Draft Mexican Wolf Recovery Plan, First Revision

U.S. Fish and Wildlife Service
Southwest Region (Region 2)
Albuquerque, New Mexico
2017

PREFACE

The purpose of a recovery plan is to provide a scientifically based, logical, and effective roadmap for the recovery of a species. It explains what is needed for species recovery and how to get there. Recovery plans are advisory documents, not regulatory documents. A recovery plan does not commit any entity to implement the recommended strategies or actions contained within it for a particular species, but rather provides guidance for ameliorating threats and implementing proactive conservation measures, as well as providing context for implementation of other sections of the ESA, such as section 7(a)(2) consultations on Federal agency activities, development of Habitat Conservation Plans, or the creation of experimental populations under section 10(j).

DISCLAIMER

Recovery plans delineate reasonable actions believed to be required to recover and/or protect listed species. Plans published by the U.S. Fish and Wildlife Service (FWS, or Service), are sometimes prepared with the assistance of recovery teams, contractors, state agencies, and other affected and interested parties. Recovery teams serve as independent advisors to the Service. Plans are reviewed by the public and submitted to additional peer review before they are adopted by the Service. Objectives of the plan will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not obligate other parties to undertake specific tasks and may not represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the Service. They represent the official position of the Service only after they have been signed by the Regional Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

We developed the Draft Mexican Wolf Recovery Plan, First Revision, using a revised recovery planning process called Recovery Planning and Implementation (RPI), adopted by the Service in 2016. RPI is intended to reduce the time needed to develop recovery plans, increase the relevancy of recovery plans over a longer timeframe, and add flexibility to recovery plans so they can be adjusted to new information or circumstances. Under RPI, a recovery plan includes statutorily required elements (objective, measurable criteria; site-specific management actions; and estimates of time and costs), along with a concise introduction and explanation of our strategy to achieve species recovery. The RPI recovery plan is supported by a separate Species Status Assessment, or in some cases, such as with the Mexican wolf, a species Biological Report, which provides background, life-history, and threat assessment information. The draft biological report for the Mexican wolf is posted on our website https://www.fws.gov/southwest/es/mexicanwolf/. Additionally under RPI, we develop a separate working document called the Recovery Implementation Strategy (implementation strategy). The implementation strategy steps down from the more general description of actions described in the recovery plan to detail the near-term, specific activities needed to implement the recovery plan. The implementation strategy, which will also be posted on our website, will be adaptable by incorporating new information as needed without revising the recovery plan, unless we need to change statutory elements.

By approving this document, the Regional Director will certify that the data used in its development represent the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in development of the plan are available in the administrative record located at New Mexico Ecological Services Field Office, U.S. Fish and Wildlife Service, 2105 Osuna Dr., NE, Albuquerque, NM, 87113, #505-346-2525 or 1-800-299-0196.

ACKNOWLEDGEMENTS

A revision of the 1982 Mexican Wolf Recovery Plan has been a long time in coming, and we are grateful to the many people who have contributed their expertise, perspectives, and dedication to the Mexican wolf recovery effort over the last four decades. In particular, we would like to express our gratitude to our interagency and tribal partners and their staff; previous recovery team members and participants in recent recovery planning workshops; colleagues in Mexico; members of the Mexican Wolf Tribal Working Group; Species Survival Plan institutions, facilities, and staff; Service leaders and staff; the local communities in the Mexican wolf reintroduction area in the United States; and the general public. We have included a more extensive list of Acknowledgments in the Draft Biological Report.

LITERATURE CITATION AND AVAILABILITY

Literature citation should read as follows:
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Copies of the document can be requested from:

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http://www.fws.gov/southwest/es/mexicanwolf

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EXECUTIVE SUMMARY

The Mexican wolf (*Canis lupus baileyi*) is an endangered subspecies of gray wolf protected by the Endangered Species Act (ESA) since 1976. Following the near extinction of the Mexican wolf due to predator eradication efforts in the mid to late 1800's to mid-1900's, the U.S. Fish and Wildlife Service, Mexico, and partner agencies initiated a binational captive breeding program with 7 wolves and began efforts to re-establish Mexican wolves in the wild in the United States (in 1998) and Mexico (in 2011).

Our recovery strategy for the Mexican wolf is to establish and maintain a minimum of two resilient, genetically diverse Mexican wolf populations distributed across ecologically and geographically diverse areas in the subspecies' range in the United States and Mexico. The recovery strategy for the Mexican wolf ameliorates the threats of human-caused mortality, extinction risk associated with small population size, and loss of gene diversity. Moreover, it ensures that Mexican wolf populations can achieve the *resiliency*, *representation*, and *redundancy* needed to downlist and delist the Mexican wolf, as described in the Rationale for Recovery Criteria. At the time of recovery, we expect Mexican wolf populations to be stable or increasing in abundance, well-distributed geographically within their range, and genetically diverse. The primary components of the recovery strategy include expanding the geographic distribution of the Mexican wolf, increasing population abundance, improving gene diversity in the wild, monitoring wild populations and implementing adaptive management, and collaborating with partners to address social and economic concerns related to Mexican wolf recovery. We developed this binational recovery strategy for the Mexican wolf in coordination with federal agencies in Mexico and state, federal, and Tribal agencies in the United States.

Recovery actions for the Mexican wolf include: managing and monitoring wolves in the wild, including implementing proactive conflict avoidance measures; conducting releases (including cross-fostering) and translocations of Mexican wolves; conducting law enforcement activities; investigating and compensating livestock depredation incidents; conducting outreach, education, and research activities; and managing the captive breeding program. We expect to recover the Mexican wolf within 25 to 35 years. To ensure we are making expeditious progress toward recovery, we will evaluate our progress at five and ten years after implementation of the recovery plan begins and subsequently adjust our management as needed.

<u>Downlisting Recovery Criteria:</u>

The Mexican wolf will be considered for downlisting to threatened status when one of the following two populations meets abundance and genetic criteria as follows:

United States

a) MWEPA average population abundance is greater than or equal to 320 Mexican wolves over four consecutive years, and

b) 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. "Surviving to

breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria.

Mexico

a) Northern Sierra Madre Occidental average population abundance is greater than or equal to 170 Mexican wolves over four consecutive years, and

b) Gene diversity available from the captive population has been incorporated into the northern Sierra Madre Occidental through scheduled releases of a sufficient number of wolves that results in 37 released Mexican wolves surviving to breeding age in the northern Sierra Madre Occidental. "Surviving to breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria.

-or-

The Mexican wolf will be considered for downlisting when each population meets abundance and genetic criteria as follows:

a) Average population abundance is greater than or equal to 150 wolves over four consecutive years with a positive growth trajectory, and

b) Gene diversity available from the captive population has been incorporated through the scheduled releases of wolves surviving to breeding age as identified in delisting criteria.

<u>Delisting Recovery Criteria</u>:

The Mexican wolf will be considered for delisting when:

1) A minimum of two populations meet abundance and genetic criteria as follows:

United States

a) MWEPA average population abundance is greater than or equal to 320 Mexican wolves over eight consecutive years, and

b) 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. "Surviving to breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria. .

Mexico

a) Northern Sierra Madre Occidental average population abundance is greater than or equal to 170 Mexican wolves over eight consecutive years, and
b) Gene diversity available from the captive population has been incorporated into the northern Sierra Madre Occidental through scheduled releases of a sufficient number of wolves that results in 37 released Mexican wolves surviving to breeding age in the northern Sierra Madre Occidental. "Surviving to breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria. .

2) 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.

I. INTRODUCTION AND BACKGROUND

The Mexican wolf, *Canis lupus baileyi*, is an endangered subspecies of gray wolf protected by the Endangered Species Act (80 FR 2488, January 16, 2015) (ESA). The Mexican wolf is a top predator native to the southwestern United States and Mexico that lives in packs and requires large amounts of forested terrain with adequate ungulate (deer and elk) populations to support the pack. Predator eradication programs in the mid to late 1800's to mid-1900's resulted in the near extinction of the Mexican wolf. Extinction was averted with the inception of a captive breeding program founded with seven Mexican wolves.

Today, Mexican wolves again inhabit portions of the southwestern United States in Arizona and New Mexico, and the northern Sierra Madre Occidental of Chihuahua in Mexico. Mexican wolves are present in these areas due to ongoing reintroduction efforts in both countries, supported by the binational captive breeding program. Additional information about the history of Mexican wolf reintroduction efforts is available in the draft Biological Report for the Mexican Wolf (USFWS 2017a), and the Final Environmental Impact Statement for the Proposed Revision to the Regulations for the Nonessential Experimental Population of the Mexican wolf (USFWS 2014). Both documents are available on our website, at: https://www.fws.gov/southwest/es/mexicanwolf/index.cfm.

Recovery Planning

The Mexican Wolf Recovery Plan, First Revision (Plan) contains the required recovery plan elements specified by the Endangered Species Act (ESA) (section 4(f)(1)):

i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and
iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

Three other recovery plans have been written for the Mexican wolf: 1) the 1982 Mexican Wolf Recovery Plan (USFWS 1982), written by a recovery team established by the Service and signed by the Service and the Dirección General de la Fauna Silvestre in Mexico; 2) the 2000 Proyecto de Recuperación del Lobo Mexicano (Proyecto de Recuperación, commonly known as "PREP") (SEMARNAP 2000); and 3) the 2009 Programa de Acción para la Conservación de la Especie: Lobo Gris Mexicano (Programa de Acción; commonly known as "PACE") (CONANP 2009). The latter two plans were written under the guidance of the responsible federal agency in Mexico at the time, in collaboration with the National Technical Advisory Subcommittee for the Recovery of the Mexican Wolf in Mexico. All three plans acknowledge the binational historical range of the Mexican wolf in the United States and Mexico, but each plan was written within the context of the federal laws governing its content. The 1982 Mexican Wolf Recovery Plan was written pursuant to the Service's obligation to develop recovery plans for species protected by the ESA, whereas the 2000 Proyecto de Recuperación was written pursuant to Mexico's Ley General del Equilibrio Ecológico y la Protección al Ambiente (or General Law for Ecological

Balance and Environmental Protection) and the 2009 Programa de Acción was written pursuant to Mexico's Ley General de Vida Silvestre (or General Wildlife Law).

The Service's 1982 Mexican Wolf Recovery Plan did not contain all three of the recovery plan elements specified in section 4(f)(1) of the ESA. At the time of writing, the recovery team could not foresee full recovery and eventual delisting of the Mexican wolf due to its dire status in the wild and their assessment of a lack of suitable habitat within historical range due to human activities. Therefore, the recovery team stopped short of providing the objective and measurable recovery criteria required by the ESA and instead laid out a "prime objective":

> To conserve and ensure the survival of *Canis lupus baileyi* by maintaining a captive breeding program and re-establishing a viable, self-sustaining population of at least 100 Mexican wolves in the middle to high elevations of a 5,000-square-mile area within the Mexican wolf's historic range (USFWS 1982:23).

The recovery actions and time and cost estimates in the 1982 Recovery Plan focused on information gathering and management recommendations in support of this prime objective. The Service initiated revisions of the 1982 Mexican Wolf Recovery Plan in the mid-1990s and early 2000's, but these revisions were not finalized due to logistical issues, including litigation related to gray wolf reclassifications (USFWS 2010).

Mexico's Proyecto de Recuperación was not required by law to set a numeric goal for recovery. The plan did, however, establish an objective to reach population levels that would ensure long-term viability by reintroducing Mexican wolves into several areas in Mexico (SEMARNAP 2000). The document explained that Mexico supported reintroduction on both sides of the Mexico-United States border, and stated that it would be difficult to find appropriate habitat for reintroduction in Mexico. The Proyecto de Recuperación suggested that the best habitat may exist within the Sierra Madre Occidental and the Sierra Madre Oriental mountain ranges (SEMARNAP 2000).

The responsibilities for Mexico's priority species were transferred to Comisión Nacional de Áreas Naturales Protegidas (CONANP) in 2004, and the Programa de Acción was finalized in 2009 with the participation of the former technical advisory subcommittee. (The rule that established the National Technical Advisory Committee for Priority Species was abolished in March 2009, therefore the subcommittee ceased to exist formally). This action plan established the necessary steps to begin the reintroduction of the Mexican wolf in Mexico, with 5 strategic goals: define at least 6 potential sites for the Mexican wolf reintroduction; strengthen law enforcement actions to protect habitat within the historical range of the species; involve a variety of sectors of society in the recovery of the species; support the subcommittee's efforts for the reintroduction of the wolf; and create the conditions to allow that the strategies of the subcommittee contribute to the goals of the PACE (CONANP 2009). The action plan is considered to be outdated and in need of revision, but revision of these actions plans are not mandated on a specific schedule.

The 2017 Mexican Wolf Recovery Plan, First Revision will replace and supersede the Service's 1982 Mexican Wolf Recovery Plan, but it does not replace, supersede, or otherwise affect

Mexico's Proyecto de Recuperación and Programa de Acción. The Service recognizes that the objectives of the 1982 Mexican Wolf Recovery Plan were largely to halt extinction and explore whether Mexican wolves could be reestablished in the wild. Together with our partners, we have achieved those objectives. The 2017 Mexican Wolf Recovery Plan, First Revision provides a strategy, criteria, and actions to fully recover the Mexican wolf pursuant to the ESA.

This Plan was developed using the best scientific information available, including Mexican wolf monitoring data from the wild and captivity, as well as data from other gray wolf populations when relevant. We utilized two recent computer modeling analyses to develop the recovery strategy and criteria in this Plan. The first computer model analyzes population viability. It uses species-specific data to predict how a population will perform over time under different scenarios. The second model analyzes habitat suitability. It uses Geographic Information System data layers to identify variations in habitat quality across the landscape. These data and analyses are provided in our draft Biological Report for the Mexican Wolf (referenced herein as USFWS 2017a, Miller 2017, and Martínez-Meyer et al. 2017, for the biological report, population viability analysis, and habitat suitability analysis, respectively.). We will finalize the Biological Report concurrent with the 2017 Mexican Wolf Recovery Plan, First Revision. We will update the Biological Report as needed to maintain a compendium of the best available scientific information upon which to base our recovery efforts for the Mexican wolf (see Disclaimer for additional explanation of the Service's new Recovery Planning and Implementation process).

Recovery Implementation in the United States and Mexico

Recovery efforts for the Mexican wolf have been underway in the United States and Mexico for several decades. Both countries are focused on maintaining the binational captive population of Mexican wolves and on re-establishing wild populations by releasing captive wolves into designated reintroduction areas.

The Mexican wolf captive breeding program was established in 1977 to 1980 with three wolves captured from the wild in Mexico. These founding wolves and their offspring were initially referred to as the Certified lineage, later renamed the McBride lineage (Parsons 1996). The captive breeding program has been managed pursuant to breeding protocols and genetic and demographic goals established by the Association of Zoos and Aquariums' Species Survival Plan since 1994 (Hedrick et al. 1997). In 1995, two additional lineages of pure Mexican wolves, the Ghost Ranch lineage, represented by two wolves, and the Aragon lineage, represented by two wolves, were integrated into the captive breeding program due to the limited genetic diversity of the captive population and the potential for inbreeding depression to hinder its success (Parsons 1996, Hedrick et al. 1997). The combination of the three lineages increased the founding base of the captive population from three to seven pure Mexican wolves (Hedrick et al. 1997).

Today, the binational captive breeding program continues to play a vital role in the conservation of the Mexican wolf by providing healthy wolves for release to the wild. The small number of founders of the captive population and the resultant low gene diversity available with which to build a captive population have been a concern since the beginning of the recovery program (Hedrick et al. 1997) and remain a concern today (Siminski and Spevak 2016, and see USFWS 2017a). Long-term viability or adaptive potential depends on the store of genetic variability. It is desirable to retain as much genetic variability as possible, and it is uncertain when loss of

genetic variability might manifest in compromised reproductive function or physical and physiological abnormality (Soulé et al 1986). As of October 21, 2016, the binational captive program houses 251 wolves in 51 institutions, and has retained approximately 83% of the gene diversity of the founders, which is lower than the recommended retention of 90% for most captive breeding programs. It is expected that even with optimal management, the gene diversity in the captive population will continue to decline over time as wolves die or reach reproductive senescence. In its current condition, the population would be expected to retain 75% gene diversity over 60 years and 70.22% in 100 years (Siminski and Spevak 2016). The gene diversity of the captive population is higher than either wild population in the United States or Mexico. This is to be expected, as only wolves that are genetically well-represented in captivity are candidates for release to the wild (USFWS 2017a) and because we are able to manage which wolves are paired each year for breeding in captivity, but not in the wild.

The United States and Mexico have each undertaken efforts to establish the Mexican wolf in the wild by releasing captive-bred wolves into areas of suitable habitat in each country. The United States and Mexico communicate their reintroduction plans with one another, share equipment, and transfer information and technology through staff visits to each country. Implementation of reintroductions occurs according to the legal frameworks and management provisions for each country.

In the United States, Mexican wolves were reintroduced to the wild in 1998 in the Mexican Wolf Experimental Population Area (MWEPA), an area designated for Mexican wolf reintroduction in Arizona and New Mexico (USFWS 1998) (Figure 1). We, with our interagency partners, continue to manage Mexican wolves in this area pursuant to regulations that provide management flexibility and aid in the conservation and recovery of the Mexican wolf (80 FR 2488, January 16, 2015). The Mexican wolf population in the MWEPA has exhibited robust growth in recent years (Figure 2). As of December 31, 2016, a population of at least 113 wild Mexican wolves inhabits the MWEPA, the largest population size reached to date (USFWS 2017b). In 2016, all Mexican wolves in the MWEPA were wild-born, with the exception of surviving cross-fostered pups from captivity (at least one surviving pup has been documented as of June 2017), demonstrating that population growth is driven by natural reproduction rather than the release of wolves from captivity. Only 10 initial releases, including 6 cross-fostered pups from captivity, were conducted between 2009 and 2016, during which time the population grew from a minimum population count of 42 to 113 wolves. We have documented wild-born wolves breeding and raising pups in the wild for 15 consecutive years.

Although population growth has been relatively steady in recent years, we consider the wolves in the MWEPA to be too closely related to one another (referred to as high mean kinship) to ensure the population will be robust over time. The high relatedness of wolves to one another and ongoing loss of gene diversity increases concerns over the potential for inbreeding depression to have negative impacts on future population growth in the MWEPA (USFWS 2017a). Due to these concerns, the recovery plan focuses on inserting gene diversity to the MWEPA through the release of wolves from the captive population. Presently, inbreeding depression in the MWEPA is impacting the probability of a breeding pair producing a litter, but not to a degree that is hindering annual population growth (USFWS 2017a, including Miller 2017). Additional information about the status and trend of the MWEPA population is available in our annual reports (online at https://www.fws.gov/southwest/es/mexicanwolf/) and draft Biological Report

for the Mexican Wolf, the latter of which also includes a more detailed discussion of the genetic condition of the MWEPA population (USFWS 2017a, including Miller 2017).

Mexican Wolf Experimental Population Area

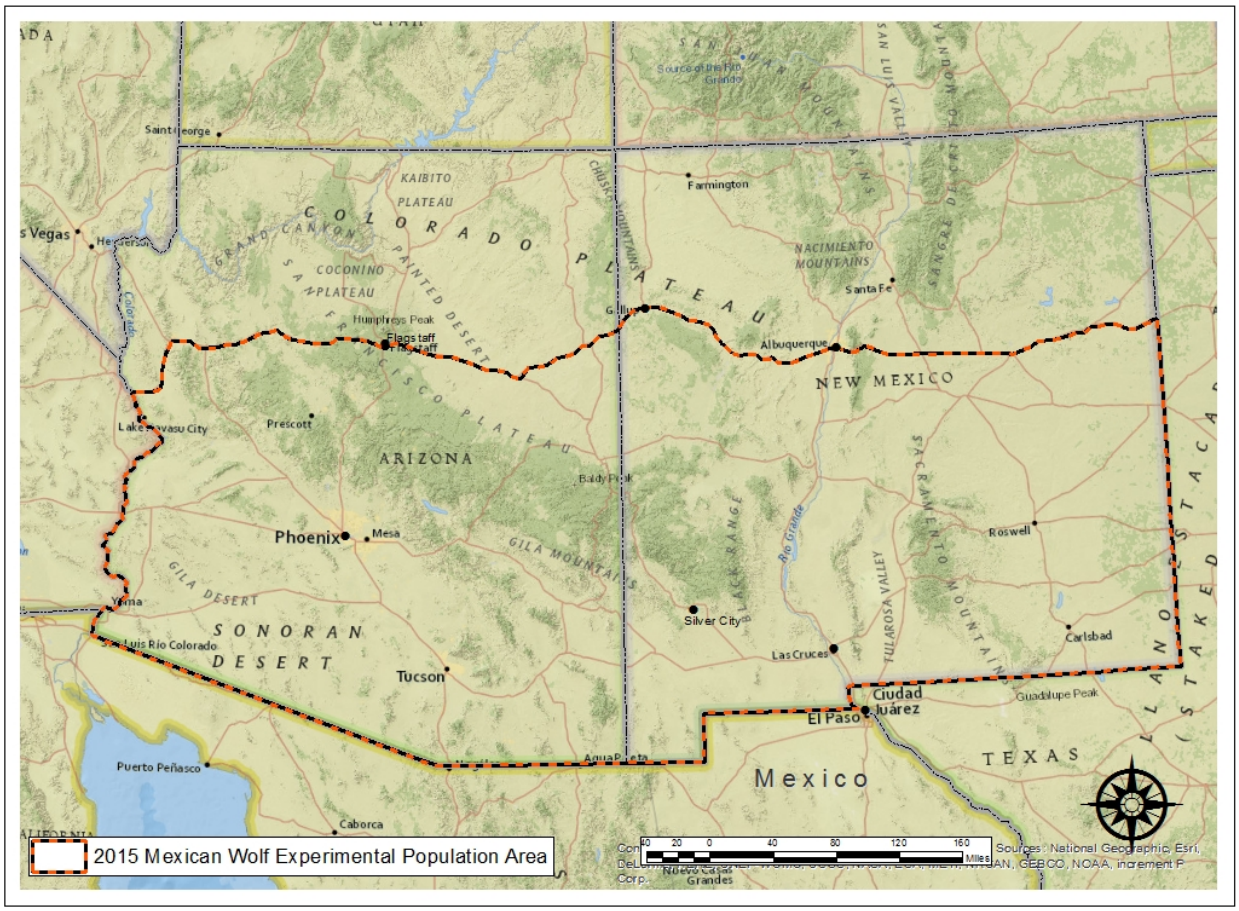

Figure 1. Mexican wolf Experimental Population Area in Arizona and New Mexico, United States (U.S. Fish and Wildlife Service files).

Mexico began reintroducing Mexican wolves to the wild in 2011 and is still in the establishment phase of their reintroduction effort. Forty-one wolves have been released in the first five years of the reintroduction, including both releases from captivity and Mexican wolves translocated from the MWEPA to Mexico. As of April 2017, approximately 28 wild Mexican wolves inhabit Chihuahua, Mexico in the northern Sierra Madre Occidental (Garcia Chavez et al. 2017). Mexico is continuing to release captive or translocated Mexican wolves to help increase abundance until such time as natural reproduction is sufficient to sustain the population. One wild pair in Mexico has reproduced in three of its four years in the wild (USFWS 2017a), and their pups are successfully establishing wild packs with other released animals.

The MWEPA and northern Sierra Madre Occidental reintroduction sites are approximately 280 miles (mi) (320 kilometers (km) from each other (measured from the center of one area to the other), a distance within the natural dispersal capabilities of the Mexican wolf. The proximity of these areas is such that Mexican wolves have the potential to move between populations

depending on how they are managed during dispersal events. Since reintroductions began, two Mexican wolves have crossed the border from Mexico into the United States (U.S. Fish and Wildlife Service, our files). Neither Mexican wolf became established in the MWEPA: one returned to Mexico and one was captured and placed in captivity.

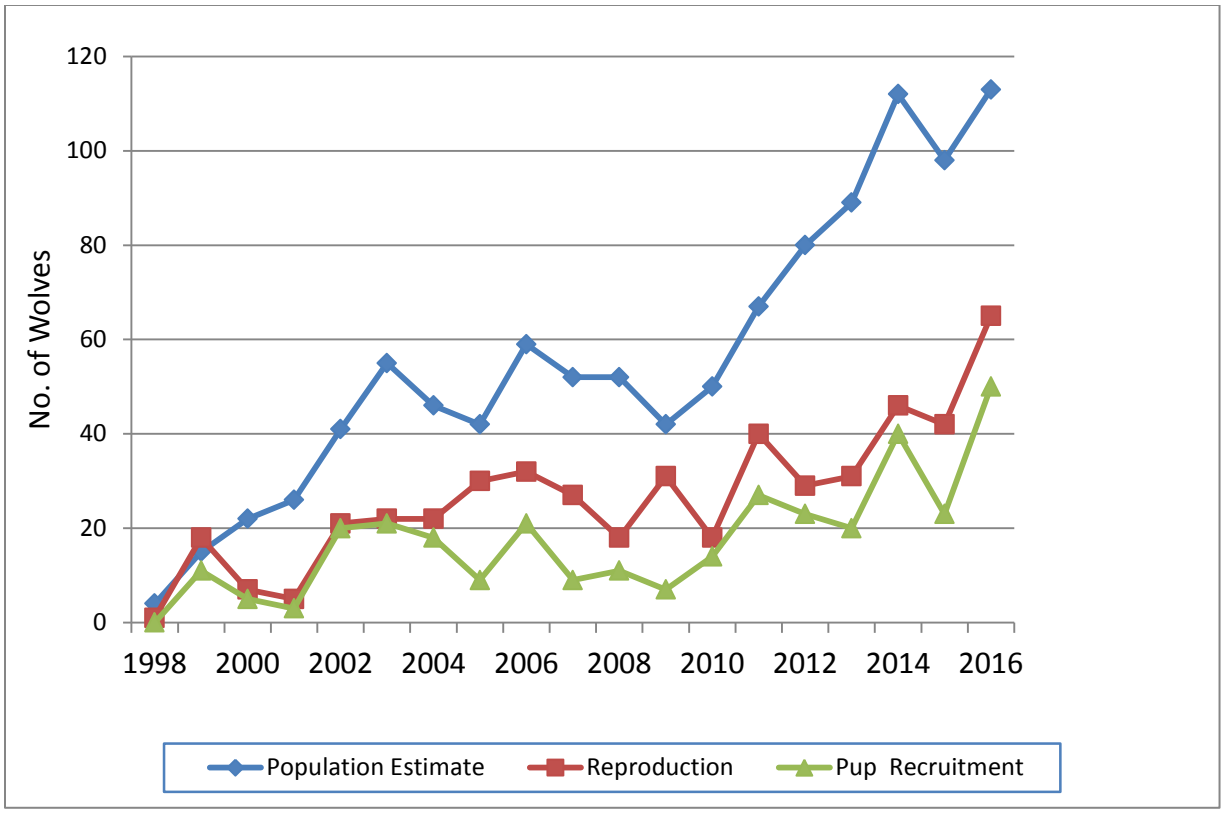

Figure 2. Annual Minimum Population Estimate of Mexican Wolves in the MWEPA, 1998-2016 (U.S. Fish and Wildlife Service files).

II. THREATS TO THE MEXICAN WOLF

We assess "threats" to a species during our determination of whether a species is threatened or endangered due to any of the five factors in the ESA:

A) the present or threatened destruction, modification, or curtailment of its habitat or range;
B) overutilization for commercial, recreational, scientific, or educational purposes;
C) disease or predation;
D) the inadequacy of existing regulatory mechanisms;
E) other natural or manmade factors affecting its survival.

We recently assessed threats to the Mexican wolf and determined that the Mexican wolf was in danger of extinction due to illegal shooting, genetic issues (inbreeding, loss of heterozygosity, and loss of adaptive potential,) and small population size (80 FR 2488-2512, January 16, 2015). More recently, we described four "stressors" -- conditions that may influence the current and ongoing recovery potential of the Mexican wolf -- in the draft Biological Report for the Mexican Wolf: 1) adequate habitat availability/suitability; 2) excessive human-caused mortality; 3) demographic stochasticity associated with small population size; and 4) continuing or accelerated loss of genetic diversity in the captive or wild populations (USFWS 2017a). Stressors and threats are highly related concepts, but may not be one and the same for a species. For example, for the Mexican wolf, habitat destruction, modification, or curtailment (Factor A) is not threatening or endangering the Mexican wolf, yet ensuring adequate habitat is available to support recovered Mexican wolf population is central to the recovery effort for the Mexican wolf (e.g., a potential stressor).

The threats to the Mexican wolf have generally remained consistent over time, including human-caused mortality and related legal protections, extinction risk due to small population size, and genetic issues. In the initial proposal to list the Mexican wolf as endangered in 1975 and in the subsequent listing of the entire gray wolf species in the contiguous United States and Mexico in 1978, the Service found that threats from habitat loss (factor A), sport hunting (factor B), and inadequate regulatory protection from human targeted elimination (factor D) were responsible for the Mexican wolf's decline and near extinction (40 FR 17590, April 21, 1975; 43 FR 9607, March 9, 1978). In the 2003 reclassification of the gray wolf into three distinct population segments, threats identified for the gray wolf in the Southwestern Distinct Population Segment (which included Mexico, Arizona, New Mexico, and portions of Utah, Colorado, Oklahoma, and Texas) included illegal killing and (negative) public attitudes (68 FR 15804, April 1, 2003). The 2010 Mexican Wolf Conservation Assessment, a non-regulatory document to assess the status of the Mexican wolf reintroduction project within the broader context of the subspecies' recovery at that time, found that the combined threats of illegal shooting, small population size, inbreeding, and inadequate regulatory protection were hindering the ability of the current population to reach the population objective of at least 100 wolves in the Blue Range Wolf Recovery Area (Service 2010).

Within the context of the recovery plan, we consider the threats to the Mexican wolf to be excessive human-caused mortality (which includes shooting and other sources), demographic stochasticity associated with small population size, and loss of gene diversity. The draft

Biological Report for the Mexican Wolf provides discussion of each of these threats/stressors (2017a). We further address these threats in our Rationale for Recovery Criteria, and identify recovery actions to alleviate each threat.

III. RECOVERY STRATEGY

The recovery strategy describes the building blocks needed to implement the recovery effort based on the current status of the Mexican wolf in the wild and the threats it faces. The primary components of the recovery strategy include expanding the geographic distribution of the Mexican wolf, increasing population abundance, improving gene diversity in the wild, monitoring wild populations and implementing adaptive management, and collaborating with partners to address social and economic concerns related to Mexican wolf recovery. We developed this binational recovery strategy for the Mexican wolf in coordination with federal agencies in Mexico and state, federal, and Tribal agencies in the United States.

The recovery strategy is built upon the concepts of *resiliency*, *redundancy*, and *representation*:

> *Resiliency* describes the ability of populations to withstand stochastic events. Measured by the size and growth rate of each population, resiliency is important because it gauges the probability that the populations comprising a species are able to withstand or bounce back from environmental or demographic stochastic events.
>
> *Redundancy* describes the ability of a species to withstand catastrophic events. Measured by the number of populations, their resiliency, and their distribution (and connectivity), redundancy is important because it gauges the probability that the species has a margin of safety to withstand or can bounce back from catastrophic events.
>
> *Representation* describes the ability of a species to adapt to changing environmental conditions. Measured by the breadth of genetic or environmental diversity within and among populations, representation is important because it gauges the probability that a species is capable of adapting to environmental changes.

Our recovery strategy for the Mexican wolf is to establish and maintain a minimum of two resilient, genetically diverse Mexican wolf populations distributed across ecologically and geographically diverse areas in the subspecies' historical range in the United States and Mexico. The recovery strategy for the Mexican wolf ameliorates the threats of human-caused mortality, extinction risk associated with small population size, and loss of gene diversity (USFWS 2017a, including Miller 2017). Moreover, it ensures that Mexican wolf populations can achieve the *resiliency*, *representation*, and *redundancy* needed to downlist and delist the Mexican wolf, as described in the Rationale for Recovery Criteria. At the time of recovery, we expect Mexican wolf populations to be stable or increasing in abundance, well-distributed geographically within their range, and genetically diverse.

Geographic Distribution

In the United States, we will implement the recovery strategy for the Mexican wolf in the area designated as the Mexican Wolf Experimental Population Area. In Mexico, federal agencies are focusing Mexican wolf recovery efforts in the northern Sierra Madre Occidental in Sonora, Durango, and Chihuahua (FIGURE 3).

We are focusing recovery implementation in the United States in the MWEPA, consistent with the range described by Parsons (1996), which the Service previously adopted when we began reintroducing wolves in 1998 (63 FR 1752; January 12, 1998). The Service selected this geographical area for recovery implementation in consultation with our partners. We consider this approach to be prudent at this time and consistent with Service regulations for nonessential experimental populations (i.e., section 10j of the ESA). Recent habitat and population viability modeling (Martínez-Meyer et al. 2017, Miller 2017) support our geographic focus because they indicate that a population of Mexican wolves in the MWEPA and a population in the Sierra Madre Occidental could be sufficient to recover the Mexican wolf. In addition, Mexico has indicated both the willingness and ability to pursue reintroduction of the Mexican wolf since 2011.

Recovery in the United States will continue to focus on one large population of Mexican wolves in the MWEPA in Arizona and New Mexico. The MWEPA contains a large expanse of contiguous high quality habitat along the Mogollon Rim in central Arizona into west central New Mexico, as well as other patches of high and low quality habitat (USFWS 2014; Martínez-Meyer et al. 2017).

In Mexico, there are two large blocks of high quality habitat in the Sierra Madre Occidental that are connected by areas of lower quality habitat and small interstitial patches of high quality habitat (Martínez-Meyer et al. 2017); we refer to these two areas as the northern Sierra Madre Occidental and southern Sierra Madre Occidental. Based on recent habitat modeling, we expect that either of these areas may be able to support a population of Mexican wolves (Martínez-Meyer et al. 2017). We expect reintroduction efforts in Mexico to remain focused in the vicinity of the current reintroduction effort in northern Sierra Madre Occidental due to logistical considerations (e.g., monitoring wolves in a single area rather than spreading resources between the northern and southern areas), and therefore the recovery strategy in Mexico focuses on this area. However, if Mexican wolves disperse to southern Sierra Madre Occidental or federal agencies in Mexico decide to release Mexican wolves into this area as part of their reintroduction effort, the recovery strategy can be adapted to include wolves in either or both areas (see Miller 2017). We have not identified large enough blocks of high quality habitat in the Sierra Madre Oriental region to support a population of sufficient size to contribute to complete recovery under the ESA (Martínez-Meyer et al. 2017), although this does not preclude Mexico from pursuing reintroduction in this area pursuant to their laws and regulations.

Our strategy to establish two populations over a large geographical area of the Mexican wolf's range addresses the conservation principles of *redundancy* and (ecological and geographical) *representation*, as discussed in the Rationale for Recovery Criteria.

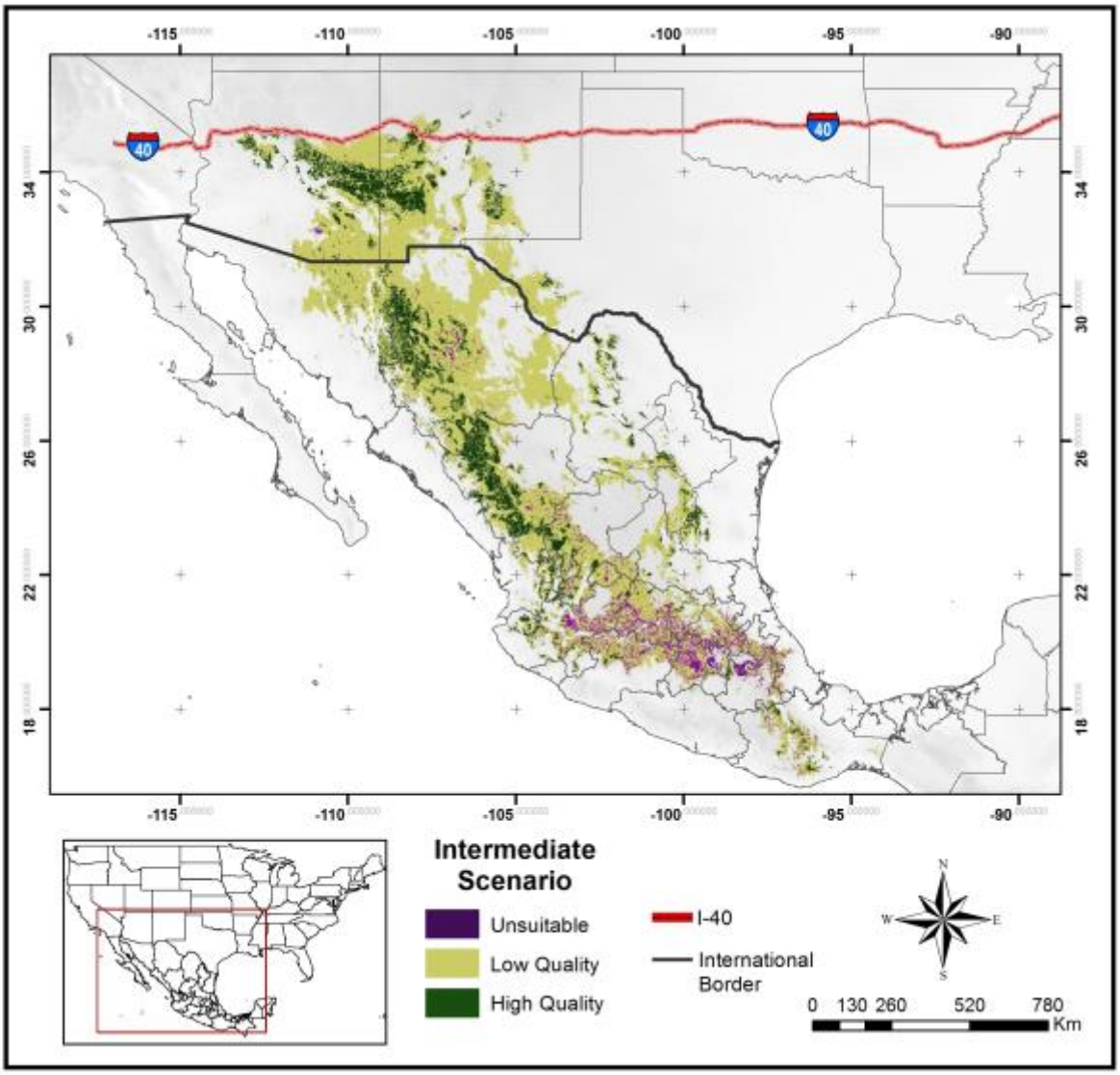

Figure 3. Focal area for Mexican wolf recovery strategy, including the MWEPA in the United States, and the Sierra Madre Occidental in Mexico. (Figure from Martínez-Meyer et al. 2017, Figure 19. Reclassified intermediate habitat suitability scenario for the Mexican wolf based on the combination of climatic suitability, land cover use, human population density, and road density.)

Population Abundance

To achieve recovery, Mexican wolf populations in the Mexican Wolf Experimental Population Area and northern Sierra Madre Occidental will need to increase in abundance from their current size to an abundance that confers a low probability of extinction.

As population abundance increases, the threat of demographic stochasticity decreases and population resiliency increases (Goodman 1987; Pimm et al. 1988; and see discussion in USFWS 2017a; 80 FR 2488, January 16, 2015; and, USFWS 2010). Currently, both the MWEPA and northern Sierra Madre Occidental populations have a high risk of extinction due to their small population size (USFWS 2017a, including Miller 2017). Therefore, both populations will need

to increase in abundance sufficient to ameliorate this risk. We consider a population that has approximately a 90% probability of persistence over 100 years to contribute to achieving recovery criteria, as described in our Rationale for Recovery Criteria. In the MWEPA, population growth will likely continue to be driven primarily by natural reproduction, although releases from captivity will also contribute to an increase in population size. In the smaller Mexican wolf population in Mexico, population growth can be stimulated by the continued release of a substantial number of Mexican wolves from captivity to the wild, with population growth from natural reproduction increasing over time as more wolves become established in the wild.

Our strategy to establish populations of sufficient size to reduce extinction risk addresses the conservation principle of *resiliency*, as discussed further in the Rationale for Recovery Criteria.

Genetic Management

To ensure the maintenance of gene diversity of Mexican wolves in the wild, Mexican wolves will be released from captivity to each population and translocated between wild populations as needed.

As of June 2017, the captive population has higher gene diversity than either of the wild populations, and both wild populations are at risk of future genetic issues unless gene diversity can be improved (USFWS 2017a). The release of Mexican wolves from captivity to the wild can result in a substantial amount of the gene diversity available in captivity being represented in the wild. Ensuring wild populations represent approximately 90% of the gene diversity retained by the captive population provides for *representation* based on community of practice in the management of captive populations (Siminski and Spevak 2016). Release strategies from captivity may include the release of individual or paired adult wolves, a pack of wolves, or cross-fostering of pups. (Cross-fostering is a relatively new technique in which we place genetically advantageous pups from captive litters into wild dens to be raised with the wild litter). Each of these release strategies has benefits and challenges that can be considered within the opportunities and limitations of the release event and progress toward recovery. Translocation of wolves between wild populations can also be a source of gene diversity to the recipient population and will be considered as a way to improve the gene diversity of wild populations. 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 releases of wolves into the wild within their respective states, and Mexico, from the captive population, with the Service providing collaborative logistical support and facilitation of those recovery actions.

Released wolves (including both releases from captivity and translocated wolves) contribute their gene diversity to the recipient population when they breed and produce offspring. Therefore, we will focus on the number of released wolves that survive to breeding age rather than just the number of releases. We estimate that an adult female of breeding age has a 77% likelihood of pairing with a male, and a 72% likelihood of producing a litter (Miller 2017). Currently, many released wolves die within the first year of release, and released Mexican wolves in both wild populations have lower survival than Mexican wolves born in the wild that are not associated with a release event (see USFWS 2017a, including Miller 2017 for data on

release survival). The low survival of released wolves results in the need to release enough wolves that a sufficient number survive to breeding age. Management to improve the survival of released wolves will decrease the number of releases needed to achieve recovery criteria.

The strategy is to release wolves from captivity to the wild and translocate wolves between populations to ensure wild populations benefit from the gene diversity available in the captive population addresses the conservation principle of (genetic) *representation*, as discussed further in the Rationale for Recovery Criteria. Population viability analysis by Miller (2017) has identified several combinations of releases and translocations that will achieve genetic *representation*, and we expect that other combinations are also possible.

The gene diversity of wild Mexican wolf populations can also be influenced through the dispersal of wolves from one wild population to another. We expect the patchy habitat in the border region of Mexico and the United States, as modeled by Martínez-Meyer et al. (2017), to have the potential to support a low level of Mexican wolf dispersal between high quality habitat patches in the MWEPA and the northern Sierra Madre Occidental (Miller 2017). Habitat quality between the northern and southern Sierra Madre Occidental sites has the potential to support a slightly higher degree of dispersal compared with the potential between the MWEPA and northern Sierra Madre site, but it is still predicted to be low (Miller 2017). While we anticipate habitat between any of the populations can support dispersing wolves and provide some connectivity, we do not expect the level of dispersal predicted between any of the sites (particularly between the MWEPA and northern Sierra Madre Occidental) to provide for adequate gene flow between populations to alleviate genetic threats or ensure *representation* of the captive population's gene diversity in both populations. Therefore, we consider genetic management such as releases from captivity (including cross-fostering pups) and translocations to serve as an effective tool during the recovery process to achieve appropriate *representation* (Miller 2017). This management is a form of artificial, or assisted, connectivity that will be necessary for at least portions of the recovery process. We do not expect regular releases from the captive population to be necessary after Mexican wolves have been recovered because gene diversity from captivity will have been incorporated into the wild populations and wild populations will be sufficiently abundant such that releases from captivity for population augmentation will not be necessary.

Monitoring and Adaptive Management

We will conduct ongoing annual monitoring to track Mexican wolf population performance and will adjust management techniques and approaches as needed in response to population performance.

Our monitoring will continue to focus on annual population growth, paying particular attention to mortality rate. Wolf mortality, combined with removal of wolves for management purposes (which functions as mortality to the population), will need to stay below threshold levels such that populations can achieve abundance targets. The majority of documented mortalities in the MWEPA are human-caused (USFWS 2017a); therefore, reducing mortalities from human-caused sources such as shooting and vehicle collision may provide our best opportunity to improve population performance and speed the time to recovery. Similarly, management removal of Mexican wolves in response to depredation incidents and conflict with humans has

been the biggest source of removal and can impact population performance. In previous years we observed the negative impact that a high number of removals can have on population performance in the MWEPA, and in response lessened our removal rate by focusing on working with landowners and permittees to implement proactive management techniques such as range riders, fladry, non-lethal ammunitions, and diversionary feeding to decrease the likelihood of depredation incidents. (Diversionary food caches are road-killed native prey carcasses or carnivore logs provided to denning wolves to reduce potential conflicts with livestock in the area). In the United States, our recovery strategy will entail adaptively managing our removal rate of Mexican wolves for management purposes in response to documented mortality during the previous year to ensure that the mean mortality rate over several years is not hindering population growth. We expect that Mexico will conduct similar monitoring of Mexican wolves to track population performance and adapt management strategies as needed.

Monitoring of wild Mexican wolf populations will help us annually track our progress in achieving the *resiliency*, *representation*, and *redundancy* necessary for recovery. In addition, we have provided evaluation periods at five and ten years after we begin implementing the recovery plan to evaluate whether the recovery strategy is effective and progress toward recovery is occurring as predicted.

Collaborative Recovery Implementation

We will continue to work with partners to identify and implement effective recovery actions necessary to recover the Mexican wolf and address conflicts related to Mexican wolf recovery in local communities.

The reintroduction of the Mexican wolf has been a collaborative effort since its earliest days. Reintroductions are intensive efforts that require participation by multiple parties within federal, state, and local governments, nongovernmental organizations, academia, and local communities. We have strong partnerships with the Species Survival Plan captive breeding facilities in the United States and Mexico. We also collaborate with Federal, State, County, and Tribal agencies through a Memorandum of Understanding and the establishment of the Mexican Wolf Interagency Field Team, which conducts the reintroduction, management, and monitoring of Mexican wolves in the MWEPA. We intend to maintain and strengthen the interagency partnerships currently in place for the MWEPA. In addition, if pursued by either Arizona or New Mexico or a tribe, we see the potential for increased state or tribal management of Mexican wolves as the status of Mexican wolves in the MWEPA improves. When the status of the Mexican wolf has improved sufficiently to downlist it to threatened, we may consider establishing a 4(d) rule under the ESA. A 4(d) rule could provide for additional management flexibility in the United States than would typical threatened status. And, unlike a 10(j) population designation such as the MWEPA, which provides management flexibility only within a designated geographic area, a 4(d) rule provides management flexibility wherever the animals are located in the United States. Opportunities for increasing levels of state and tribal management will be explored as recovery progresses.

IV. RECOVERY CRITERIA

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the ESA are no longer necessary and the Mexican wolf may be delisted. We provide both downlisting and delisting criteria for the Mexican wolf as follows:

<u>Downlisting Recovery Criteria</u>

The Mexican wolf will be considered for downlisting to threatened status when one of the following two populations meets abundance and genetic criteria as follows:

United States

a) MWEPA average population abundance is greater than or equal to 320 Mexican wolves over four consecutive years, and

b) 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. "Surviving to breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria.

Mexico

c) Northern Sierra Madre Occidental average population abundance is greater than or equal to 170 Mexican wolves over four consecutive years, and

d) Gene diversity available from the captive population has been incorporated into the northern Sierra Madre Occidental through scheduled releases of a sufficient number of wolves that results in 37 released Mexican wolves surviving to breeding age in the northern Sierra Madre Occidental. "Surviving to breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria.

-or-

The Mexican wolf will be considered for downlisting when each population meets abundance and genetic criteria as follows:

a) Average population abundance is greater than or equal to 150 wolves over four consecutive years with a positive growth trajectory, and

b) Gene diversity available from the captive population has been incorporated through the scheduled releases of wolves surviving to breeding age as identified in delisting criteria.

Delisting Recovery Criteria

The Mexican wolf will be considered for delisting when:

1) A minimum of two populations meet abundance and genetic criteria as follows:

United States

a) MWEPA average population abundance is greater than or equal to 320 Mexican wolves over eight consecutive years, and

b) 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. "Surviving to breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria.

Mexico

c) Northern Sierra Madre Occidental average population abundance is greater than or equal to 170 Mexican wolves over eight consecutive years, and

d) Gene diversity available from the captive population has been incorporated into the northern Sierra Madre Occidental through scheduled releases of a sufficient number of wolves that results in 37 released Mexican wolves surviving to breeding age in the northern Sierra Madre Occidental. "Surviving to breeding age" means a pup that lives two years to the age of breeding or an adult or subadult that lives to the year following its release. "Scheduled releases" means captive releases and translocations that achieve genetic representation, as described in Rationale for Recovery Criteria.

2) 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 wolves are highly unlikely to need protection of the ESA again.

Rationale for Recovery Criteria

Resiliency

The abundance criteria ensure that populations are *resilient* and the threats of demographic stochasticity and human-caused mortality have been ameliorated.

We consider a *resilient* population to be one that is able to maintain approximately a 90% likelihood of persistence over a 100-year period. At this level of *resiliency*, the threat of demographic stochasticity has been ameliorated because the population is secure from random population fluctuations and mortality rates are sufficiently low to allow for stable, long-term persistence of the populations (USFWS 2017a). Based on population viability modeling, we

predict the MWEPA population will achieve *resiliency* when an average population of 320 wolves can be maintained for eight years, given an average adult mortality rate below 25% (Miller 2017). We predict the northern Sierra Madre Occidental will be able to achieve *resiliency* when an average population abundance of 170 wolves can be maintained for eight years, also at an average adult mortality rate below 25% (ibid). Establishing a criterion for an average abundance means that in some years the populations may exceed abundance targets (320 and 170, respectively for the MWEPA and northern Sierra Madre Occidental), while in some years they may fall below their target; this is consistent with the annual population fluctuations predicted by population viability modeling results (Miller 2017). Years in which the population grows above 320 are expected and will enable progress toward the abundance criterion for the MWEPA more quickly than when the population hovers at or near 320.

In the MWEPA, we may employ management actions to maintain the population between 320 and 380 Mexican wolves. We recognize 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). Therefore, the population viability model scenarios used to inform the development of recovery criteria (Miller 2017) were structured such that populations were not allowed to increase over 380 Mexican wolves in the MWEPA and 200 wolves in the northern Sierra Madre Occidental. This structure ensured that simulated populations could reach and maintain recovery criteria (referred to as management targets in Miller 2017) for resiliency sufficient that they would be unlikely to need immediate relisting after reaching recovered levels, yet without allowing them to grow to levels that would cause socioeconomic concerns. We recognize there will be a trade-off between allowing the MWEPA population to grow larger and achieve recovery more quickly versus curtailing population growth between 320 and 380 to address socioeconomic concerns. We consider it not only possible, but preferable, to achieve recovery while addressing the concerns of local communities and economies. Therefore, we expect to adapt our management approach for population sizes between 320 and 380 Mexican wolves in the MWEPA based on the circumstances at that time. In Mexico, we do not anticipate that strictly maintaining population growth between 170 and 200 Mexican wolves will be needed, but a similar strategy could be utilized as appropriate.

To ensure populations have a high likelihood of maintaining *resiliency*, they must meet the average population abundance for eight years. Eight years provides an appropriate amount of time to observe the populations' demographic performance for several reasons. First, an eight-year window is equivalent to approximately two wolf generations, grounding the criteria in a biologically relevant timeframe. Observing the population for longer than a single generation will provide assurance that population metrics such as reproduction and mortality rates are fluctuating within expected levels at the target abundance and that populations are performing such that recovered status is likely to be maintained after delisting. Specifically, it allows us to observe population trend, which we expect to be stable or growing as populations achieve recovery, although we also expect annual fluctuations could include population declines for one or a few years during an eight-year period. We estimate that an eight-year period will include one catastrophe cycle (i.e., an event of extreme pup mortality, as described in Miller 2017), allowing us to ensure that the population is able to rebound following such an event. Downlisting criteria require only a single generation because protections under threatened status

would remain in place to insure that populations remain robust through various population cycles.

One of the key components of establishing and maintaining *resilient* populations will be ensuring that mortality rates are sufficiently low. Mortality rates are a primary indicator of wolf population trajectory (Fuller et al. 2003). Previous studies have primarily pooled results across age classes for pups older than approximately six months, yearlings and adults (Fuller et al. 2003, Adams et al. 2008). However, Miller's (2017) results were based on estimated mortality rates for Mexican wolves in each of the three age classes. Thus, the results are not necessarily directly comparable to other studies. However, simulated populations with mean adult mortality rates less than 25%, combined with mean sub-adult mortality rates less than 33% and mean pup mortality (for radio-marked pups greater than 4 months old) less than 13% resulted in an increasing population that should meet recovery criteria. Population performance in Miller's results was most sensitive to relatively small changes in adult mortality rate. Miller's results are consistent with meta-analyses that suggest a wolf population should stabilize with an overall average mortality rate of 34% (Fuller et al. 2003). Miller's results indicate the populations need to perform at mortality rates lower than Fuller et al. (2003) because: (1) the Mexican wolf population needs to exhibit growth (rather than stability) to achieve recovery, (2) the results are based on specific characteristics of the Mexican wolf population rather than wolves in general, and (3) other studies of wolf population growth are significantly influenced by immigration and emigration (Adams et al. 2008), and do not predict significant immigration or emigration between the Mexican wolf populations. Miller's results are also consistent with growing wolf populations in central Idaho and the Greater Yellowstone area (Smith et al. 2010). The mean mortality rate utilized for Miller's results incorporates human-caused mortality and demonstrates that Mexican wolf populations will still be stable or increasing.

Our management of Mexican wolves will also factor in to the MWEPA population's ability to reach the abundance criterion. We expect to adaptively manage the population to reduce or increase removals based on documented mortality from other causes during the previous year to ensure that the mean mortality rate over several years does not exceed those identified by Miller (2017). If population growth is such that management action is necessary to maintain the population between 320 and 380 in the MWEPA, any and all management options will be considered, including allowing mortality rates to rise higher than 25% through permitted take or other mechanisms.

Miller's results predict that recovery could be reached within 25-35 years, although fewer removals between a population size of 320 and 380 Mexican wolves in the MWEPA could speed the time to recovery because larger population sizes would reach the abundance criterion more quickly. Population viability modeling results predict downlisting could be possible within approximately 16-20 years (Miller 2017). Miller's results are useful for estimating the time frame to recovery assuming the conditions specified in the population viability model are similar (which we expect) to those observed in the wild during recovery implementation. The time to recovery for the MWEPA is longer than our previous predictions of future population growth because the population trajectory observed from Miller's results are based on realistic parameterization of the underlying biological population characteristics (e.g., survival rates, pup

production, pair formation, and releases) rather than applying a single growth rate expectation for every year, which results in steady growth to the population target (USFWS 2014).

Representation

The gene diversity criterion ensures that Mexican wolf populations have genetic *representation* and that genetic threats have been ameliorated, while having Mexican wolves across large portions of their range ensures ecological *representation*. Ensuring gene diversity in the near term will help ensure that inbreeding depression is avoided, while over a longer timeframe it will ensure the Mexican wolf has the ability to respond and adapt to various and changing environmental conditions.

We consider the degree to which wild populations contain the gene diversity (expected heterozygosity) available from the captive population to be an important indication of genetic *representation* for recovery (USFWS 2017a). Ensuring wild populations represent approximately 90% of the gene diversity retained by the captive population provides for *representation* based on community of practice in the management of captive populations (Siminski and Spevak 2016). We consider approximately 90% to be reasonable for recovery because it ensures wild populations contain a high degree of the gene diversity available (Siminski and Spevak 2016), while recognizing that we cannot control breeding events in the wild and need flexibility in our management of wolves (e.g., removal of Mexican wolves from the wild for management purposes may positively or negatively affect the gene diversity of the population). Miller 2017 identifies several release scenarios that are able to achieve 90% gene diversity of the captive population in the wild within approximately 20 years. We would expect to utilize one of these release scenarios or a comparable scenario. The extent to which released Mexican wolves are able to influence the gene diversity of a wild population is a function of the number of released wolves in relation to the recipient population abundance (i.e., larger proportional releases result in greater genetic and demographic effect). Therefore, the timing of releases is a critical factor in the degree to which releases will ensure that 90% of the gene diversity available in captivity is represented in each wild population, and is the reason why it will be important for us to establish a schedule of releases as stated in the recovery criteria.

We consider all releases subsequent to January 2016 to contribute to the genetic criteria for the United States (MWEPA) and all releases subsequent to December 2016 to contribute to the genetic criteria for Mexico (northern Sierra Madre Occidental). These are appropriate starting dates because Miller's (2017) scenarios were initiated with the pedigree of both populations as of December 2015, but Mexico's 2016 releases were included in the first time step of the model due to the large number of releases that year and the resultant effect on the population's genetic and demographic condition.

Ecological *representation* is addressed by the distribution of Mexican wolves across large portions of their historical range (per Parsons 1996) in the United States and Mexico. Martínez-Meyer et al. (2017) estimate 44,477 km^2 (17,173 mi^2) of high quality habitat in the MWEPA, 21,538 km^2 (8,316 mi^2) in the northern Sierra Madre Occidental, and 34,540 km^2 (13,339 mi^2) in the southern Sierra Madre Occidental. Habitat conditions vary between the MWEPA and Sierra Madre Occidental sites in both terrain and vegetation, as well as the abundance and distribution of prey (USFWS 2017a). These differences will expose the Mexican wolf genome to different

environments that may result in different selection pressures. We anticipate genetically diverse wild populations in the MWEPA and northern Sierra Madre Occidental will be better able to respond to not only the current range of habitat conditions, but also future changing conditions such as shifts in prey availability, drought, or other environmental fluctuations. Variation in environmental conditions (such as drought, fire, prey fluctuations) and episodic threats such as disease are characteristic of wild populations of most species, including Mexican wolves. Mexican wolf populations that are genetically robust will be more likely to recover from episodic threats (USFWS 2010). While we do not consider climate change to be a threat to the Mexican wolf (see our discussion at 80 FR 2488, January 16, 2015), we recognize that climatic conditions may change over the longer term and consider establishing populations with genetic representation in ecologically/geographically varied habitat to provide Mexican wolves with the potential to withstand these changes.

Redundancy

The establishment of two *resilient* populations of Mexican wolves with genetic and ecological representation provides for *redundancy* (USFWS 2017a). Redundancy provides for security against extinction from catastrophic events that could impact a single population by ensuring that one or more additional resilient, representative populations persist. We recommend two populations for *redundancy* for several reasons. Martínez-Meyer et al. 2017 estimate at least 58,985 km^2 (22,774mi^2) of suitable habitat in the United States and Mexico, including the MWEPA and northern Sierra Madre Occidental sites. If the southern Sierra Madre Occidental site is also considered, an additional 39,610 km^2 (15,293 mi^2) of suitable habitat is available. These areas of suitable habitat in Mexico, which are within the historical range of the Mexican wolf (Parsons 1996), are of sufficient size to establish populations that achieve recovery in combination with the MWEPA.

The Need for Regulatory Protection

Prior to delisting, we will ensure that the state and tribal agencies that will be responsible for maintaining the recovered status of the Mexican wolf have adequate regulations in place to ensure levels of human-caused mortality will enable the population to retain the average population abundance specified by the abundance criterion. We will work with these agencies during the implementation of the recovery plan as needed to prepare for a change in management from federal to state and tribal regulatory control of the Mexican wolf.

Explanation of Downlisting Criteria

The downlisting criteria are intended to demonstrate that the status of the Mexican wolf has improved such that it is no longer endangered. We provide two options for downlisting the Mexican wolf to threatened status in recognition that progress toward recovery could occur in either of two ways: one of the two populations will make faster progress than the other, or both populations will progress at a similar pace in reaching threatened status.

The first option for downlisting is appropriate if one of the two populations has made progress toward recovery but the second population is lagging behind. In this situation, one of the populations has achieved the abundance criterion for four of the eight years and releases of wolves to provide gene diversity (*representation*) have been conducted. This population will be close to achieving *resiliency* and will have achieved *representation*, but the *redundancy* provided by the second population will not yet be achieved.

The second option is appropriate if both populations are progressing toward recovery, such that headway toward *redundancy* is substantial and releases of wolves to provide gene diversity (*representation*) have been conducted. However, in this situation, neither population's abundance is sufficient to achieve *resiliency*. The criterion of 150 Mexican wolves is not intended as a proportion of the population abundance required for delisting, but rather is an indicator of a population abundance that confers a lesser degree of extinction risk than the populations currently face.

As recovery of the Mexican wolf progresses, including but not limited to downlisting to threatened status, we will explore management options with the states and tribes in the United States to increase management flexibility and foster the conservation of the Mexican wolf, as discussed in the Recovery Strategy.

V. EVALUATION OF THE RECOVERY STRATEGY AND PROGRESS TOWARD RECOVERY

Due to the intensive logistical, economic, and socio-political nature of the Mexican wolf recovery effort, it is critical to ensure that progress toward recovery is advancing in a timely manner. Therefore, we will evaluate the efficacy of the recovery strategy and progress toward recovery five years and ten years after implementation of the recovery plan begins to determine whether the recovery strategy is proving effective.

5-Year Status Review 2022:
In the first 5-year review of the recovery plan, we will assess the status of each population contributing to recovery. The purpose of the assessment will be to identify each population's progress toward recovery criteria, as measured by:

- Interim abundance targets of approximately 120 wolves in MWEPA and 60 wolves in northern Sierra Madre Occidental;

- Interim release targets of a sufficient number of wolves to result in approximately 9 released wolves surviving to breeding age in the MWEPA and 30 released wolves surviving to breeding age in the northern Sierra Madre Occidental.

Based on this information, we will identify aspects of population performance needing improvement and will determine what actions are necessary to address identified needs. Our evaluation will include the feasibility of the needed actions, including timelines, cost, and other relevant considerations. To complete the review, we will update the Recovery Implementation Strategy as needed.

10-Year Status Review 2027:
In the second 5-year review of the recovery plan, we will assess the status of each population contributing to recovery. The purpose of the assessment will be to identify each population's progress toward recovery criteria and determine whether the recovery strategy is proving effective/feasible. Progress toward recovery will be measured by:

- Interim abundance targets of approximately 220 wolves in MWEPA and 140 wolves in northern Sierra Madre Occidental;

- Interim release targets of a sufficient number of wolves to result in approximately 13 released wolves surviving to breeding age in the MWEPA and 33 released wolves surviving to breeding age in the northern Sierra Madre Occidental.

Based on this information, in addition to findings of the 2022 5-year review, we will make a determination that the recovery strategy is proving effective/feasible or needs to be revised. If we determine the recovery strategy is effective but some elements of recovery implementation need improvement, we will identify what needs to be improved, including actions to address identified needs and the feasibility of conducting such actions such as timelines and costs. If we determine the recovery strategy is not proving effective, we will identify the reasons for such

finding and develop a revised strategy. Any such revised strategy should include revised time/cost estimates necessary to achieve recovery based on necessary actions. We will revise the Recovery Plan or Recovery Implementation Strategy as necessary based on either finding. We expect changes in strategy could include, but will not be limited to, a determination that a specific reintroduction location is not feasible and other reintroduction areas in the United States or Mexico should be considered; a change is needed in techniques used to address gene diversity (e.g., use of gene bank, releases/translocations/cross-fostering); or other substantive change.

VI. ACTIONS NEEDED

Recovery actions are recommendations to guide site-specific activities to address threats and achieve the recovery criteria. Implementation of the recovery actions will involve participation from the States, Federal agencies, tribes, non-federal landowners, non-governmental organizations, academia, and the public in the United States and Mexico. Recovery actions are accompanied by estimates of the cost and time required to achieve the plan's goal to recover the Mexican wolf.

The site-specificity of the recovery actions are provided primarily at the geographic scale of the population, e.g., the MWEPA or northern Sierra Madre Occidental. The Plan does not provide more specific locations for actions for which the locations cannot be determined until future conditions are known. For example, the Plan does not identify at which approved release site a future release may occur several years from now because it is unknown whether a specific site will be available (depending on wolf distribution). Similarly, we do not know when or where events that require law enforcement response will be necessary.

A separate Recovery Implementation Strategy will provide additional detailed, site-specific near-term activities that are needed to implement the actions identified in the recovery plan. We intend to update the implementation strategy as frequently as needed by incorporating new information, including the findings of the two major assessments at five and ten years after recovery plan implementation begins. Because the implementation strategy will provide near-term (e.g., 1-3 years) activities that will be continually updated as recovery implementation progresses, we anticipate being able to provide a greater degree of site-specificity in the implementation strategy than the recovery actions in the recovery plan. We will only revise the recovery actions in this recovery plan if there are needed changes based upon the findings of our 5 and 10-year reviews, or subsequent evaluation of progress toward recovery.

ESTIMATED COST AND TIMING OF DOWNLISTING AND DELISTING

We expect the status of the Mexican wolf to improve such that we can downlist to threatened status in approximately 16-20 years. We expect to achieve delisting criteria in approximately 25-35 years for a total estimated cost of $262,575,000. These timeframes are based on expectation of full funding, implementation as provided for in the recovery plan and implementation strategy, and full cooperation of binational partners.

ACRONYMS USED IN RECOVERY ACTION TABLE

AZGFD	Arizona Game and Fish Department
CONANP	Comisión Nacional de Áreas Naturales Protegidas
FAIR	Fort Apache Indian Reservation, White Mountain Apache Tribe
MWEPA	Mexican Wolf Experimental Population Area
NMDGF	New Mexico Department of Game and Fish
PROFEPA	Procuraduría Federal de Protección al Ambiente

SMOCC	Sierra Madre Occidental
TESF	Turner Endangered Species Fund
USFWS	U.S. Fish and Wildlife Service
WMAT	White Mountain Apache Tribe

Table 1. Estimated Cost, Time, and Priority for Recovery Actions for the Mexican Wolf

SITE-SPECIFIC ACTION	RESPONSIBLE PARTY	ESTIMATED COST/Year (in US dollars)	ESTIMATED TIME (years)	TOTAL COST (in US dollars)	PRIORITY[i]	ADDRESSES THREAT[ii]
Manage and monitor wolves in the wild[iii]						
1. Manage and monitor wolves in MWEPA	USFWS, AZGFD, NMDGF	1,665,000	35	58,275,000	1	1, 2, 3
1.A. Conduct releases, cross-fostering, and translocations in MWEPA	AZGFD, NMDGF, USFWS	Costs are imbedded above	5 (non-consecutive)	NA	1	1, 2
2. Manage and monitor wolves in SMOCC	CONANP	200,000	35	7,000,000	1	1, 2, 3
2.A. Conduct releases, cross-fostering, and translocations in SMOCC	CONANP	Costs are imbedded above	5 (non-consecutive)	NA	1	1, 2
3. Manage and monitor wolves on Fort Apache Indian Reservation	WMAT and USFWS	225,000	35	7,875,000	1	1, 2, 3
3.A. Conduct releases, cross-fostering, and translocations on Fort Apache Indian Reservation	WMAT and USFWS	Costs are imbedded above	5 (non-consecutive)	NA	1	1, 2
4. Manage and monitor wolves on other Tribal lands (including conducting releases, cross-fostering, and translocations)	Tribes and USFWS	40,000-500,000 (pending tribal participation)	35	1,400,000-17,500,000	2	1, 2, 3
5. U.S. Forest Service Liaison	Forest Service	300,000	35	10,500,000	3	3
6. Depredation investigations – United States	USDA Wildlife Services	200,000	35	7,000,000	3	3
7. Depredation investigations	CONANP	100,000	35	3,500,000	3	3

SITE-SPECIFIC ACTION	RESPONSIBLE PARTY	ESTIMATED COST/Year (in US dollars)	ESTIMATED TIME (years)	TOTAL COST (in US dollars)	PRIORITY[i]	ADDRESSES THREAT[ii]
- Mexico						
Manage the Mexican wolf captive breeding program						
8. Coordinate Mexican Wolf SSP captive breeding program	Living Desert and USFWS	30,000	25	750,000	2	1, 2
9. Manage and monitor wolves at Sevilleta WMF	USFWS	440,000	25	11,000,000	1	1, 2
10. Manage Ladder Ranch Wolf Management Facility	Turner Endangered Species Fund and USFWS	45,000	25	1,125,000	2	1, 2
11. Individual Mexican Wolf Species Survival Plan Captive Facilities	Various SSP Institutions	905,000	25	22,625,000	2	1, 2
Recovery Program Management[iv]						
12. Recovery Program management – United States	USFWS	500,000	35	17,500,000	3	1, 2, 3
13. Recovery Program management – Mexico	CONANP	100,000	35	3,500,000	3	1, 2, 3
14. Depredation compensation and Payments for Presence – United States	USFWS, AZGFD, NMDGF, WMAT	1,000,000	35	35,000,000	2	3
15. Depredation compensation – Mexico	CONANP	100,000	35	3,500,000	2	3
16. Conduct 5 year and 10 year reviews	USFWS, AZGFD, NMDGF, WMAT, Forest Service,	50,000	2 (non-consecutive)	100,000	2	1, 2, 3

SITE-SPECIFIC ACTION	RESPONSIBLE PARTY	ESTIMATED COST/Year (in US dollars)	ESTIMATED TIME (years)	TOTAL COST (in US dollars)	PRIORITY[i]	ADDRESSES THREAT[ii]
	CONANP					
Law Enforcement						
17. Investigations of wolf mortalities – United States	USFWS, AZGFD, NMDGF, WMAT and other participating tribes	400,000	35	14,000,000	2	3
18. Investigations of wolf mortalities – Mexico	PROFEPA	100,000	35	3,500,000	2	3
Education and Outreach						
19. Education and outreach - United States	USFWS, AZGFD, NMDGF, WMAT, Forest Service	500,000	35	17,500,000	3	2, 3
20. Education and outreach - Mexico	CONANP	100,000	35	3,500,000	3	2, 3
Research						
21. Research Projects	USFWS, AZGFD, NMDGF, WMAT, Forest Service	100,000	35	3,500,000	3	1, 2, 3
22. Genetic Analyses	University of Idaho and USFWS	30,000	35	1,050,000	2	1
23. Curatorial services to preserve Mexican wolf remains	University of New Mexico and USFWS	15,000	35	525,000	2	1
TOTAL COST				**262,575,000[v]**		

[i] Recovery actions are assigned numerical priorities to highlight the relative contribution they may make toward species recovery (48 FR 43098). **Priority 1** – An action that must be taken to prevent extinction or to prevent the species from declining irreversibly. **Priority 2** – An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction. **Priority 3** – All other actions necessary to provide for full recovery of the species.

[ii] Threats numbering system: 1) Loss of gene diversity; 2) Extinction risk/demographic stochasticity; 3) Exceeding threshold mortality rate

[iii] Managing and monitoring wolves in the wild includes working with livestock producers and communities; implementing proactive conflict avoidance measures; management removals; releases, translocations, and cross-fostering; trapping and collaring wolves; conducting monitoring flights and ground telemetry; reviewing satellite data and trail cameras; searching for tracks and scat; and conducting annual count and capture operations.

[iv] Recovery Program Management includes preparing 5-year reviews, preparing annual reports, preparing release and translocation plans; responding to Freedom of Information Act requests; responding to media, Congressional, and public inquiries; overseeing field operations; overseeing management of pre-release facilities; coordinating with captive release facilities; assisting with depredation compensation programs; managing budgets, purchasing, contracts, and agreements.

[v] Total cost estimate for recovery uses the maximum cost estimate for management and monitoring Mexican wolves on other Tribal lands.

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