updates are posted on Project websites and disseminated throughout local communities within the BRWRA. Furthermore, livestock producers and affected members of the public are informed about wolf presence, depredations, and nuisance animals found in the vicinity of their livestock or residence.

Finding: This is consistent with Recommendations 23 and 24 in the Recommendations Component of the 5-Year Review.

35. Provide accurate bi-monthly information on FWS website by the USFWS

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: In 2003, the IFT converted bi-monthly updates into monthly updates to increase the amount of detail and depth of these reports. These reports are also accessible via the AGFD and USFWS websites. Individuals requiring immediate information on wolf locations (i.e. livestock producers and affected citizens), due to depredation or nuisance behavior, are provided appropriate information by the IFT.

Finding: This is consistent with Recommendations 23 and 24 in the Recommendations Component of the 5-Year Review.

36. Identify resources, individuals, or groups that can aid outreach activities.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: This Recommendation was implemented through development and coordination of teacher wolf workshops, in cooperation with the Information and Education Branch of the AGFD, and other organizations. Partnerships between the IFT and volunteer groups are also occurring to aid in development and dissemination of outreach materials.

Finding: This is consistent with Recommendations 23 and 24 in the Recommendations Component of the 5-Year Review.

37. Information provided in outreach programs should be balanced and objective and not designed to persuade attitudes and opinions.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: All information provided during outreach programs is evaluated for its balance and objectivity as outlined in SOP 3.0: Outreach. Recommended changes can be made through IFT staff and supervisors, public comment, AMOC, and AMWG.

Finding: This is consistent with Recommendations 23 and 24 in the Recommendations Component of the 5-Year Review.

38. Increase the sensitivity of program staff and partners to cultural differences in attitudes and values specific to the program.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: Project personnel are cognizant there is a diverse array of cultural attitudes and values specific to the wolf reintroduction. Information is presented to the public in a non-biased manner and Project personnel are receptive to all questions and concerns. Understanding different cultural attitudes and values toward the Project enables the IFT and agency administrators to appropriately represent the full spectrum of public interests. AMOC and AMWG provide forums for the public and public representatives to address issues of this nature.

Finding: This is consistent with Recommendations 23 and 24 in the Recommendations Component of the 5-Year Review.

39. Scientists and administrators involved in the program need to have a high level of sensitivity to the political factors, operating at various levels, that seek to influence the program and resist purely politically motivated solutions to problems.

Status (Time Frame): Completed/being implemented

Assessment: The IFT generally attempts to resolve issues by specifically addressing solutions based on the scientific literature and overall working knowledge of specific problems. Political realities should always be a part of the IFT and AMOC decision -making process, however.

Finding: The IFT's primary role is to present the best science-based recommendations (while keeping in mind political and other considerations). AMOC's responsibility is to evaluate the recommendations and consider the socio-political context.

40. Incorporate local citizen views into the Mexican gray wolf recovery program.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: AMOC and AMWG provide opportunities for local citizen views to be incorporated into the Reintroduction Project. In addition, the Mexican Wolf Recovery Team Stakeholder Sub-Group is composed of representatives from local communities and organizations involved in development of a new Mexican Wolf Recovery Plan.

Finding: This is consistent with Recommendation 34 in the Recommendations Component of the 5-Year Review.

41. Cooperators and stakeholders develop and define measurable techniques for reducing livestock and animal conflict by the end of the 5-Year Review.

Status (Time Frame): Not completed/being implemented (time frame for completion unspecified)

Assessment: Techniques to reduce livestock and animal conflicts are described in SOP 13.0: Control of Mexican Wolves. Defenders of Wildlife coordinated discussions with Project cooperators, stakeholders, and interested parties, trying to develop an insurance compensation program for livestock depredations, which doesn't require depredations to be confirmed in order to receive monetary compensation. However, this compensation system is only a concept at present, in preliminary discussion phase. Project personnel also acquire input from stakeholders through day-to-day interactions.

Finding: This is consistent with Recommendation 12 in the Recommendations Component of the 5-Year Review.

42. Develop information dissemination network to provide current and timely information to pet owners, sporting dog owners, recreationists within occupied wolf areas.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: Project briefings and signs are posted throughout the BRWRA, special notices are posted at trailheads or campgrounds, and personal contacts are made with campers, hunters, and residents when wolves are in their area.

Finding: IFT and AMOC will continue to seek innovative solutions to provide current and timely information to all users of the land within occupied wolf areas.

43. Minimize management action (e.g., capture/recapture, supplemental feeding, and removal of wolves).

    Status (Time Frame): Completed/being implemented

    Assessment: Management actions have been minimized through application of hazing techniques, release of family groups with pups, reductions in the number of wolves directly released from captivity, and less supplemental feeding of wolves. However, management actions will always be needed to address various reintroduction concerns.

    Finding: Toward this end, a set of Reintroduction Project SOPs has been developed to guide when and how various management actions will be applied.

44. Monitor long-term disease and health trends to include a health assessment and vaccinations into wolf handling protocols to limit health and disease concerns.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Long-term disease and health trends have been and are being monitored through regular testing of wolves and blood samples.

    Finding: Health assessments, vaccination tracking, and blood collection have been incorporated into SOP 21.0: Handling, Immobilization, and Processing Live Mexican Wolves.

45. Identify local misconceptions, with help of local sources of the Mexican wolf, and address them as part of the outreach plan.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Many local misconceptions were identified through the 3-Year Review public open house and workshop process. All these misconceptions were considered during development of SOP 3.0: Outreach, which is carried out by Project personnel during formal presentations and informal communication with the public.

    Finding: AMOC is preparing a "myth busters" document to address the more common misconceptions dealing with Mexican wolf reintroduction. The document will be downloadable from http://azgfd.gov/wolf when it is completed.

46. There is a need to address the issue of livestock carcass detection and disposal to reduce wolf and livestock conflicts.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: Carcasses of livestock are, when feasible and acceptable to the livestock owner(s), made unavailable to wolves by removal, rendering inedible, or on-site disposal by the IFT (however, see C/R 257 in the AMOC Responses to Public Comment Component). Carcasses on public lands that are seen during aerial telemetry flights, or discovered through regular field monitoring, are routinely disposed of or rendered inedible by the IFT, when feasible and acceptable to the permittee. Similar actions are taken by the IFT on private lands, when given permission.

Finding: This is consistent with Recommendations 12.b and 29 in the Recommendations Component of the 5-Year Review.

47. Compile and review all monitoring and recapture information collected to date on dispersing wolves to evaluate effectiveness, program costs, and impacts to landowners and other stakeholders due to current boundaries.

Status (Time Frame): Not completed (time frame for completion unspecified)

Assessment: It would be difficult, if not impossible, to split off time and expense figures for monitoring dispersing wolves. In addition, the effectiveness of the activities would be difficult to define and the impacts to landowners might be extremely difficult to quantify. However, managing wolves that establish territories wholly outside the BRWRA requires an extensive amount of resources, and limits the ability of IFT staff to pursue other field responsibilities.

Finding: This is consistent with Recommendation 13 in the Recommendations Component of the 5-Year Review.

48. Conduct a staffing need assessment based on Project experience to date.

Status (Time Frame): Completed/being implemented (2005)

Assessment: AGFD conducted a staffing needs assessment, and initiated an expansion and reorganization of the AGFD portion of the IFT to reflect roles and responsibilities, as described in the MOU. Thus, as of 2005, AGFD has 5 full-time employees assigned to the IFT. WMAT recruited a technician in 2003 to complement the existing wolf biologist position. USFWS stationed the Mexican Wolf Field Projects Coordinator in Alpine AZ, to facilitate communication between cooperating agencies and become a functional member of the IFT. NMDGF has hired an additional person for the IFT who will report for duty in early 2006. WS has assigned 2 employees to part-time duty (total 1.25 FTEs) on the IFT.

Finding: This is consistent with Recommendations 29, 30, and 31 in the Recommendations Component of the 5-Year Review.

49. Compile, review, and publish an assessment of all release program impacts reported to date on existing land uses, local customs, cultures, and economies in Arizona and New Mexico, including a determination of appropriate measures.

    Status (Time Frame): Completed

    Assessment: This Recommendation is addressed in the Socioeconomic Component of the 5-Year Review.

    Finding: See the Socioeconomic Component of the 5-Year Review for information compiled to date on this Recommendation. This is also consistent with Recommendation 13 in the Recommendations Component of the 5-Year Review.

50. Compile and analyze all incidents involving livestock, other domestic animals, or humans to identify preventative measures and to assess the effectiveness of current management options.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: All reported incidents of wolf-livestock or wolf-human interactions during the initial stages of the Project are discussed in the Technical Component of the 5-Year Review.

    Finding: Compilation and analysis of all incidents involving livestock, other domestic animals, and humans is completed as supported in this document.

51. Assess the impact of wolves on other species of wildlife.

    Status (Time Frame): Not completed (time frame for completion unspecified)

    Assessment: To produce valid information a study would have to extend over several years, for each species studied, requiring significant funding which has not been available. With approximately 50 wolves spread out over 2500 mi^2 it would be very difficult to assess with any accuracy the wolves' impact on other species of wildlife, in any specific area. Another impediment to completing this Recommendation is the lack of any defensible density data for any of the various prey species in the area.

    Finding: This is consistent with Recommendation 25 in the Recommendations Component of the 5-Year Review.

52. Survey the public, academicians, and agencies to identify areas in which they believe they can appreciably contribute knowledge that is not currently reflected in the program.

Status (Time Frame): Completed/being implemented (ongoing)

Assessment: This was done through the 3-Year Review process, and continues through the activities of AMOC and AMWG, as well as, the 5-Year Review. The Recovery Team is comprised of a diverse group of people from the public, academia, and government agencies; it contributes knowledge and information that otherwise might not be as well represented in the Reintroduction Project.

Finding: This is consistent with Recommendation 34 in the Recommendations Component of the 5-Year Review.

53. Survey the public and program staff to identify information gaps, weaknesses, perceived misleading information that affect their understanding of the need for and/or quality of the program.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: This is already being done on an informal basis but could be better structured to provide more complete information to the public.

    Finding: This was done through the 3-Year Review process and continues through the activities of AMOC and AMWG, as well as the 5-Year Review.

54. Collect data on aversive conditioning to identify management actions.

    Status (Time Frame): Completed/being implemented

    Assessment: Hazing of wolves through intensive short-term harassment usually causes wolves to move from an area temporarily or sometimes permanently. Management actions conducted by the Project revealed that aversive conditioning has greater success in smaller defined areas.

    Finding: The IFT will continue to gather literature on aversive conditioning and document all pertinent data (e.g. method employed, wolf response, follow-up) when aversive conditioning is applied. These data will be used through adaptive management to evaluate, modify, and improve the efficacy of aversive conditioning actions applied to Mexican wolves.

55. Collect data on Mexican wolf food habits to quantify actual diet composition.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: A graduate student completed a Master's Thesis (Reed 2004), analyzing wolf scats to determine food habits of Mexican wolves. Intensive winter monitoring and opportunistic collection and analysis of wolf kills have also provided characteristics of prey used by Mexican wolves. In addition, a graduate level study on wolf predation patterns is underway to further address this issue.

Finding: Innovative approaches to refine, expand, and fund Mexican wolf food habit studies will continue to be sought out.

56. Conduct a population/habitat viability analysis of the wild population in the BRWRA using modern, scientifically accepted methods, to be completed by FWS contracted experts by February 2002.

    Status (Time Frame): Not completed

    Assessment: A population/habitat viability analysis has not been completed for three reasons: (a) AMOC believes there is not yet sufficient demographic and other required information to conduct a robust PVA; (b) expert opinion is mixed at best on the utility of population/habitat viability analyses in "real world" management; and (c) population/habitat viability analyses are significant time and money sinks, and until both (a) and (b) have been satisfactorily resolved, AMOC will place higher priority on other facets of the Reintroduction Project, such as on-the-ground wolf management and community outreach. However, in anticipation of these problems being overcome, AMOC will collaborate with an independent entity to identify all information needs (e.g. data types and sample sizes) for a statistically valid habitat/population viability analysis for the BRWRZ wolf population to be conducted and completed in Calendar Year 2010.

    Finding: This is consistent with Recommendation 32 in the Recommendations Component of the 5-Year Review.

57. Establish baseline numbers and distribution data for selected (examples) wild organisms and ecological processes by August 2002, and implement ongoing monitoring of change.

    Status (Time Frame): Not completed (not considered necessary)

    Assessment: This is beyond the scope of the BRWRA Reintroduction Project, and would require resources and research assets not currently available. However, AMOC encourages independent research on this and other aspects of the wolf reintroduction.

    Finding: This is consistent with Recommendation 16 in the Recommendations Component of the 5-Year Review.

58. Analyze the short and long term effects of management actions on wolf behavior, social structure, and evolution.

    Status (Time Frame): Not completed

    Assessment: Analysis of management actions on wolves is an ongoing activity.

Finding: Data related to this Recommendation are routinely collected during ongoing IFT management activities. An objective assessment of this Recommendation will require dedicated research. This Recommendation is consistent with Recommendation 16 of the Recommendations Component of the 5-Year Review.

59. Collect and analyze all available historical information on past wolf numbers and distribution.

    Status (Time Frame): Completed

    Assessment: This information can be found in the FEIS (USFWS 1996) for reintroduction of Mexican wolves.

    Finding: See the FEIS (USFWS 1996), Parsons (1996), and Brown (1983) for scholarly discussions of the history of Mexican wolves, including past numbers and distribution.

60. Develop a better understanding of ethical considerations related to Mexican gray wolf recovery, including the reintroduction of captive-raised predators into the wild, allowing extinction of this sub-species, and the conflicting attitudes and resulting stresses among residents of the area directly affected by wolf recovery.

    Status (Time Frame): Completed/being implemented (ongoing)

    Assessment: Prior to inception of the reintroduction effort, extensive deliberation occurred on whether or not Mexican wolves should be reintroduced, analyzing the ethical, biological, and socio-political implications and ramifications. Conclusions from this analysis were incorporated into the policies, rules, and regulations that govern the Reintroduction Project.

    Finding: Ethical considerations are discussed and analyzed through AMOC and AMWG. Information on conflicting attitudes and resulting stresses is provided in the Socioeconomic Component of the 5-Year Review.

61. Contract an independent comprehensive economic (costs - benefits) analysis that evaluates and quantifies the potential and actual benefits and losses of the Wolf Reintroduction in the activities of the local communities. The results have to be immediately incorporated to the adaptive management in the program, the 5-Year Review and any subsequent reviews in order to maximize the benefits and minimize the costs.

    Status (Time Frame): Completed

    Assessment: A Socioeconomic study was conducted as part of the 5-Year Review.

    Finding: See the Socioeconomic Component of the 5-Year Review for a synopsis of the best information gathered to date on cost/benefit analysis of Mexican wolf reintroduction.

62. Evaluate effectiveness of current compensation fund and implement monetary reimbursement.

    Status (Time Frame): Not completed (time frame for completion unspecified)

    Assessment: A sub-group from AMOC has been created to handle this issue.

    Finding: This is consistent with Recommendation 12 in the Recommendations Component of the 5-Year Review.

63. Analyze behavior of wolves released to date to determine what the recovery zone boundaries should be from a biological perspective (i.e. considering denning and foraging behavior, and seasonal or other movements).

    Status (Time Frame): Completed

    Assessment: Data discussed in the Technical Component of the 5-Year Review reveal that present recovery zone boundaries are inadequate. Wolves are natural dispersers, traveling extensive distances in search of available home range, mates, and appropriate habitat. Since inception of the Reintroduction Project, several wolves have dispersed outside the BRWRA, and even outside the experimental population area, before localizing and establishing a home range. A few denning packs have also established territories wholly outside the BRWRA. All the aforementioned wolves were subsequently removed and relocated due to violation of the boundary rule. Further analysis is being conducted through the 5-Year Review to determine whether or not recovery zone boundaries should exist, and if so what they should be from a biological perspective. The New Mexico Game Commission has also directed NMDGF to analyze this Recommendation.

    Finding: This is consistent with Recommendation 5 in the Recommendations Component of the 5-Year Review.