APPENDIX D: WOLF POPULATION, DISTRIBUTION, AND DENSITY PROJECTIONS FOR ALTERNATIVES ONE-FOUR

In order to analyze the environmental consequences of the implementation of our proposed action and alternatives, we estimated the expected Mexican wolf population, distribution, and density in the MWEPA when the population reached the population objective of Alternative One or achieved medium-high wolf densities in Alternatives Two-Four, after which time we would expect impacts to remain fairly constant for all Alternatives. We based our estimations on the extrapolation of information and data from Mexican wolves in the BRWRA and other wolf populations, and related scientific literature.

1.1 Population Growth

We selected an average annual increase in population size for the proposed action and alternatives after considering the experimental population's growth during the last 16 years, growth exhibited by other wolf populations, and the specific considerations of our project study area and management provisions. We describe how population size or growth may vary between each alternative, below.

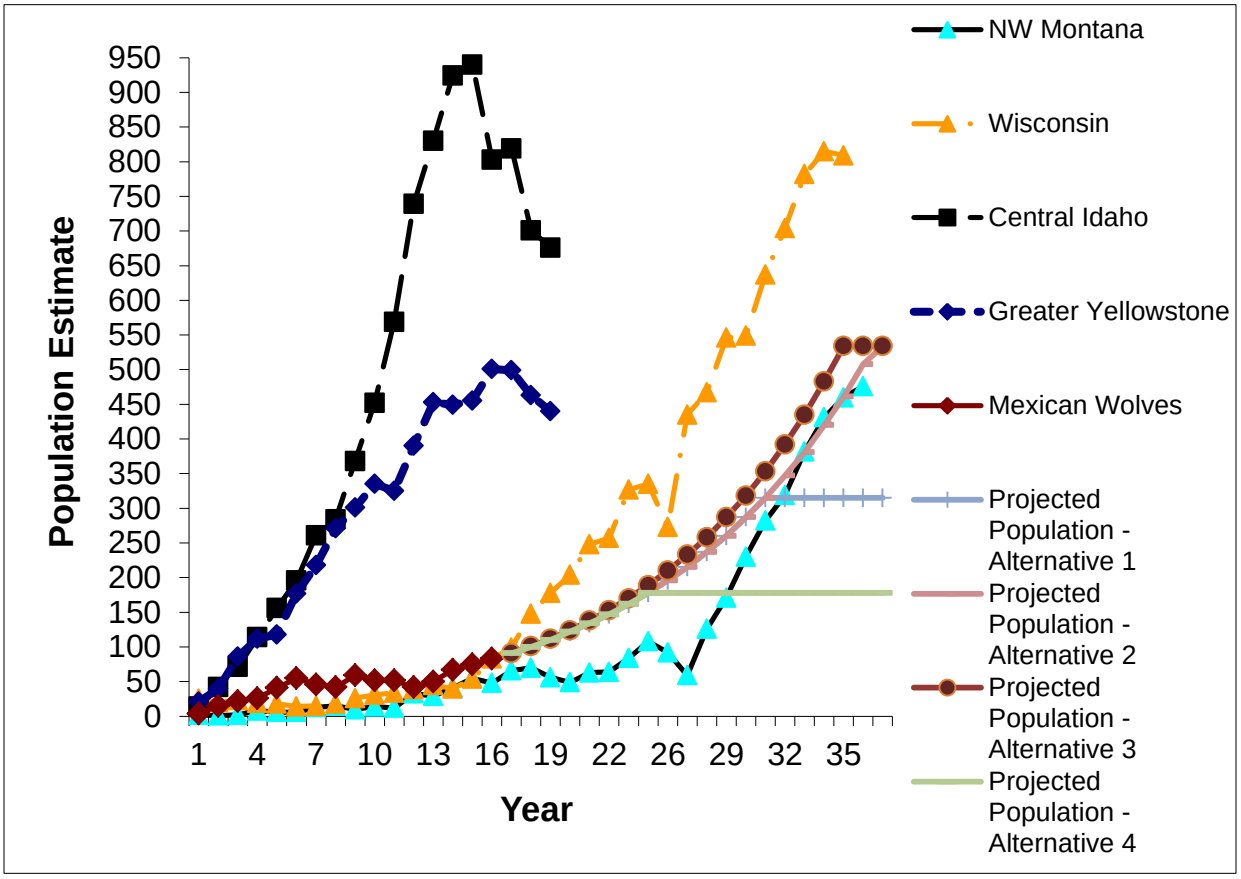
Wolf population growth can be highly variable from one time period to the next or for different wolf populations (Fuller et al. 2003, Table 6.8). Natural population growth is driven by pup survival, immigration, and limiting factors such as food availability, disease, and mortality (Fuller et al. 2003), and can be influenced artificially by release of animals or removal of animals, as in the case of a managed, reintroduced population such as the Mexican wolf experimental population. For example, population increases of 450% have been observed from one year to the next in a gray wolf population, as have drastic declines due to harvest or disease (Fuller et al. 2013). Over the reintroduction time frame (1998 to 2013), the Mexican wolf population exhibited an average annual increase of 33% per year, with significant annual variation -- the population decreased by 19% (from 52 to 42 wolves) during 2009, but increased by 40% during 2006 (from 42 to 59 wolves: http://www.fws.gov/southwest/es/mexicanwolf/pdf/MW_popcount_web.pdf).

We have gained extensive knowledge over the last 16 years of the Reintroduction Project regarding the efficacy of the 1998 Final Rule. In particular, we have documented the synergistic or antagonistic interaction of our regulations and our management actions, and their effect on the persistence and growth of, and the genetic variation within, the experimental population (USFWS 2010a). For example, we have observed additive negative population effects from the regulations that restrict initial release, require that we capture and return wolves that disperse outside the boundaries, and that result in increased management related to removal of nuisance or depredating wolves. In the years 1998 through 2002, we conducted a high number of initial releases and translocations (n = 110) and a moderate number of removals (n = 58), which contributed to a net gain of 38 wolves in the overall population and the highest average population growth rate (1.003) (e.g. the average population growth was approximately 100 percent per year: calculated as the population count at year two minus the population count at year one divided by the population at year one) experienced by the population. From 2003 through 2007, we conducted a moderate number of initial releases and translocations (n = 68) and a high number of temporary and permanent removals (n = 84), resulting in a net gain of 10 wolves in the overall population and an average population growth rate that was relatively flat (0.069). Between 2008 and 2013, which was characterized by a low number of releases and translocations (n = 21) but also a low number of removals (n = 17), we observed a net gain of 31 wolves and a higher average population growth rate (0.095) than the previous phase (Tables 1-2 and 1-3).

Using the 2008-2013 period (0.095, or 9.5%) as a starting point from which to develop our population growth estimate, we refined our estimate for the alternatives by considering the specific circumstances of the project for the Mexican wolf. One of the most significant differences the experimental population will experience due to project implementation is exposure to a matrix of suitable and unsuitable habitat,

as opposed to the current BRWRA composition of 87% suitable habitat on primarily National Forest land. We consider the potential for wolf mortality due to illegal killing, vehicular mortality, or removal due to depredation or nuisance issues as likely to occur at the same or increased levels, compared to current levels, as wolves disperse within the MWEPA. However, we expect boundary related removals to be reduced, compared to past levels, and initial releases and translocations to occur at higher numbers relative to the 2008 to 2013 time period because of the proposed action. On balance, we expect the proposed changes to result in a slightly higher average population growth compared to the 2008 - 2013 time period. With these considerations in mind, we developed a baseline annual population growth of 11%, which we further refined based on the circumstances of each alternative (below).

The projected baseline population growth rate (11%) we estimated for the Mexican wolf experimental population would exhibit similar growth as the naturally recovering populations of gray wolves in northwestern Montana and Wisconsin (Figure D-1) when these populations were fully protected as endangered species. Population growth of Mexican wolves has never mimicked the higher growth rates that have been observed in the Greater Yellowstone Ecosystem and Central Idaho populations, but has in the past resembled the growth of populations in northwestern Montana and Wisconsin (Figure D-1). We recognize that actual population growth from year to year during the implementation of our proposed action may fluctuate significantly, as it has in the past. The amount of suitable habitat within the MWEPA (excluding tribal lands) is slightly higher (68,938 km^2, including Zone 3) than the amount of high quality habitat within northwestern Montana (44,929 km^2) and the Greater Yellowstone Ecosystem (45,900 km^2) (Oakleaf et al. 2006, pp. 559). However, the suitable habitat within the MWEPA is more patchily distributed than habitat in the Northern Rocky Mountain population. This ancillary information is supportive of a Mexican wolf population that would be limited by habitat at population levels slightly above northwestern Montana or the Greater Yellowstone Ecosystem, but below Central Idaho, which has a greater amount (77,596 km^2) (Oakleaf et al. 2006, pp. 559) and more uniform distribution of high quality habitat. In addition, the Northern Rocky Mountain population has larger protected (e.g., wilderness and national parks with limited or no grazing) areas than the MWEPA.



Data for the Central Idaho, Greater Yellowstone, and northwestern Montana populations were obtained from U.S. Fish and Wildlife Service et al. 2014, while data for the Wisconsin population was obtained from MacFarland and Wiedenhoeft 2013.

Figure D-1. Comparison of experimental Mexican wolf population from 1998-2013 (Year 1 to Year 16) and projected into the future (Year 17 to Year 38) under different alternatives relative to other recovering wolf populations.

1.2 Effective Migrants

We will strive to supplement the experimental population with a specific number of effective migrants per generation to improve the genetic composition of the population (Carroll et al. 2014). We estimate a wolf generation to be 4 years. We expect to achieve effective migration into the MWEPA utilizing initial release of Mexican wolves and cross-fostering of Mexican wolf pups.

Initial releases of Mexican wolves from the captive population are a method to improve genetic composition of the experimental population, as the captive population currently has greater genetic diversity and lower mean kinship than that of the experimental population. Another method to improve genetic composition of the experimental population would be dispersal between other populations of Mexican wolves that have become established. We have considerable experience conducting initial releases and resulting data upon which to guide our actions. Between 1998 and 2013, our initial release success rate has been about 21% (USFWS 2002-2014). In other words, for every 100 wolves we release, only 21 of them survive, breed, and produce pups, therefore becoming effective migrants. Based on this success rate, we expect that we will need to initially release 10 wolves to achieve 2 effective migrants. Based on assessment of initial release success of various releases strategies (single wolves, pairs, packs,

etc.), we would expect to achieve this target by releasing 2 packs, each with an adult pair and several pups (estimated as~3 pups), during years 1-4 and 4-8, and 1 or 2 packs during the next three successive generations until year 20, or for 5 generations. The number of effective migrants could decrease in the third and subsequent generations, assuming the population is above 250, as a population of that size is more robust (Carroll et al. 2014). This number of effective migrants (7-10 wolves over 5 generations) is negligible from a population size standpoint but should be significant from a genetic standpoint assuming animals selected for initial release are genetically desirable contributions to the population (Carroll et al. 2014, Fredrickson et al. 2007)

Cross-fostering is a management tool that we began using in 2014. Cross-fostering occurs when offspring are removed from their biological parents and placed with surrogate parents. Our proposed action and alternatives (with the exception of the No Action Alternative which would only allow cross fostering of genetically appropriate animals in the Primary Recovery Zone of the BRWRA (See Figure 1-4)) allow for cross-fostering in Zone 1 and Zone 2, although Alternative One would restrict cross fostering in Zone 1 and Zone 2 based on the phase being implemented (see below). Therefore, we could potentially improve the genetic composition of the experimental population by placing wolf pups from captivity with adult wolves in the MWEPA. It would take at least two years to determine whether a cross-fostering effort has produced an effective migrant (i.e. pups survive to adulthood to breed with other wolves). As this is a new technique for our program, we do not have extensive data regarding its success, although we recognize that once cross-fostered pups have been successfully integrated into a pack, their likelihood of surviving, breeding, and producing pups is equalivant to the other wolves in the experimental population.

1.3 Distribution and Density

As with population growth, wolf density can vary significantly from one population to the next, driven in large part by available ungulate biomass (Fuller et al. 2003, Figure 6.2). Wolf densities of more than 50 wolves per 1,000 km^2 (386 mi^2) to less than 10 wolves per 1,000 km^2 (386 mi^2) have been observed in North America (Fuller et. al., Table 6.2). We estimate wolf density in the BRWRA and the Fort Apache Indian Reservation (FAIR) to be between 3.5 wolves per 1000 km^2 (386 mi^2) to 11.3 wolves per 1000 km^2 (386 mi^2) of suitable habitat depending on the methodology used to calculate density (Table 1-Appendix F). We calculated the current density of wolves within the BRWRA and the FAIR using three methodologies to account for the variation observed in the population. Density in methods 1 and 2 was calculated using the 2012 population count as adjusted (80 wolves) in the 2012 Mexican Wolf Annual Report addendum (USFWS 2013a), with a potential for an additional 10% of wolves being missed during the census (e.g., 88 wolves). Method 1 used the largest area of suitable wolf habitat, that is, suitable wolf habitat on the BRWRA and FAIR. Method 2 used a smaller area to calculate density than method 1 to account for the lower likelihood that some areas have been surveyed or the lower likelihood of wolf presence due to distance from the core population of wolves. Thus, method 2 represented the suitable wolf habitat in the BRWRA and FAIR that was east of highway 73 and north of the Burro Mountains. Finally, method 3 was based on the suitable wolf habitat in the BRWRA and FAIR within the 95% kernel home range of Mexican wolves during 2012 and the number of known wolves occurring within those home ranges (55 wolves); therefore this estimate utilized the smallest area of potential wolf habitat and the smallest number of wolves of the three estimates (Table D-1).

Table D-1. Density estimate of Mexican wolves in BRWRA and FAIR.

Category	Amount of Suitable Wolf Habitat (km^2)	# of Wolves	Density (# of Wolves/1000 km^2)
Method 1	22,851	80-88	3.5-3.9
Method 2	18,457	80-88	4.3-4.8
Method 3	4,874	55	11.3

The density estimate resulting from method 2 is likely the most realistic description of current wolf density in the BRWRA and the FAIR. Our density estimate resulting from method 1 may result in an artificially low density estimate because it included areas that were either not intensively surveyed or too far from the core population to expect wolves to establish; it would be the second lowest density (out of 32 other studies) for gray wolf populations in North America (Fuller et al. 2003). Our density estimate resulting from method 3 may be artificially high because it assumes that wolf territories are adjacent to one another without any interstitial space between territories throughout suitable habitat, which is highly unlikely (Mech and Boitani 2003).

In order to establish a likely future density for wolves to use as a guide for estimating the impacts of our alternatives, we estimated 8 Mexican wolves per 1000 km^2 (calculated based on the estimated wolf population in two 10,000 km^2 restoration zones south of Interstate 40 in Carroll et al. 2006). We chose this density because it does not assume wolf territories are adjacent to each other without interstitial space (e.g. 11.3 wolves per 1000 km^2), but allowed for higher densities than that currently documented in the BRWRA and FAIR (e.g. 4.5). Therefore, we projected the population growth associated with Alternatives Two-Four until such time as the population reached a density of approximately 8 wolves per 1000 km^2 of suitable habitat in Zones 1 and 2 (note: Alternatives One, Two, and Three excluded suitable habitat on tribal lands because tribes have the option of allowing wolves on these lands and determining the number of allowable wolves. Under Alternative Four we included the FAIR because the White Mountain Apache Tribe currently allows wolves to occupy that area).

Over the project time period, we expect wolves to occupy, and have a higher likelihood of persistence in, areas we have identified as suitable habitat in the proposed MWEPA, rather than habitat that is not considered suitable (Figure 1-21). This assumption is supported by our experience with Mexican wolves in the BRWRA (see Figure D-2, note that wolves have not occupied the area in the southwestern portion of the BRWRA despite releases occurring in this area in 1998 and 1999). However, for our proposed action and alternatives, we do not know which patches of suitable habitat may become occupied first (with the exception of the No Action Alternative, see below). For Alternatives Two and Three, wolves dispersing from Zone 1 into Zone 2 may take the first patch of suitable habitat available, resulting in areas in Zone 2 closest to Zone 1 becoming occupied first; or, they may bypass unoccupied habitat and establish a territory further from Zone 1, as has been observed in other gray wolf populations in which wolves disperse beyond the "frontier" of their population (Mech and Boitani 2003). Our translocations and limited initial releases in Zones 2 throughout the time period may also affect wolf distribution. Locations for these management actions will be determined based on our release criteria and the specific circumstances attending the action; thus no discernible pattern can be predicted, although we expect to concentrate our translocation or limited initial release actions in contiguous habitat adjacent to occupied areas. Similar to what has been observed for other gray wolves, whose territories shift over time (Mech and Boitani 2003), Mexican wolves may occupy a patch of suitable habitat for a period of time and then the habitat may become unoccupied due to dispersal, prey availability, mortality, or removal actions.

Under Alternative One, we would implement a phased approach to provide a gradual expansion of wolf occupancy, such that wolves are moving into and occupying contiguous habitat adjacent to occupied areas. We developed two scenarios (A and B) to represent the range of potential desities and impacts relative to Alternative One because of the uncertainty associated with the implementation of the phases. We maintained growth rates at 10% for each scenario, but in scenario A, we assumed that we would remain in Phase 1 for years 1 through 11, thus wolf densities would be highest in this scenario because wolves are distributed in a smaller area than scenario B. In scenario B, we assumed that we would implement Phase 2 for years 6-8, and Phase 3 for years 9-11, which would result in the lowest wolf densities during the first 11 years because wolves would occupy the largest area possible under the phased approach. We examined the projected densities at year 5, year 8, and year 11 to represent the maximum difference between the scenarios during each Phase. Regardless of scenario, we projected that the wolf

population in this Alternative would stabilize at approximately 315 wolves based on the population objective of 300-325. Thus, the maximum density for Alternative One would be approximately 4.72 wolves per 1000 km^2 (calculated by dividing the number of wolves (315) by the amount of suitable habitat on non-tribal land in Zones 1 and 2 (66,808 km^2)). The maximum density would be reached around year 13 and would stabilize thereafter (see section 1.4.1 below for specific differnces through time from implementation of the two scenarios).

For Alternatives Two and Three, the population stabilized at approximately 534 wolves (calculated by multiplying 8 wolves per 1000 km^2 by the amount of suitable habitat on non-tribal land in Zones 1 and 2 (66,808 km^2). Full occupancy of Zones 1 and 2 is projected to occur at year 19 under Alternative Two and year 17 under Alternative Three. Due to lack of suitable habitat, we expect wolf density in Zone 3 to be at or near zero (unoccupied) at the end of the project time period for all Alternatives. Under Alternative Four, a maximum of approximately 178 wolves would be present on the BRWRA and FAIR at year 7 to 8 based on wolves occupying suitable habitat at a density of 8 wolves per 1000km^2, and the population would remain stable into the future.

1.4 Alternatives

1.4.1 Alternative One

In this Alternative we assume a 10% annual population growth until the population achieved the population objective (300-325), for an estimate of around 315 wolves in year 13 regardless of which Scenario (A or B) was implemented (Table D-2). This is less than the baseline of 11% because in this alternative we will include two new provisions for take on non-Federal land that the 1998 Final Rule does not include (see proposed rule (7)(iv)). One provision allows for the take of Mexican wolves by domestic animal owners or their agents if wolves are in the act of biting, killing, or wounding a domestic animal on non-Federal lands. This provision expands the previous take provision for livestock under the 1998 Final Rule to now include non-feral dogs on non-Federal lands. We estimate, based on the number of dog injuries or mortalities that have occurred from 1998 to 2013 (30 dogs over 16 years, or 1.9 dog injuries or deaths per year across all land types, an incident rate of 0.041 dogs per wolf, that this provision could result in the attempted take of approximately 1.9 wolves per year (one wolf per dog incident), or approximately 4 potential incidents that allow for take per 100 wolves. However, it is likely that some of these events will occur at night or in conditions in which attempts to take a wolf are unsuccessful. We estimate that actual take of a wolf would occur only in about 25% of the instances in which take would be authorized, or the take of 1 wolf every other year. However, because the wolf population would be increasing over time, we also analyzed the information relative to our population size at a rate of 0.01025 per wolf (0.25 (probability of successful take) multiplied by 0.041 (probability of an individual wolf being involved in a dog incident), which results in the average take of approximately 2 wolves per year. Based on these calculations, we use a 10% average annual growth for this alternative, rather than the baseline growth rate of 11%.

The second take provision would provide for the conditional issuance of permits to allow domestic animal owners or their agents to take (including intentional harassment or kill) any Mexican wolf that is present on non-Federal land owned by the domestic animal owner. In these instances, we are allowing the permittee to assist us in completing a management action to address a conflict situation. The permit will thus not allow for any take beyond that which we are already attempting to conduct. Therefore, the amount of take we expect if we issue these permits is equivalent to the amount of take we expect if we do not issue them.

Scenarios A and B were modeled with the same growth rate, but differed relative to the implementation of the phases and thus the area that wolves were allowed to occupy. The density of wolves, and therefore the associated impacts would be more concentrated under Scenario A within the smaller area defined by

Phase 1 relative to the broader area defined by Phase 3. To illustrate this pattern we calculated wolf:elk ratios and wolf density through time (Table D-2). The two Scenarios result in no differences in density or wolf:elk ratios through year 5, minor differences in years 6-8, larger differences in year 9-11, and no differences following year 12.

Table D-2. Experimental population projection at 10% annual growth until the population goals of 300-325 wolves are achieved.

Year	End-of-Year Population	Density of Wolves under Scenario A (wolves/1000 km^2 of suitable habitat)[1]	Density of Wolves under Scenario B (wolves/1000 km^2 of suitable habitat)[1]	Wolves per 1000 elk Ratio under Scenario A[2]	Wolves per 1000 elk Ratio under Scenario B[2]
*2014**	*91*	*N/A*	*N/A*	*N/A*	*N/A*
Year 1	100	1.92	1.92	1.46	1.46
Year 2	110	2.11	2.11	1.60	1.60
Year 3	122	2.34	2.34	1.78	1.78
Year 4	134	2.57	2.57	1.95	1.95
Year 5	147	2.82	2.82	2.14	2.14
Year 6	162	3.11	2.74	2.36	2.04
Year 7	178	3.41	3.01	2.59	2.24
Year 8	196	3.76	3.31	2.86	2.47
Year 9	215	4.12	3.22	3.13	2.69
Year 10	237	4.55	3.55	3.45	2.96
Year 11	260	4.99	3.89	3.79	3.25
Year 12	287	4.30	4.30	3.59	3.59
Year 13	315	4.72	4.72	3.94	3.94
After year 13	315	4.72	4.72	3.94	3.94

Note: *2014 is not included in the project time period but assumes 10% growth from 2013 in order to provide a starting point for the projection.

[1]Based on the amount of suitable habitat on non-tribal lands in Zones 1 and 2 in Phase 1 (52,143 km^2) for Scenario A and suitable habitat on non-tribal lands in Phase 1 (52,143 km^2) in years 1-5, Phase 2 (59,045 km^2) in years 6-8, and Phase 3 (66,808 km^2) in years 9-11 for Scenario B. Years 12 and beyond were based on full implementation at 66,808 km^2 of suitable habitat.

[2]Elk populations were based on herd units in Arizona and New Mexico. In herd units where a herd unit was bisected by the boundaries for the specific Phase, we used the geographic proportion of the herd unit in each phase to represent the proportion of elk in each phase. This resulted in 68,641 elk available in Phase 1, 79,458 elk in Phase 2, and 79,933 elk in Phase 3 or full implementation on non-tribal lands in New Mexico and Arizona.

We would expect to provide at least 2 effective migrants via initial releases to the population in years 1-4 and 5-8, and 1-2 effective migrants in subsequent generations until year 20 (or five generations). In Alternative One, initial release sites in the Tonto, Pleasant Valley, and Payson Ranger Districts of the

Tonto National Forest, the Sitgreaves National Forest, the Magdalena Ranger District of the Cibola National Forest, and the Gila National Forest, in addition to the Apache National Forest, would be available for us to choose from as we select the best site for each release. Depending on our management agreements with tribal governments, we may also be able to conduct initial releases on tribal land. We may also develop management agreements with other private landowners (with the concurrence of the respective State game and fish agency) and tribes in Zone 2 for release and management of wolves. We expect to utilize the same, or similar, release criteria as those currently in place for the BRWRA, which specify:

"Releases sites must be:

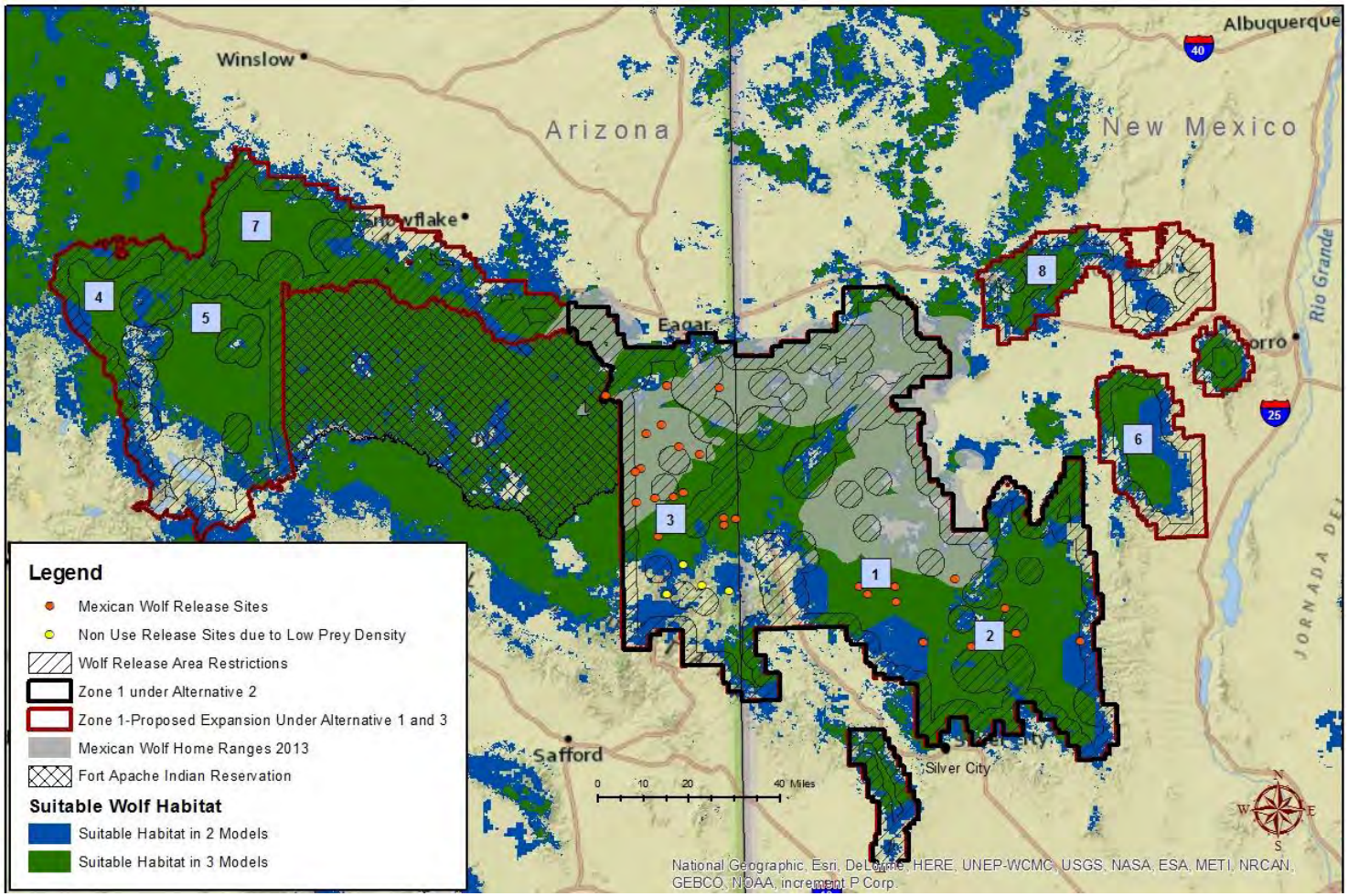
i. Five or more miles from a town.

ii. Three or more miles from a dwelling occupied year-round.

iii. Three or more miles from Recovery Area boundaries.

iv. In areas of adequate prey abundance (e.g. elk, deer, and other native ungulates), based on the best available information from the appropriate state or tribal wildlife agency."

Based on applying our current criteria to Zone 1, we expect to have adequate availability of initial release sites for the initial releases during future generations (see Figure D-2) that is, we would need 7-10 sites available (unoccupied by established wolf packs) for the release of packs. However, these actions will also depend on the natural recolonization of the area. Coordination with state and federal agencies, counties, tribes, and the public would be needed prior to identifying specific release sites in Zone 1 outside of the BRWRA (Figure D-2). Scenario A differs slightly from Scenario B relative to areas available to initially release wolves, such that under Scenario A, area 4 (Figure D-2), would not be available until after year 11 whereas in Scenario B, it would be available after year 5. In addition, we would expect Scenario A to result in a higher density of wolves in years 6-11 (Table D-2), which could also limit available release sites due to the occupancy of those sites by recolonizing wolves. Combined, these impacts could limit the recruitment of individuals and should be considered by decision makers when determining if the next phase of implementations should occur. Conversely, cross-fostering efforts could provide effective migrants and would mitigate these concerns. Thus, decision makers should also consider the number of effective migrants that are achieved through cross-fostering during determination of phased implementation.



Credit: USFWS.

Figure D-2. Map of release restrictions in Zone 1 under Alternative One (black and red polygons), Alternative Two (black polygon only), and Alternative Three (black and red polygons) and current release sites approved within the BRWRA (Orange and Yellow Dots).

Numbers represent areas where effective migrants could potentially be recruited into the population as initial releases depending on Alternatives. Suitable habitat is identified as blue or green areas. Wolf home ranges are considered proprietary information and not displayed on the Fort Apache Indian Reservation per agreement with the White Mountain Apache Tribe.

Under Alternative One, wolf occupancy in the MWEPA would be influenced by a combination of initial releases (Zone 1, and the potential to conduct initial releases under management agreements with private landowners (with the concurrence of the respective state wildlife agency) and tribes in Zone 2), translocations (Zones 1 and 2), natural reproduction and dispersal events (Zones 1, 2 and 3), as well as management removals and mortalities. At the beginning of the project time period (year 1), wolves will occupy the Gila and Apache National Forests in Zone 1. Based on 2013 occupancy, wolves will occupy approximately 30% (9,579 km^2 (3,698 mi^2) of Zone 1, or about 33% (8,975 km^2 (3,465 mi^2)) of the suitable habitat in Zone 1. Our ability to begin conducting initial releases into the Gila National Forest (the former SRZ of the BRWRA) and the Magdalena Ranger District of the Cibola National Forest, the Sitgreaves National Forest, and the Tonto, Payson, or Pleasant Valley Ranger Districts of the Tonto National Forest, as well as continued ability to conduct (limited, due to spatial constraints from existing wolf occupancy) initial releases in the Apache National Forest, will likely result in these areas serving as sources of wolves dispersing into unoccupied suitable habitat elsewhere in the MWEPA. Zone 1 is comprised almost entirely (83%) of suitable habitat.

At the beginning of the project time period, based on 2013 occupancy, wolves will occupy approximately 3% (5,419 km^2 (2,092 mi^2)) of Zone 2, or about 6% (3,313 km^2 (1,279 mi^2)) of suitable habitat in Zone 2, due to their presence on the FAIR. Zone 2 contains a more varied matrix of suitable (27%) and unsuitable (83%) habitat than Zone 1. Wolf occupancy will expand in Zone 2 over time from natural dispersal out of Zone 1 or from FAIR, by a translocation, or (less likely) an initial release we conduct into this zone. These events could happen relatively quickly after project implementation (during the first year), pending the appropriate local coordination and planning. A phased management approach would provide a more predictable pattern of expansion.

At the beginning of the project time period, no wolves will occupy Zone 3. Wolves may disperse into Zone 3 from Zone 2, but we consider it unlikely that a wolf would establish a territory in Zone 3, as it contains very little suitable habitat (1% of Zone 3 is suitable habitat). We therefore see no real likelihood of occupancy in Zone 3.

We do not provide a location-specific projection of occupancy of suitable habitat due to our inability to predict occupancy of a specific patch of suitable habitat at a specific time, recognizing that occupancy will be continually shifting due to natural population dynamics and management actions (e.g., translocations or removals), particularly in Zone 2. Based on our population projections, density predictions, and the amount of suitable habitat in Zones 1 and 2, we do not expect Alternative One to be habitat limited. That is, in Zones 1 and 2, wolves will not likely occupy all available suitable habitat.

1.4.2 Alternative Two

Alternative Two mirrors Alternative One in all provisions except for: (1) the geographic designation of Zone 1: in this Alternative, the Tonto, Sitgreaves, and Cibola National Forests would be in Zone 2 (Figure D-2), (2) the phased approach to management would not be used, and (3) we would not establish a population objective. We would therefore be limited to conducting initial releases in the Gila National Forest and the entire Apache National Forest. In addition, the population would expand beyond the population objective of Alternative One and become limited by wolf densities in suitable habitat. Depending on our management agreements with tribal governments, we may also be able to conduct initial releases on tribal land in Zone 2. We may also develop management agreements with other private landowners (with the concurrence of the respective state wildlife agency) in Zone 2 for release and management of Mexican wolves. Due to its similarity to Alternative One, we assume a 10% annual average population growth over 19 years in Alternative Two, for a population estimate of around 534

wolves in year 19 (Table D-3), at which time the population would be limited by habitat constraints set at a density of approximately 8 wolves per 1000 km^2.

Table D-3. Experimental population projection at 10% annual growth until the density achieves approximately 8.0 wolves per 1000 km^2.

Year	End-of-Year Population	Density of Wolves under Alternative Two (wolves/1000 km^2 of suitable habitat)[1]	Wolves per 1000 elk Ratio under Alternative Two[2]
*2014**	*91*	*N/A*	*N/A*
Year 1	100	1.50	1.25
Year 2	110	1.65	1.38
Year 3	122	1.82	1.53
Year 4	134	2.01	1.68
Year 5	147	2.20	1.84
Year 6	162	2.42	2.03
Year 7	178	2.66	2.23
Year 8	196	2.93	2.45
Year 9	215	3.22	2.69
Year 10	237	3.55	2.96
Year 11	260	3.89	3.25
Year 12	287	4.30	3.59
Year 13	315	4.72	3.94
Year 14	347	5.19	4.34
Year 15	381	5.70	4.77
Year 16	420	6.30	5.25
Year 17	461	6.90	5.77
Year 18	508	7.60	6.36
Year 19	534	7.99	6.68
After Year 19	534	7.99	6.68

Note: *2014 is not included in the project time period but assumes 10% growth from 2013 in order to provide a starting point for the projection.

[1]Based on the amount of suitable habitat on non-tribal lands in Zones 1 and 2 at 66,808 km^2.
[2]Elk populations were based on herd units in Arizona and New Mexico that were estimated at 79,933 elk.

In this alternative, we would expect to provide at least 2 effective migrants via initial releases to the population in years 1-4 and 5-8, and 1-2 effective migrants in subsequent generations (through at year 20, or 5 generations). Based on 2013 occupancy of established packs (Figure D-2), the BRWRA currently

has 2-3 sites available for initial releases that are considered to be within suitable habitat that is currently unoccupied by established wolves (Figure D-2). With natural population growth and the translocations of wolves into these areas during 2014-2015, these areas may become occupied by wolves in the next 2 years (Note: Initial releases or translocations were conducted during 2014 at sites near locations 1, 2, and 3 in Figure D-2). If they do not become occupied, we would have the minimum capacity necessary to conduct 2 releases during the first 4 years, with very little or no flexibility in site selection. It is highly unlikely, with a growing population, that any release sites would be available during subsequent generations; therefore, we would be unable to achieve the level of effective migration we are seeking from conducting initial releases, unless we were to translocate wolves out of occupied habitat to allow for additional initial releases. In this situation, we could attempt to improve the genetics of the population through cross-fostering of pups; however, we are unsure of our ability to successfully integrate cross-fostered wolves into the population. Therefore, we have greater uncertainty under Alternative Two than under Alternative One (or Three) that we would achieve the level of effective migration we deem necessary to improve the genetic composition of the experimental population.

Signifigant differences occur relative to the ultimate density and number of wolves between Alternatives One and Two because we do not establish a population objective in Alternative Two (Table D-3).

Based on 2013 occupancy, wolves will occupy approximately 46% (8517 km^2 (3289 mi^2) of Zone 1 at the beginning of the time period. In this Alternative, suitable habitat occurs in 87% of Zone 1; there are 16,221 km^2 (6,263 mi^2) of suitable habitat in Zone 1. Mexican wolves occupied about 50% (8029 km^2 (3100 mi^2)) of the suitable habitat in Zone 1 in 2013. At the beginning of the project time period, based on 2013 occupancy, wolves will occupy approximately 3% (6468 km^2 (2497 mi^2)) of Zone 2, or about 7% (4259km^2 (1645 mi^2)) of suitable habitat in Zone 2, due to their presence on the FAIR. Approximately 30% of Zone 2 is suitable habitat; there are 65,008 km^2 (25,100 mi^2) of suitable habitat in Zone 2.

We expect a different occupancy pattern and density in Zones 1 and 2 under Alternative Two than Alternative One due to maintenance of a population objective in Alternative One. While, under Alternative 2, we would not be conducting initial releases into the Magdalena Ranger District of the Cibola National Forest, the Sitgreaves National Forest, and the Tonto, Payson, and Pleasant Valley Ranger Districts of the Tonto National Forest, these areas would likely become occupied via natural dispersal of wolves from Zone 1 or by our translocation events, as they provide high quality suitable habitat on Federal land. We do not foresee any difference in wolf occupancy in Zone 3 in this Alternative as compared with Alternatives One or Three; that is, wolf dispersal into, and occupancy of, Zone 3 will be rare or nonexistent.

We expect a wolf population of approximately 534 wolves to be habitat limited, but additional wolves could be present on tribal lands with the agreement of the tribal government. In addition, impacts in various resource areas are expected to be higher under Alternative Two than Alternative One principally due to the higher number and density of wolves under Alternative Two.

1.4.3 Alternative Three

This alternative mirrors Alternative One in all provisions (and therefore initial occupancy descriptions) except that: (1) the two take provisions discussed under Alternative One would not be allowed, (2) the modified definition of unacceptable impacts to wild ungulates and the modified take provision related to unacceptable impacts to wild ungulates would not be included, (3) the phased approach to management would not exist, and (4) we would not establish a population objective. Consequently, we would expect the wolf population to grow slightly more rapidly towards the limit of habitat constraints at a density of 8.0 wolves per 1000 km^2. Therefore we projected an 11% annual average population growth until the

wolves reached a density of 8 wolves per 1000 km^2 (Table D-4). This resulted in wolves reaching a population of 534 in Year 17 (Table D-4) rather than year 19 (Table D-3) under Alternative Two.

Table D-4. Experimental population projection at 11% annual growth until the density achieves approximately 8.0 wolves per 1000 km^2.

Year	End-of-Year Population	Density of Wolves under Alternative Two (wolves/1000 km^2 of suitable habitat)[1]	Wolves per 1000 elk Ratio under Alternative Two[2]
*2014**	*91*	*N/A*	*N/A*
Year 1	101	1.51	1.26
Year 2	112	1.68	1.40
Year 3	125	1.87	1.56
Year 4	139	2.08	1.74
Year 5	154	2.31	1.93
Year 6	171	2.56	2.14
Year 7	190	2.84	2.38
Year 8	210	3.14	2.63
Year 9	234	3.50	2.92
Year 10	259	3.88	3.24
Year 11	288	4.31	3.60
Year 12	319	4.77	3.99
Year 13	355	5.31	4.44
Year 14	394	5.90	4.93
Year 15	437	6.54	5.47
Year 16	485	7.26	6.06
Year 17	534	7.99	6.68
After Year 17	534	7.99	6.68

Note: *2014 is not included in the project time period but assumes 10% growth from 2013 in order to provide a starting point for the projection.

[1]Based on the amount of suitable habitat on non-tribal lands in Zones 1 and 2 that we estimated at approximately 66,808 km^2.

[2]Elk populations were based on herd units in Arizona and New Mexico that were estimated at 79,933elk.

We expect a wolf population of approximately 534 wolves to be habitat limited, but additional wolves could be present on tribal lands with the agreement of the tribal government. In addition, impacts in various resource areas (such as elk populations in this example) are expected to be higher under Alternative Three than Alternative One, principally due to the higher number and density of wolves under

Alternative Three. Because Alternative Three has higher growth rates (due to fewer take provisions) than Alternative Two, this alternative reaches suitable habitat saturation two years earlier than Alternative Two. Alternative Three also has more areas to conduct initial releases than Alternative Two, which should allow for more certainty in attaining goals for effective migrants. However, Alternative One is similar in terms of areas for initial releases, particularly under Scenario B.

1.4.4 No Action Alternative

In this Alternative, we would expect population growth to remain similar to what we observed from 2008-2013, until such time as the population was limited by factors such as: (1) inbreeding and decreased reproductive success resulting from a reduced ability to conduct initial releases (Fredrickson et al. 2007), (2) increasing numbers of management actions and removals due to boundary violations as wolves search for unoccupied habitat, and (3) limited translocations due to reduced availability of suitable translocation sites. Thus, we selected an initial population growth rate of 10% for this alternative. However, we projected that suitable habitat would become saturated before the end of the project time period and thus we also limited the number of wolves based on projected densities in this Alternative.

Based on a medium-high density of wolf occupancy in the BRWRA and the FAIR (8 wolves per 1000km^2) most suitable habitat is filled by no later than midway through year 7 of the project. Therefore, we projected 10% growth for years 2015 to 2021 and no growth thereafter. We would expect a population of around 178 wolves (i.e., 7 years of 10% growth (through 2021 see Table D-2) 0% growth in subsequent years), to arrive at a density of approximately 8.0 wolves per 1000 km^2 of suitable habitat.

Under this Alternative we would not have the capacity to conduct initial releases to achieve 2 effective migrants per generation. We attempted 2 initial releases in 2014 into habitat deemed to be marginal within the PRZ due to its proximity to other wolves; both initial releases failed likely due to interactions with wolves in nearby territories, resulting in the two pairs of wolves splitting up and the two initially released animals failing to be incorporated into the population. We consider it highly unlikely that we would be able to conduct adequate initial releases during the first generation (note: only area 3 in Figure D-2 would be available for initial releases), and even less likely in the second, third, or subsequent generations. In this alternative, spatial constraints from the expanding population would also mean that unoccupied habitat for translocations would not be available. We would not meet our genetic goals under this alternative, and, as the population grows, the lack of genetic variation in the population will become more pronounced and the likelihood of inbreeding will increase (Fredrickson et al. 2007, Siminski and Spevak 2013). Our best option for reducing the risk of inbreeding in the population might be to remove wolves that have genes that are overrepresented in the population or show evidence of inbreeding and replace them with genetically desirable wolves. This would not be a long-term solution, however, as population size would be constrained under this Alternative, ultimately constraining the genetic composition. We could also conduct cross-fostering within the portion of the Apache National Forest that is considered the Primary Recovery Zone (PRZ) of the BRWRA. However, we have been prepared to conduct cross-fostering in each of the past three years, but for a variety of reasons, primarily related to the wolves denning outside of the PRZ, we have been unable to attempt cross-fostering in this area with pups from captivity (which would be considered an initial release).

This Alternative represents a continuation of the regulations in the 1998 Final Rule. At the beginning of the time period, wolves will occupy approximately 46% of the BRWRA (50% of suitable habitat in the BRWRA) at their current density. Occupancy of currently unoccupied suitable habitat would be driven primarily by natural population growth and dispersal, with very limited or no initial releases and translocations due to our spatial limitations within which to conduct these management actions. We would expect an increasing number of boundary violations over time, as space available in the BRWRA

to establish territories becomes more and more limited due to population growth (AMOC and IFT 2005). We would expect most of the suitable habitat in the BRWRA, and presumably the Fort Apache Indian Reservation to the degree allowable as established in our management agreements with the White Mountain Apache Tribe, to be occupied at densities that may be unachievable because of the juxtaposition of suitable habitat to the boundaries of the BRWRA.

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