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Public Comments Processing

Attn: Docket No. FWS-R2-ES-2017-0036

U.S. Fish and Wildlife Service,

New Mexico Ecological Services Field Office,

2105 Osuna Road NE,

Albuquerque, NM 87113

Submitted via www.regulations.gov

Re: Comments on Mexican Wolf Draft Recovery Plan, First Revision (Docket #: FWS–R2–ES–2017–0036)

Dear Regional Director Tuggle,

I, Dr. Carlos Carroll, herein provide comments on the U.S. Fish and Wildlife Service's (FWS) Mexican Wolf Draft Recovery Plan, First Revision and associated documents and appendices (82 Fed. Reg. 22918-22920, June 30, 2017), which requests "comments on the recovery strategy, recovery criteria, recovery actions, and the cost estimates associated with implementing the recommended recovery actions." My qualifications to review the scientific basis for the recovery plan and associated documents stems from my more than two decades as a research scientist focused on population viability and habitat analysis for wolves and other large carnivores. I served as a member of the Science and Planning Subgroup of the Mexican Wolf Recovery Team convened in 2011, and as a technical advisor to the previous Mexican Wolf Recovery Team in 2005. In the course of this research, I have authored peer-reviewed papers on the science underpinning the recovery of the Mexican wolf (*Canis lupus baileyi*) (e.g., Carroll et al. 2014a, 2014b).

The purpose of recovery under the US Endangered Species Act (ESA) is to recover species to the point at which the protections of the Act are no longer necessary, because the species exists in wild, self-sustaining populations and no longer meets the definition of an endangered or threatened species under the Act, i.e., is not at risk from the threats that led to its endangerment in the first instance.

Recovery criteria, a key part of every recovery plan, establish objective and measurable criteria, based solely on the best available scientific and commercial data, which effectively address all of the major threats to the species, as specified in a five-factor analysis which categorizes threat factors based on the language of the Act. The FWS uses the three criteria of resiliency, redundancy, and representation (the so-called 3 Rs; Shaffer and Stein 2000) as an aid to evaluate whether a species has achieved recovery.

Although my comments below focus on the science underpinning the draft plan, I frame the discussion in the context of the ESA's definition of recovery. I establish several areas where the draft plan, particularly the proposed recovery criteria, falls short of the requirements of the ESA, including by:

a) failure to accurately represent best available scientific information;

b) failure to establish criteria which objectively and comprehensively address key threats;

c) failure to establish criteria which, if achieved, would indicate that the species exists in wild, self-sustaining populations which as a whole achieve resiliency, redundancy, and representation, such that the Mexican wolf no longer meets the definition of a threatened or endangered species.

<u>I. The draft plan and proposed recovery criteria do not accurately represent best available scientific information.</u>

I review below two documents which underpin the draft plan's recovery criteria: the "Population Viability Analysis for the Mexican Wolf, June 13, 2017 version" ("PVA") and the "Mexican Wolf Habitat Suitability Analysis in Historical Range in Southwestern US and Mexico, April 2017 version" ("habitat analysis").

<u>General comments on the Population Viability Analysis</u>

Population viability analyses (PVA) are important tools in informing development of recovery criteria, especially for well-studied species such as wolves. PVA is a tool that helps planners systematically elicit and synthesize the best available biological information, such as factors affecting the demographic and genetic status of threatened species, and the influence of these factors on population viability and endangerment.

It is important to remain aware of two limitations of PVA. Firstly, there are limitations in the biological data that informs parameterization of the model. This leads to the “garbage in, garbage out” problem, in which PVA results can be no more accurate than their input data. Secondly, planners must understand the limitations of the model itself. The primary strength of the Vortex PVA model used here is its ability to incorporate detailed information on the genetic composition and pedigree of existing individuals and project the genetic development of the population over time. However, Vortex only incorporates an extremely simplified representation of the spatial, behavioral, and other factors influencing the dynamics of real-world populations. Due to these limitations, Vortex results should be seen as information that can assist in devising effective recovery strategies, rather than as accurate predictions of the future status of the population. This has strong implications for the adequacy of the draft plan’s proposed genetic criteria as detailed below.

In particular, the search for an exact number that represents a “minimum viable population” (MVP) is no longer seen as an informative framework for PVA. The goal is instead to use a comprehensive set of metrics from the PVA results to craft an effective strategy to address threats and grow a population beyond the stage where small-population factors such as genetic inbreeding are important. In contrast, the Mexican wolf PVA, rather than use PVA to identify what would be a minimum population size that might afford long-term viability, and then use that threshold (with some precautionary buffer) to set recovery goals to be reached and surpassed, seeks to identify a size that is marginally adequate, and then control numbers via offtake so that the populations cannot exceed these minimal levels. This approach turns the modern concept of PVA on its head, harkening back to the now outdated focus on a single MVP threshold.

<u>Specific comments on parameter values used in the PVA</u>

<u>Mortality rates</u>

In a previous study, Carroll et al. (2014a) found that the adult mortality rate was the most important parameter affecting extinction risk among simulated populations of Mexican wolves. Carroll et al. (2014a) used a base adult mortality rate of 22.9%/year. The adult mortality rate used in the PVA scenario that underpins the draft plan's criteria (scenario "379_200_200_249_EISx220_20") is 24.9%/year. This rate is similar to that experienced by wolves prior to delisting in the Northern Rocky Mountains (Smith et al. 2010). However, Mexican wolves in the US have historically experienced higher mortality rates. The plan justifies use of the lower mortality rates by assuming that future human-caused mortality rates will be lower than those observed in the past for Mexican wolves. However, as discussed below, unlike in the earlier draft plan (USFWS 2012, MWRT-SPS 2013), no recovery criteria have been proposed that would ensure that mortality rates are as low or lower than the rate assumed in the PVA. Additionally, mortality rates in the PVA are affected by assumptions regarding the extent and number of years in which supplemental feeding of the wild population occurs. The PVA assumes that, unlike in other wolf recovery regions, significant levels of supplemental feeding will continue in perpetuity for the Mexican wolf. Due to expected future resource limitations on agencies conducting supplemental feeding, the PVA's assumptions regarding such feeding are likely unrealistic.

<u>Proportion of females in the breeding pool</u>

In wild wolf populations, the proportion of adult females that breed may have large effects on the growth rates and persistence of wolf populations. Wolf pack size, which is typically smaller in heavily exploited populations, influences what proportion of females can become dominant and achieve a high probability of breeding. Carroll et al. (2014a) found that the proportion of adult females in the breeding pool was the second most important parameter affecting extinction risk among simulated populations of Mexican wolves. Carroll et al. (2014a) used a parameter value of 0.50 (i.e., half of a population's adult females), whereas the current PVA used a value of 0.77.

The proportion of adult females breeding is often difficult to estimate in wild wolf populations. Available data, however, suggest that the proportion of adult females that breed may in large part be determined the density of wolves in a population as well as prey abundance. Fredrickson (unpublished) summarized the results from 9 published studies, and found a mean proportion of females breeding of 68.1% (SD 19.4%). Smith et al. (unpublished) found a significant relationship between wolf population density and proportion of females breeding in the Yellowstone population.

When wolf populations are at low absolute densities, or at low densities relative to prey populations, a higher proportion of adult female wolves breed. When wolf populations are at high densities, or at high densities relative to prey populations, wolves may form larger packs in which fewer females breed each year, or females may become nutritionally stressed, reducing the proportion of females that breed (Boerteje and Stephenson 1992).

The Mexican wolf population in the two decades since reintroduction would be expected to have an anomalously high rate of females breeding due to the fact that 1) the population is still in an initial expansion phase from reintroduction, and 2) mortality rates have been high as is typical of a heavily exploited population. Both of these factors would tend to create small pack sizes and opportunities for almost all adult females to breed. Analysis of data from the Blue Range population in fact show a decline in the proportion of females breeding as that population has grown in size (Fredrickson, unpublished).

The current PVA justifies the use of a high parameter value (0.77) based on rates observed since reintroduction. However, this rate would be expected to decrease as population density increased, and if mortality rates were reduced. In fact, a reduced mortality rate is used in place of the observed rate based on the assumption that mortality will be lower in the future, but the observed proportion of females breeding (which resulted in part from historically high mortality rates) is used without adjustment. The assumptions of the current PVA concerning the two most important parameters are thus inconsistent.

Inbreeding depression

Genetic threats resulting from inbreeding effects on survival and fecundity have been documented in most small populations (Frankham et al. 2017). The Vortex model was developed in large part to allow more accurate assessment of such threats. Carroll et al. (2014a) found that the strength of inbreeding depression was the fourth most important parameter affecting extinction risk among simulated populations of Mexican wolves.

Inbreeding can affect fecundity either by increasing the odds of failure of a pair to produce any offspring or by reducing the litter size of those litters that are produced. Whereas

Carroll et al. (2014a) parameterized effects of inbreeding depression on both litter probability and litter size based on published sources (e.g., Fredrickson et al. 2007), the current PVA incorporates inbreeding effects on the probability of producing a litter, but not as an influence on litter size. This weaker inbreeding effect parameterization is based on a new analysis (Clement and Cline, 2016) that has not been published in the peer-reviewed literature, and is only incompletely described in the PVA report itself.

1) Although Clement and Cline (2016) present few details of their analysis, and do not state which if any alternative models they considered, it is clear from their plot C-1 that their model is misspecified. For both the supplementally-fed and non-fed groups, many more than half of the data points fall below the predicted relationships. Clearly, the red and green regression lines shown in the figure do not fit the data points well. There appears to be a clear downward trend with inbreeding in the observed data points for pup count of wolves not receiving supplemental feeding, implying that the data shows a negative inbreeding effect that is not captured in their model. This alone suggests that their reported results are erroneous.

Additionally, deriving good estimates of inbreeding depression, especially from a relatively small sample size, can be complicated by a number of factors:

2) The extensive supplemental feeding from 2009 to 2014 would be expected to mask inbreeding effects and allow pups that would otherwise be compromised by inbreeding to survive. As stated by the FWS's invited peer reviewers, it is well known that inbreeding depression is environmentally dependent, with greater inbreeding depression evident in more harsh environments. If diversionary feeding were eliminated, it is likely that any negative association of inbreeding and litter size would be more easily observed.

3) As pointed out by the FWS's invited peer reviewers, the Blue Range (MWEPA) population might already be fixed for a number of deleterious alleles. In this case, there would be no evidence of inbreeding depression because virtually all individuals, independent of inbreeding level, would have detrimental genotypes. Given that there are only two founder genome equivalents remaining in the population, it is likely that that this factor could contribute to the difficulty in estimating inbreeding effects in this population.

4) The genetic relationships and level of inbreeding in the 7 founders of the Mexican wolf population were unknown. Without molecular genetic assays of inbreeding (e.g., based on genome-wide homozygosity), any pedigree-based inbreeding estimates could be inaccurate.
5) In uncontrolled experiments such as this, a number of confounding factors (age of dams, prior breeding experience, provisioning, different levels of disturbance, etc.) can complicate analyses. Clement and Cline (2016) and Oakleaf and Dwire (2016) tried to account for some of these factors in their models, but it is not clear if they looked for interaction effects (as would occur if supplemental feeding obscured inbreeding effects). And even "best supported" models can do a poor job of identifying causal factors when many factors (including quadratic terms) that are not well balanced are included in the analysis. For example, older dams might tend to have lower inbreeding levels (because they were born earlier in the program), so factoring out a positive effect of dam age can also incidentally partially remove an inbreeding effect. The statistical model of Clement and Cline (2016) included inbreeding and supplemental feeding only as independent, additive effects, and not as interacting effects (which is what would be expected).

I agree with FWS invited peer reviewer 2 that the "results of Clement and Cline (2016) are quite surprising and unsupportable", for the reasons detailed above. If as seems likely, the parameters used in the current PVA underestimate the effects of inbreeding depression, this implies that the PVA results are overoptimistic, and that the draft plan's criteria are inadequate to address the genetic threats that arise due to small population size.

Probability of stochastic events such as disease

One of the primary strengths of Vortex and other PVA simulation models is the fact that they can incorporate effects of infrequent episodic threats such as disease outbreaks. Carroll et al. (2014a) parameterized episodic threats based on data from the Yellowstone wolf population which showed distemper outbreaks and "related population declines as often as every 2–5 years", and affecting primarily fecundity rather than survival (Almberg et al. 2009, 2010). The Carroll et al. (2014a) PVA estimated that in a year with a disease outbreak, fecundity would be reduced by 80%, and survival of all age classes would be reduced by 5%. The current PVA assumes that disease outbreaks occur on average every 6.7 years, and that in a year with a disease outbreak, pup survival would be reduced by 65%, and survival of all other age classes would be reduced by 5%. The current PVA's parameters are thus more optimistic than those used in Carroll et al. (2014a), and less consistent with what is known from other wolf populations with a longer data record regarding disease outbreak frequency. Distemper has been recently detected in the Mexican wolf wild population (Fredrickson, pers.comm.). Importantly, data from other inbred wolf populations such as that of Isle Royale suggests that inbreeding depression may make wolves more susceptible to disease and other stochastic threats. This interaction is not incorporated in the 2014 or 2017 PVAs and would tend to make their results somewhat overoptimistic.

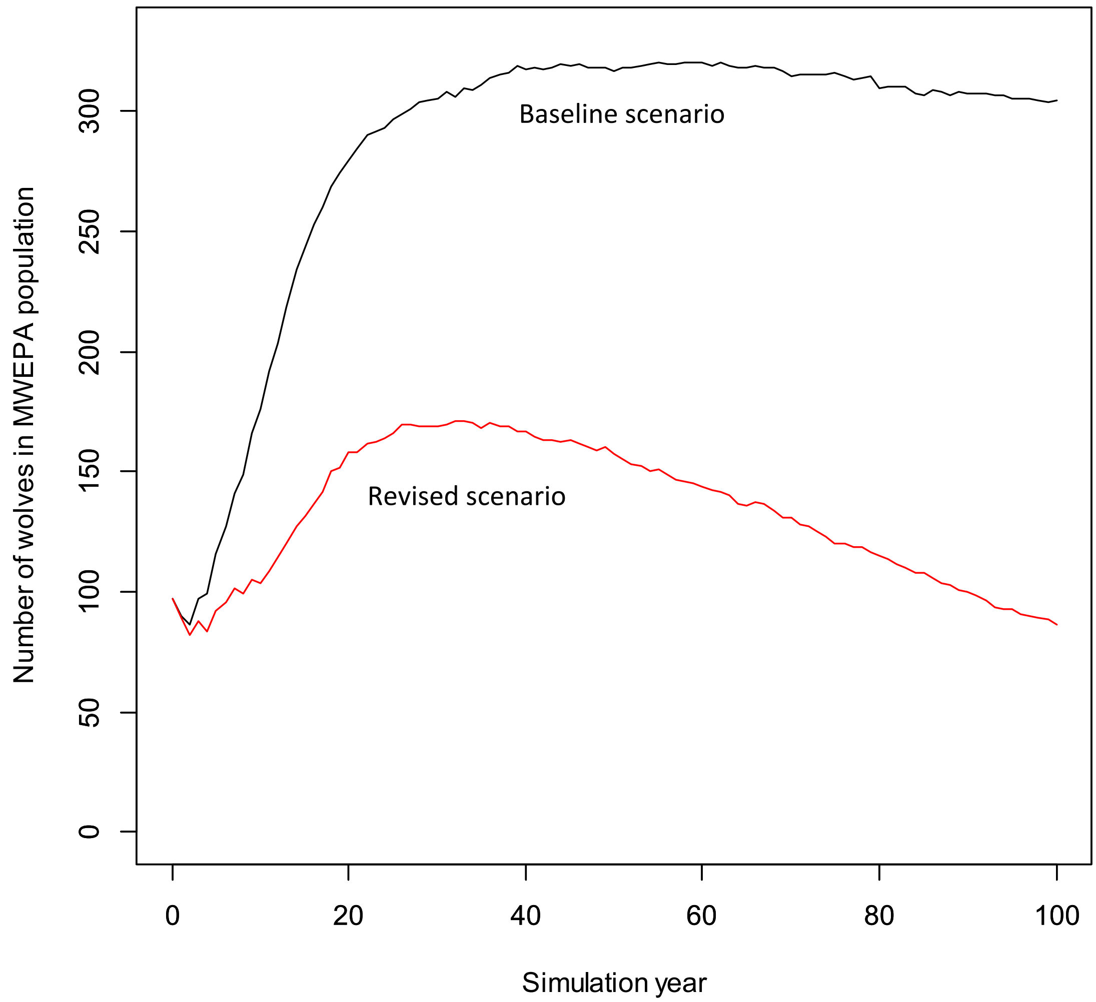
In summary, it appears that the draft plan's PVA opts for parameter values giving the most optimistic results as to persistence. Any one parameter choice would not be determinative but in sum, the suite of overoptimistic parameters is highly unlikely to accurately represent dynamics of wild Mexican wolf populations.

Results of simulation with revised parameters

I reran the Vortex simulations using the baseline scenario with two revisions. Firstly, the proportion of females in the breeding pool was revised downward from 77.6% to 69%, which is the mean value from 10 studies (the 9 studies reviewed by Fredrickson (unpublished) and the Blue Range population). Secondly, the frequency and intensity of disease outbreaks were changed from the values used in the current PVA to those used in the Carroll et al. (2014a) PVA, which were based on data from Yellowstone (Almberg et al. 2009, 2010). Importantly, although the baseline PVA likely underestimates the strength of inbreeding depression, this parameter was not altered because I did not have access to the data necessary to re-estimate the regression model developed by Clement and Cline (2016).

The effects on population persistence were nonetheless striking (Figure 1). Probability of extinction of the MWEPA population increased to 42%, and the MWEPA population showed a steady decline towards extinction (versus the gradual decline shown under the baseline scenario). The average MWEPA population size never reached the delisting threshold of 320 wolves. These results clearly demonstrate the fragility of the PVA's conclusions to the overoptimistic assumptions on which its parameter values are based.

Figure 1. Projected mean population numbers by year for the MWEPA population and metapopulation under a) the baseline scenario used to support proposed recovery criteria, and b) the baseline scenario with parameters for proportion of females breeding and disease outbreaks adjusted to better reflect available published data from multiple wolf populations.



Review of the Habitat Analysis

A rigorous analysis of the distribution of suitable habitat is a key aspect of recovery planning. Estimates of the carrying capacity of different regions is used as one input in the Vortex PVA. However, the primary value of habitat analysis for reintroduced species such as the Mexican wolf is to prioritize which regions are most likely to be able to support core populations of wolves before and after delisting due to expected low levels of human-caused mortality and adequate prey.

When considering the potential role of Mexico in recovery, we should clearly distinguish between the demographic and geographic components of recovery. That is, a wolf population in Mexico may be necessary to fulfill goals of geographically-extensive recovery. For this reason, previous recovery teams have all suggested including Mexico in recovery efforts. However, unless habitat areas in Mexico support secure populations with low levels of human-caused mortality, these populations will remain small and isolated and unlikely to contribute demographically to recovering the Mexican wolf metapopulation as a whole.

The habitat analysis associated with the draft plan ("Mexican Wolf Habitat Suitability Analysis in Historical Range in Southwestern US and Mexico, April 2017 version") estimates the extent and distribution of suitable habitat based primarily on climatic niche modeling. These models use correlation between climatic maps and the recorded locations of a species (e.g., historical locations of collection of wolves by museums) to make predictions as to what other areas have an environment (e.g., climate) similar to where wolves once occurred. While such models are useful when applied in the appropriate context, they have well-known limitations and should not be used in isolation to assess habitat availability for recovery, as they measure only one dimension of a complex habitat niche.

I discuss below how the accuracy and relevance of the habitat analysis results depends on several factors, summarized in the form of key questions which must be addressed before one can have confidence that the resulting information can support recovery planning:

<u>a) Do the occurrence locations used to build the model represent the pre-settlement distribution of the Mexican wolf?</u>

The relevance of climatic niche model results is dependent on the quality of the input distributional data. Historical species locations should be representative of the fundamental climatic niche of the species, rather than biased by uneven survey effort or past extirpation of the species from otherwise suitable habitat. Extirpation of wolves, including Mexican wolves, from large portions of their historic range occurred prior to the era when the locations used in the niche model were collected.

The conclusions of the habitat analysis regarding the extent of climatically suitable habitat contrast with those of previous niche models (e.g. Hendricks et al. 2016; see Figure 2).

This may be partially due to two contrasts between the distributional data used. Firstly, Hendricks et al. (2016) included 7 northerly sample points from areas with historical admixture between Rocky Mountain wolves and Mexican wolves. Secondly, the habitat analysis reviewed here includes many anecdotal reports of wolf occurrence from the southern portions of the range in Durango, Mexico, but does not include similar survey effort in other regions. The sensitivity of results to alternate input data sets suggests caution before excluding northerly areas from consideration as suitable habitat.

b) Are climatic factors expected to be the primary constraints on Mexican wolf distribution?

The relevance of niche model results depends on the assumption that the climatic or other variables used represent the primary factors limiting distribution of the species. This is unlikely to be true for a species such as the wolf which is a relative habitat generalist but highly limited by human-caused mortality. In the current habitat analysis, the influence of non-climatic habitat variables was evaluated only after areas had been excluded from consideration based on the climatic niche analysis.

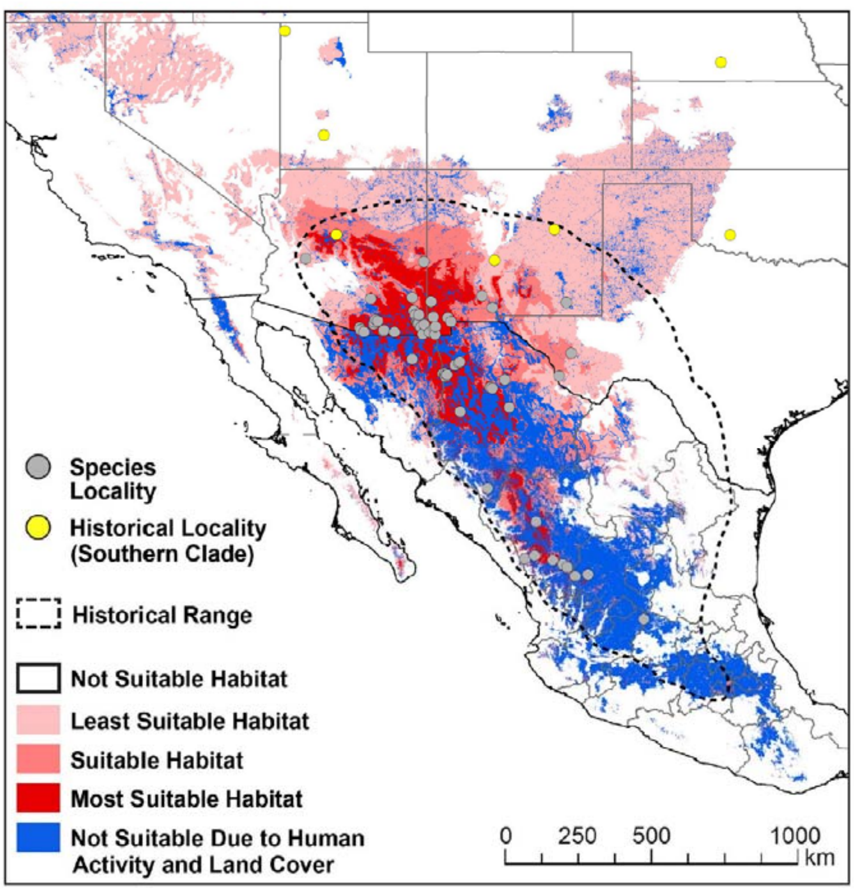
c) Does the final suitability map (here a binary "consensus" map) accurately represent the aggregate model results?

The final binary map of suitable vs. non-suitable habitat produced in the habitat analysis is quite conservative in its bias towards delimiting a less extensive region of suitability. The analysis excludes 4 of the 8 models tested due to their "overprediction" (i.e., identification of areas not within the limited set of occurrence data). Next, the analysis further limits the region of suitability to areas where 2 or more of those 4 models simultaneously identified habitat. In contrast, Hendricks et al. (2016) retained information on areas of lower climatic suitability (Figure 2), as such options may be important to planners if other factors such as human-caused mortality risk impact areas of higher predicted climatic suitability.

d) Do secondary variables used to screen areas within the climatic niche accurately represent non-climatic limiting factors?

The habitat analysis reviewed here does not adequately consider several major limiting factors for wolf survival and persistence. The primary factor limiting wolf distribution is human-caused mortality (Fuller et al. 2003, Mladenoff et al. 2009). The past 20 years of experience from wolf recovery efforts in the US demonstrates that large blocks of public land are key to at least the initial stages of wolf recovery. This is true even in states such as Wisconsin, where territories of recolonizing packs were initially anchored by the few blocks of federal and state forestlands. The habitat analysis provides no data demonstrating that sufficiently large habitat blocks, suitable to support a population of a wide-ranging carnivore such as the wolf, currently exist in Mexico. 35-40% of the US southwestern landscape is federal public land, but these conditions do not exist in Mexico, where >95% of the landscape is in small private landholdings. The FWS conducted an analysis in 2012 that concluded that potential recovery areas in Mexico were not only smaller, but also had far higher livestock density (making conflict with wolves more likely) and lower native prey biomass than areas in the southwestern US (Table 1). The experience with wolf recovery in Mexico to date has reinforced the sense that recovery of a widely-ranging carnivore in such a landscape of fragmented private holdings is challenging: wolves must be supplementally fed to discourage them from ranging beyond the site of reintroduction into the broader high-risk landscape.

Figure 2. Species distribution model of Mexican wolves developed by Hendricks et al. (2016).



The data that is used in the habitat analysis to assess factors related to survival (e.g. roads; INEGI 2000) in Mexico has well-known limitations. The data is much less comprehensive in representing unpaved roads than are US roads data sets, leading to an overestimate of suitable habitat in Mexico. Additionally, those prey surveys that are available for northern Mexico are primarily from game farms (UMAs) or lack sufficient sample size and cannot be easily generalized beyond the limited area in which surveys have been conducted, so cannot be used to provide a robust landscape-scale estimate of prey abundance or wolf carrying capacity. Previous Mexican wolf recovery teams have concluded that, due to alteration by human development and resource use of the historic habitat inhabited by Mexican wolves in Mexico, recovery of wolves in Mexico will be slow and will not contribute demographically to the larger metapopulation in the short and medium term.

Table 1. Comparison of potential Mexican wolf recovery areas in the United States and Mexico, in terms of percentage of public land, prey density, and cattle density. Excerpted from material prepared by the USFWS Mexican Wolf Recovery Team Science and Planning Subgroup in December 2012.

AREA	% PUBLIC LAND	PREY DENSITY (DEPU)	CATTLE DENSITY
Southern Rockies	64.4	7.6	3.4
Grand Canyon	54.9	4.1	1.4
Blue Range	66.1	5.6	1.6
West Texas	0.07	~3	2.7
Chihuhua/Sonora	<1	2.2	4.3
Durango/Zacatecas	<1	2.2	9.3
Coahuila	<1	0.60	4.3
Nuevo Leon	7.2	0.23	6.3

II. The draft plan does not establish criteria which objectively and comprehensively address key threats.

The ESA defines an endangered species as "at risk of extinction throughout all or a significant portion of its range" (16 U.S.C. §1532(3.6)), and a threatened species as "likely to become endangered in the foreseeable future" (16 U.S.C. §1532(20)). The ESA's legislative history indicates that Congress intended the Act to afford a high level of security to listed species (Carroll et al. 2012). Because a population's extinction risk is never zero, establishing risk thresholds in listing and recovery actions involves a normative dimension (i.e., specifying what level of endangerment is acceptable) and a scientific dimension (i.e., determining whether a species meets that level of endangerment)(Vucetich et al. 2006).

Although the U.S. Congress mandated that agencies consider "solely" the best science in making listing decisions (16 U.S.C. §1533 (3b)(1A)(a1)), lawmakers addressed the normative nature of such decisions only qualitatively when they emphasized in the ESA the high degree of protection they intended to afford to biodiversity (Carroll et al. 2012). While the ESA does not explicitly define quantitative thresholds for acceptable risk, this does not mean that administrative agencies may apply such risk thresholds inconsistently. Clear and consistent implementation of statutes is necessary to maintain the continuity in conservation policy that is required to realize the goals of the ESA.

While data for many species are too limited for quantitative PVA-based extinction risk estimates, such estimates are possible for relatively well-studied taxa such as the Mexican wolf. Gilpin (1987), one of the few authors to consider the normative aspects of this issue, argued for considering risks of extinction for 200-year time frames simply because he believes humanity's immediate challenge is to eke through the next two centuries while losing as few species as possible. Shaffer (1981) adopted a 99% persistence probability for 1000 years as a viability criterion for grizzly bears.

However, Soulé (1987) and Shaffer (1987) expressed concern that targeting a minimum viable population (MVP) level is inadequate for sound conservation, because most PVAs underestimate long-term uncertainty in stochastic events and MVPs provide minimal capacity for populations to withstand unforeseen circumstances. They argue that PVA results should be used instead to provide information on the general relation between risk and factors such as abundance, genetic diversity, and distribution (Shaffer et al. 2002). Recovery goals appropriately include a sufficient margin of safety to ensure that unanticipated future events do not cause species to fall below the threshold that would again make listing warranted.

The statutory language is consistent with this concern in that is does not require the agencies to define recovery for a given species as the absolute minimum population size and geographic distribution that equates to a specified persistence level. For species that are experiencing severe declines, the recovery goal is often to reverse the decline and restore the population to a previous status rather than some minimum size.

Consistent with best practice in recovery planning, point estimates of population viability from the Vortex model should be used as one source of information in a decision-support context. Consistent with Congress' intent to institutionalize caution in order to avoid uncertainty about a species' future status, recovery plans should identify criteria that provide a margin of safety because they resulted in conditions under which the species is unlikely to become threatened or endangered again in the foreseeable future: 1) a low predicted potential for extinction (e.g., <1% over 100 years), and 2) a high likelihood that populations would meet specified size criteria over the long term. Due to the role wolves play in their ecosystems (Estes et al. 2011), such precautionary criteria also increase the probability of conserving ecosystems and ecosystem function (16 U.S.C. §1531 (a)(5)(b)).

The proposed recovery criteria do not meet either of these standards, due to at least two factors. Firstly, the extinction risk threshold proposed in the draft plan (10% extinction risk over 100 years) is unusually high and inconsistent with generally accepted practice. A 10% extinction risk over 100 years is considered by the IUCN red list to place a species in the "vulnerable" category. Secondly, even using the overoptimistic baseline parameters, PVA results indicate that delisting of the MWEPA population at the proposed size (320) would result in a significant (40%) risk of the population falling below that threshold of 320 in the future and needing to be relisted. This is due to genetic and other risks to small populations, and occurs despite the fact that the proposed threshold at which removal of wolves to cap the population will begin (379) is higher than the delisting threshold of 320.

Downlisting criteria

Angliss et al. (2002) proposed that, to be consistent with the statute, criteria for downlisting from endangered to threatened status should be defined by reference to the criteria for endangered status rather than directly in terms of extinction risk. This approach was subsequently incorporated into recovery plans for species such as the fin whale (*Balaenoptera physalus*), which will be removed from the list of threatened species when it "has less than a 10% probability of becoming endangered (has more than a 1% chance of extinction in 100 years) in 20 years" (NMFS 2010). This framework is relevant for the Mexican wolf, although an appropriate timeframe for the "foreseeable future" would be 100 years (as in the draft plan) rather than 20 years because genetic threats require decades to accumulate to deleterious levels. Unlike in the earlier effort (MWRT-SPS 2013), the downlisting criteria proposed in the 2017 draft plan are arbitrary rather than objective, because they are not linked to the PVA or other quantitative analysis. To be consistent with best practice, the draft plan should be revised to specify downlisting criteria which assure a low probability of the species again falling into the category of an "endangered" species (based in part on PVA results).

Population size and number criteria

The concept of redundancy acknowledges that demographic persistence is enhanced by creation of a metapopulation, in which multiple subpopulations are linked by dispersal. This is in part due to "spreading of risk", since episodic threats such as disease outbreaks may not affect all subpopulations simultaneously (DenBoer 1968). A comprehensive set of demographic recovery criteria should include criteria on the size of individual subpopulations, the number of subpopulations, and the degree of metapopulation connectivity. The status of two populations of the same size would differ if one was stable while the other was declining. Demographic recovery criteria should thus specify both the required state or status and trend over time in population size and demographic rates.

The draft plan predicts that at the time of recovery, Mexican wolf populations will be stable or increasing in abundance, well-distributed geographically within their range, and genetically diverse. However, this statement is at odds with the results of the PVA, suggesting that the draft plan is internally inconsistent and that the draft plan's proposed criteria are inadequate. These aspects of the PVA results are obscured in the draft plan's text but become evident once more detailed and comprehensive PVA metrics are evaluated.

The draft plan proposes recovery criteria related to population size which are purportedly supported by results of the baseline scenario (“379_200_200_249_EISx220_20”). I reran this scenario and explored the output in greater detail than is presented in the PVA report. Although the PVA simulations were run including all 3 populations, I focus primarily here on results for the US (“MWEPA”) population, because a) this is the largest population and thus has the highest probability of persistence and retention of genetic diversity (i.e. resilience in the face of known threats), and b) the FWS’s mandate for recovery is strongest for recovery efforts within the US.

The baseline scenario resulted in a MWEPA population that was, on average across simulations, in decline after 39 years, due to accumulating effects of genetic and other small population threats. Populations that are projected to be in decline cannot be considered “stable or increasing”, and anticipated decline in a population, even if extinction itself is delayed, indicates that threats have not been adequately addressed and that population size criteria are too low. It should be noted that support for the adequacy of the population threshold is highly contingent on assumptions that adult mortality will be <= 24.9%/year, yet, unlike in the earlier draft plan (MWRT-SPS 2013), no recovery criterion in the 2017 draft plan addresses the threat of human-caused mortality.

Criteria addressing genetic threats

The criteria proposed in the draft plan do not objectively and adequately address known genetic threats to Mexican wolves. The plan proposes that threats to genetic diversity will have been addressed when a cumulative total of releases from the captive population has been reached. This is a metric that measures the history of recovery efforts but says nothing about the actual genetic status of the wild population at the time of delisting. The baseline PVA scenario suggests that a specified number of releases to the MWEPA (70, composed of 28 adults and 42 pups) results in a certain effect on genetic diversity of the wild population in the simulations. However, the PVA uses a highly simplified model of real-world wolf populations. It is certain that the individuals actually released into the wild will not be exactly the same genetically as those projected to be released in the simulations, and that subsequent matings and offspring production in the wild population will not match those that occur in the model simulation. FWS recovery guidance correctly concludes that “PVA should not be viewed as a replacement for criteria based on threats, but as a supplement to them. The criteria describe the conditions under which it is anticipated the PVA would indicate long-term viability” (Interim Recovery Guidance 5.1:18).

Therefore, the plan should base the recovery criterion addressing genetic threats on a metric related to the actual genetic status of the wild population at the time of recovery, not a criterion that only records the history of recovery efforts (such as number of individuals released). The genetic status of the wild population can now be directly and economically assessed using modern genetic techniques. Additionally, criteria related to the status (rate) of metapopulation connectivity (see below) can help to address genetic threats.

Several southwestern states have in the past worked to oppose and delay releases from the captive into the wild population. The draft plan proposes to give these states effective control of the timing of releases (USFWS 2017, lines 683-688, “In order to achieve the genetic criteria for downlisting and delisting the Mexican wolf in this Plan, the states of New Mexico and Arizona, and the Mexican government, will determine the timing, location and circumstances of wolves into the wild within their respective states, and Mexico, from the captive population, with the Service providing collaborative logistical support and facility of those recovery actions.”) PVA results and hence adequacy of criteria are highly contingent on the forecast number of wolves actually being released at the year specified in the model (e.g., in the first decade of recovery efforts). If releases are delayed for any reason, the cumulative total of releases specified in the recovery criterion would have a different (and likely lower) effect in reducing loss of genetic diversity.

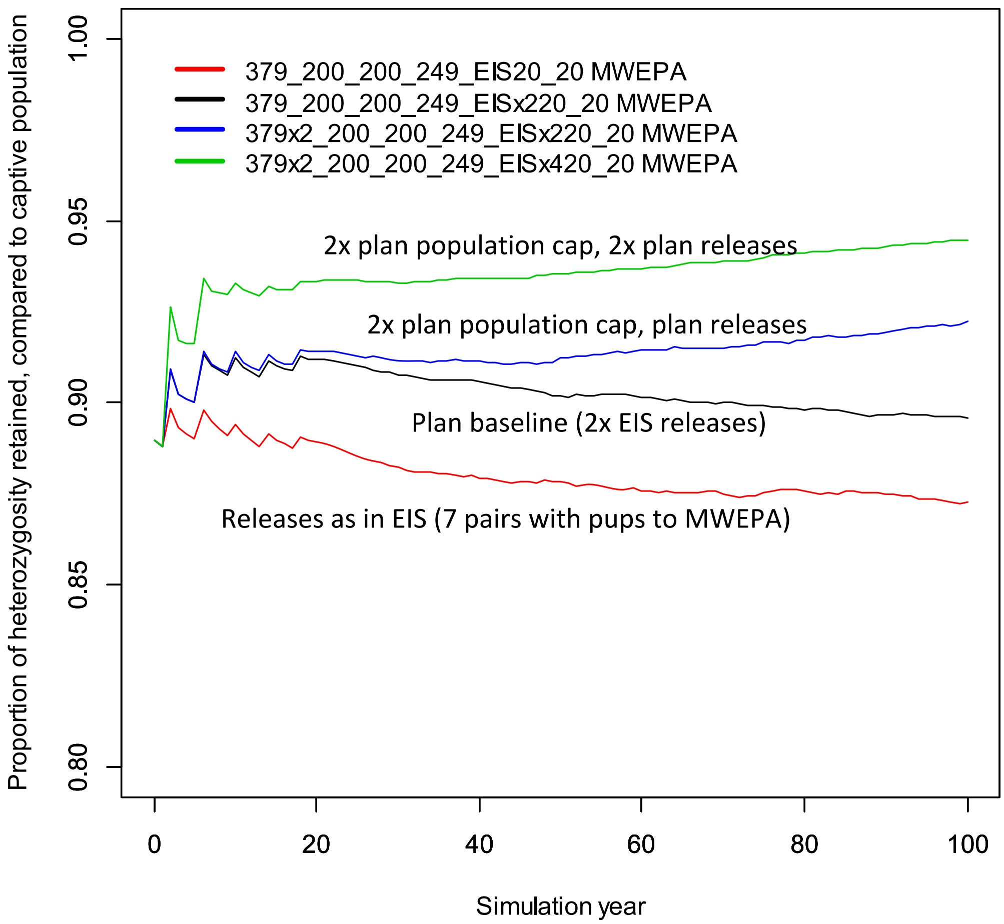
Additionally, the metrics chosen in the draft plan and PVA to assess genetic level provide inadequate information on whether genetic threats are actually being addressed. The recovery criteria in the draft plan seek to establish wild populations that will retain 90% of the genetic diversity retained by the captive population 100 years in the future. By focusing solely on relative rather than absolute genetic metrics, the draft plan ignores the current genetic context of the wild population. Genetic criteria typically consider and address the fact that captive populations started from small founder numbers can be poor representations of historical wild diversity, and even that starting diversity will decay over time. The genetic health of the population is assessed by comparing it to the initial (starting) wild population.

In the draft plan, that concept gets turned on its head. The draft plan merely accepts that the captive population is badly depleted genetically (and, thus, both a poor representation of what was once a Mexican wolf and also at risk of inbreeding damaging demography), and then uses that "shifting baseline" as the standard against which the wild populations will be measured. Thus, if the future wild population isn't too badly damaged genetically relative to the current, already depleted captive population, the draft plan assumes that the program meets genetic goals. The actual level of gene diversity that the draft plan is willing to accept as the long-term fate of the species – approximately 60% to 70% of the initial wild diversity – is extremely low. This translates to a population in which all the animals are more closely related to each other than full-siblings, i.e., genetic diversity that is no more than what you would get by sampling a single litter from the original wild population. The draft plan thus accepts a continued significant decline of genetic diversity that is likely to accentuate rather than address genetic threats.

The genetic diversity of the captive population is inherently limited by the low number of wolves (~300) than can practically be maintained by the existing zoo network. Due to these limitations, genetic diversity of the captive population will decline relatively rapidly over time unless a larger wild population can be established in the near future. It is also questionable whether the existing level of resources required to support 300 Mexican wolves in captivity can be maintained by the zoo network in perpetuity (as assumed in the PVA) given the needs of other threatened species.

To be consistent with the ESA's mandate for recovery, genetic goals should attempt to retain within the wild population a large and increasing proportion of the total overall current diversity present in both the wild and captive population. This is possible if a greater number of initial releases occur, and if the wild population is allowed to grow to a larger size than the captive population. I simulated retention of genetic diversity under scenarios that doubled the number of initial releases to the MWEPA (from 70 to 140 (28 pairs with pups)) and/or doubled the MWEPA population cap (from 379 to 758)(Figure 3).

Figure 3. Proportion of heterozygosity expected to be retained by the US wild population (MWEPA), expressed as a proportion of the heterozygosity retained by the captive population, under four Vortex scenarios with differing population caps (as proposed (379) and twice that proposed (379x2) in the draft plan) and number of wolves released from the captive to wild population (as proposed in the EIS (EIS), as proposed in the draft plan (EISx2), and twice that proposed in the draft plan (EISx4)).



The results suggest that it is possible for the wild population to retain an increasing proportion of the diversity of the wild population over time rather than a decreasing proportion, as would occur under the draft plan's proposed criteria. The number of initial releases from the captive to wild population determines the proportion of genetic diversity retained at ~ year 10 in the model. This metric is of course in itself highly important for addressing genetic threats.

To show an increasing trend in diversity retention after these initial releases, the wild population must be of significantly larger size than the proposed population cap, and thus larger (in both census size and genetically effective population size) than the captive population. Such an increasing trend is more consistent with the definition of recovery under the ESA, which requires effectively addressing identified threats to a species rather than only slightly ameliorating them, than is the draft plan's proposed criterion.

Connectivity criteria

Connectivity between populations in the PVA is assumed to be very low. However, it is well known that connectivity can increase the retention of genetic diversity within component populations (Carroll et al. 2014b). Thus, increased dispersal between wild populations would help to address the severe genetic threats evident in Mexican wolf populations. The 2013 draft recovery criteria addressed genetic threats by proposing a criterion related to the measured rate of connectivity among wild populations (expressed in terms of the number of genetically effective migrants per generation)(Table 2). Previous wolf recovery plans from the Northern Rocky Mountains and Great Lakes have also required recovery of interconnected populations. No such connectivity criteria are proposed in the 2017 draft plan.

Mortality or human-caused loss (HCL) criteria

Human-caused mortality is the primary threat to wolf population persistence both globally and for the Mexican wolf (Fuller et al. 2003, Carroll et al. 2014a). The Mexican wolf population has in the past experienced high rates of human-caused losses (defined to include human-caused mortalities from poaching and vehicle collisions as well as management removals). Genetic threats from small population size and consequent inbreeding affect demographic rates such as mortality and fecundity. The Mexican wolf population may be more sensitive to fluctuations in human-caused mortality rates than most other wolf populations, because fecundity and recruitment rate (the process that balances mortality rate) has been negatively affected by inbreeding depression. Carroll et al. (2014a) found that the adult mortality rate was the most important parameter affecting extinction risk among simulated populations of Mexican wolves.

Table 2. Types of recovery criteria in the 2013 and 2017 draft Mexican wolf recovery plans.

Type of criteria	2013 draft criteria	2017 draft criteria
1. **Population size and number and metapopulation size**	A metapopulation consisting of a minimum of 3 primary core populations in the wild, each with a census population size of at least 200 individuals, and a total metapopulation size of at least 750 individuals.	MWEPA (US) average population abundance is greater than or equal to 320, and Northern Sierra Madre Occidental (Mexico) average population abundance is greater than or equal to 170.
2. Population trend	Population trend in each of the 3 primary core populations has a high probability (80% confidence) of being stable or increasing over 8 years, based on a statistically reliable monitoring effort.	Stated population abundance is maintained or exceeded over 8 consecutive years.
3. **Population connectivity (including releases from captive to wild population)**	Immigration into each of the 3 primary core populations via natural dispersal at a rate of at least 1 genetically effective migrant every generation, averaged over a period of 8 successive years, as measured by a statistically reliable monitoring effort. A genetically effective migrant is defined as a wolf that breeds in a non-natal population and produces at least 1 pup that survives to at least December 31 of the year of its birth.	Gene diversity available from the captive population has been incorporated into the MWEPA through scheduled releases of a sufficient number of wolves to result in 22 released Mexican wolves surviving to breeding age in the MWEPA, and 37 released Mexican wolves surviving to breeding age in the northern Sierra Madre Occidental.
4. **Amelioration of human-caused losses (HCL)**	The estimated annual rate of human caused losses averaged over an 8-year period is less than 20% as measured by a statistically reliable monitoring effort. This is the greatest rate of anthropogenic mortality and removal that a Mexican wolf population could have and still be expected to have an approximately 75% or greater chance of being stable or increasing.	None.
5. **Post-delisting monitoring**	To monitor the continued stability of the recovered Mexican wolf, a post-delisting monitoring plan has been developed and is ready for implementation within the affected states as required in section 4(g)(1) of the ESA.	None.
6. **Regulatory mechanisms**	State management plans and adequate post-delisting regulatory protection and capacity confirmed. Components of an adequate plan will include assurances that: (1) the natural dispersal rate required for delisting is not precluded by HCL; and, (2) management targets for population size are sufficiently large relative to delisting criteria and HCL rates are sufficiently low to ensure that there is no greater than a 10% chance that the Mexican wolf will fall below the recovery criteria within a 10-year period.	Effective State and Tribal regulations are in place in the MWEPA in those areas necessary for recovery to ensure that killing of Mexican wolves is prohibited or regulated such that viable populations of wolves can be maintained. In addition, Mexico has a proven track record protecting Mexican wolves. Based on these protections, Mexican wolves are highly unlikely to need the protection of the ESA again.

Therefore, if future mortality rates are higher than assumed in the draft plan, populations will have a greater probability of decline and show higher extinction risk than projected in the draft plan. Therefore, the PVA results, and the adequacy of the proposed population size criteria based on those results, are highly dependent on this assumption of relatively low mortality (24.9%). Unlike the 2017 draft plan, the 2013 draft recovery criteria included a criterion addressing the threat posed by human-caused mortality, to ensure that this threat had been addressed, and that the assumptions behind other recovery criteria (such as population size) contingent on amelioration of this threat were indeed met at the time of delisting (Table 2).

III. The draft plan does not establish criteria which, if achieved, would indicate that the species exists in wild, self-sustaining populations which as a whole achieve resiliency, redundancy, and representation, such that the Mexican wolf no longer meets the definition of a threatened or endangered species.

Wolves are among the most widely distributed of large terrestrial vertebrates and have proved highly adaptable to a wide variety of habitats. Experience with wolf recovery in other regions suggest that it is eminently feasible to recover wolves to the point where they persist in a wild, self-sustaining population with minimal human management necessary beyond that typical of other large carnivores (e.g., removals in response to depredation or other conflicts with humans)(Carroll et al. 2014b). In contrast, the draft plan seems to propose that Mexican wolves will require an intensive "conservation-reliant" approach involving expensive management interventions over many decades, including after delisting. Such an approach is inconsistent with the intent of the ESA, and would be unnecessary if the plan contained a more adequate and science-based recovery strategy and criteria.

Firstly, the PVA underpinning the draft plan's criteria assumes that supplemental feeding of the wild population will continue in perpetuity. The PVA assumes that "feeding will begin to decline five years into the simulation, with the subsequent rate of decline from 70% feeding determined by the extent of growth toward that population's management target. Authorities assume that the long-term feeding rate will not drop to zero but will likely be maintained at approximately 15% to allow for management of occasional livestock depredations." The PVA results and the adequacy of the draft plan's recovery criteria are contingent on this feeding occurring at the rate specified.

Wolves are among the most vagile of all terrestrial mammals and can disperse over 800 km (Forbes and Boyd 1997). However, the draft plan's recovery criteria and strategy make no effort to ensure genetically-effective natural dispersal between wolf populations, which is a key method of addressing genetic threats. This contrasts with the 2013 draft recovery criteria, which included a criterion related to natural dispersal (which can be ensured through management of habitat connectivity and mortality threats to dispersing wolves).

Thirdly, the draft plan proposes that the US wild population be capped (at between 320 and 380 wolves) via removals prior to and post-delisting. The draft plan states (lines 891-893) that "population growth significantly above 320 may erode social tolerance in local communities or cause other management concerns such as unacceptable impacts to wild ungulates from Mexican wolves (USFWS 2014)." However, no scientific basis is given to support the hypothesis that wolf populations above 320 would significantly decrease tolerance or ungulate abundance.

The relevance of Mexican wolf historical range in the light of available information on genetics of Mexican wolves

The draft plan justifies limiting recovery efforts to areas to the south of Interstate Highway 40 based on an outdated understanding of Mexican wolf historic range and how information on historic distribution appropriately informs recovery planning. The draft plan bases its description of historic range on a view that morphological analysis is superior to modern genomic analysis in determining similarities or differences between taxonomic groups. This view is based on a recent paper (Heffelfinger et al. 2017) that was effectively rebutted by a group of leading wolf geneticists (Hendricks et al. in press, see also Hedrick 2017). Similarities in morphology may or may not reflect similar ancestry, while differences in genomic data will always reflect different ancestry. Recent comprehensive genomic analyses of canids (Hendricks et al. 2016, vonHoldt et al. 2016) more accurately represents best available scientific information than do almost century old morphological studies.

The plan's text regarding historic wolf distribution, and genetic and population effects of interbreeding between Mexican and northern gray wolf subspecies, also reflect an outdated view that assumes that wolf subspecies were historically genetically disjunct. Genomic studies demonstrate that wolf range was largely continuous with genetic isolation by distance (sufficient to maintain the relative distinctness of subspecies such as the Mexican wolf) but with some intermixing via dispersal as is typical of subspecies in general and particularly in canids (vonHoldt et al. 2016).

Hybridization occurs between many species and particularly in canids, and is an important evolutionary process. We know from genomic analysis that intermixing between northern wolves and Mexican wolves occurred historically, and it would contribute to recovery if this genetic cline was reestablished as wolves moved south from the Northern Rocky Mountains and Mexican wolves moved north (Leonard et al. 2005). Past experience demonstrates that any hybrids produced between wolf subspecies would be protected under the ESA. For example, crosses between Texas cougars and Florida panthers are all considered Florida panthers for the purposes of the ESA, and are protected.

Genetic intermixing only constitutes deleterious swamping when it exceeds a certain level. Hedrick (1995) concluded that swamping would not occur in Florida panther if the level of Texas cougar ancestry was maintained below 20% to 30%. Carroll et al. (2014a) concluded that intermixing between southwestern and northern wolves would be relatively low compared to interchange within either the northern or southern metapopulation. The Mexican wolf genetic variants that were adaptive in southwestern ecosystems would remain or increase in the mixed population, while detrimental alleles would be selected against. The biological report is therefore misguided when it states (line 1172) that the FWS "would manage against such breeding events occurring in the MWEPA".

An exclusive focus on historical range is not mandated in the ESA or related FWS policies. There is no direct reference to historical range in the ESA, and only one ESA related policy makes reference to it: 50 CFR 17.81(a)] states "The Secretary may designate as an experimental population a population of endangered or threatened species that has been or will be released into suitable natural habitat outside the species current range (but within its probable historic range) …”. But even here the FWS Director has discretion based on current conditions [50 CFR 17.81(a)]: “... an experimental population can be established outside a species historic range if the Director finds that the primary habitat of the species has been unsuitably or irreversibly altered or destroyed.” Even if one rejects genomic analyses (e.g. Leonard et al. 2005, Hendricks et al 2016) indicating a more extensive historic range for Mexican wolves, available information indicates that the lack of sufficient suitable habitat with low mortality risk in Mexico requires defining a recovery region that includes sufficient suitable habitat from areas to the north of Interstate 40 where secure habitat areas are found in the Grand Canyon region and Southern Rockies, as shown in a figure (Figure 4) reproduced from earlier FWS analyses of Mexican wolf habitat).

Figure 4. Potential wolf habitat in Arizona and New Mexico, as shown in green in Figure ES-4 of USFWS (2014a).

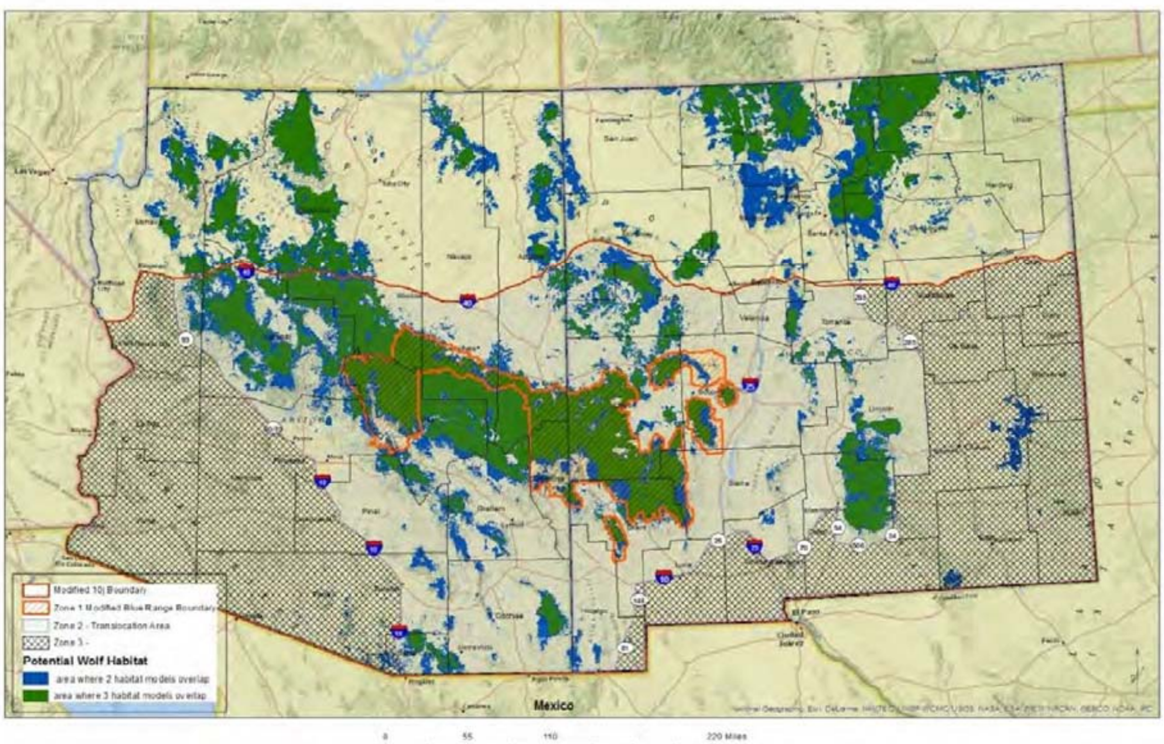


Figure ES-4. Alternative Three (BRWRA Expansion; MWEPA Expansion with Management Zones)

FWS has in the past supported endangered species recovery efforts in regions that were not considered recent historical range, including black-footed ferret conservation efforts near Janos, Mexico; California condor reintroductions in northern Arizona; and westslope cutthroat trout conservation efforts in southwestern Montana. There is even a previous example in terms of gray wolf recovery: according to some authors (e.g. Nowak 2003), the plains gray wolf (*Canis lupus nubilus*) occupied the northern Rocky Mountains historically rather than the northwestern gray wolf (*Canis lupus occidentalis*). However, *C. l. occidentalis* individuals from Alberta and British Columbia, Canada, were used for reintroductions because the animals were familiar with the habitats and prey (Fritts et al. 1997).

Threats due to climate change

In an increasingly dynamic and uncertain world, recovering taxa outside purported historical ranges following assessment of historical, contemporary, and future conditions will become increasingly common. This will likely be especially true for species that are defined by ecologically similar subspecies with historical distributions that included extensive zones of intergradation. Such an approach to recovery will allow such species to experience greater security than a more conservative approach based on an exclusive focus on subspecies' historical ranges (Frankham et al. 2017).

Recent court decisions for other species (e.g. Alaska Oil and Gas Association v P. Pritzker, et al., United States Court of Appeals for the Ninth Circuit. CV 00018-RRB 2016) have reinforced the conclusion that listing and recovery actions must consider the implications of projected climate change. Although Mexican wolves, like other wolf subspecies, are relatively generalist in their habitat preferences, increased aridity due to climate change (Notaro et al. 2012), especially in the southern portion of the range, might be expected to decrease forage and prey abundance. This implies that recovery plans should consider the role of areas to the north of Interstate 40, within the zone of historic genetic intergradation between Mexican wolves and northern wolves, in increasing resilience of recovery efforts to climate change.

Conclusion

Early wolf recovery plans (USFWS 1982, 1987) based their recovery criteria solely on expert judgement, thus precluding substantive and science-informed debate over their adequacy. The FWS is to be commended for performing a quantitative PVA in association with development of the draft plan. This allows the scientific basis of proposed recovery criteria to rigorously evaluated by both invited peer reviewers and scientists such as myself who submit public comments. Some of the conclusions of the PVA analysis are clearly robust to the issues identified here. For example, the PVA demonstrates that in order for Mexican wolf populations to achieve recovery, a higher rate of releases from the captive to the wild population must occur than is envisioned in the recent EIS.

However, despite these strengths, I conclude based on the information presented above that the draft plan and its recovery criteria are based on a population viability analysis (PVA) which incorporates overly optimistic and inaccurate parameters which are unlikely to accurately represent dynamics of wild Mexican wolf populations. There is always some uncertainty regarding demographic parameter values for even well-studied species. However, it appears that the PVA authors have erred consistently in the direction of selecting the parameter value that provides the most optimistic outcome in terms of species viability. This results in a suite of parameter values which is strongly biased towards underpredicting extinction risk. The PVA's predictions regarding extinction risk (and hence the draft plan's criteria) are not robust or precautionary because they become invalid if even one or two of these overoptimistic parameter estimates is incorrect (Figure 1).

All previous Mexican wolf PVAs (Seal 1990, IUCN 1996, Carroll et al. 2014a) have included a sensitivity analysis to evaluate the robustness of conclusions to uncertain parameters. The fact that no sensitivity analysis is provided with the current PVA in itself makes the PVA conclusions of limited value in devising science-based recovery criteria. Even if one accepts the parameters used, the PVA results, if examined in detail, do not support the adequacy of the proposed criteria in ensuring recovery in the context of how the ESA defines the term. In combination, the use of overoptimistic parameters and a minimal set of criteria do not meet the ESA's mandate to comprehensively address threats and ensure population resilience.

The gray wolf, as well as its subspecies the Mexican wolf, have been listed under the ESA for several decades. The Eastern Timber Wolf recovery plan established a recovery criteria of two populations, with one of 1,250-1,400 individuals, and a second population of >100 (USFWS 1992). The Northern Rocky Mountains Gray Wolf recovery plan established a recovery criteria of three populations of >100 each, interconnected by dispersal (USFWS 1987). The 1982 Mexican wolf recovery plan did not establish formal recovery criteria (USFWS 1982). The existing recovery plans for the Mexican wolf, Northern Rocky Mountains Gray Wolf, and Eastern Timber Wolf are relatively old, and significant changes in the best available science regarding wolf biology and genetics have occurred in the intervening decades. The new draft Mexican wolf recovery plan would ideally have been an opportunity to effectively incorporate the current best available scientific information.

Three attempts (initiated in approximately 1995, 2005, and 2011) have been initiated since 1982 to revise the Mexican wolf recovery plan. Both of the latter two efforts resulted in recommended population criteria involving three interconnected populations of >250 individuals each. The 2011-2013 process resulted in a draft recovery plan of similar length to the current draft plan (>250 pages including appendices), but the process was suspended after southwestern state governments objected to the proposed recovery criteria.

The current draft recovery plan results from a process initiated in 2015. This process differed from previous attempts in at least two aspects. Previously, while the larger recovery team included a diverse spectrum of stakeholders, a subgroup made up primarily of wolf biologists was charged with developing recovery criteria based solely on best available science. In the current process, criteria were devised by a group of which a majority of members lacked training in wolf biology. The group included state game biologists, FWS staff, several non-governmental wolf biologists, as well as non-biologists such as the Utah assistant attorney general. Secondly, final responsibility for drafting of criteria as well as writing of the plan rested with FWS staff rather than participating scientists or the recovery team as a whole. I raised these two issues at the time that the current planning process was initiated. When these issues were not resolved, I declined to accept an invitation to participate in the workshops because in my view the process did not guarantee that the resulting recovery criteria would be appropriately based on best available scientific information.

In the end, this process does in fact appear to have resulted in a draft plan whose criteria, rather than being based on best available science, were pre-determined as a policy decision in order to provide support for wolf population and distribution limits that had been negotiated between the FWS and state agencies as part of the 2014 revision to Mexican wolf management (USFWS 2014b). For example, notes from one of the workshops which resulted in the current draft plan record a decision to artificially limit habitat analysis to the south of Interstate 40 for "geopolitical reasons" (see page 4, Draft Notes Mexican Wolf Recovery Planning Workshop, April 11-15, 2016, Galleria Plaza Reforma, Mexico City, Mexico). Although I do not know at first hand the internal FWS process which resulted in development of the draft plan, I have concluded based on the information presented above that the process resulted in recovery criteria that do not represent best available science and thus do not meet the requirements of the ESA.

Thank you for your consideration of these comments.

Sincerely,

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